

Biology education research trends in Turkey

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This paper reports on a content analysis of 633 biology education research [BER] papers published by Turkish science educators in national and international journals. The findings indicate that more research has been undertaken in environment and ecology, the cell and animal form and functions. In addition learning, teaching and attitudes were in the forefront as the frequently investigated subjects. Undergraduate and secondary school students were mostly studied and the sample size mostly varied between 31-100 and 100-300 and also, quantitative research was mostly preferred. Besides, commonly used data collection tool included; achievement tests, questionnaires and attitude scales and the commonly used data analysis and presentation techniques were frequency/percentage tables, central tendency measures, t-tests and ANOVA/ANCOVA analyses.

Keywords: Biology education research [BER]; Content analysis, Research trends, Turkey.

INTRODUCTION

Science is taught as a core subject in most schools around the world (Turkmen, & Bonnsetter, 2007). In terms of school establishments, the mission of science education has been to prepare individuals who would develop a certain level of scientific understanding after their formal education in school. These scientifically literate individuals would be capable of applying their knowledge and skills acquired in science, whenever personal or socially relevant issues demanded such understanding (Wang, & Schmidt, 2001).

The interest in, and commitment to science instruction spans many years. In the past two decades, organizations such as the National Science Foundation (NSF), the National Research Council (NRC), and the American Association for the Advancement of Science (AAAS) have made significant contributions to the improvement of science education (Minner, Levy, & Century, 2010). Moreover, while the content and subject

sequences are more or less similar, each country has developed along different paths in teaching science as a result of unique cultural and political influences. It is important to study not only the current international science education content and pedagogy curriculum, but to understand the developmental path that has led each country to this point. Like many countries, Turkey has given special attention and importance to the teaching of science (Turkmen, & Bonnsetter, 2007).

Turkey, with a population of over 76 million, is a bridge between Europe and Asia. After the Ottoman Empire collapsed at the end of the First World War the Republic of Turkey was established in 1923. Since the science foundation of the new state educational development has been regarded as the most important factor in Turkey reaching the level of the civilized countries (Grossman, Onkol, & Sands, 2007; Sozbilir, Kutu, & Yasar, 2012). The most recent major effort to improve the educational system was undertaken through a multi-phased comprehensive reform of the sector introduced in the 1990s. In Turkey the real shift towards improving the educational system, particularly in science education, was observed after a reform movement under the auspices of the National Education Development Project (NEDP) made another step towards the improvement of the quality of teacher education. This project was initiated by the Higher Education Council [YOK], financed by the World Bank and administered by YOK (Çiltaş, Güler, & Sözbilir,

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State of the literature

- Science education is important to the development of any nation and comprises a lot of subjects such as biology, chemistry, physics, environment, health, geoscience etc. which are combined with education.
- Biology education, similarly other disciplines, is an important science field and it needs to improve teaching the methods and learning. A large number of BER publications have been published in a need of such improvements.
- Content analysis of BER offers science, especially biology, education researchers an opportunity to overview of general tendency of BER.

Contribution of this paper to the literature

- This is one of the first attempts to analyze the biology education research [BER] papers published by Turkish science educators.
- Although biology education is a new research enterprise in Turkey, it showed a significant development in the last 15 years.
- In biology education researches published in Turkey, mostly quantitative research methods are preferred indicating a need for training in terms of research methodologies for science educators.

2012; Grossman et al., 2007; Sozbilir et al., 2012). The development of this project in Turkey has led to considerable change and improvement in teacher education in recent years. As a result of NEDP, schools of teacher education (the type of the courses and the academic structures of teacher training colleges) and curricula (the content of courses) were re-structured across the nation in 1998 (Türkmen, 2007).

The biology education curriculum had previously been reconstructed after many studies were undertaken starting from 1993. At that time, the Educational Research and Development Directorate (ERDD) prepared a curriculum development model with the help of the Ministry of National Education (MoNE). The needs assessment was done for this curriculum development model and, studies for need assessment were implemented with the pilot study of participants (academicians, scholars in the field, teachers and students) in 34 high schools in Turkey. This pilot study indicated that the new biology curriculum was sufficient and suitable in many respects, but for efficient application of the curriculum, the materials to be used and the number of students per class were found as important factors. Another point to be mentioned is that, although new biology curriculum intended a student-centered teaching, observations showed that it was rather teacher-centered (Özcan, 2003).

As a result of the needs assessment and analyses the necessary a lot of changes and regulations determined that only graduates of university departments of biology and biology teacher training could become biology teachers. Following the re-structuring by the YÖK in 1998, the secondary teacher training was extended from four to five years.

Following the re-structuring in the schools of teacher training in 1998, there has been a large increase in the amount of discipline-based education research [DBER] which plays an important role in shaping of the education and teacher training. These studies aim to increase the quality and functionality of the education system (Göktaş, Hasançebi et al., 2012). Therefore, the concern for quality in research seems to be an important issue. That in itself can be seen as a very positive development. Moreover, despite the achievements in recent years, it has been lamented that the findings of research in science education often do not find their way into educational practise (Richardson, 1994). Thus, science education research is subject to some fundamental criticism. In order to respond to this criticism and to gain new stimuli for future research, it is necessary to reflect on the work that has been undertaken (Eybe, & Schmidt, 2001).

In order to examine the content of studies it is important to determine the trends of the research in science education by reviewing and organizing them periodically to provide a guiding light to the scientist who wants to conduct research in the related field (Çiltaş et al., 2012). Falkingham and Reeves (1998) suggested using content analysis to summarize large amounts of published studies in particular subject fields, to assist readers in digesting the material more easily. Content analysis enables quantifiable statements to be made about the whole body of research activity in a particular field: for example, the types of people are carrying out the research, the methods are used, the paradigms being followed, and the types of output arise. Therefore, a more comprehensive content analysis of professional publications may be helpful to gain a more detailed view of the development trends and current status of research (Chang, Chang, & Tseng, 2010; Lee, Wu, & Tsai, 2009; Tsai, & Wen, 2005; White, 1997).

In the field of science education, there has already been some systematic investigation of the research papers published in academic journals in many research fields outside Turkey. For example, in relation to biology education, Asshoff and Hammann (2008) conducted a systematic analysis of articles published in the first five years of the proceedings of the European Researchers in Didactics of Biology (ERIDOB) conferences. They suggested that the findings from their study would help researchers and educators reflect on past trends in the highly diverse field of biological education research.

Similarly, in a review of BER by DeHaan (2011), the way in which teaching and learning of the emerging sub-disciplines of biology developed historically at the higher education level, primarily in the United States was investigated. Results from the study showed that BER began early in the 21st century with sporadic investigations. These were performed largely by science educators in colleges of education, and primarily focused on efforts to improve teaching in high school and introductory college biology courses.

In addition to DeHaan (2011), a study by Dirks (2011) focused on summarizing the contributions of undergraduate BER from 1990 to 2010, as well as discuss the limitations of the research and future directions of the field. In addition, exceptional articles on biochemistry and medical education were also included. This extensive search of BER studies revealed many exciting and relatively new areas of research in three main areas; (1) student learning or performance, (2) student attitudes and beliefs, and (3) concept inventories and validated instruments.

In recent years several studies have examined the developments in the increasing research on educational studies in Turkey together with the development of research in educational sciences (Erdem, 2011), educational technologies (Kucuk, Aydemir, Yildirim, Arpacik, Goktas, 2013), mathematics education (Çiğtaş et al., 2012) science education (Çalık, Ünal, Coştu, & Karataş, 2008; Erdoğan, Marcinkowsky, & Ok, 2009; Sozibilir et al., 2012) and chemistry education (Sözbilir, Kutu & Yaşar, 2013). Although some of the science education studies cover biology education research studies, apart from research on environmental education (Erdoğan et al., 2009; Erdogan, Usak, & Bahar, 2013) and thesis published in biology education (Umdu-Topsakal, Çalık, & Çavuş, 2012) only few of them are particularly focusing on the content analysis of research papers (Erdoğan et al., 2009, Erdogan et al., 2013) and thesis (Umdu-Topsakal et al., 2012) in biology education undertaken in Turkey.

Erdoğan et al. (2009) conducted a study to content analyze 53 environmental education research papers published over the years 1997–2007 in Turkey. According to the findings, quantitative surveys were the most common method. The findings indicated that greater attention was paid to knowledge of ecology and natural history, and knowledge of environmental problems and issues with less attention being paid to the components of affect, and very little attention was paid to socio-political-economic knowledge, cognitive skills and environmentally responsible behavior. In addition, Erdogan et al. (2013) conducted a study to analyze the research published as a journal article, conference papers and an unpublished thesis (master/PhD) on environmental education in non-traditional settings in Turkey from 2000 to 2011. Of the published studies; 6

appeared in national journals and 3 in international journals, with 5 appearing in conference proceedings.

The only study that particularly focused on analyzing trends in BER in Turkey was carried out by Umdu-Topsakal et al. (2012) and investigated graduate theses. In their study, 138 graduate theses were analyzed in regard to the year, research interest, research methodology and sample. The findings show that the use of descriptive study for the research interest and a survey for research methodology were highly dominant in the graduate theses. Also, even though learning involves an interaction among student, teacher, parent and administrators, there was no study that investigated what parents think about their responsibility for their children's learning.

As shown in the summary above there has been no comprehensive study that examined the main trends in BER in Turkey. Therefore, this study aimed to conduct content analysis on the papers published in the field of biology education by Turkish science educators in national and international journals over the period 1997 to 2012. Thus, this study was designed to answer the following research questions:

- *What were the trends in BER papers published by Turkish science educators in terms of the language of the papers, nationality of the authors and index of the journals in which papers were published?*
- *What topics in BER were frequently investigated by Turkish science educators?*
- *What subject matters in BER were frequently investigated by Turkish science educators?*
- *What research methods/designs in BER were frequently used by Turkish science educators?*
- *What data collection tools in BER were frequently used by Turkish science educators?*
- *What samples and sample sizes in BER were frequently used by Turkish science educators?*
- *What data analysis methods in BER were frequently used by Turkish science educators?*

METHODOLOGY

The main purpose of the document analysis is to analyze the resources including the written information about events or phenomena. Document analysis is often used in historical research and different areas of social research and involves reading written materials. It can be also used in particular, when it is not possible to undertake observations, in-depth interviews and extensive research as a stand-alone research method (Şimşek, Özdamar, Becit, Kılıçer, Akbulut & Yıldırım 2008). Documents can be analyzed through content analysis achieved quantitative or more rigorous qualitative data analysis approaches. Content analysis as a research method is a systematic and objective means

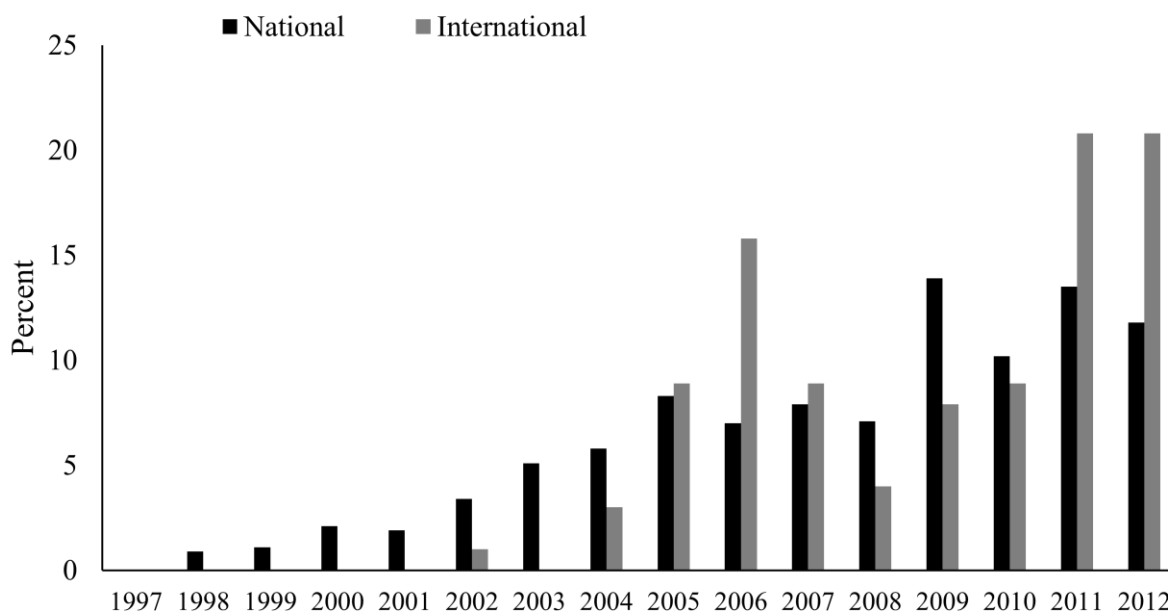


Figure 1. Number of national and international papers published across years (1997-2012)

of describing and quantifying phenomena (Downe-Wamboldt, 1992; Sandelowski, 1995). The content analysis can, in general, be grouped under three sub-headings “meta-analysis, meta-synthesis (thematic content analysis) and descriptive content analysis” (Çalık & Sözbilir, 2014). In this study, the descriptive content analysis is utilized as the research design. It is a systematical review that aims to identify and describe the general trends and research results in a particular research discipline (Çalık & Sözbilir, 2014). The biology education content papers published by the Turkish science educators from 1997 to 2012 were subjected to the content analysis. The year 1997 is the beginning of the re-structuring took place in the teacher training colleges in Turkey which significantly influenced the development of science education research in Turkey. In addition, because of the fact that this study was started in the middle of 2013 and one of selection criteria was that all volumes of journals were published during its present years, reviewing process was limited to the years 1997-2012. As a result, in this study to provide deeper insights into research trends within period 1997 to 2012, a detailed analysis of the papers that were examined under different categories.

Process of the content analysis

Although the papers subjected to content analysis were accessed through the national and international databases and online, the library records of Atatürk

University were used and personal communication with the authors was also employed. It is believed that the majority of the papers from the selected period were collected, although there were some journal issues that had restricted access. As a result we collected 633 papers from 74 different journals (63 national, 11 international) and 4 of which were indexed in Social Science Citation Index [SSCI] of Thomson Reuters®. The titles of the journals that were surveyed and the number of papers covered are listed in Appendix 1.

In order to ensure the validity and reliability of the content analysis, a paper classification form [PCF], originally developed by Sozbilir et al. (2012), was utilized and revised in accordance with the field of biology education. In revising the PCF, the classification system for biology topics presented in Reece et al. (2011) was taken into account. The form consists of seven components which provide descriptive information for the identification, topic and subject matter of the paper, together with the methods, data collection tools, sample and sample sizes, and data analysis methods. The paper classification form is given in Appendix 2. In order to establish the reliability of the content analysis, initially both authors worked together. A random sample of 30 papers (approximately 5%) was selected and content analyzed together. The inconsistencies that were identified and the differences were settled through discussion. The remainder of the papers was content analyzed by the first author but when, from time to time, any problems that were encountered were resolved

Table 1. Descriptive statistic for the papers subjected to content analysis (N=633)

Language of the papers	f	%
Turkish	543	85.8
English	88	13.9
Others	2	0.3
Total	633	100
<i>Nationality of the authors</i>		
Turkish	618	97.6
Joint authorship	15	2.4
Total	633	100

Table 2. Frequently investigated biology topics by biology educators in Turkey

	f	%
Environment and ecology	184	29.1
Animal form and function	72	11.4
The cell	70	11.1
The evolutionary history of biological diversity	44	7.0
Genetics and biotechnology	39	6.2
Mixed	36	5.7
The chemistry of life	21	3.3
Mechanisms of evolution	11	1.7
Plant form and function	10	1.6
Others	146	23.1
Total	633	100

Table 3. Frequently investigated subject matters by biology educators in Turkey

	f	%
Teaching	173	27.3
Learning	143	22.6
Attitude/perception/self-efficacy etc.	137	21.6
Studies on teaching materials	51	8.1
Computer-aided instruction	41	6.5
Test/scale development or translation	23	3.6
Curriculum studies	18	2.8
General educational problems	13	2.1
Teacher training	6	0.9
Nature of science	5	0.8
Other subjects (concept analysis etc.)	23	3.6
Total	633	100

by both authors. After completing the content analysis, all data was transferred to a database then information in the database were transferred to the Microsoft Excel program for the final error check and finally the data was analyzed using SPSS 20.0 statistical program. The results were descriptively presented in charts, percentages and frequency tables.

RESULTS

The data obtained from review of BER during the years 1997-2012 in Turkey was presented respectively on the basis of research questions. Table 1 shows that the majority (85.8%) of the studies in the field of biology education was published in Turkish and the

remainder were in English (13.9%) and other languages (0.3%). In addition, it seems that the majority (97.6%) of the studies were published by a single Turkish educator and a few papers were written as jointly.

The re-structuring of the teacher training colleges in 1997 has led Turkish science educators to focus on science education research. Parallel to this new initiative studies in the field of biology education started to appear in the educational sciences literature too. Figure 1 shows that first BER papers were published in 1998 in national journals while the first international papers by Turkish biology educators appears in 2002. In addition, Figure 1 also shows that the number of published papers increased steadily until 2005 and 2006 for national and international papers respectively.

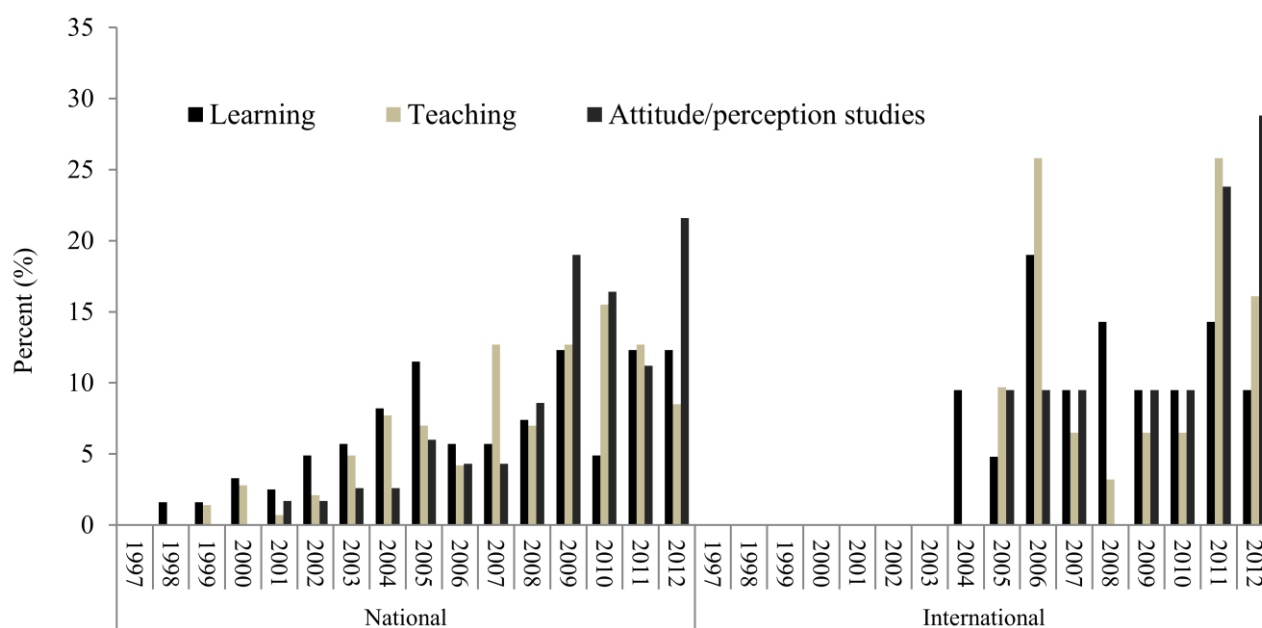


Figure 2. Percentages of most frequently studied subject matters at national and international journals across years (1997-2012)

Table 4. The distribution of the contents of the publications examined in two main categories according to sub-topics (N=453)

	f	%
<i>Learning*</i>	143	22.59
Misconception	69	10.90
Learning styles	8	1.26
Determining of achievement/knowledge	66	10.43
Other	0	0
<i>Teaching*</i>	173	27.3
Method comparing	97	15.32
Effect of teaching on attitude	61	9.64
Effect of teaching on achievement	94	14.85
Effect of teaching on scientific process skills	7	1.11

* Some of the subject matters are marked into more than one sub-subject. Therefore the total may exceed 453.

In addition to the findings above, the number of the national papers (13.9%) reached a peak in 2009 and since then there has been a significant increase in international papers. This significant increase in the number of international papers is due to a state policy in which Turkish academics must publish in international journals in order to progress in their academic careers.

Frequently investigated biology topics

Frequently investigated topics in biology education research are given in Table 2 where it can be seen that a significant percentage of the papers (29%) are published

on the topics of environment and ecology. The remainder of the papers are gathered around topics such as structure and function of animals (11%), cell structure (11%), biodiversity (7%), genetics and biotechnology (6%) and mixed topics (6%). There are a significant percentage of papers classified as other (23.1%). These studies are mostly focused on the development of scales, biology teacher training studies that have no biology content but related to biology education.

Table 5. Frequently used research design/methods by biology educators

	Research Design	Research Methods	f	%
QUANTITATIVE	Experimental	True-experimental	0	0
		Quasi experimental	156	24.6
		Pre-experimental	21	3.1
		Single subject	0	0
		Sub-total	177	27.7
	Non-experimental	Descriptive	77	12.2
		Comparative	53	8.4
		Correlational	5	0.8
		Survey	146	23.1
		Ex-post facto (causal comparative)	0	0
		Secondary data analysis	0	0
	Sub-total	281	44.5	
	QUALITATIVE	Interactive	Descriptive	101
Ethnographic study			0	0
Phenomenological study			9	1.4
Case study			13	2.1
Grounded theory			0	0
Critical studies			0	0
Others			2	0.3
Sub-total		125	19.8	
Non-Interactive		Historical analysis	0	0
		Concept analysis	17	2.7
		Review	9	1.4
		Meta-synthesis	0	0
		Others	2	0.3
	Sub-total	28	4.4	
MIXED	Mixed	Explanatory (Quan to Qual)	8	1.3
		Exploratory (Qual to Quan)	1	0.2
		Triangulation (Quan + Qual)	13	2.1
		Sub-total	22	3.6
Total			633	100

Frequently investigated subject matters

Table 3 displays the findings concerning the second research question showing that, there are three main areas that dominates about 70% of all studies. These are studies are; focusing on learning (22.6%), teaching (27.3%) and attitudes, perceptions, opinions (21.6%).

Other subjects are range from 8.1 to 2.1 percent including; the development of teaching materials, computer-aided instruction, test/scales development or translation, curriculum studies, and general educational problems. When the frequently studied areas are investigated in detail (see Table 4) studies focusing on the identification of misconceptions (10.90%) and the determination of academic achievement level (10.43%) dominated the learning studies, while studies that focusing on comparison of different methods (15.32%), effect of teaching on achievement (14.85%) and effect of teaching on attitude (9.64%) dominated the teaching studies.

The distribution of the three most widely studied subjects (learning, teaching, and attitude) across the years at national and international journals are given in Figure 2. As shown in the chart, initially, the studies on biology education research in Turkey in national and international journals were focused on learning. These studies, especially in national journals, increased until 2005. Then, in 2006 a sudden decrease can be observed. However, there is an increase in the studies concerning this subject in international journals. More recently, starting in 2011, more studies on teaching and attitudes were published in the international journals.

Frequently used research design/methods

Table 5 shows the research designs/methods that are frequently used in biology education studies in Turkey. As shown in Table 5, the majority of the studies (72%) employed quantitative and the remaining studies (24%) followed a qualitative research tradition. Only a small

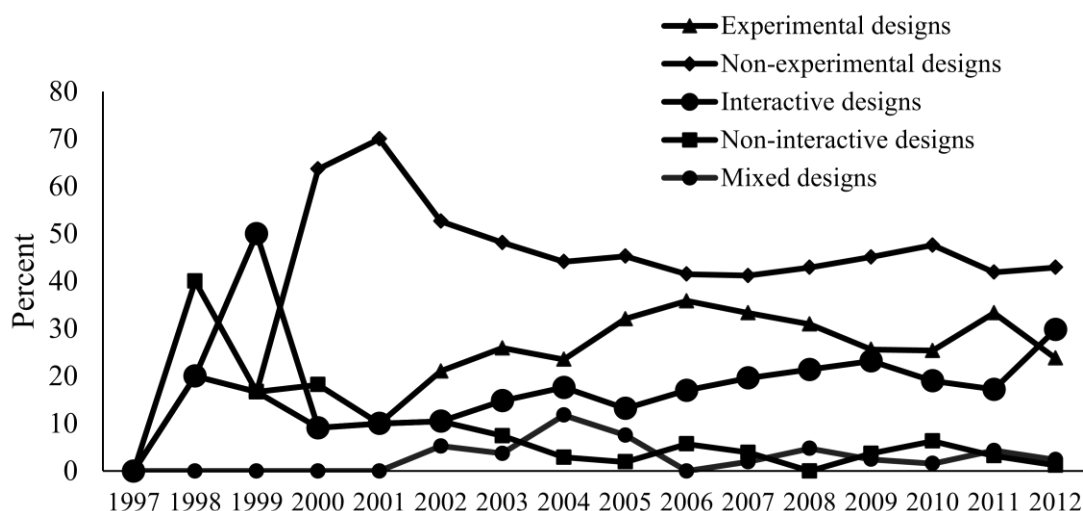


Figure 3. Trends in research designs across years (1997-2012)

number of papers (~4%) employed a mixed method as a research approach.

The non-experimental research designs were used most commonly (44.5%), these were followed by experimental research designs (27.7%). It is also evident that the most common type of experimental research method is quasi-experimental (24.6%) with few pre-experimental research methods (3.1%). In addition, it was found out that there is no true experimental and single subject research. Similar to the findings of Sozbilir et al. (2012), biology education research is mainly carried out in schools with previously determined groups, or classes, so the commonality of quasi-experimental research method is understandable. Regarding the non-experimental research designs, it was found that the survey method was dominant (23.1%), followed by descriptive (12.2%), comparative (8.4%) and correlational (0.8%) studies. Besides, there are no studies using ex-post facto (Causal comparative) and secondary data analysis as research methods.

As shown in Table 5, regarding the qualitative research designs, the use of interactive designs (19.8%) were more common than non-interactive designs (4.4%). Regarding qualitative interactive research designs, that the descriptive method was dominant (16.0%), followed by case studies (2.1%), phenomenological studies (1.4%) and other methods (0.3%). No studies identified using ethnographic study, grounded theory or critical study as research method. Regarding non-interactive research designs, there were few studies that counted as concept analysis (2.7%), review (1.4%) and other methods (0.3%), and there were no historical analysis and meta-synthesis studies.

As stated above, very few mixed method research designs in studies in the field of biology education in Turkey were used (3.6%). In terms of the mixed research designs, the use of a triangulation method was dominant (2.1%). Previous research also showed that the use of mixed methods was quite uncommon in Turkey (Çiltaş et al. 2012, Göktaş, Hasançebi et al., 2012; Sozbilir et al., 2012).

Figure 3 displays the trends in the studies on biology education in Turkey across the selected years in terms of the different research designs. As seen in Figure 3, there are few non-interactive and mixed research designs and type of these designs did not show much change over the years.

Frequently used data collection tools

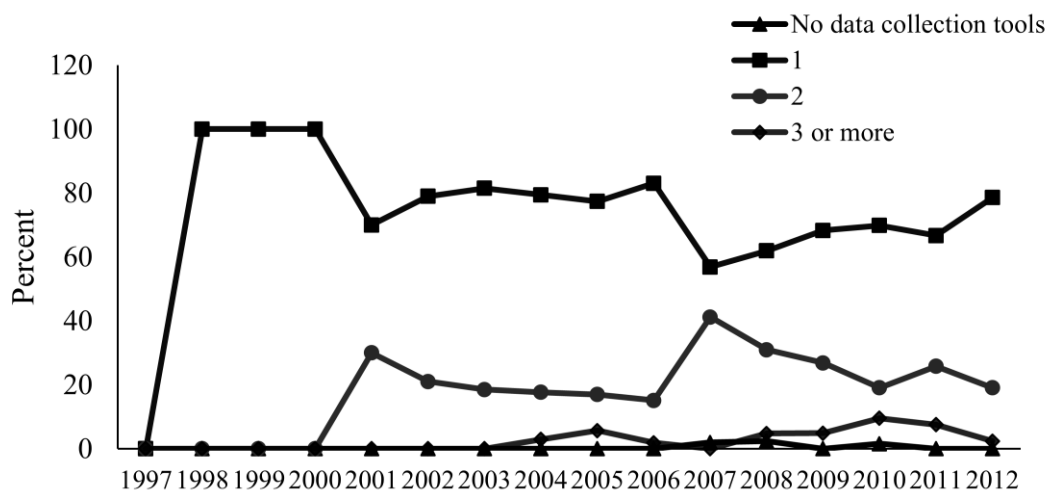
Table 6 lists the data collection tools used in BER. The most commonly used quantitative data collection tools, included; achievement tests (36.5%), questionnaires (29.7%), and attitude scales (28.6%). Qualitative data collection tools were less used and tended to consist of interviews (12.5%) and documentation (14.8%). Alternative data collection tools (5.2%) were rarely used and the least preferred tool was observation (3.5%).

Regarding achievement tests the most widely used was multiple choice (29.7%). The reason for this may be that multiple choice tests are easier to mark than the other alternative tests such as two or three tier diagnostic tests. In addition, Likert type questionnaires were more widely used. As stated above, assessment tools such as observation and interview were used less frequently because qualitative research is rarely chosen

Table 6. Frequently used data collection tools in biology educators

Type of data collection tools	f	%
Questionnaires*	188	29.7
Open-ended	29	4.6
Multiple choice	2	0.3
Likert type	152	24.0
Others	20	3.2
Achievement tests*	231	36.5
Open-ended	42	6.6
Multiple choice	188	29.7
Others	15	2.4
Aptitude, attitude, perception, personality etc. tests	181	28.6
Interviews*	79	12.5
Structured	11	1.7
Semi-structured	65	10.3
Unstructured	0	0
Focus group interviews	4	0.6
Observations	22	3.5
Participant observation	8	1.3
Non participant observation	14	2.2
Alternative assessment tools	33	5.2
Documents	94	14.8

* Some of the data collection tools are marked more than one sub-instrument

**Figure 4.** Number of different data collection tools used across years (1997-2012)

in Turkey due to researchers' inexperience in carrying out this type of research. However, it was also stated by Sozibilir et al. (2012) that the semi-structured interviews are used more commonly as quantitative data collection tool.

The trends in the use of different data collection tools across years in the field of biology education research are given in Figure 4. As shown in this figure, it is clear that one data collection tool was used more commonly. There was also a remarkable increase in the number of the studies conducted with two data collection tools between 2005 to 2007.

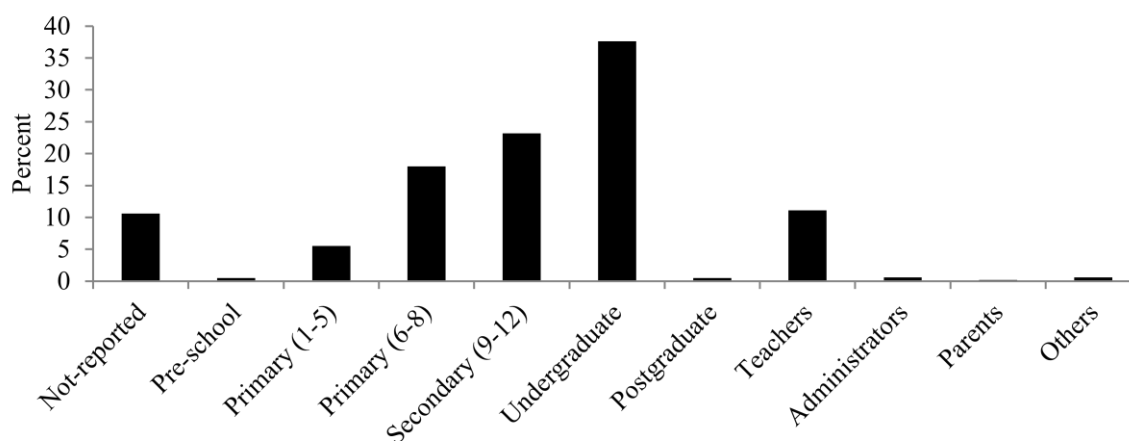
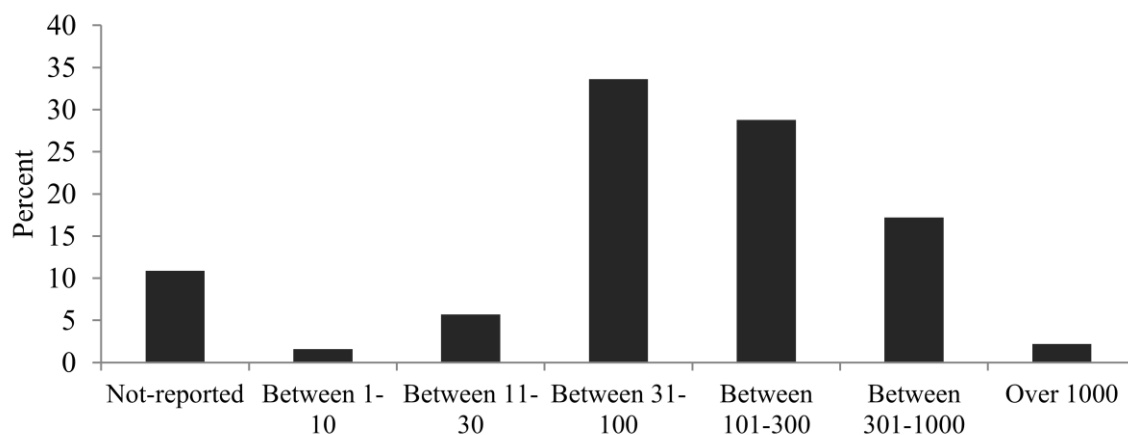
Frequently used samples and sample size

Table 7 and Figure 5, show that researchers generally prefer studying undergraduate (37.6%), secondary students (23.2%) and at the second level of elementary education (18.0%). The findings also indicate that researchers rarely choose the other types of samples. This finding may result from the fact that researchers did not the opportunity to access different types of sample groups.

The frequently studied sample sizes are shown in Figure 6 and it can be seen that majority of the sample

Table 7. Frequently studied samples

	<i>f</i>	%
Undergraduate	238	37.6
Secondary (9-12)	147	23.2
Primary (6-8)	114	18.0
Teachers	70	11.4
Primary (1-5)	35	5.5
Administrators	4	0.6
Pre-school	3	0.5
Postgraduate	3	0.5
Parents	1	0.2
Others	4	0.6
Not-reported	67	10.6

**Figure 5.** Frequently studied samples in BER in Turkey**Figure 6.** Frequently studied sample sizes

sizes commonly ranged from 31 to 100 participants (34%) and 101 to 103 participants (28.8%). However, researchers rarely work with small groups such as 1–10 participants (1.6%) and larger groups with over 1000 participants (2.2%).

Frequently used data analysis methods

The distributions of the data analysis methods frequently employed across the selected years are given in Figure 7. Regarding data analysis methods used, there was an increase in descriptive statistics and inferential

statistics in 2000 and also a small number of qualitative data analysis methods showed a decline in the same year. In the years following 2000, each of the three data analysis methods remained almost stable. Generally speaking, descriptive statistical methods were the most commonly used (74.57%) and this was followed by inferential statistical methods (61.30%). In addition, qualitative analysis methods (34.91) have showed a slight increase since 2010; however, they have been used less than the other methods.

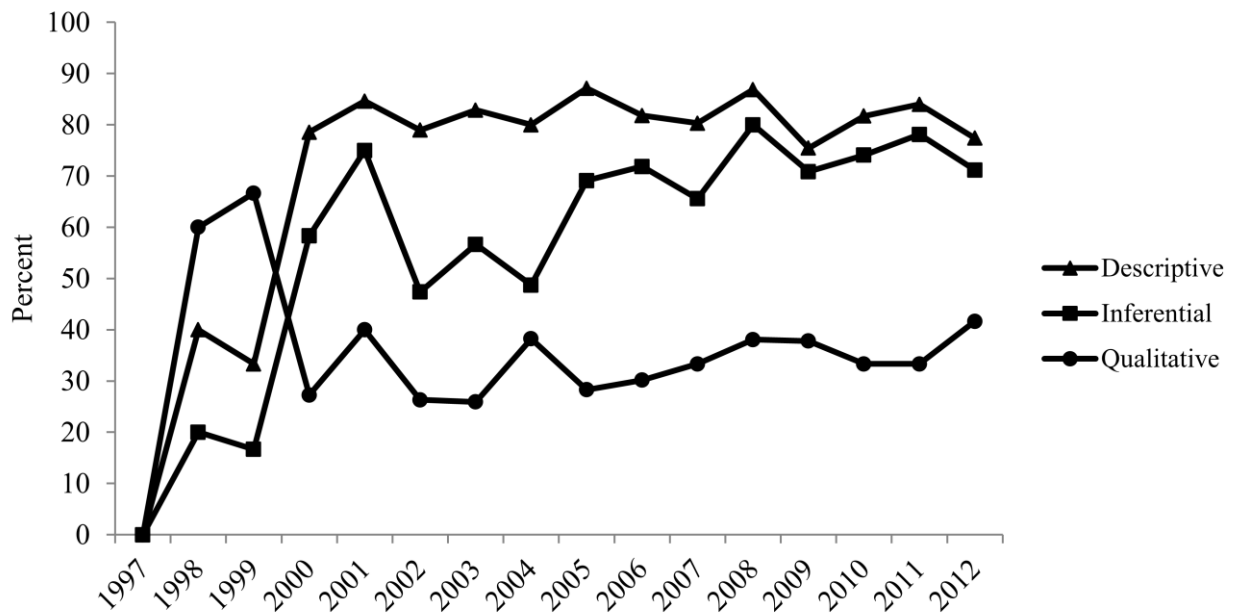


Figure 7. Trends in frequently used data analysis methods

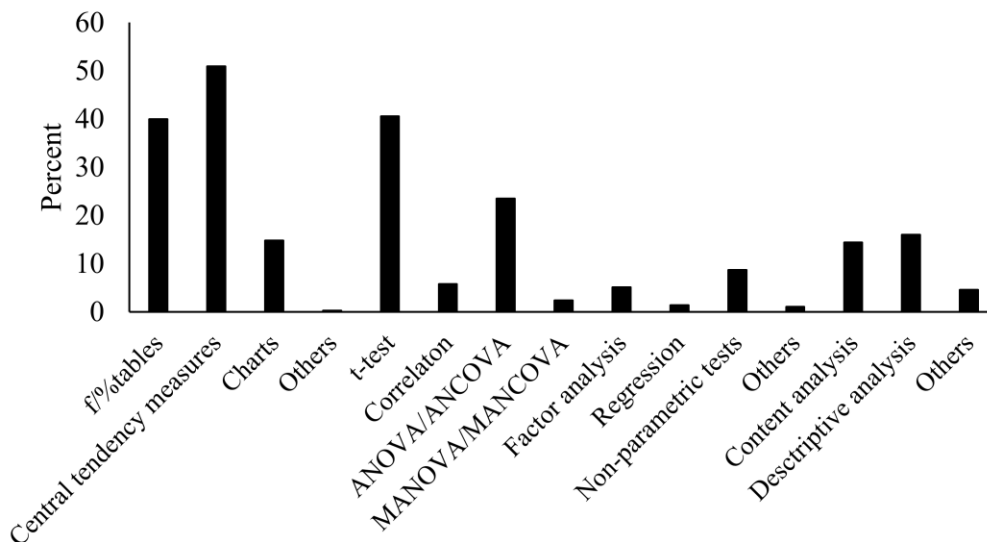


Figure 8. Frequently used data analysis methods and techniques

Figure 8 displays that various data analysis methods were used in the studies carried out in the field of biology education in Turkey. Central tendency measures as a descriptive statistical method was the most commonly used (50.9%) followed by frequencies/percentages (40.0%). Figure 9 shows that the use of charts in descriptive analysis was quite common. Regarding the inferential data analysis methods, the use of t tests (40.6%) was more common followed by ANOVA/ANCOVA (23.5%) analysis. Regarding qualitative statistical methods both qualitative descriptive methods (16.0%) and content analysis methods (14.4%) were frequently used.

In addition to the findings given above, Figure 9 shows that three or more data analysis methods (42.5%) were used in the majority of studies. In addition, most

of the researchers more frequently chose to use a single data analysis method (32.7%).

DISCUSSION AND CONCLUSION

Interest in discipline-based education research [DBER] in Turkey started almost 15 years ago (Sozbilir et al., 2012). Although DBER is new in Turkey, it has a significant place in the whole of the published research related to educational disciplines (Göktaş, Hasançebi et al., 2012). This suggests that it is necessary to identify the trends in DBER in Turkey. Therefore, this study could be considered as a first attempt to examine and evaluate the BER studies that have been published in Turkey.

The comprehensive content analysis of BER in Turkey presented in this paper showed that the majority

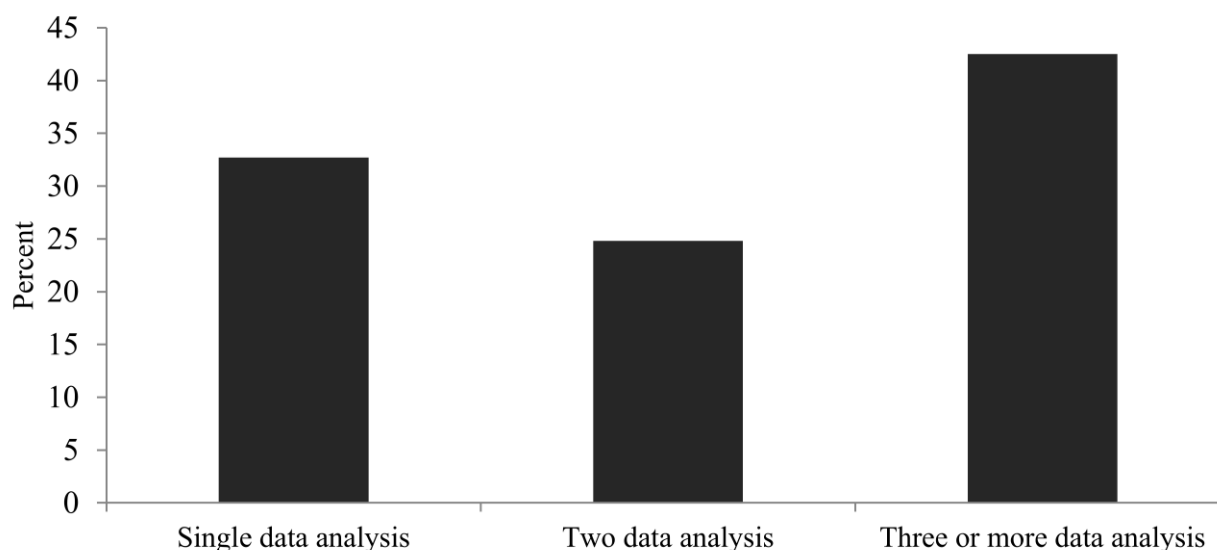


Figure 9. Number of different data analysis methods combined in a study

of the studies in the field of biology education were published in Turkish although there has been an increase in the number of papers published in international journals in recent years (Table 1). The increasing interest towards publishing in national international journals are due to a state policy that encourages Turkish researchers towards publishing research results either in Turkish and other languages. The employment and academic advancement are mainly based on the number of papers published by the researchers. However, there are several barriers for Turkish science educators to publish in high impact factor international journals due to limited competence in communicating in a foreign language as well as research method knowledge and skills required for science education research as it is relatively new in Turkey. As a result of this barriers a group of Turkish science educators aim to mainly at low impact factor journals. This results is parallel to Gökteş, Küçük et al. (2012)'s findings that Turkish researchers not only lack the foreign language skills but also the quality of their research is not of a sufficiently high level. The reason for this is that DBER is new in Turkey and most researchers are in the early stages of learning how to carry out high quality DBER research under the state policy of publishing internationally.

The content analysis presented in this paper showed that a significant percent of papers are published about environment and ecology. This is often considered to be a different discipline, however, it is a hybrid research area, and therefore researchers from different disciplines are also interested in environment and ecology studies. In addition, contrary to the many research papers in the topic of environment and ecology, there have been few research papers on the topics of evolution, and structure and function of plants. In addition, regarding the biology education in literature, there is a large amount of

research which was concerned with learning difficulties and misconceptions regarding topics such as; photosynthesis, osmosis-diffusion, cell divisions, ecology, evolution, body systems and genetics.

Sozbilir et al. (2012) stated that globally, science educators are generally interested in areas such as; learning, teaching, educational technology, curriculum, learning environments, teacher education, environmental education, assessment and evaluation, history and philosophy of science, and scientific literacy. However, Turkish science educators are mainly undertaking research in teaching, learning and studies on attitudes in general. In this study, similar to Sozbilir et al. (2012), it seems that the common areas of interest to Turkish biology educators are learning, teaching and studies on attitudes. In addition, it also seems that in regard to learning, concept misconceptions and identification of achievement level are dominant and in relation to teaching, the leading areas are; method comparing, effect of teaching on achievement and effect of teaching on attitude. These results are parallel to other studies (Chang et al., 2010; Çıltaş et al., 2012; Englund, 2006; Hsu et al., 2012; Lee et al., 2009; Sozbilir et al., 2012). Furthermore, it was found that few studies were conducted concerning issues such as concept analysis, nature of science, teacher training, general educational problems, and curriculum studies. These results imply Turkish researchers need to direct some of their attention to these areas too.

Regarding the frequently used research designs/methods, quantitative studies predominated within BER and qualitative research and mixed method research approaches were less frequently chosen. These results are supported by other studies (Çalık et al., 2008; Çıltaş et al., 2012; Erdoğan et al., 2009; Gökteş, Hasançebi et al., 2012; Sozbilir et al., 2012). The frequent application of quantitative methods may stem

from the fact that quantitative methods have many positive aspects. For example, research results derived from these methods can be generalized; their results are relevant to large samples; and they provide advantages in terms of saving time and money (Göktaş, Küçük et al., 2012). The reason that a minority of the studies employed qualitative or mixed method tradition compared to quantitative studies might be connected to the researchers' lack of knowledge and skills in relation to qualitative research methodology and their attitude towards this method. Thus, quantitative research design may be preferred by researchers due to; the difficulty in reaching an appropriate sample, the requirement of working in a natural environment, the obligation to undertake in-depth research, and the implementation and analysis process being time consuming. Therefore, being more focused on qualitative research designs especially in postgraduate courses could be useful in eliminating the researchers' deficiencies at this subject and help them overcome the difficulties they can face in the process of research.

When the content of quantitative studies was investigated in detail, it became evident that non-experimental research designs were employed more often than experimental research designs. The small number of the latter may stem from the many features of these designs. For example, experimental studies require the creation of experimental and control groups; the implementation process is time-consuming; its data analysis can be more complex unlike non-experimental studies. Regarding non-experimental studies, it is evident that it is more frequently utilized in descriptive and survey methods. This result probably indicates that biology educators frequently prefer to undertake studies related to the existing current situation, rather than determining cause-and-effect relationship between variables. Research using a descriptive design also simply provides a summary of an existing phenomenon by using numbers to characterize individuals or groups (McMillan, & Schumacher, 2009). Similarly, regarding qualitative research designs, it was found that descriptive method was dominant. It was also found that concept analysis and case studies were frequently used. Even so, it seems that some qualitative research methods such as ethnographic studies, grounded theory, critical studies, historical analysis and meta-synthesis were not frequently used. This indicates that biology educators do not have sufficient knowledge and skills concerning qualitative and mixed research designs and thus there is a need for self-development in this area.

In supporting of the findings given above, most of the biology education research papers were based on data collected through quantitative data collection tools, such as achievement tests, questionnaires and attitude tests and also frequently used single data collection tools in their studies. However, to increase the validity and

reliability of the study findings and to reach more accurate and consistent results, it is suggested that researchers need to use more than a single data collection tool. The frequent use of the Likert type questionnaire in studies may stem from the researchers' need to obtain as much data as possible in the shortest time. Additionally, the frequent selection of multiple choice tests may result from the researchers' taking into account that it is easier to make assessments from these tests. Other data collection tools such as interview, observation and alternative tests were used less frequently.

Generally, in most of the studies, the samples consisted of undergraduate students (see Table 7 and Figure 5). This result, is supported by Çiltaş et al. (2012), Göktaş, Küçük et al. (2012) and Sozbilir et al. (2012) that the researchers mostly preferred subjects that could be easily accessed. In addition the results of this study show that a secondary school sample is more frequently chosen rather than a primary sample. This may be due to the fact that biology-based topics in the secondary school curriculum are more comprehensive and more detailed. There is a need to extend the samples in order to address the problems that involve a variety of groups engaged in teaching and learning of biology; such as faculty members, parents, administrators, primary school students and teachers.

Regarding the frequently studied sample sizes in Figure 6, researchers generally worked with small samples ranging from 31 to 300 subjects. Furthermore, researchers rarely used sample groups of 1-10 or over 1000 subjects. This result is supported by Göktaş, Küçük et al. (2012), Lubiensky & Bowen (2000). This result may be caused by many factors such as frequently engaging in experimental studies which only requires small sample sizes, collection of data from a small number of the groups in a short period of time or analysis and assessment of data obtained over a short time.

Figure 7 indicates that the majority of studies were analyzed by quantitative tradition such as the descriptive and inferential analysis methods and the qualitative analysis methods showed a small number of increases in recent years and also each of the three analysis methods remained stable. This implies that descriptive analysis continues to be popular. In addition, regarding the data analysis methods, Figure 8 indicates that frequencies/percentages tables and central tendency measures are commonly used as data analysis method and also parametric tests such as t test and ANOVA/ANCOVA are used in inferential analysis. As stated by Erdem (2011), the power of non-parametric tests is much weaker than parametric tests. Therefore, it can be considered to be a positive situation that non-parametric tests are not frequently used in studies in Turkey. However, the fact that researchers rarely use

advanced statistical techniques such as MANOVA/MANCOVA, factor analysis, regression analysis in the studies that were reviewed probably implies that the researchers lack knowledge of advanced statistical techniques.

Regarding quantitative research methods, researchers commonly used both content analysis and descriptive analysis. These results are supported by other studies (Erdem, 2011; Göktaş, Hasaebi et al., 2012). In addition to the results described above, Figure 9 shows that three or more data analysis methods were used in the majority of studies. In other words, contrary to the findings of many studies in the literature, despite the fact that single data collection tools are frequently used in biology education research, using more than one method of analysis may be an indicator that the researchers examined more in-depth data by comparing different dimensions.

Consequently, this study can be considered as a guide for educators, researchers studying biology and other academics to undertake future research taking into account the following points.

There is a serious need for more high-quality studies at the international level and indexed especially in SCI/SSCI in Turkey. In addition to the topics that are well researched (environment and ecology, cell structure, animals and functions) more research focus should be placed on difficulties in learning in areas such as evolution.

There is an indication in the results that researchers in Turkey need to direct their attention towards subject matter; such as concept analysis, nature of science, teacher training, general educational problems, and curriculum studies. On the other hand the research need to be guided by the problems experienced by the biology education community rather than solely following trends. The aim of the research is to produce solutions to the problems that society faces.

The findings also indicated that qualitative and mixed methods are uncommon and the majority of research papers in Turkey are produced superficially using quantitative methods. However, there is a need to carry out in-depth analyses since innovations in scientific research have revealed many new dimensions. It is known that quantitative and qualitative research designs have different advantages and their results are more reliable when used together. Therefore, it is time for Turkish biology educators to focus on advanced statistical techniques, and qualitative and mixed research designs in future studies. In order to do this, more emphasis should be placed on the teaching of qualitative and mixed research designs in addition to advanced statistical analysis methods particularly in postgraduate courses.

Finally, it is suggested that future studies use different sample groups, increase sample size and use

more data collection tools in order to obtain more reliable, consistent, and comprehensive results to improve educational practices.

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Appendix 1. List of journals surveyed

<i>Title of Journal</i>	<i>Journal Type</i>	<i>f</i>	<i>%</i>
Educational Sciences: Theory and Practice	International	17	2.7
Eurasian Journal of Educational Research (EJER)	International	28	4.4
International Journal of Environmental and Science Education	International	18	2.8
International Online Journal of Educational Sciences	International	6	0.9
International Journal of Environmental Educ. (IEJEE-Green)	International	6	0.9
The Turkish Online Journal of Educational Technology	International	9	1.4
Other International Journals (less than 5 papers from each)	International	13	2.3
Abant İzzet Baysal Univ. Journal of Education Faculty	National	7	1.1
Ahi Evran Univ. Journal of Kırşehir Education Faculty	National	17	2.7
Bayburt University Journal of Education Faculty	National	10	1.6
Contemporary Education	National	12	1.9
Çukurova University Journal of Education Faculty	National	13	2.1
Çukurova University Journal of Social Sciences Institute	National	7	1.1
Dicle Univ. Journal of Ziya Gökalp Education Faculty	National	12	1.9
Dokuz Eylül Univ. Journal of Buca Education Faculty	National	10	1.6
Ege University Journal of Education Faculty	National	6	0.9
Education and Science	National	9	1.4
Educational Science & Practice	National	5	0.8
Journal of Research in Education and Teaching	National	7	1.1
Journal of EKEV Academy	National	6	0.9
Electronic Social Sciences Journal	National	6	0.9
Erzincan University Journal of Education Faculty	National	26	4.1
Gazi University Journal of Education Faculty	National	28	4.4
Hacettepe University Journal of Education	National	90	14.2
Iğdır University Journal of Social Sciences Institute	National	5	0.8
Elementary Education Online	National	19	3
Kastamonu University Journal of Education Faculty	National	35	5.5
Journal of Theoretical Educational Science	National	7	1.1
Marmara Univ. Atatürk Educ. Fac. Journal of Educ. Sci.	National	13	2.1
Mehmet Akif Ersoy Univ. Journal of Education Faculty	National	6	0.9
National Education Journal	National	11	1.7
Balıkesir Uni. Necatibey Educ. Fac. Elec. J. Sci. & Math. Educ.	National	13	2.1
Ondokuz Mayıs University Journal of Education Faculty	National	14	2.2
Pamukkale University Journal of Education Faculty	National	14	2.2
Sakarya University Journal of Education Faculty	National	5	0.8
Selcuk Univ. Journal of Ahmet Keleşoğlu Educ. Faculty	National	15	2.4
Journal of Turkish Science Education	National	33	5.2
Turkish Educational Sciences Journal	National	8	1.3
Uludağ University Journal of Education Faculty	National	16	2.5
Other International Journals (less than 5 papers from each)	National	51	8.6
TOTAL		633	100

Appendix 2. Paper classification form

A. INFORMATION ABOUT PAPER			
1. Title:			
2. Author/s:		3. Auth. Nation. a. TR <input type="checkbox"/> b. Foreign <input type="checkbox"/> c. Mixed <input type="checkbox"/>	
4. Journal Name:		5. Journal Type: a. International <input type="checkbox"/> National <input type="checkbox"/>	
a. Year:	b. Volume:	c. Issue:	d. Pages:
7. Indexes: a. SCI/SSCI: <input type="checkbox"/>		b. ERIC-BEI-EI-AEI: <input type="checkbox"/>	
c. ULAKBİM SBVT <input type="checkbox"/>		d. No Index <input type="checkbox"/>	
e. Other <input type="checkbox"/>			
B. MAIN DISCIPLINE THAT PAPER BELONGED			
<input type="checkbox"/> 1. Chemist. of life	<input type="checkbox"/> 2. The cell	<input type="checkbox"/> 3. Genetics and biotech.	<input type="checkbox"/> 4. Mech. of evolution
<input type="checkbox"/> 5. Biodiversity	<input type="checkbox"/> 6. Plant form and func	<input type="checkbox"/> 7. Animal form and func	<input type="checkbox"/> 8. Environment and Echology
<input type="checkbox"/> 9. General biology	<input type="checkbox"/> 10. Other		
C. SUBJECT OF THE PAPER			
1. <input type="checkbox"/> Learning O Mis O LS O Ach. O Other	4. <input type="checkbox"/> Study on teaching materials	10. <input type="checkbox"/> Test, scale development or translation	
2. <input type="checkbox"/> Teaching O MC O Att. O Ach. O SPS	5. <input type="checkbox"/> Computer-aided teaching	11. <input type="checkbox"/> Research methods studies	
3. <input type="checkbox"/> Teacher training O PTE O IT O Other	6. <input type="checkbox"/> General educational probl.	12. <input type="checkbox"/> Nature of science O SPS O SL O ATS O SiEL	
	7. <input type="checkbox"/> Concept analysis	13. <input type="checkbox"/> Other.....	
	8. <input type="checkbox"/> Attitude, perception research		
	9. <input type="checkbox"/> Curriculum studies		
D. RESEARCH METHODS/DESIGNS			
QUANTITATIVE		QUALITATIVE	
1. Experimental	2. Non-Experimental	3. Interactive	4. Non-Interactive
11. <input type="checkbox"/> True-experimen.	21. <input type="checkbox"/> Descriptive	31. <input type="checkbox"/> Ethnography	41. <input type="checkbox"/> Historical analy.
12. <input type="checkbox"/> Quasi-experim.	O Longitudinal	32. <input type="checkbox"/> Phenomenography	42. <input type="checkbox"/> Concept analy.
13. <input type="checkbox"/> Pre-Experimen.	O Cross-age/sect.	33. <input type="checkbox"/> Case study	43. <input type="checkbox"/> Review
14. <input type="checkbox"/> Single subject	22. <input type="checkbox"/> Comparative	34. <input type="checkbox"/> Grounded theory	44. <input type="checkbox"/> Metasynthesis
	23. <input type="checkbox"/> Correlational	35. <input type="checkbox"/> Critical studies	45. <input type="checkbox"/> Other
	24. <input type="checkbox"/> Survey	36. <input type="checkbox"/> Descriptive	
	25. <input type="checkbox"/> Ex-post facto	37. <input type="checkbox"/> Other	
	26. <input type="checkbox"/> Sec. Data analy.		
E. DATA COLLECTION TOOLS		F. SAMPLE	
1. <input type="checkbox"/> Questionnaire O Open-end. O Mulp. choice O Likert O Other		a. Sample	
2. <input type="checkbox"/> Achievement test O Open-end. O Mulp. choice O Other		1. <input type="checkbox"/> Pre-school	
3. <input type="checkbox"/> Aptitude, attitude, perception, personality etc. tests Please write the title		2. <input type="checkbox"/> Primary (1-5)	
4. <input type="checkbox"/> Interview		3. <input type="checkbox"/> Primary (6-8)	
O Structured O Semi-Str O Unstructure. O Focus G		4. <input type="checkbox"/> Secondary (9-12)	
5. <input type="checkbox"/> Observation O Participant O Non-participant		5. <input type="checkbox"/> Undergraduate	
6. <input type="checkbox"/> Alternative assessment tools (Diagnostic tests, concept map., portfolio etc.)		6. <input type="checkbox"/> Post-graduate	
7. <input type="checkbox"/> Documents		7. <input type="checkbox"/> Educators	
8. <input type="checkbox"/> Others (please provide title)		8. <input type="checkbox"/> Administratives	
		9. <input type="checkbox"/> Parents	
		10. <input type="checkbox"/> Others	
		11. <input type="checkbox"/> Not reported	
G. DATA ANALYSIS			
QUANTITATIVE DATA ANALYSIS		QUALITATIVE DATA ANALYSIS	
1. Descriptive Statistics	2. Infrential Statistics	3. Qualitative Analysis	
11. <input type="checkbox"/> Frequency /percentage tables	21. <input type="checkbox"/> t-test	31. <input type="checkbox"/> Content analysis	
12. <input type="checkbox"/> Central tendency measures	22. <input type="checkbox"/> Correlation	32. <input type="checkbox"/> Descriptive analysis	
13. <input type="checkbox"/> Charts	23. <input type="checkbox"/> ANOVA/ANCOVA	33. <input type="checkbox"/> Other	
14. <input type="checkbox"/> Others.....	24. <input type="checkbox"/> MANOVA/MANCOVA		
	25. <input type="checkbox"/> Factor analysis		
	26. <input type="checkbox"/> Regression		
	27. <input type="checkbox"/> Non-Parametric tests		
	28. <input type="checkbox"/> Others.....		
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		2014	