

Investigation of impacts of differentiated instruction applied in a primary school in attitudes of students towards the course

Cihad Senturk*, Faculty of Education, Karamanoglu Mehmet Bey University, Karaman, Turkey.

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Abstract

The aim is to identify impacts of the differentiated instruction implemented in the primary school fourth grade science course in attitudes of the students towards the course. The mixed method-designed and carried out research was conducted with 9–10 aged students in fourth grade in a primary school in Bilecik during 2015–2016 Spring semester. Quantitative data were obtained with the science attitude scale and quantitative data were obtained with observations, student diaries and interviews with students and teachers. Quantitative data were analysed using descriptive statistics and *t* test, qualitative data were analysed using the content analysis. Finally, a statistically significant difference was observed between the groups in favour of the experimental group comparing post-test scores of the experimental and control groups obtained from the attitude towards the course scale. As for the qualitative data, findings indicated that the differentiated instruction improved attitudes of the students towards the course. Various recommendations are suggested.

Keywords: Individual differences, differentiated instruction, curriculum differentiation, science education, academic achievement, mixed research method.

1. Introduction

Students with diverse characteristics study together in education institutions. There are different learning habits and strategies, different levels of knowledge or skills, different motivational levels and different personality traits that each student brings to the class. A teacher who embraces the existence of these differences more effectively attains as many students as possible structuring teaching with individual differences. On the contrary, even if the teacher applies a high-quality teaching practice it is not possible to achieve effective learning for all students if the differences of students are ignored (Tomlinson, 2001). Today's education systems are diversified since there are students with very different needs in their classes (Tomlinson, 2005b). Thus, taking into account individual differences, education programmes ought to be prepared in a level and quality that meet the needs of individuals.

Individuals differ from each other in numerous aspects (Kurt & Ekici, 2013; Kuzgun & Deryakulu, 2006). Parameters such as age, gender, preliminary learning and environmental factors lead to individual differences in individual characteristics and learning styles (Eddy, 2012). These differences may emerge through various sources such as physical, mental, emotional development and environment. In addition, students' skills, intelligence levels, interests, willingness to study and efforts are approached within individual differences (Fer & Cirik, 2007). According to Postlethwaite (1993) individual differences that emerge amongst students in educational environments are 'educational differences', 'physiological differences' and 'socioeconomic and cultural differences'. According to Tomlinson (2001) students differ in terms of their characteristic features. These are level of student's readiness, willingness and learning profile. In this regard, the differentiated learning proposed by Tomlinson (2001) is defined as the differentiation of the curriculum in terms of content, process, outcome, environment and assessment elements according to their willingness, readiness level and learning profiles.

2. Literature review

The differentiated learning can be seen as a new form of ancient idea dating back to 17th century, when teachers deal with students with different levels and needs in schools in a single class at the same time (Gundlach, 2012). As the schools became crowded, a great number of classes emerged and the concept of collective teaching was adopted no longer differentiating teaching in such a process (Bourini, 2015). As the academic achievement tests became to emerge, it became apparent that there were differences among students; as a result, the differentiation of teaching became a necessity inevitably (Tomlinson, 2001). Differentiated instruction was initially employed due to an awareness of students who needed special education in the society (Ward, 1986), over time the differentiated instruction was implemented in mixed skill classes (Tomlinson & McTighe, 2006).

The differentiated instruction is not primarily a teaching strategy or an instructional model. It is a philosophical form of thinking that advocates a teaching approach in which the individual is centralised in the learning process and needs of them are met identifying their needs continuously during the process without ignoring interests, readiness levels and learning profiles of students and a predetermined action plan (Gregory & Chapman, 2002; Tomlinson, 2001; 2014a). In other words, the differentiated instruction is a philosophy that argues that students would realise the most effective learning when teachers orchestrate their teaching according to interests, readiness levels and learning profiles of the students (Tomlinson, 2005b). The main goal of the instruction embraced this philosophy is to maximise the learning potential of each student (Tomlinson, 2001; 2003a; 2003b). In this respect, it can be indicated that the differentiated instruction is a form of thinking which embraces principles of the life-centred programme design approach (Demirel, 2013), one of the learning-centred design approaches, which argues that the actual interests and needs of students cannot be predicted in advance, the interests and needs of each student would not be similar; therefore, the curriculum cannot be planned for all students in

advance, the curriculum ought to be flexible in the process for amendments and besides teachers ought to arrange the appropriate environments for each student. The differentiated instruction can be considered as an approach implemented in learning environments in line with the above-mentioned principles.

Children with same age differ from each other in learning environments. Construction of teaching develops over similarities that the students have in a differentiated instruction-based class and at the same time individual differences are seen as an important factor in teaching and learning process. The simplest and the most basic expression of the differentiated instruction can be defined as 'reshaping' of what is happening in the classroom in order to provide learners with a variety of options to receive information, meanings as well as to express their learning and exhibit different learning outcomes. In other words, a differentiated instruction-based class offers different ways of exploring the content, meaning the information, developing and presenting learning outcomes so that each student realises the learning.

Today's students differ from each other in terms of their past experiences, cultures, language competencies, educational skills and interests in the classroom. The best way to meet the needs of these highly diverse learners is through diversifying curriculums by teachers in the process according to students' needs and expectations. Studies also revealed the necessity of differentiation in curriculums taking into account the individual differences and indicated that the differentiated instruction increased their achievements and attitudes towards the course (Parsons, Dodman & Burrowbridge, 2013; Rock, Gregg, Ellis & Gable, 2008; Santamaria, 2009; Tomlinson et al., 2003). Educators who practice the differentiated instruction in their class ought to design their teaching plan with students' interests, readiness levels and learning profiles, as well as approach the time, the environment, materials and teaching strategies with the flexibility to meet the needs of students, transform classes into environments in which love and respect emerged, activities and responsibilities shared, the highest individual and group improvement demonstrated and form learning communities that act within this perspective in the classroom (Tomlinson, 2005b).

The reason to implement the differentiated instruction into the science course is due to low levels of science literacy of Turkish students (Organisation for Economic Co-operation and Development, 2016; Tas, Arici, Ozarkan & Ozgurluk, 2016) in the international exams (PISA), which requires employing alternative practices in science teaching. Besides, no specific policy of support for students with low level of achievement in science education seems to appear not only in Turkey but also in Europe (Eurydice, 2011). Therefore alternative learning-teaching approaches such as the differentiated instruction ought to be embraced in order to improve science literacy levels of individuals. Various studies appear to investigate the effect of the differentiated instruction in academic achievement, whereas researches exploring its effect in attitudes towards the course are limited. In addition, while quantitative studies related to the differentiated instruction frequently appear, studies with qualitative or mixed methods are limited. In this regard, it is considered that this study would provide significant contributions and illuminate new perspectives for the niche stated in the literature.

3. Purpose of the study

The aim of this study is to identify effects of the differentiated instruction implemented in the primary school fourth grade science course in attitudes of the students towards the course and opinions of the students and teachers related to its tutorial contributions. In this context, answers were sought for the following two research questions:

1. What is the effect of the differentiated instruction implemented in the primary school fourth grade science course in attitudes towards the course?
2. How does the differentiated instruction implemented in the primary school fourth grade science course improve attitudes of students towards the course?

4. Methodology

In this study in which the effect of the differentiated instruction implemented in the primary school fourth grade science course in attitudes of the students towards the course examined, the mixed method that uses quantitative and qualitative research techniques together was embraced (Creswell, 2012; Creswell & Plano Clark, 2011; Fraenkel & Wallen, 2009; Punch, 2011). The mixed method is the usage of quantitative and qualitative data collection and data analysis methods together in order to explore the problem of a study in all the processes of the research (Creswell, 2005; 2012). The basic aim of the mixed method is to provide a better understanding of the research problems or a phenomenon with the combination of quantitative and qualitative approaches. In the study, ‘triangulation’ method was embraced among mixed method designs (Creswell, 2009).

In this research, the mixed design considered as the research design was formed with the experimental design, statistical analysis based on quantitative data and deductive hypothesis and qualitative data analysis (Patton, 2002). The pre-test–post-test control-grouped quasi-experimental design (Dugard & Todman, 1995) as well as observations, interviews (students and teachers) and document analysis (students’ diaries) methods among qualitative research methods were used as the experimental design in the research (Yildirim & Simsek, 2011). ‘Triangulation’ in the formation of qualitative data was adopted in order to obtain both in-depth and deep data and thus increase the strength of the study (Creswell, 2009; Merriam, 2009; Patton, 2002; Yin, 2003).

Table 1. The experimental design used in the research

Groups	Pre-test	Experimental process	Post-test	Qualitative data Generation tools
Experimental group	T_1	Differentiated instruction practices	T_1	1. Observation 2. Interview 3. Student diaries
Control group	T_1	Current curriculum and student course book activities	T_1	1. Observation 2. Interview

One of the study groups is the experimental group and another is the control group. The groups were randomly assigned as the experimental and control group in the study (Creswell, 2012; Fraenkel & Wallen, 2009). While the differentiated science instruction was adopted in the experimental group, activities involved in the current primary school fourth grade science student book were conducted (Aytac, Turker & Ucuncu, 2015). Pre-test was applied to both experimental and control groups prior to implementations in the research, the ‘Attitude towards Science Course Scale’ (T_1) was carried out. The attitude scale was carried out as protest at the end of the experimental process. Systematic observations, students and teachers interviews were conducted to explore the effect of the practices implemented in the experimental group and diaries kept by the students throughout the process.

5. The study group

This study was conducted with the fourth grade students studying in a state primary school in Bilecik in Turkey. In the study, two equal groups were identified considering scores obtained from pre-tests. Between these equal two groups, one group was assigned as the experimental group ($n = 23$), another group was as the control group ($n = 21$) with the random assignment method (Fraenkel & Wallen, 2009). Prior to experimental process, it was identified that average scores of the groups

obtained from the attitude towards the science course scale were equal to each other within the scope of affective traits ($t_{(42)} = 0.598, p > 0.05$).

6. The experimental process

In the study, the differentiated instruction proposed by Tomlinson (2001) was conducted in the 4/A class, the experimental group, in the primary school fourth grade science course between 14 February 2016 and 1 June 2016 for 12 weeks. At the end of these 12 weeks, it was tested whether there was a significant difference between attitudes of students in the experimental and control groups towards the course. At the same time, contributions of the applied differentiated instruction into attitudes towards the course also emerged with qualitative means. In this section, efforts that were fulfilled during the experimental process were briefly described.

Prior to implementations of the differentiated instruction proposed by Tomlinson (2001) based on individual differences, the draft 'student analysis form' was created in order to reveal individual differences by utilising studies of Tomlinson (2000a; 2001; 2005a; 2005b; 2014a; 2014b), Tomlinson et al. (2003), Tomlinson and Strickland (2005), Tomlinson and McTighe (2006), Tomlinson, Brimijoin and Narvaez (2008), Tomlinson and Imbeau (2010), Tomlinson and Moon (2013) and Stefanekis (2011) in the relevant literature. This draft form was assessed with expert opinions and the form was finalised in line with the feedbacks of the experts. After identifying students' interests, skills, readiness levels, preliminary learning, preferences, expectations and learning profiles with the student analysis, the preliminary draft primary school fourth grade science teaching plans based on the differentiated instruction introduced by Tomlinson (2001) were reconsidered and differentiated in terms of the content, learning-teaching process, learning outcomes and assessment items in line with differentiated instruction principles.

The contents of the units covered during the experimental implementation process ('Lighting and Sound Technologies from Past to Present', 'Microscopic Livings and the Environment' and 'Simple Circuits') were differentiated and deepened on the basis of the current student textbook content. The content was differentiated and deepened by utilising scientific and cultural kid magazines such as National Kids, Science Kid, Atlas Kid, Researcher Kid, TSE Pioneer Kid, TRT Kid as well as various books, encyclopaedias, visual and written media sources such as newspapers and so on. The content was differentiated and enriched with simpler or deeper texts depending on the students' levels, activities addressing their different readiness levels, resources and materials in which students study in depth about the topic, in pieces and simplified and sometimes presenting by deduction and sometimes by induction.

Teaching strategies among differentiated instruction strategies of Tomlinson (2001) such as 'learning centres', 'stations', 'cascaded activity', 'complex teaching', 'reading cycle', 'thought ring', 'puss-in the corner', 'graffiti', 'paper cycle', 'multi-level teaching', 'agendas', 'story-based learning', 'group research', 'individual research' and 'thought circle' were utilised in differentiation of learning process according to interests, readiness levels and learning profiles of the students. Furthermore, the physical layout of the class was designed and differentiated in the learning-teaching process according to the requirements of the strategies of the differentiated instruction and activities. In the differentiation of the learning outcomes, students were enabled to reveal unusual differentiated learning outcomes other than known. Some unusual learning outcomes emerged by students can be indicated as 'invention of microscope with a mobile phone', 'plant trees brother game', 'simple circuit with aluminium foil', 'robots run with solar panels', 'simple circuits theatre show', 'engine with magnet and battery'.

The assessment process of the implementation was differentiated and enriched by utilising differentiated measurement and assessment tools such as 'KWL table', 'tree diagram', 'structured grid', 'making boxes and circles', 'self and peer evaluation forms', 'student participating scales', 'control lists', 'checklists', 'agendas', 'student diaries', 'concept maps', 'portfolios', 'observation

forms', 'interview forms', 'learning percentages', 'thought circle', 'who wants thousand scores game', 'let's plant trees brother game' and 'zigzag-snap game' in line with measurement and assessment principles and strategies of the differentiated instruction approach. The layout of the class was differentiated with activity types, various seating arrangements, independent study areas, stable and mobile areas, alternative seating places and the arrangement of materials and furniture and class rules and so on was differentiated according to the nature of the differentiated instruction.

7. Data collection tools

Quantitative data required in the study were obtained with 'Attitude towards the science course scale' related to achievements in the units of 'Lighting and Sound Technologies From Past to Present', 'Microscopic Livings and the Environment' and 'Simple Circuits'. Qualitative data required in the research were obtained with reformed 'observation form', 'interview form' (student and teacher) and 'student diaries'. Explanatory information for the scale and forms used in the research were described in brief below.

7.1. Science course attitude scale

The 'Science Course Attitude Scale' was used to identify whether there was a significant difference between the attitude levels of experimental and control groups towards the course at the end of the teaching process. The relevant literature was reviewed, attitude scales towards science courses in the literature were examined, the attitude scale developed by Yasar and Anagun (2008) deemed appropriate for the primary school fourth grade students and used with necessary permission from the researcher. The KMO Barlett coefficient was observed as 0.93, which indicates the construct validity of the scale. It was observed that factor loads of the items of the scale with five Likert-type and 19 items were in the range of 0.47–0.64. Accordingly, it was achieved that the scale of these items could measure a certain structure. Results of the factor analysis indicate that the scale is with three sub-scale structure. These factors are named as 'pleasure', 'learning willingness' and 'individual views for the science'. Reliability coefficient of the scale was observed as 0.89 and the internal consistency coefficients for sub-scales were found as 0.86 for the first factor, 0.81 for the second factor and 0.70 for the third factor, respectively. Accordingly, it was achieved that items that constitute the factors are made up of items with high internal consistency (Anagun, 2008; Yasar & Anagun, 2008). The Cronbach Alpha internal consistency coefficient was calculated as 0.98 for the scale used in this research.

7.2. Observation form

Observation describes the monitoring process of gathering the data required for the research by utilising humans, the society or a tool (Buyukozturk, Kilic-Cakmak, Akgun, Karadeniz & Demirel, 2012). Observation that is an essential source in gathering qualitative data is one of the basic foundations in clarifying complexity in social events (Patton, 2002). In this respect, it was considered to include the observation method in diversification of the data within the scope of the research. Observation forms in the relevant literature were examined to demonstrate how the differentiated instruction affects the attitudes of the students towards the course and reveal its contributions in their attitudes (Ayers, 2008; McGraw-Hill, 2010; Stronge Teacher Effectiveness Performance Evaluation System, 2012; Subban & Round, 2015). Accordingly, a semi-structured observation form was created considering observation forms used in the relevant literature in order to demonstrate how the differentiated fourth grade science curriculum reflects on the learning process. Expert opinions were consulted for the draft form in order to ensure validity of this created observation form and appropriate amendments and changes were realised on the form in line with the feedbacks of the experts. The pilot study was carried out with this prepared draft observation form and it was attempted to identify whether this draft form was operational in the pilot study.

7.3. Student diary form

Student diaries that are recommended as a way to encourage students to evaluate what they did in the class, their attitudes, their behaviours, their participations and their learning are essential data sources to reveal individuals' experiences, feelings and thoughts, perspectives and attitude and behaviours (Glesne, 2012; Kaufeldt, 2010). In the research, student diaries were utilised to respond the qualitative sub-problems of the study and generate variations in the data. The student diary is a form designed to enable students to reflect on the effects of differentiated science instruction in attitudes of the students towards the course on a weekly basis. Certain dimensions were assured in this diary that was formed to enable students to focus on variables of the research. For this, various diaries used in different studies (Bas, 2015; Ersozlu, 2008; Kurnaz, 2007) in the literature were examined and a draft daily form was created for the students to use effectively and efficiently during the research. The created draft form was prepared as semi-structured. The created draft form was assessed with experts' opinions and appropriate amendments, changes and adding were included in the relevant parts of the form with the feedbacks of the experts. As stated by Wragg (2012), the students were informed regarding how students ought to reflect on the diary and reminded the points they ought to focus when reflecting on the diary.

7.4. Interview form

Interviews in the research are allocated into three, such as unstructured, structured and semi-structured. A semi-structured interview was carried out in this research. In the semi-structured interview, the researcher may include new questions based on the topic stream and deepen research questions (Ekiz, 2003; Merriam, 2013). In this regard, the semi-structured interview method was embraced to provide flexibility to the researcher. The semi-structured interview method was carried out in order to diversify the data in the research and thus gather more significant data. Interview forms used in the relevant literature (Amadio, 2014; Burkett, 2013; Koeze, 2007; Maddox, 2015; Robinson, Maldonado & Whaley, 2014) were examined in order to reveal how the differentiated instruction reflects on the attitudes of the students towards the course. Semi-structured teacher and student interview forms were prepared considering available interview forms in the relevant literature. It was considered that it would be essential to evaluate their opinions in the context of the research by taking the opinions of both teachers and students regarding the contribution of the applied differentiated instruction in attitudes towards the course in the research. Expert opinions were received to ensure the validity of the prepared draft interview forms. Appropriate amendments, changes and adding were included in the prepared forms in line with the feedbacks of the experts. The interview form was finalised with the feedbacks of the experts. The prepared draft interview forms were piloted to find out whether the draft forms were operational. It was reached in the pilot study that both two interview forms are operational.

8. Validity and reliability of qualitative data

Studies are valuable as long as validity and reliability of the data are provided in the studies carried out with the qualitative research methods (Maxwell, 2005). Validity in the qualitative researches can be expressed as observing the phenomenon as are and as unbiased as possible (Yildirim & Simsek, 2011). In general research is more or less mixed with bias but it is important to minimise this bias as much as possible. In this research, necessary measures were taken to reduce the bias to the minimum level. In this respect, the findings were presented with the context of the environment in which the data emerged in order to ensure the validity of the data. Findings were first defined by quotations and then interpreted. The concepts forming the themes were evaluated among themselves and the consistency of each theme with each other was assessed in order to ensure the consistency of the emerged findings and it was checked whether they constitute a meaningful whole by considering feedbacks of an expert in the field. Data variations were ensured to gather detailed data and data

validity. Furthermore, the notes kept were presented to both the teachers and students after the interviews by using participant confirmation technique (Creswell, 2013; Merriam, 2009; Yildirim & Simsek, 2011). Both teachers and students were allowed to take out the parts they are not willing to include in the interviews. Prior to implementation, expert feedbacks were taken for semi-structured interview and observation forms as well as for the student diary form. In addition participants participated in the interviews on the volunteer basis. Teachers and students were recorded with their permissions and then their records were transcribed. The researcher realised the interviews in person in order to ensure students with sincere and heartfelt responses.

Although it is difficult to provide the reliability in qualitative researches, there are various methods suggested to ensure the reliability of the research. One of the measures taken to increase the reliability of the research is asking people with general idea about the topic and experts in the qualitative research methods to examine the research in terms of different aspects (Yildirim & Simsek, 2011). The written data (interviews, observations and student diaries) were separately and independently coded by the researcher and two academicians who are in Classroom Education and Curriculum and Instruction fields and experienced in the qualitative research as well as a teacher of Educational Science to ensure the reliability of the study. Then the emerged codes were compared. For the reliability, the reliability calculation formula [$\text{Reliability} = \frac{\text{Agreement}}{\text{Agreement} + \text{Disagreement}} \times 100$] developed by Miles and Huberman (1994) was applied to codes created by the researcher and other experts. The agreement percentage was calculated as 87% between the three coders. In qualitative research, it was concluded that 70% or more of the agreement percentages were sufficient to ensure reliability in data analysis (Miles & Huberman, 1994). Sharing the data gathered in the qualitative researches with experts in the qualitative researches and getting feedbacks from them increases the reliability of the research (Glesne, 2012). From this point of view, the data obtained and the themes emerged in the research were shared with two experts in the qualitative research and feedbacks were taken for the reliability of the data of the research. Necessary amendments were included in the appropriate parts with the feedbacks received. In the study, processes of data generation, processing, analysis, interpretation and achieving results were addressed in a clear and detailed way within the scope of the external validity of the study and emerged data were directly conveyed with a descriptive approach without any comment within the scope of the internal validity of the study.

9. Data analysis

9.1. Quantitative data analysis

Prior to the statistical analysis of the collected quantitative data, it was checked whether the data indicated a normal distribution and whether there was a significant difference between the distributions of variances. The number of individuals in the group is important to check whether the data indicate a normal distribution. The Kolmogorov–Smirnov Z test ought to be used in case the group size is more than 50, the Shapiro–Wilk test ought to be used in case the group size is less than 50. In this study, the Shapiro–Wilk test was used to check whether the data were normalised as the number of the students of the experimental group ($n = 23$) and the control group ($n = 21$) were not more than 50. In the study, the Shapiro–Wilk test results of pre-test scores and also post-test scores were normally distributed. Therefore it was considered appropriate to employ parametric test statistics in the analysis of quantitative data in the study. In the study, the independent samples *t* test in comparing the groups (Buyukozturk, 2011; Creswell, 2012; Fraenkel & Wallen, 2009).

9.2. Qualitative data analysis

In the research, observation forms, interview forms and student diaries were fulfilled to obtain qualitative data. Prior to analysing the qualitative data, the qualitative data gathered with

participation of the students in the experimental group were transferred to the computer by the researcher. The all recorded qualitative data were separately classified according to their data and types (observation, interview and diary). Prior to analysis process of the qualitative data, a code list was formed based on the relevant literature (Bogdan & Biklen, 2003; Creswell, 2013; Denzin & Lincoln, 2005; Merriam, 2009; Yildirim & Simsek, 2011). In the coding process of the qualitative data, the teacher was assigned with ORT code, the student was assigned with ORN code as well as the observation note was assigned with GN and the student diary was assigned with OG. In the study, the experts approved these codes and it was decided to code the qualitative data in this way.

The ‘content analysis’, one of the qualitative research data analysis methods, in the analysis of the obtained data was implemented in the study. By the content analysis, it is aimed to reveal deeper and more numerous themes rather than an analysis based on pre-determined themes according to the results of the research (Miles & Huberman, 1994). In this respect, the content analysis method was consulted to identify in depth the reflection of the differentiated instruction in attitudes of the students towards the course and reveal different perspectives. The obtained qualitative data were coded by the researcher within the scope of the content analysis. Themes were formed considering the common or different characteristics of these codes. The set of the qualitative data were read continuously by the researcher and draft codes were created in the data. In this way, several draft coding appeared. Thus, the draft codes made several times were compared with each other to ensure the consistency of the codes. After the draft codes, the actual code process was carried out and themes that codes form meaningful patterns (Auerbach & Silverstein, 2003) emerged. In the realisation of the actual coding, two academicians who are specialists in the educational science helped to decide which codes in the data set would be grouped under which themes. Then, the findings were described by arranging these codes and themes.

10. Results

In the quantitative aspect of the research, the answer was sought for the question of ‘is there a significant difference between attitude level of the group in which the differentiated instruction was implemented and attitude level of the group in which the current curriculum was implemented at the end of the teaching process?’ The post-test scores of the experimental and control groups obtained from the science course attitude scale were compared in order to explore this research question. However, first, it was decided to compare the mean scores of the experimental and control groups obtained from pre-test and post-test within the group. In the study, after comparing the scores of the experimental and control groups obtained from the attitude towards the course scale pre-test and post-test, it was decided to compare between groups. Dependent groups *t* test was employed to compare pre-test and post-test scores of the students in the experimental group obtained from the attitude towards the course scale. Analysis results obtained from the employed dependent group’s *t* test are given in Table 2.

Table 2. Comparison of the attitude towards the course scale pre-test and post-test scores of the experimental group students

Group	<i>n</i>	Test	\bar{x}	SD	<i>df</i>	<i>t</i>	<i>p</i>
Experimental group	23	Pre-test	67.04	17.50	22	-6.610	0.000*
		Post-test	91.73	2.78			

SD = standard deviation. **p* < 0.05.

As seen in Table 2, pre-test score of the experimental group students obtained from the attitude towards the course scale is $\bar{x}_{pre-test} = 67.04 \pm 17.50$ and post-test score is $\bar{x}_{post-test} = 91.73 \pm 2.78$. It was observed that there was a statistically significance between the attitude towards the course scale pre-test and post-test scores in the experimental group ($t_{(22)} = -6.610, p < 0.05$). When the findings were examined, it was revealed that there was a difference of 24.69 scores in favour of post-test

between pre-test and post-test average scores of the students in the experimental group obtained from the attitude towards the course scale. Based on this finding, it can be stated that the differentiated instruction was effective in improving attitudes of the students in the experimental group towards the course. Dependent groups *t* test was carried out in order to compare pre-test and post-test scores of the students in the control group obtained from the attitude towards the course scale and the analysis results are presented in Table 3.

Table 3. Comparison of pre-test and post-test scores of the students in the control group with the attitude towards the course scale

Group	<i>n</i>	Test	\bar{x}	SD	<i>df</i>	<i>t</i>	<i>p</i>
Control group	21	Pre-test	64.61	6.49	20	-1.613	0.122*
		Post-test	72.71	21.32			

SD = standard deviation. **p* > 0.05.

As seen in Table 3, the attitude towards the course scale pre-test score of the students in the control group is $\bar{x}_{\text{pre-test}} = 64.61 \pm 6.49$ and post-test score is $\bar{x}_{\text{post-test}} = 72.71 \pm 21.32$. Furthermore, no statistically significant difference was observed between the attitude towards the course scale pre-test and post-test scores of the students in the control group ($t_{(20)} = -1.613, p > 0.05$). Based on this finding, it can be stated that the current curriculum is not effective in improving attitudes of the students in the control group towards the course. Independent group's *t* test was carried out in order to compare post-test scores of the students in the control group obtained from the attitude towards the course scale and the analysis results are presented in Table 4.

Table 4. Comparison of the attitude towards the course scale post-test scores of the experimental and control groups

Group	<i>n</i>	Test	\bar{x}	SD	<i>df</i>	<i>t</i>	<i>p</i>
Experimental group	23	Post-test	91.73	2.78	42	4.056	0.000*
Control group	21	Post-test	72.71	21.32			

SD = standard deviation. **p* < 0.05.

As seen in Table 4, the post-test score of the students in the experimental group obtained from the attitude towards the course scale is $\bar{x}_{\text{experimental}} = 91.73 \pm 2.78$ and the post-test score of the control group is $\bar{x}_{\text{control}} = 72.71 \pm 21.32$. A statistically significant difference ($t_{(42)} = 4.056, p < 0.05$) was observed between the groups when the post-test scores of the experimental and control groups obtained from the attitude towards the course scale were examined. This emerging significant difference was in favour of the students in the experimental group comparing arithmetic means of the groups obtained from the post-test scores.

Considering the findings of the research, even though no significant difference was observed between pre-test average scores of the experimental and control groups obtained from the attitude towards the science course scale, it was identified that there was a difference of 19.02 scores between post-test averages in favour of the experimental group. Whilst the level of attitude of the experimental group towards the course indicated a significant difference from pre-test to post-test, it was seen that the level of the attitude of the control group towards the course did not indicate a significant difference from pre-test to post-test. In this respect, based on the emerging finding, it was revealed that the experimental group with the differentiated instruction has a higher level of attitudes towards the course compared to the control group with the current curriculum. It can be stated with this result that the differentiated instruction implemented in the primary school fourth grade science course improved the attitudes of the students towards the science course.

In the qualitative aspect of the research, it was sought to find out how the differentiated instruction improves attitudes of the students towards the course. In the study, findings obtained from interviews (teachers and students), student diaries and observation notes of the researcher in order to identify their acquired affective traits are presented in Table 5.

Table 5. Opinions of the participants for the acquired affective traits

Main theme	Sub theme	Qualitative data codes*	Qualitative data codes** (% and f)			
Acquired affective traits	Development of attitudes towards the course	ORT, ORN1, ORN2, ORN3, ORN4, ORN6, ORN7, ORN8,	OORN		OG	
		ORN9, ORN10, ORN11, ORN14, ORN15, ORN16, ORN17, ORN18, ORN19, ORN20, ORN21, ORN22, ORN23, OG2, OG3, OG4, OG5, OG6, OG7, OG9, OG10, OG11, OG13, OG14, OG15, OG17, OG18, OG19, OG20, OG21, OG23, GN	% 87	f 20	% 78	f 18

*ORT = Teacher Interview Transcription; OG = Student Diary Transcription (Student Diary Record); ORN = Student Interview Transcription; GN = Investigator Observation Transcription.

**Since ORT and GN are individuals, % and f values are not given in the table.

As seen in Table 5, the participants indicated that the differentiated instruction improved their attitudes towards the course. Besides the interviews with the participants, ‘enhancement of the course-oriented attitude’ emerged as a sub-theme in the observations and diary notes. In the data obtained from the participants, it was found that attitudes of the students towards the science course improved positively. The participants stated that the students who were not interested in the course or did not like before began to grow enthusiasm towards the course. This emerging finding is consistent with the finding that the attitudes of the students in the experimental group towards the course indicated a significant difference in the quantitative data. It appeared that the students improved the positive attitude towards the course from the student–teacher interviews, student diaries and observation notes of the researcher.

The Science course seemed to me very confused before. I saw that it was not hard at all. It was very fun. I do not know why we did not have the course in this way. I love this course now. I consider being a scientist in the future [ORN14].

Actually I knew everything about this course. My dad always gets me child magazines. Therefore, these courses were used to be boring for me. The courses did not appeal to me. But the implementation [the differentiated instruction] we had in the second semester excited me. I was not bored anymore in the courses. We had many different activities that I never saw before. This course became fun to me. I was not bored anymore. I began to like the course very much [ORN20].

While one of the students, ORN7, stated that his or her peers who did not like the course began to grow enthusiasm towards the science course and everybody participated with willingness in the course. ORN18, another student, stated that his or her some friends indicated in breaks that the course was fun, even those who did not like the science course began to love the course now, even some friends were excited about what they would do in the course next day. ORN6, one of the participants, stated that they liked the course as it became interesting and they enjoyed the activities.

I like the Science course very much. We have so much fun in the course. Everything is very nice for us. I wish all courses were like this [OG20].

Everyone began to like the science course. I do not have any friends who do not like the course. Everyone now expresses that they like the course [OG4].

I now learn new things in this course. And the courses are fun. I love this course a lot now. I thank my teacher for enabling us to have this experience. I began to like the course thanks to my teacher. Right now I believe I am successful in this course [OG21].

Considering the opinions of the experimental group teacher [ORT], it is observed that the attitudes and interests of the students towards the course changed positively, even those who did not like the course or were not interested in the course began to grow interests towards the course and participated with willingness in the course. In addition, ORT stated that positive progress in the attitudes and interests towards the course were observed among students.

Previously some students were not interested in the course. The reluctant students consisted of either students who were behind the class level or students who were ahead of the class level. I had doubts about what I could do for these students and how I could improve their participations and attitudes towards the course. I witnessed that these problems were eliminated with the differentiated instruction activities. All of my students are willing to participate in the course and exhibit positive attitudes. I am glad with this, which also makes my works easier [ORT].

When the observation records of the researcher were examined, it was seen that all students were interested in the differentiated instruction activities. In observation notes, it was seen that even students who were identified to score lower in the attitude scale carried out as pre-test actively participated in the course. In addition, when field notes taken at breaks in quick chats with the students were examined, it was seen that students stated that students began to like the science course now and look forward to having the science courses. Considering these all findings, it is seen that the data obtained from the qualitative aspect of the research support the quantitative data. Therefore, it can be stated that the differentiated instruction implemented in the primary school fourth grade science course improved the attitudes of the students towards the course.

11. Discussion and conclusion

In this study, it is possible to explain some of the reasons why the experimental group with the differentiated instruction significantly improved the attitudes of the participants towards the science course compared to the control group as follows. First, realisation of teaching in the context of the differentiated instruction in line with interests, needs, expectations, readiness levels, learning profiles and opinions of the students may have contributed positively to the attitudes of the students towards the science course. In this study, individual differences of the students were taken into account in the process based on the basic philosophy of the differentiated instruction. The students played an active role in planning, organising, conducting, regulating and assessment of the learning process. The content, process, outcome and assessment and the environment were formed in line with needs, expectations and participations of the students with the differentiated instruction.

The finding that the differentiated instruction has a positive effect on the attitudes towards the course was revealed not only in this research but also in other studies. According to the results of the studies, academic achievements, learning levels, participation and attitudes of the students towards the course increased with the differentiated instruction classes (Baumgartner, Lipowki & Rush, 2003; Beecher & Sweeny, 2008). These findings of the research regarding attitudes towards the course are similar with the finding of McAdamis (2001) indicating that the differentiated instruction approach increased attitudes and motivations of the students towards the course. Similarly, the finding of the study of Chen (2007) that the differentiated instruction improved attitudes of the students towards the course supports the findings of this research. Furthermore, the studies of Adam and Dooley (2009), Rojo (2013) and Zonnefeld (2005) with differentiated instruction indicating a significant difference in attitudes towards the course post-test scores in favour of the experimental group at the

end of the differentiated instruction obtained similar results with this research. Reis, McCoach, Little, Muller and Kaniskan (2011) revealed in their study in which the effect of the differentiated instruction on the reading skills were examined that reading skills were improved by the differentiated instruction and positive attitudes emerged towards reading and obtained results agreeing the differentiated instruction improved attitudes of the students towards the course. Likewise, Boerger (2005) stated in the experimental study in which the effect of the differentiated instruction was examined that the students in the experimental group grew positive attitudes towards the mathematics course at the end of the differentiated instruction activities.

Current researches indicate that active learning method and techniques employed in the differentiated instruction are effective in encouraging inquired or inquisitive teaching strategies, teacher roles exhibited in the differentiated instruction, improving attitudes of the students towards the course, promoting confidence and competence towards the course (Ensign, 2012; Tomlinson & Jarvis, 2006; Valli & Buese, 2007). Student analysis carried out in this study realised with the differentiated instruction was differentiated with interests, readiness levels and learning profiles of the students. As a result of this, the students were experienced with differentiated content, process, outcome, assessment and the environment according to their interests, readiness levels and learning profiles. The differentiated instruction, which is carried out considering individual differences of the students, forming with the needs of the students, forming a supportive climate for the students, creating perpetual learning opportunities, ensuring them to feel important and respected maximises capacities of each student, ensures improving attitudes of the students towards the course and increases their motivations (Tomlinson, 2000b; Tomlinson, 2001; Tomlinson & Imbeau, 2010). It can be said that the differentiated instruction implemented in the primary school fourth grade science course in this research contributed in improving attitudes of the students towards the science course increasing their motivations.

In the qualitative aspect of the research, the 'enhancing attitude towards the course' sub-theme emerged related to acquired affective traits in the differentiated instruction theme. It was seen in the data obtained from the participants that students improved positively their attitudes towards the science course. It was revealed in the research that interests and attitudes of the students changed positively towards the course, even students who previously did not like the course or like very little began to grow enthusiasm towards the course and participated with willingness in the course. It was identified in the research that students had fun, participated with willingness in the course, enjoyed very much with the differentiated instruction-oriented courses. Furthermore, it appeared that even students who did not like the science course before began to grow enthusiasms towards the course and improved positive attitudes towards the course. Some participants even described positive attitudes that students developed towards the course expressing their peers indicated in break times that the courses were fun, even those who did not like the science course now began to like the course, so much so that some students were eager to see what activities they would have in the next lesson. The students participated in the study stated that beginning to understand the course as well as becoming fun and interesting were effective in growing enthusiasm towards the course. Likewise, some students participated in the research stated that they did not like the course previously as they did not understand it but now they began to like the course as they began to understand it. Therefore, this qualitative finding of the research is consistent with the quantitative finding obtained for the first aim of the research.

Other studies also revealed that the differentiated instruction improved attitude towards the course (Beecher & Sweeny, 2008; Beler, 2010; Boerger, 2005; Chen, 2007; Celik, 2016; Karadag, 2010; Karadag & Yasar, 2010; Ozyaprak & Davasligil, 2015; Reis et al., 2011). Besides, Zonnefeld (2005) revealed that the mathematics teaching carried out with the differentiated instruction improved attitudes of the students towards the course. Furthermore, it was stated that the students also improved motivation, enjoyment, valuing and self-confidence dimensions, which are sub-dimensions of the attitude towards the course in this study. In this regard, it is considered very important in this

study that the students improved positive attitudes towards the science course with the differentiated instruction. Because a student with positive attitude towards the course would have a high motivation level and believe in achieving the course, which reflect positively on the academic achievement. In the opposite case, it can be stated that a student with negative attitude towards the course would not like the course, not indicate any interests and not believe in achieving the course. When the studies examined, it appears that positive attitude towards the course is effective in the academic achievement and there is a positive significant difference between these variables (Cakici, Aricak & Ilgaz, 2011; House & Prison, 1998; Kan & Akbas, 2006). In this context, it can be specified that the differentiated instruction implemented in this study affects, improves and contributes positively to the attitudes of the students towards the course.

12. Suggestions

It was found that the activities improved attitudes of the students towards the course in this study in which the impact of the differentiated instruction implemented in the primary school fourth grade science course was examined in attitudes of the students towards the course using the mixed method approach. From this point of view, teachers who desire to increase attitudes of the students towards the course can differentiate the content, process, learning outcomes and learning environment in line with interests, readiness levels and learning profiles of the students in the scope of the principles and methods of the differentiated instruction by primarily carrying out student analysis considering the differentiated instruction proposed by Tomlinson (2001). Although preparation of the differentiated instruction takes certain amount of time, teachers get opportunities to know their students more closely with these preparations, design student-centred environments meeting the needs and expectations of the students. In addition, it seems beneficial to carry out long-term studies including theory and practice aspects with teachers establishing differentiated teaching centres or workshops and so on guided by experts in order to implement effective teaching in the context of this approach. Prior to these studies, identifying the teaching–learning traditions and perceptions of teachers and replacing their traditional teaching perceptions is important.

Teachers who implement the differentiated instruction can raise awareness of other teachers about embracing the differentiated instruction approach by sharing their experiences through various media streams such as the internet, conferences, group meetings and so on. Furthermore, academicians can spread the differentiated instruction implementations in schools by sharing their experiences related to the differentiated instruction or realising sample practices with teachers related to the differentiated instruction. Besides, current approaches whose effectiveness were demonstrated in various researches (Bas, 2014; Bas & Beyhan, 2010; Cevik, 2017; Cigerci & Gultekin, 2017) such as the multi-intelligence approach, the project-based approach, the science, technology, engineering and mathematics education, digital stories can be synthesised with the differentiated instruction and a distinctive differentiation can be achieved by teaching in this way. Employment of modern approaches such as the differentiated instruction in higher education and especially in education faculties can be suggested. It seems also beneficial to re-design teacher-training programmes on the basis of contemporary educational philosophies and approaches. Because a teacher candidate or a teacher who does not have necessary understanding, attitude, knowledge and skills about the differentiated instruction does not seem to implement this approach effectively.

This research was implemented in the primary school fourth grade science course. Similar studies can be carried out in different classes (first, second and third grades) at the same education stage as well as in different courses (Turkish, mathematics, life science, social science, English, sports, arts, music and so on) and different education stages (kindergarten, primary schools, high schools and higher education). Considering especially studies related to the differentiated instruction are limited, implemented in the certain courses at a certain level of education stage, it is important to realise the studies related to the differentiated instruction in

various education stages and disciplines. Furthermore, studies on the differentiated instruction were usually carried out with quantitative research methods and it can be stated that qualitative research is highly needed. Therefore, researchers can conduct a variety of exploratory studies to gather wealthy data related to the differentiated instruction and reveal in-depth explanations by qualitative or mixed methods.

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