Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.1 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

# Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

**Cemal TOSUN**

**Department of Science Education, College of Education, Bartin University, Bartin, 74100, TURKEY**

**E-mail: cemaltosun22@gmail.com**

**M. Diyaddin YASAR**

**Department of Educational Sciences, College of Education, Kilis 7 Aralik University, Kilis, TURKEY**

# Contents

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.2 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
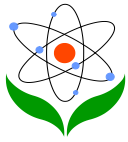Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

# Abstract

Content analysis of the studies of both Turkish and foreign authors on PBL in science education in national and international journals was made considering such variables as the research subject, method, sample, diversity of data collection tools and the data analysis methods. To this end, content analysis of 104 papers - 42 by Turkish authors and 62 by foreign authors - which were carried out between the years 1986- 2012, was made. All these papers were accessed in full text. It was identified that in 40.4% of the studies whose content analysis was made, the focus was on the effect of PBL on learning, while in 35.6% the focus was on concept analysis. It is seen that while Turkish authors worked on teaching studies in 59.5% of their studies, foreign authors focused on concept analysis in 41.9% of their studies. Also while Turkish authors mostly preferred quantitative research methods (61.9%) in their studies, foreign authors preferred qualitative research methods (66.1%). The commonly used data collection tools for Turkish authors were questionnaire and achievement test, while foreign authors preferred interview and alternative data collection tools. In terms of choosing a sample group, it is seen that studies with undergraduate and secondary school students (9-12) were preferred more often. The findings of the study reveal that studies on PBL were not very common in our country until 2005; that they reached the highest number between the years 2005-2009, and that foreign authors published the highest number of papers in 2006. While the foreign authors had a superiority over Turkish authors in terms of their papers on PBL in science education until 2005, it is seen that as of 2005, except the year 2006, the number of papers of Turkish authors has been equal to/higher than the number of papers by foreign authors until 2012. Besides, it is also identified that most of these studies were mixed and in the field of chemistry education. It is believed that this study is significant in terms of providing an opinion to young researchers working in the field of PBL and to those who are planning to work in the field.

**Keywords**: Problem-based learning, content analysis, national and international papers, PBL

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.3 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers
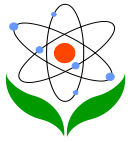
# Introduction

First studies on science education in the world started with the changes in curriculum studies at the end of 19th century and beginning of the 20th century. Although these new curriculum studies which were quite costly could not bring the expected success in science education, it contributed a lot to the development and advance of science education (Duit & Treagust, 1998). Whether the changes made had an impact on students' achievement in science classes was examined. In the following years, these studies gave way to researches towards identifying the misconceptions in different subject matters. And in the next years, the emphasis was on removing these misconceptions and on conceptual change works. Later, the ways to remove these misconceptions and conceptual change works were concentrated on. And in the following years, the question of "which information will be taught how" has arisen and studies on teaching methods that enable students to acquire studying in cooperation with others as well as considering individual differences have become the focus of interest. One of these methods is the "Problem Based Learning (PBL)" which is one of the constructivist learning methods enabling students to acquire problem solving and thinking skills, which they cannot acquire in traditional university education.

PBL first emerged in the medical faculties of Case Western Reserve and McMaster universities during the 1950-1960s, when science teaching programs entered into a restructuring period. According to McDonald (2002), however, the theoretical support of PBL goes back to the researches of John Dewey. PBL method, which is implemented at preclinical courses at medical schools of Harvard University and New Mexico University, is implemented at the medical schools of Hacettepe, Ankara, Dokuz Eylül and Pamukkale Universities in our country.

PBL, which was widely used in many fields around the world after it became popular in medical schools, has many implementations in science education at different levels at national and international levels ranging from primary education to higher education (e.g. Akinoglu & Ozkardes-Tandogan, 2008; Araz & Sungur, 2007; Gallagher et al., 1995; Gurses et al., 2007; Kelly & Finlayson, 2007; 2009; Overton & Brodley, 2010; Peterson & Treagust, 1998; Ram, 1999; Smith, 2012; Senocak, Taskesenligil & Sozbilir, 2007; Soderberg & Price, 2003; Tarhan & Ayar-Kayali, 2007; Sungur, Tekkaya & Geban, 2006; Sungur & Tekkaya, 2006;

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.4 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers
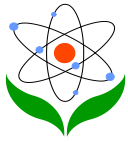
Tarhan & Acar, 2007; Tatar & Oktay, 2011; Tosun & Taskesenligil, 2013; Ward & Lee, 2004; Williams, et al., 2010).

PBL, which became rapidly widespread all around the world after it earned a reputation at medical schools, is found to have some disadvantages as well as advantages. The advantages of PBL can be listed as: i) it promotes deep learning ii) it promotes problem-solving skills iii) it helps students to develop metacognitive skills iv) it promotes critical thinking skills v) it promotes team working skills vi) it promotes self-learning skills vii) it promotes student skills to reach the resources they need and viii) it promotes self-efficacy skill. According to Uden and Beaumont (2006) the disadvantages of PBL can be listed as: i) time limitations ii) the insufficiency of the places where the group works will be done iii) not being able to reach the needed resources iv) difficulties in preparing the problem situations for each course (Dolmans et al.,1992) v) student anxiety arising from meeting the PBL method for the first time vi) the familiarity of the teachers to their traditional roles and vii) the requirement of in-depth learning of the subjects although there are many subjects in the curriculum.

According to Hoffman and Ritchie (1997) multimedia can help to reduce some of the disadvantages faced during the PBL practices. The roles of teacher and student in traditional teaching method completely changed in PBL method. Since the learning process is based on the learner in PBL, the passive student concept is replaced with "active learner" and the concept of teacher is replaced with "tutor". The responsibility of what is learned as well as how it is learned belongs to the students (Greenwald, 2000). Tutors in PBL is not someone who transfers the information to the student but someone who guides students to reach a solution. Students will analyze the problem scenarios and if they cannot get the necessary guidance they need during the search for the solution in time, they will use most of their time unnecessarily. Electronic directions in multimedia facilitate the presentation of additional resources students need. In addition, since students are followed via the computer systems also in the working process outside the classroom, it becomes easier to identify student needs and to help them (Hoffman & Ritchie, 1997).

In classrooms where PBL method is implemented, students form small groups in order to find solutions to the problems that are not well-structured and the problems they encounter or they might encounter in everyday life. Then they make research and analyze the problem with their group members and try to find alternative

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.5 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers
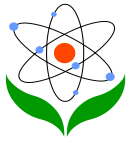
solutions to the problem. As Anderson (1998)' and Darling-Hammond and Synder (2000) cite from Stenberg (1994), the tests implemented in traditional classrooms are not useful tools to measure student achievement in this complex and open-ended activities. In PBL method, summative assessment is used as well as formative assessment technique (Duch & Groh, 2001; Savin-Baden & Major, 2004).

There are not many studies in science education before 1990s in our country. When the changes in science education in the world in the last thirty years is considered, it is found that Turkey runs behind in studies in science education. Yet she caught up with the world in studies in teaching (Sozbilir & Canpolat, 2006). This study makes an inventory of the studies on PBL in science education both in our country and in the world. Thus, where Turkey stands in PBL studies in science education is tried to be specified.

It is important and necessary to regularly carry out studies, which make an inventory of the studies in science education in the world and in Turkey and which set forth the similarities and differences. There are many international (e.g. Chang, Chang & Tseng, 2009; De Jong, 2007; Lee, Wu & Tsai, 2009) and national (e.g. Bacanak et al., 2011; Calik et al., 2008; Dogru et al., 2012; Sozbilir, Kutu & Yasar, 2012; Sozbilir & Kutu, 2008; Tatar & Tatar, 2008) guiding studies in the literature which are designed to respond to the needs of researchers in science education and in which the document analysis of the studies in science education is made.

In addition to studies which highlight the advantages and disadvantages of PBL in the literature, there are other studies which mention the roles of students and teachers in PBL. Besides, in some studies, technology, assessment and problem scenarios in PBL are discussed as well. In such PBL studies in different fields, there are many studies researching the efficiency of PBL for different learning products. And this brings along the need for a systematic collection in this subject. To this end, there are national and international meta-analysis studies on the efficacy of PBL and the problem related to the PBL (e.g. Dochy et al., 2003; Gijbels et al., 2005; Ustun & Eryilmaz, 2012; Yaman, 2012). However, in order for such studies to reach their objectives, it is necessary to hold them regularly and to make an inventory of studies carried out in the field.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.6 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

# The Purpose of the Study

The purpose of this study was to identify the subject areas both Turkish and foreign scientists working on PBL in science education focus on; the subjects, research methods and data collection tools they prefer, sample groups participating in their implementations and data analysis methods they use. Thereby, the tendencies of national and international studies done with PBL method on science education in the world and in our country until today were examined, the existing condition was revealed and a comprehensive content analysis study was carried out to gather all the studies under one roof. The studies on PBL in national and international papers on science education between 1986- and 2012 were analyzed in detail using "Paper Classification Form", and answers to the following questions were looked for:

### Research Questions

- What is the distribution of studies by Turkish and foreign authors on PBL in science education between 1986-2012 by years like?
- What is the distribution of studies by Turkish and foreign authors on PBL in science education between 1986-2012 by areas like?
- What is the distrubition of studies by Turkish and foreign authors on PBL in science education between 1986-2012 by subject matters like?
- What is the distribution of the research methods used by Turkish and foreign authors in their studies on PBL in science education between 1986-2012 like?
- What is the distribution of the data collection tools used by Turkish and foreign authors in their studies on PBL in science education between 1986-2012 like?
- What is the sample and sample size used by Turkish and foreign authors in their studies on PBL in science education between 1986-2012 like?
- What are the data analysis methods used by Turkish and foreign authors in their studies on PBL in science education between 1986-2012 like?

# Method

Content analysis method, a frequently used method in quantitative researches, was used in this study. A systematic and detailed analysis of a total number of 104 papers- including 42 papers from Turkish authors and 62 papers from foreign authors - was made. Thereby, similar data were gathered around certain concepts

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.7 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

and themes; organized in a way that is meaningful to the reader and then interpreted (Yildirim & Simsek, 2006).

### Data Source

Document analysis of a total number of 104 papers-including 42 papers from Turkish authors and 62 articles from foreign authors - on PBL in science education in 59 different journals (22 Turkish journals and 37 journals abroad) was made. Title of each journal and the number of papers on PBL are given in Appendix 1.

### Data Collection Tool

"Paper Classification Form" developed by Sozbilir, Kutu and Yasar (2012) was used as the data collection tool. This form is made up of seven sub-dimensions, which are descriptive information about the identity of the papers, the area of the paper, the subject matters, research methods, data collection tools, sample and data analysis methods.

### Data Analysis

In order to ensure the reliability of the study, randomly chosen 11 papers in the classification process of the papers were separately analyzed by the authors. Thereby, whether there was a high consistency among the papers analyzed or not was examined. It was determined that there was an agreement among the authors most of the time and when there was a disagreement among the authors, a consensus was arrived after discussions among the authors. The document analysis of the remaining papers was made by the 2nd (second) author who has works on content analysis (e.g. Sozbilir, Kutu & Yasar, 2012; Kizilaslan, Sozbilir & Yasar, 2012). The data were obtained by filling the online papers evaluation form prepared using "Google Drive". This program enabled the data to be well-organized and presented in excel. Thus, the results were transferred into graphic, frequency and percent tables and presented descriptively.

## Findings

The studies in which PBL method was used in science education in the journals examined were subjected to a content analysis and the findings related to each research question are given below. Among the 104 papers whose content analysis

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.8 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

was made 15.4% were in national journals while 84.6% were international journals (See Table 1). And 21.1% of the studies were written in Turkish while 78.9% of them were written in English. Of all the papers in this study, 42 of them are papers of Turkish authors in national and international journals and 62 are papers of foreign authors in international journals.

**Table 1.** Classification by journal type and language of paper and nationality of the authors
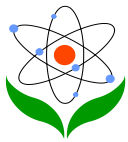
| Type of Journal | f | % | The language of paper | f | % | Nationality of the authors | f | % |
|---|---|---|---|---|---|---|---|---|
| National | 16 | 15.4 | Turkish | 22 | 21.1 | Turkish | 42 | 40.3 |
| International | 88 | 84.6 | English | 82 | 78.9 | Mixed | 62 | 59.7 |

Table 2 and Figure 1 are made to show the development of PBL method in science education.

**Table 2.** Number of paper related to PBL over years (1986-2012; N=104).

| Year | 1986 | 1995 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TR | -- | -- | -- | -- | 2 | -- | 1 | -- | -- | -- | 7 | 2 | 6 | 6 | 7 | 5 | 3 | 3 | 42 |
| INT | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 4 | 5 | 5 | 3 | 8 | 3 | 3 | 7 | 4 | 3 | 5 | 62 |
| Total | 1 | 2 | 2 | 2 | 5 | 1 | 2 | 4 | 5 | 5 | 10 | 10 | 9 | 9 | 14 | 9 | 6 | 8 | 104 |

When Table 2 and Figure 1 are examined, it is seen that the first publication on PBL in science education was in 1986 (Birch, 1986) in "Studies in Higher Education" journal and the second publication was in 1995 (Gallagher et al., 1995; Savery & Duffy, 1995) in "School Science and Mathematics" and "Educational Technology" journals. In Turkey, on the other hand, the first publication on PBL method in science education was published in 1999 (Cakir & Tekkaya, 1999; Unal, 1999) in the journal of "Hacettepe University Journal of Education" and "Marmara University Journal of Ataturk Educational Faculty of Educational Sciences". Among these two journals "Hacettepe University Journal of Education" has been indexed in ERIC since 2004 and in SCI/SSCI since 2007.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.9 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

According to Table 2 and Figure 1, the highest number of papers on PBL in science education by foreign authors hit the peak in 2006 while the peak was hit in 2005 and 2009 for Turkish authors. While foreign authors had predominance over Turkish authors until 2005 in terms of papers on PBL in science education, as of 2005, except the year 2006, the number of papers of Turkish authors has been equal to/higher than the number of papers by foreign authors until 2012. And in 2012, again the papers of foreign authors on PBL in science education outnumbered those of Turkish authors.
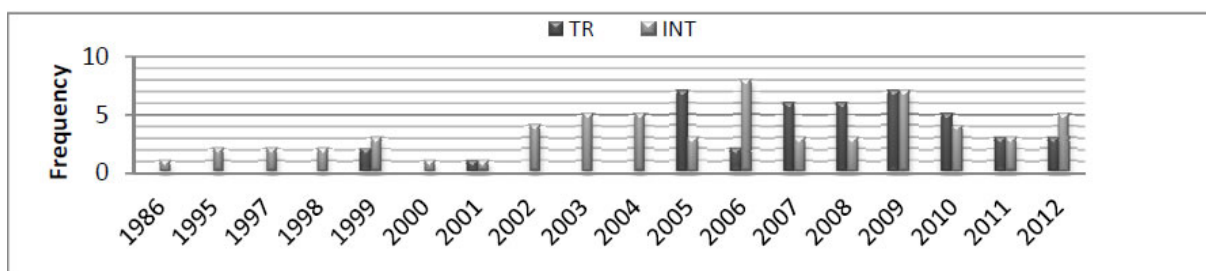


**Figure 1.** Number of national and international papers published across years (1986-2012).

As a result of classifying the papers according to "Paper Classification Form", Figure 2 was formed., It is seen that 35.6% of the studies are mixed, while 30.8% are on chemistry, 13.5% are on science and technology, 11.5% are on biology and 7.7% are on physics (see Figure 2). Also, according to Figure 2, of all the studies on PBL in science education by Turkish authors, 33.3% is mixed, while 23.8% is on chemistry, 19.1% is on science and technology and 11.9% on physics and biology. Of all the papers of foreign authors in this study, on the other hand, it is seen that 37.1% is mixed, 35.5% is on chemistry, 11.3% is on biology, 9.7% is on science and technology and 4.8% is on physics.
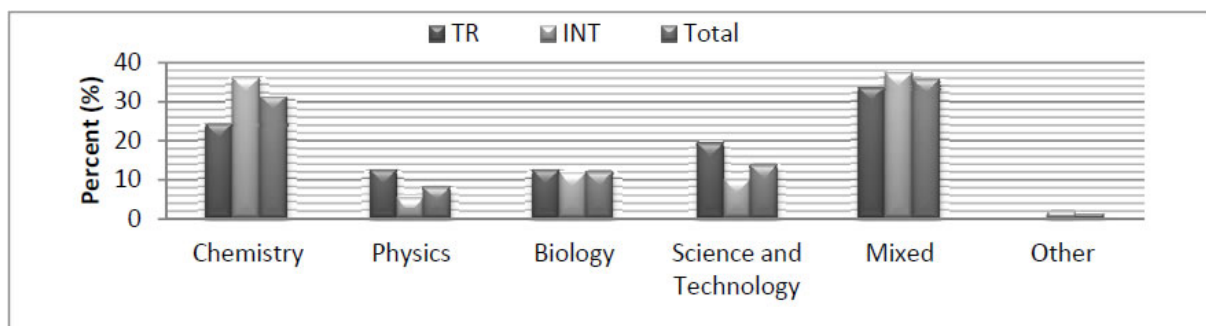


**Figure 2.** Discipline

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.10 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

Identifying which subject matters both Turkish and foreign authors prefer in their papers on PBL in science education is another research question in this study. In Figure 3, it is seen that 76% of the studies whose content analysis was made is about teaching and concept analysis (40.4% teaching and 35.6% concept analysis). Identifying attitude-interest and developing course/ project/ activity/ scenario for PBL make up the 7.7% of all studies.

It is seen that in studies on PBL in science education Turkish authors prefer teaching in 59.5% of their studies, concept analysis in 26.2%, attitude-interest determining in 11.9% and scale-test development - translation in 2.4% of their studies. Foreign authors, on the other hand, prefer concept analysis in 41.9% of the studies, teaching in 27.4% of the studies, developing course/project/activity/scenario for PBL in 12.9% of the studies, teacher training and computer-aided teaching in 3.2% of the studies and learning, assessment and evaluation based on PBL and workshop based on PBL in 1.6% of the studies.

Table 3 details which sub topics are examined in learning, teaching and teacher training subjects, which are frequently studied both by Turkish and foreign authors. The table was prepared by taking into consideration if studies cover more than one sub-topics of teaching, learning and teacher training.

In Table 3, it is seen that in 25% of all papers, the impact of teaching on success was examined while in 24% the impact of teaching on attitude and in 20,2% the impact of teaching on scientific process skills were examined. In 42.9% of the studies of Turkish authors, the effect of teaching on success was examined; while in 38.1% the impact of teaching on attitudes and in 30.9% the impact of teaching on scientific process skills were examined. In 12.9% of the studies by foreign authors on PBL in science education, on the other hand, the impact of teaching on success was examined; while in 14.5% the impact of teaching on attitudes and in 12.9% the impact of teaching on scientific process skills were examined.
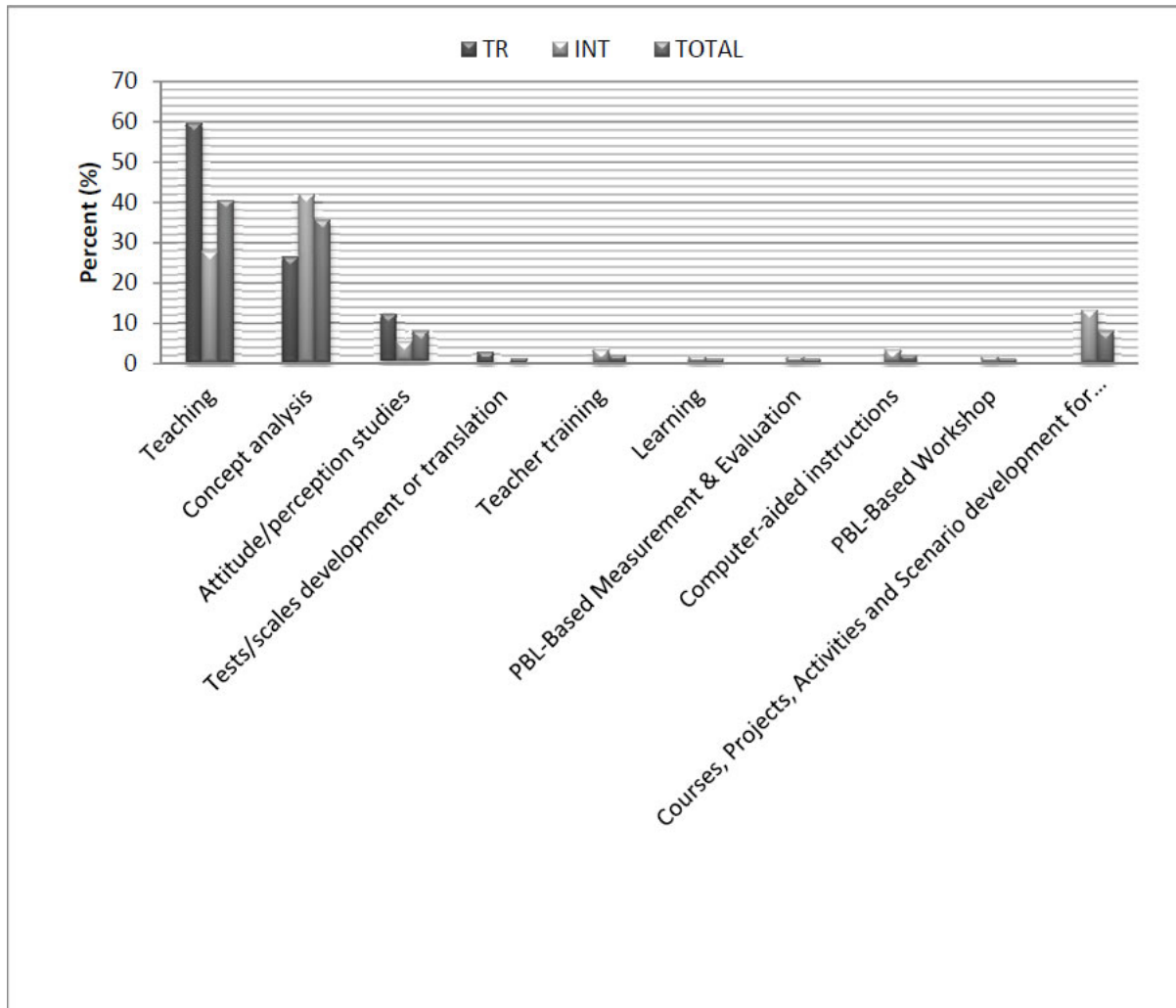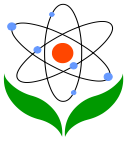
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.11 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

**Figure 3.** Frequently investigated subject matters by the paper on PBL science education researches

Again Table 3 demonstrates that success level and identifying learning styles under learning; preservice teacher education and in-service training under teacher training, and comparing effectiveness of different teaching method, methods under teaching constitute a small number of the studies whose content analysis was made, and these subjects were only preferred by foreign authors.
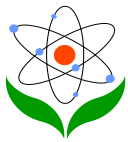
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.12 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

**Table 3.** Frequently investigated sub-topic of learning, teaching and teacher training

| Subject matter | | TR | | INT | | Total | |
|---|---|---|---|---|---|---|---|
| | | f | % | f | % | f | % |
| Learning | To determine the level of success | --- | --- | 1 | 1.6 | 1 | 0.9 |
| | Learning style identification | --- | --- | 1 | 1.6 | 1 | 0.9 |
| Teaching | Teaching methods on students' academic achievement | 18 | 42.9 | 8 | 12.9 | 26 | 25.0 |
| | Teaching methods on students' attitudes | 16 | 38.1 | 9 | 14.5 | 25 | 24.0 |
| | Teaching methods on students' scientific process skills | 13 | 30.9 | 8 | 12.9 | 21 | 20.2 |
| | Compared the effectiveness of different teaching methods | --- | --- | 1 | 1.6 | 1 | 0.9 |
| Teacher training | Preservice Teacher Education | --- | --- | 2 | 3.2 | 2 | 1.9 |
| | Inservice Training | --- | --- | 1 | 1.6 | 1 | 0.9 |

The research methods used in the papers on PBL in science education are given in Figure 4. According to Figure 4, while qualitative research methods were preferred in 50.9% of the studies, quantitative research methods were preferred in 33.6% of the studies and mixed research methods were preferred in 10.6% of the studies. It is understood that Turkish authors preferred quantitative research methods (61.9%) more than qualitative (28.6%) and mixed research methods (2.4%), while foreign authors preferred qualitative research methods (66.1%) more than quantitative research methods (14.5%) and mixed research methods (16.1%).
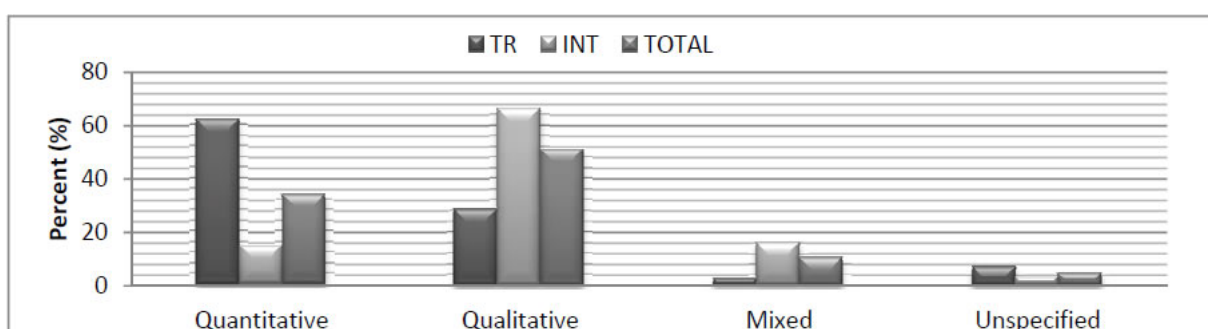


**Figure 4.** Frequently used research design/methods on PBL in science education

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.13 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
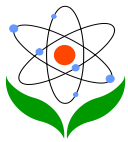analysis of research papers

Figure 5 includes which of qualitative, quantitative and mixed methods- are preferred by both Turkish and foreign authors in their studies on PBL in science education.

It is seen that in 35.6% of the studies, non-interactive research, a qualitative research method, was used. Experimental research as a, quantitative research method was preferred in 27.9%. Interactive, mixed and non-experimental research methods; were used in 19.2%, 10.6%, and 5.8%, respectively. It is also seen that in the papers of Turkish authors, 57.1% preferred experimental research method while 26.2% preferred non-interactive research methods; 7.1% preferred interactive research methods, 4.8% preferred non-experimental methods; 2.4% preferred mixed research methods. Foreign authors, on the other hand, preferred non-interactive research methods in 41.9% of their studies; interactive research methods in 27.4% of their studies; mixed research methods in 16.1% of their studies; experimental in 8.1% of their studies and non-experimental research methods in 6.5% of their studies.
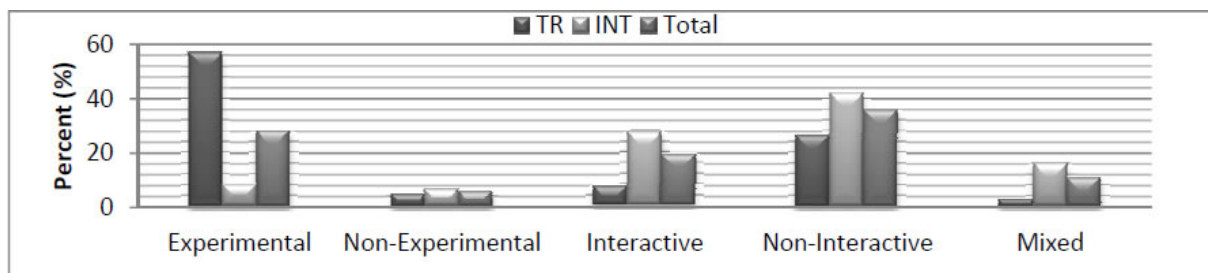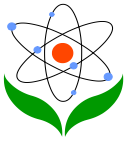


**Figure 5.** Frequency of research design/methods on PBL

Figure 6 is formed to identify which research methods among qualitative, quantitative and mixed research methods are preferred in studies on PBL in science education.

Looking at Figure 6, it is understood that Turkish authors preferred quantitative research methods in their studies on PBL in science education and in 47.6% of their studies they used quasi-experimental research; while in 23.8% of their studies they preferred concept analysis; in 9.5% of the studies they preferred pre-experimental; in 7.1% of the studies they preferred case study and in 2.4% of the studies they preferred review, correlation, survey and triangulation. It is also figured out from the figure that foreign authors, on the other hand, preferred qualitative research methods in their studies and preferred concept analysis in 35.5% of their studies; case study in 27.4% of their studies; triangulation in 11.3% of their studies;

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.14 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

quasi-experimental and review in 6.5% of their studies; survey, comparative and explanatory research design in 3.2% of their studies; pre-experimental and exploratory research design in 1.6% of their studies.
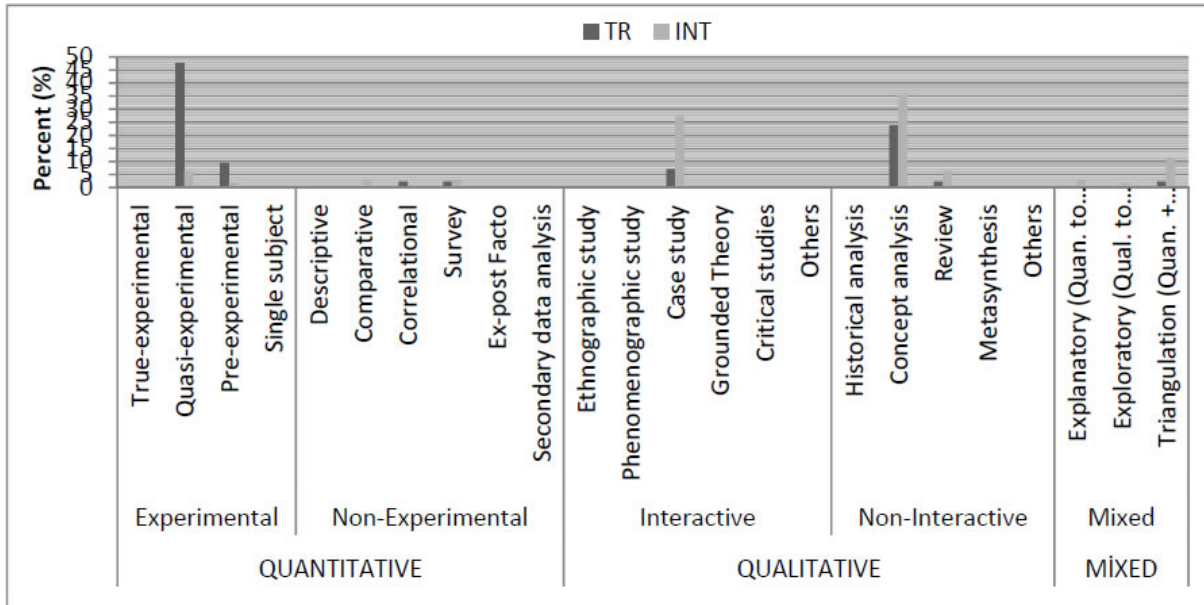


**Figure 6.** Frequently used research design/methods on PBL in science education

Figure 7 is made to show the frequency of the research methods that Turkish and foreign authors preferred in their studies by years.
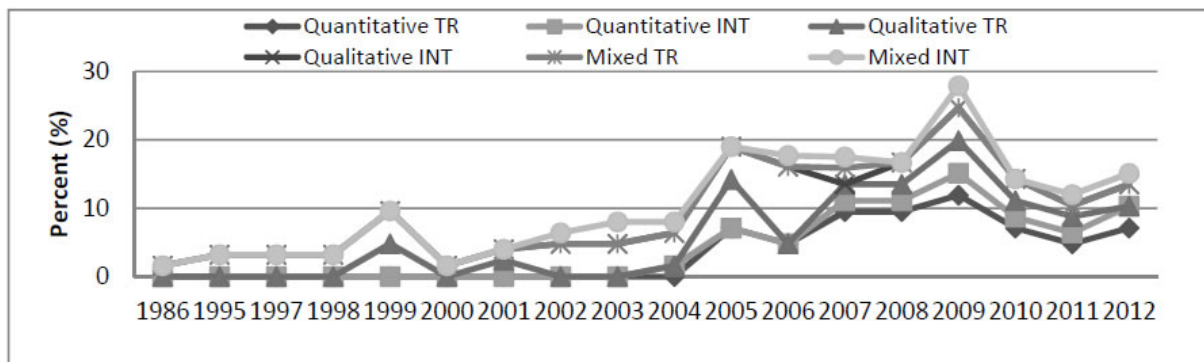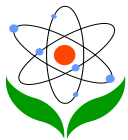


**Figure 7.** Trends in research designs across years (1986-2012)

According to Figure 7, in 11.9% of the studies that Turkish authors published in 2009, they preferred quantitative research methods the most. Foreign authors, however, seem to have preferred qualitative research methods most in 11.3% of their studies in 2006.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.15 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers
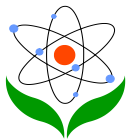
Frequently preferred data collection tools in studies on PBL in science education are given in Table 4. While forming Table 4, whether more than one data collection tool is used in one study was considered. And while calculating the percentages for Turkish authors, the number of the data collection tools used was calculated by dividing them by total number of papers that Turkish authors made, whereas the same thing was done by dividing the number of data collection tools by total number of papers that foreign authors published.

**Table 4.** Frequently used data collection tools in science education researches

| Type of data collection tools | TR | | INT | | TOTAL | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| Achievement tests | 16 | 38.1 | 11 | 17.7 | 27 | 25.9 |
| Questionnaires | 17 | 40.5 | 16 | 25.8 | 33 | 31.7 |
| Interviews | 8 | 19.0 | 18 | 29.0 | 26 | 25.0 |
| Observations | --- | --- | 15 | 24.3 | 15 | 14.4 |
| Alternative assessment tools | 5 | 11.9 | 17 | 27.4 | 22 | 21.2 |
| Perception, attitude, skill, personality tests etc. | 13 | 30.9 | 5 | 8.1 | 18 | 17.3 |
| Documents | 1 | 2.4 | 1 | 1.6 | 2 | 1.9 |

According to Figure 4, questionnaires were used in 37.1% of the papers on PBL in science education; while achievement test was used in 25.9% of the studies; interviews were used in 25% of the studies; alternative evaluation tools were used in 21.2% of the studies. Other scales like perception, attitude, skill, personality tests etc. were used in 17.3% of the studies; observation was used in 14.4% and documents were used in 1.9% of the studies.

It is seen that Turkish authors preferred questionnaires the most (40.5%) in their studies on PBL in science education. It is followed by achievement tests (38.1%), perception-attitude-skill-personality etc. scales (30.9%), interviews (19.0%), alternative evaluation tools (11.9%) and documents (2.4%) respectively. Foreign authors, on the other hand, seem to have preferred interviews in most of their studies (29.0%); and interviews were followed by alternative evaluation tools (27.4), questionnaires (25.8%), observation (24.3%), achievement test (17.7%), perception- -attitude-skill-personality etc. scales (8.1%) - and documents (1.6%), respectively.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.16 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

In the studies whose content analysis was made using paper classification form, the type of questionnaires preferred were identified as well as the type of questions used in achievement tests. The type of observations and interviews used in these studies were also included. Among the total 33 papers in which questionnaires were used as data collection tools, likert-type questionnaires were preferred in 26 of them - in 13 papers of Turkish and foreign authors each while in 9 papers open-ended questionnaires were preferred - in 4 Turkish and 5 foreign authors' papers. And among 27 papers in which achievement test was used, multiple-choice questions were preferred in 24 of them- in 16 Turkish and 8 foreign authors' studies- while open-ended questions were preferred in 10 - in 6 Turkish authors' and 4 foreign authors' studies- and questions grouped as "other" in 2 studies- in 1 Turkish author's study and 1 foreign author's study. In 21 of the studies, among 26 in which interview was used as data collection tool, semi-structured interview was used (in 7 Turkish and 14 foreign authors' papers), while in 2 of them, focus group discussion was preferred (in 1 Turkish author's and 1 foreign author's paper). In 3 studies that belong to foreign authors, the type of interview was not specified. All 15 studies in which observation was used as data collection tool belong to foreign authors; and among these studies, nonparticipant observation was preferred in 11 studies. In 4 studies, the type of observation made was not given.

Figure 8 includes the frequency of data collection tools preferred by Turkish and foreign authors in their studies on PBL in science education. In 35.6% of the studies analyzed, there were no data collection tools used or specified. The rate of studies in which only one data collection tool was used was 25.0%; while the rate of studies in which 2 data collection tools were used was 19.2%, and the rate of studies in which 3 and more data collection tools were used was 20.2%.
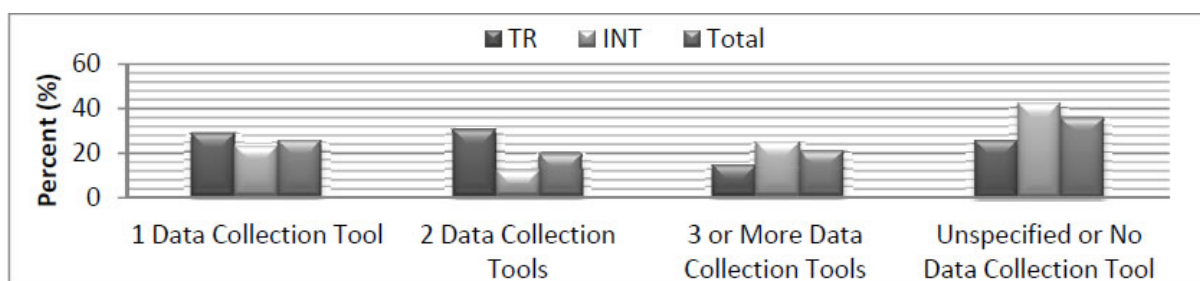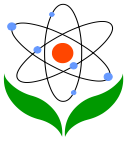


**Figure 8.** Frequency of different data collection tools

Figure 8 reveals that in 30.2% of their studies, Turkish authors preferred 2 data collection tools while in 27.9% of their studies, they preferred one data collection

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.17 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

tool and in 13.9% of the studies, they preferred three or more data collection tools. Foreign authors, on the other hand, preferred three or more data collection tools in 24.2% of their studies; one data collection tool in 22.6% of their studies and two data collection tools in 11.3% of their studies.

The frequently preferred samples in the studies on PBL in science education are given in Figure 9. In 36.5% of the studies, whose content analysis was made, samples were not given. In 35.6% of the studies, undergraduate students were chosen as the sample, while in 13.5% secondary school students (9-12) were chosen as the sample; in 9.6% primary school students (6-8); in 3.8%, teachers; in 1.9% primary school students (1-5) and in 0.9%, faculty members were chosen as study samples. In 42.9% of the studies carried out by Turkish authors on PBL in science education, undergraduate students were preferred; while in 16.7% secondary school students (9-12); in 11.9% primary school students (6-8) and in 2.4% primary school students (1-5), faculty members and teachers were preferred. In 26.2% of the studies by Turkish authors, the samples of the study was not specified. On the other hand, in 30.6% of the studies by foreign authors on PBL in science education, undergraduate students were preferred as the samples of the study; while in 11.3% secondary school students (9-12); in 8.1%, primary school students (6-8); in 4.8%, teachers and in 1.6%, primary school students (1-5) were preferred as the population of their studies. And in 43.6% of the studies of foreign authors, the samples of the study was not given.
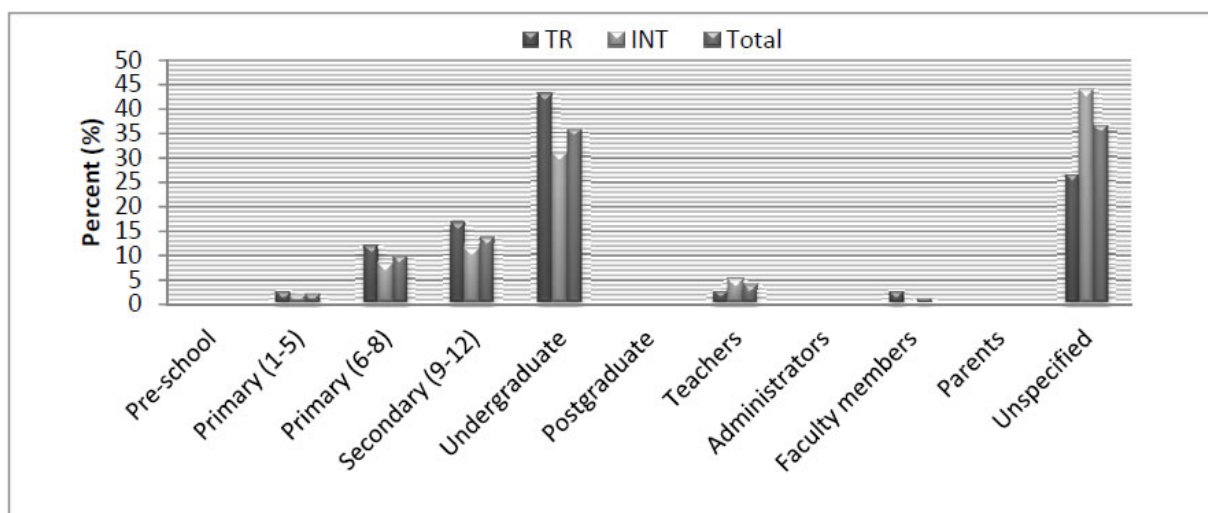


**Figure 9.** Frequently studied samples.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.18 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
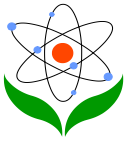analysis of research papers

Figure 10 is made regarding the sample sizes. When Figure 10 is analyzed, it is seen that in 39.4% of the studies on PBL in science education, sample sizes is not specified. It is seen that in 30.8% of the studies, sample size was between 31-100; while in 15.4%, it was between 101-300; in 7.7%, it was 11-30; in 2.9%, it was 1-10 and again in 2.9%, it was 301-1000 and in 0.9%, it was over 1000. It is seen from the Figure 10 that in 40.5% of the studies by Turkish authors and in 24.2% of the studies by foreign authors, sample sizes was between 31-100; while in 23.8% of the studies by Turkish authors and 9.7% of the studies by foreign authors, sample sizes was between 101-300. And in 7.1% of the studies by Turkish authors and in 8.1% of the studies by foreign authors, sample sizes was 11-30; while in 2.4% of the studies by Turkish authors and 3.2% of the studies by foreign authors, sample sizes was between 301-1000. Again, according to Figure 10, Turkish authors did not work with sample sizes between 1-10 and over 1000 and that in 26.2% of the studies of Turkish authors, they did not specify sample sizes of their studies. Foreign authors, on the other hand, preferred 1-10 sample sizes in 4.8% of their studies on PBL in science education and over 1000 sample sizes in 1.6% of their studies; and in 48.4% of their studies, they did not mention study sample sizes.
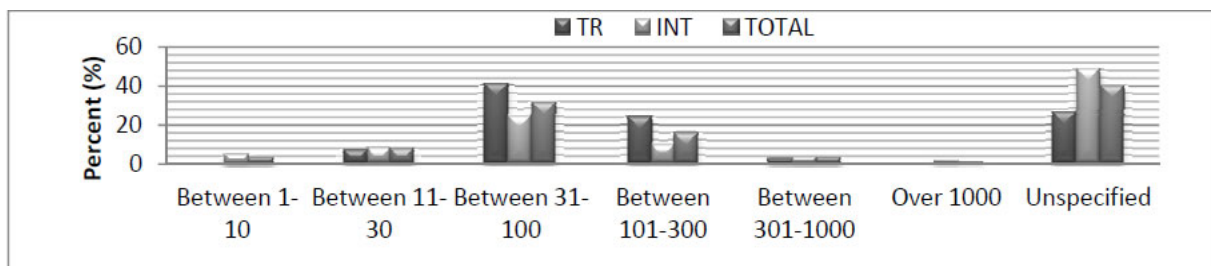


**Figure 10.** Frequently studied sample sizes.

Frequently preferred data analysis methods of both Turkish and foreign authors on PBL in science education are given in Table 5 and Figure 11.
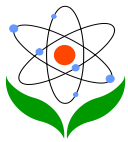
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.19 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

**Table 5.** Frequently used data analysis methods and techniques

| | | | TR | | INT | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | | | f | % | f | % | f | % |
| QUANTITATIVE ANALYSIS | Descriptive statistics (%54.0) | f / % tables | 28 | 25.2 | 28 | 28.0 | 56 | 26.5 |
| | | Central tendency measures | 26 | 23.4 | 19 | 19.0 | 45 | 21.3 |
| | | Charts | 4 | 3.6 | 9 | 9.0 | 13 | 6.2 |
| | | Others | --- | --- | --- | --- | --- | --- |
| | Inferential statistics (%29.9) | t-testi | 18 | 16.2 | 8 | 8.0 | 26 | 12.3 |
| | | ANOVA/ANCOVA | 12 | 10.8 | 4 | 4.0 | 16 | 7.6 |
| | | MANOVA/MANCOVA | 5 | 4.5 | --- | --- | 5 | 2.4 |
| | | Factor analysis | 2 | 1.8 | --- | --- | 2 | 0.9 |
| | | Correlation | 4 | 3.6 | 1 | 1.0 | 5 | 2.4 |
| | | Regression | 1 | 0.9 | 3 | 3.0 | 4 | 1.9 |
| | | Non-Parametric Tests | 2 | 1.8 | 3 | 3.0 | 5 | 2.4 |
| QUALITATIVE ANALYSIS | Qualitative analysis (%16.0) | Content analysis | 2 | 1.8 | 4 | 4.0 | 6 | 2.8 |
| | | Descriptive analysis | 7 | 6.3 | 21 | 21.0 | 28 | 13.2 |
| | | Others | --- | --- | --- | --- | --- | --- |
| | | Total | 111 | 100 | 100 | 100 | 211 | 100 |

According to Table 5 and Figure 11, in 54.0% of the studies, whose content analysis was made, descriptive analysis, one of the quantitative data analysis methods, was used; while in 29.9% inferential analysis, another quantitative data analysis methods, was used; and in 16.0% qualitative data analysis method was preferred. In 26.5% of the studies, whose content analysis was made, frequency/percent tables were the most preferred methods; while in 21.3% central tendency measures; and in 13.2% qualitative descriptive analysis methods were preferred methods. In 25.2% of the studies of Turkish authors on PBL in science education, frequency/percent tables were preferred; while in 23.4%, it was the central tendency measures that was preferred; in 16.2% it was the t-test and in 10.8%, ANOVA/ANCOVA was preferred the most. In 28.0% of the studies by foreign authors on PBL in science education, on the other hand, frequency/percent tables were frequently used ; while in 21% of their studies it was the qualitative descriptive analysis and central tendency measures in 19.0% .
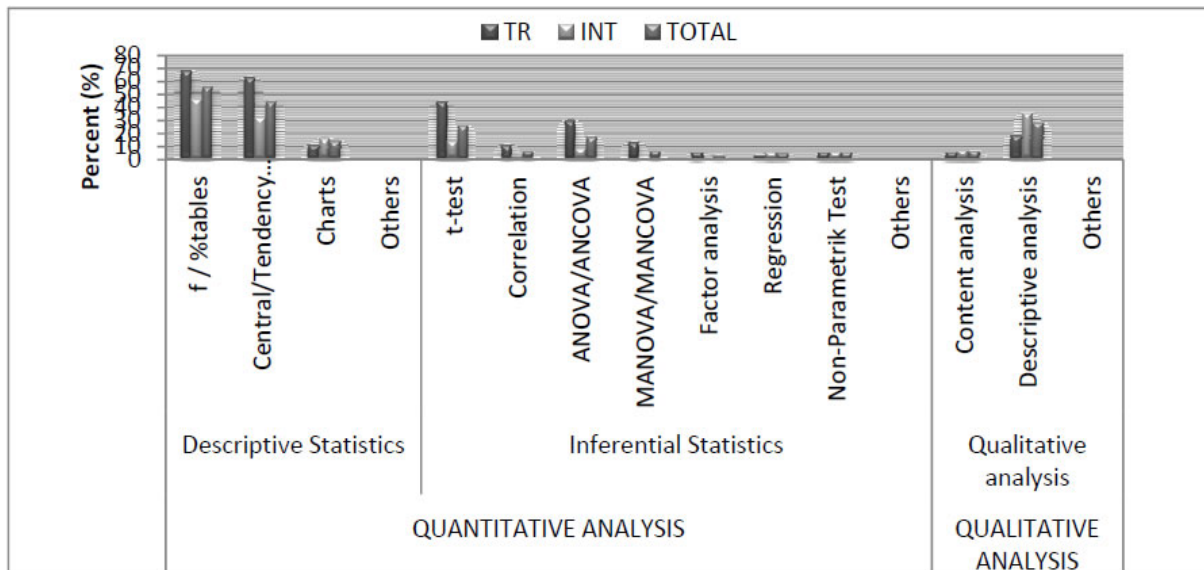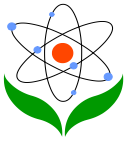
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.20 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

**Figure 11.** Frequently used data analysis methods and techniques

Figure 12 shows the number of data collection tools preferred both by Turkish and foreign authors in only one study.
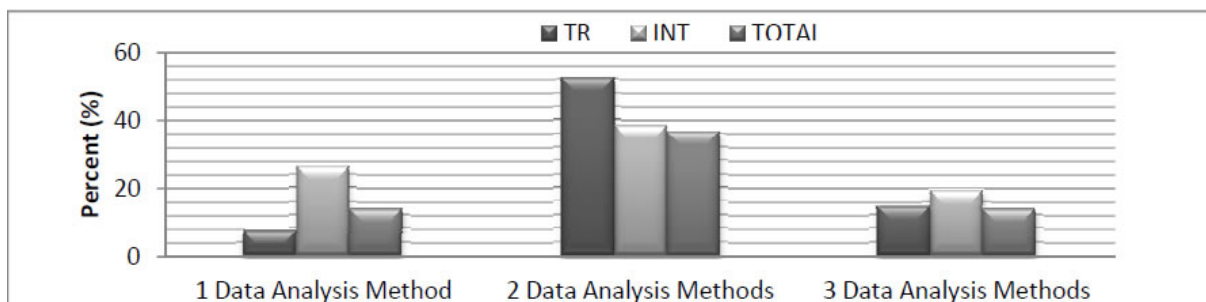


**Figure 12.** Number of different data analysis methods combined in a study

When Figure 12 is examined, it is seen that two different data analysis methods were the most preferred methods in the studies. That rate is 36.5%. And in 13.5% of all the studies, one and three different data analysis methods were preferred. In 36.5% of the studies, whose content analysis was made, the data analysis method was not specified. Turkish authors preferred two different data analysis method in 52.4% of the studies they made while the rate is 38.1% in the studies of foreign authors. In 14.3% of the studies, Turkish authors preferred three different data analysis methods while foreign authors preferred three different data analysis method in 19.0% of their studies. And while Turkish authors preferred one data analysis method in 7.1% of their studies, foreign authors preferred one data analysis method in 26.2% of their studies.

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.21 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

# Result and Discussion

The aim of this content analysis study was to determine the status of both national and international papers on PBL in science education both in Turkey and abroad. To this end, the content analysis of a total of 104 papers, including 42 papers belonging to Turkish authors and 62 articles belonging to foreign authors, published between 1986-2012 on PBL in science education was made.

It can be said that until 2005, the interest towards PBL in science education in Turkey was very limited; and between 2005 and 2009 this interest reached its peak. While the foreign authors had a superiority over Turkish authors in terms of their papers on PBL in science education until 2005, it is seen that as of 2005, except the year 2006, the number of papers of Turkish authors has been equal to/higher than the number of papers by foreign authors until 2012. This situation is in compliance with findings of Kizilaslan, Sozbilir & Yasar, (2012) which states that until 2006, the number of papers made using inquiry-based method in our country is limited.

It is seen that almost one in every three studies that Turkish and foreign authors working on PBL in science education, it is the mixed study that the authors preferred; and it is chemistry one in every three study that is preferred. Besides, it is seen that studies with undergraduate and secondary school (9-12) students were focused on in PBL studies on science education. This finding complies with the finding of Goktas et. al. (2012) in which he states that it is undergraduate students and teachers who are preferred as the samples of educational researches in Turkey. There are no studies in which either Turkish or foreign authors preferred preschool students, graduate students, administrators and parents as the sample of their studies. This can be evaluated as a lacking issue in studies on PBL in science education both in Turkey and abroad.

On the other hand, in a majority of studies on PBL 31 to 100 participants took place. This is because both authors in Turkey and abroad prefer to use purposeful sampling and convenience sampling out of non-random sampling methods. When choosing convenience sampling method, the groups or individuals for whom participating in the research process was easier were preferred. These findings are in compliance with the findings of the studies by Sozbilir, Kutu & Yasar, (2012).
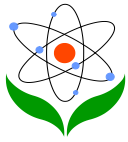
The first studies on science education started with the changes in the curricula and later, studies on learning science concepts were concentrated on. Then, it had been

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.22 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

the studies on private teaching methods that were the focus of researchers. PBL studies whose practices have been made in the last 10-15 years, is not a new teaching method for Turkish science educators. However, it is observed that in almost half of the studies carried out by Turkish authors, quasi-experimental methods, a quantitative research design was preferred; and in almost one fourth of those studies, concept analysis was preferred. Ciltas (2012) made a content analysis of the dissertations on mathematics education in Turkey between 2005- and 2010. As a result, quantitative research design were preferred more in the dissertations in the field of mathematics. Similar results were obtained from the studies of Kizilaslan, Sozbilir & Yasar, (2012) and Goktas et al. (2012). On the other hand, it is seen that in one third of the studies by foreign authors, it was concept analysis that was preferred and in almost one fourth of their studies, it was case study that was chosen. The reason behind this could be that in studies towards determining the efficiency of teaching, Turkish authors mostly prefer achievement test and questionnaire as the data collection tool while foreign authors prefer interviews and alternative evaluation tools.
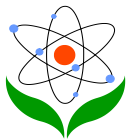
This study shows that compared to foreign authors, Turkish authors studying science education in their articles had more studies in which the effect of teaching on achievement, attitude and scientific process skills were examined at one time. Foreign authors, on the other hand, included interview, observation and alternative evaluation tools more in their studies. This shows that Turkish authors studying PBL in science education prefer product-based evaluation methods as in traditional teaching methods more compared to process-based evaluation methods. As for Nendaz and Tekian (1999) Turkish authors neglect process-based evaluations, a basic characteristic of PBL, in their PBL practices.

Besides, it is found that there are no studies on multimedia which will enable the integration of PBL with technology as well as the removal of some of the disadvantages faced in PBL practices. As for Hoffman and Ritchie (1997) multimedia reduces some of the disadvantages faced in PBL practices. However, it is seen that there are no studies related to multimedia that will enable the integration of PBL and technology either by Turkish authors or foreign authors. The results of this content analysis work offers a framework for both Turkish and foreign science educators on PBL studies.
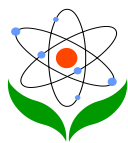
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.23 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
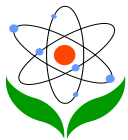analysis of research papers

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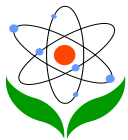
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.24 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
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Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers
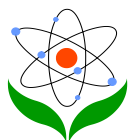
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Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

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Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.27 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
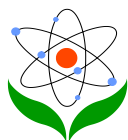analysis of research papers

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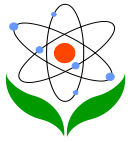
Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.28 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

# Appendix

*Appendix 1. Title of the journals covered the articles about PBL subjected to the content analysis by Turkish authors*

| Nr | Title of the Journal | Type of Journal | Frequency | % |
|---|---|---|---|---|
| 1 | Hacettepe Uni. Educ. Fac. Journal | National | 7 | 16.7 |
| 2 | Asia Pacific Forum on Science Learning and Teaching | International | 4 | 9.5 |
| 3 | Eurasia Journal of Mathematics, Science & Technology Education | International | 3 | 7.1 |
| 4 | Research in Science & Technological Education | International | 3 | 7.1 |
| 5 | Journal of Turkish Science Education | National | 3 | 7.1 |
| 6 | Kastamonu Uni. Kastamonu Educ. Fac. Journal | National | 3 | 7.1 |
| 7 | Research in Science Education | International | 2 | 4.8 |
| 8 | Journal of Science Education and Technology | International | 2 | 4.8 |
| 9 | Journal of Education and Social Sciences | National | 2 | 4.8 |
| 10 | Educational Research | National | 1 | 2.4 |
| 11 | The Journal of Educational Research | International | 1 | 2.4 |
| 12 | International Journal of Environmental & Science Education | International | 1 | 2.4 |
| 13 | Biochemistry and Molecular Biology Education | International | 1 | 2.4 |
| 14 | Educational Sciences: Theory & Practice | National | 1 | 2.4 |
| 15 | Dokuz Eylul Uni. The Journal of Graduate School of Social Sciences | National | 1 | 2.4 |
| 16 | Inonu Uni. Educ. Fac. Journal | National | 1 | 2.4 |
| 17 | Erzincan Uni. Erzincan Educ. Fac. Journal | National | 1 | 2.4 |
| 18 | Ataturk Uni. Kazım Karabekir Educ. Fac. Journal | National | 1 | 2.4 |
| 19 | Ankara Uni. Journal of Faculty of Educational Sciences | National | 1 | 2.4 |
| 20 | Marmara Uni. Ataturk Educ. Fac. Journal | National | 1 | 2.4 |
| 21 | Elementary Education Online | National | 1 | 2.4 |
| 22 | Dokuz Eylul Uni. Buca Educ. Fac. Journal | National | 1 | 2.4 |
| Total | | | 42 | 100 |

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.29 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content analysis of research papers

*Appendix 2.* Title of the journals covered the articles about PBL subjected to the content analysis by Foreign authors

| Nr | Title of the Journal | Type of Journal | Frequency | % |
|---|---|---|---|---|
| 1 | Chemistry Education Research and Practice | International | 8 | 12.9 |
| 2 | Journal of Chemical Education | International | 6 | 9.7 |
| 3 | Journal of Science Education and Technology | International | 4 | 6.5 |
| 4 | Science Education | International | 4 | 6.5 |
| 5 | Journal of Interactive Learning Research | International | 3 | 4.8 |
| 6 | The Interdisciplinary Journal of Problem Based Learning | International | 3 | 4.8 |
| 7 | Journal of Technology and Teacher Education | International | 2 | 3.2 |
| 8 | Journal fo Family and Consumer Science Education | International | 2 | 3.2 |
| 9 | Journal of Further and Higher Education | International | 2 | 3.2 |
| 10 | Research in Science Education | International | 1 | 1.6 |
| 11 | Research in Science & Technological Education | International | 1 | 1.6 |
| 12 | International Journal of Science and Technology Education Research | International | 1 | 1.6 |
| 13 | International Journal of Environmental & Science Education | International | 1 | 1.6 |
| 14 | International Journal of Science Education | International | 1 | 1.6 |
| 15 | Physics Education | International | 1 | 1.6 |
| 16 | Biochemistry and Molecular Biology Education | International | 1 | 1.6 |
| 17 | Educational Technology | International | 1 | 1.6 |
| 18 | Educational Technology Research and Development | International | 1 | 1.6 |
| 19 | Analytical and Bioanalytical Chemistry | International | 1 | 1.6 |
| 20 | Journal of Elemantary Science Education | International | 1 | 1.6 |
| 21 | New Directions for Teaching and Learning | International | 1 | 1.6 |
| 22 | The Science Teacher | International | 1 | 1.6 |
| 23 | The Journal of the Learning Science | International | 1 | 1.6 |
| 24 | School Science and Mathematics | International | 1 | 1.6 |
| 25 | Studies in Higher Education | International | 1 | 1.6 |
| 26 | University Chemical Education | International | 1 | 1.6 |
| 27 | Journal of Interactive Learning | International | 1 | 1.6 |

Asia-Pacific Forum on Science Learning and Teaching, Volume 14, Issue 2, Article 4, p.30 (Dec., 2013)
Cemal TOSUN and M. Diyaddin YASAR
Comparison of problem-based learning studies in science education in Turkey with the world: Content
analysis of research papers

| 28 | Cell Biology Education | International | 1 | 1.6 |
|---|---|---|---|---|
| 29 | Journal of College Science Teaching | International | 1 | 1.6 |
| 30 | Journal of Investigative Surgery | International | 1 | 1.6 |
| 31 | Instructional Science | International | 1 | 1.6 |
| 32 | Computer in Human Behaviour | International | 1 | 1.6 |
| 33 | Peabody Journal of Education | International | 1 | 1.6 |
| 34 | Educational Psychology Review | International | 1 | 1.6 |
| 35 | Educational Psychologist | International | 1 | 1.6 |
| 36 | The Journal of Cases in Educational Leadership | International | 1 | 1.6 |
| 37 | International Union of Biochemistry and Molecular Biology | International | 1 | 1.6 |
| **Total** | | | **62** | **100** |