

The Effect of Learning by Teaching on Pre-Service Science Teachers' Attitudes towards Chemistry

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ABSTRACT

This study examined the effect of learning by teaching on pre-service science teachers' attitudes towards chemistry. The method used in this study; *learning by teaching*, was developed by Jean-Pol Martin for foreign language classes and is frequently used in Germany. This method has been restructured over a 3-year process to be used in a science course in this study. The current study presents the implementation of the method after three years' revision. The sequential explanatory method was followed which is one of the mixed methods research designs. The study was conducted during the 2015–2016 academic year with 49 pre-service science teachers, who were selected by purposeful sampling. Data was collected twofold: with a Chemistry Attitude Scale and focus group interview. The results of this study showed that learning by teaching was effective in positively increasing the attitudes towards chemistry.

Keywords: Attitude towards chemistry, learning by teaching, pre-service science teachers.

INTRODUCTION

Students' attitudes have a significant position in educational research (Osborne, Simon & Collins, 2003). The fact of attitudes being emphasised in instructional programmes also addresses their significance in education. A positive increase in students' attitudes is stated as an important goal in these programmes (National Board of Education [NBE], 2013, p. 1, 3, 23, 25). There are two main reasons behind the intent to positively increase students' attitudes towards the content (e.g. chemistry). The first one is the positive relationship between attitude and academic achievement (Bakar, Tarmizi, Mahyuddin, Elias, Luan & Ayub, 2010; Hacıeminoğlu, 2016; Hançer, Uludağ & Yılmaz, 2007; Narmadha & Chamundeswari, 2013; Wang, Tsai, Chu, Lei, Chio & Lee, 2015). In other words, students' attitudes affect their academic achievement. The second reason is that attitudes can predict behaviour (Kayaoğlu, 2011, p. 175). They have an impact on feelings, beliefs and behaviours (Jain, 2014). Attitudes can influence students' decisions on choice of career or course (e.g. socio-scientific issues like GMOs) as well as their participation in an activity in a certain discipline (Germann, 1988).



Thus, it can be suggested that once students' attitudes are revealed, their behaviours can be predicted (Arkonaç, 2008, p. 137).

The definition of attitude is in support of these explanations provided above. Güney (2013, p. 219) defines attitude by consolidating a wide range of definitions in the research base: 'Attitude is a tendency of reaction created in a cognition, affect and behaviour coherence. This tendency is organised based on experiences and knowledge towards oneself and towards everything else; alive or not, concrete or not.' According to the studies conducted on attitudes, it can be concluded that attitude has three components: cognitive, affective and behavioural (Arkonaç, 2008, p. 138; Güney, 2013, p. 224–228; Jain, 2014; Yüksel, 2006, p. 102).

In the cognitive component, the organisation of knowledge is the sum of the individual's views, ideas and beliefs towards the attitude object (e.g. chemistry) (Arkonaç, 2008, p. 138; Güney, 2013, p. 227; Jain, 2014). The feelings and evaluation of the individual towards the attitude object forms the affective component. This includes judgements such as liking or not liking and loving or not loving attitude objects. These objects can be alive-not alive or concrete-abstract. (Güney, 2013, p. 227; Jain, 2014; Yüksel, 2006, p. 102). The affective component is considered the most important component because emotions play a major role in the attitude development process (Jain, 2014). The final component of attitude, the behavioural component, can be described as the tendency to move in line with the emotion or with the claims (Güney, 2013, p. 228). This is the verbal or practical representation of the attitude (Yüksel, 2006, p. 102) and can result in positive or negative actions towards the attitude object. It can be predicted that one would show positive behaviour towards the attitude object if she/he has a positive attitude towards it. Similarly, one would show negative behaviour towards the attitude object if she/he has a negative attitude towards it (Güney, 2013, p. 228).

When the above information is considered from the perspective of students' attitudes towards chemistry, important conclusions can be drawn. Students' attitudes towards chemistry might have an effect on their academic achievement in chemistry and on their decisions and behaviours within chemistry content. In this respect, it is significant to increase students' positive attitudes towards chemistry. The literature on attitudes towards chemistry can be summarised in four prominent headings. These can be stated as a) developing or adapting surveys to measure students' attitudes towards chemistry (Cheung, 2009; Coll, Dalgety & Salter, 2002; Demircioğlu, Aslan & Yadigaroglu, 2014; Kan & Akbaş, 2005; Salta & Tzougraki, 2004; Şenocak, 2011), b) comparing students' attitudes towards chemistry among grade levels or between certain classes (Can & Boz, 2012; Çalık, Ültay, Kolomuç & Aytar, 2015; Heng & Karpudewan, 2015; Kan & Akbaş, 2006; Salta & Tzougraki, 2004), c) examining the correlation between attitudes towards chemistry and other variables (Berberoğlu & Demircioğlu, 2000; Fah & Hoon, 2012; Dara & Charles, 2011; Demircioğlu & Norman, 1999; Kan & Akbaş, 2006; Kingır & Aydemir, 2012) and d) investigating the effect of an instructional approach, method, technique, tool or activity on students' attitudes towards chemistry (Akgün, 2005; Ayyıldız & Tarhan, 2012; Buluş Kırıkkaya & Vurkaya, 2011; Chase, Pakhira & Stains, 2013; Marasigan & Espinosa, 2014; Morgıl, Gungor Seyhan, Ural Alsan & Temel, 2008). The present study can be considered among the fourth group of studies presented above. The goal of this study is to understand the effect of the instructional method, learning by teaching, on pre-service science teachers' attitudes towards chemistry. The literature on the implementation of this method in chemistry education is limited. This study also presents an example of such an implementation within chemistry curriculum.

The learning by teaching (LbT) method comprises two important processes: learning to be able to teach others and teaching others what has been learned (Fiorella & Mayer, 2013). It can be stated that these two processes provide a powerful way of learning. LbT is practised

in various ways (Fiorella, & Mayer, 2013; Frager & Stern, 1970; Okita, Turkay, Kim & Murai, 2013; Goto & Schneider, 2010; Norintan, 2008; Roscoe, 2014; Suvannatsiri, Santichaiant & Murphy, 2015). One of these applications is the way used in Jean-Pol Martin's foreign language lessons (Aslan, 2015; Grzega & Klüsener, 2011; Grzega & Schöner, 2008; Karakaya, 2007; Lernen durch Lehren, 2015; Martin & Kelchner, 1998; Skinner, 1994). The LbT method used in this study has been developed based on Jean-Pol Martin's applications. The first implementation was in the academic year 2012–2013 with the LbT method that Jean-Pol Martin suggested for foreign language classes. In line with the students' views and the constructivist paradigm, the framework was restructured to make it more effective with science content (see Aslan, 2014). The second implementation took place in the academic year 2013–2014 in a 'Special Topics in Chemistry' class. Following this, the LbT method was revised once more based on students' views and experiences during the second implementation. This new revised version was practised in the academic year 2014–2015. In summary, after each implementation, the method was restructured and new stages were added based on students' views and experiences (see Aslan, 2015).

This study represents the last stage of the method that was modified. This last stage was changed from a 'Writing to learn activity (letter writing): Writing a letter regarding the topic to a recipient chosen by all the students' to 'Reflective thinking activities: Creating an activity (letter, story, poem, concept map, picture, poster, banner, puzzle, etc.) reflecting what the students learned on each topic'. This includes a different activity for each topic (e.g. letter, story, poem, concept map, picture, poster, flyer, puzzle). The new version of the method can be visualised as shown in Figure 1.

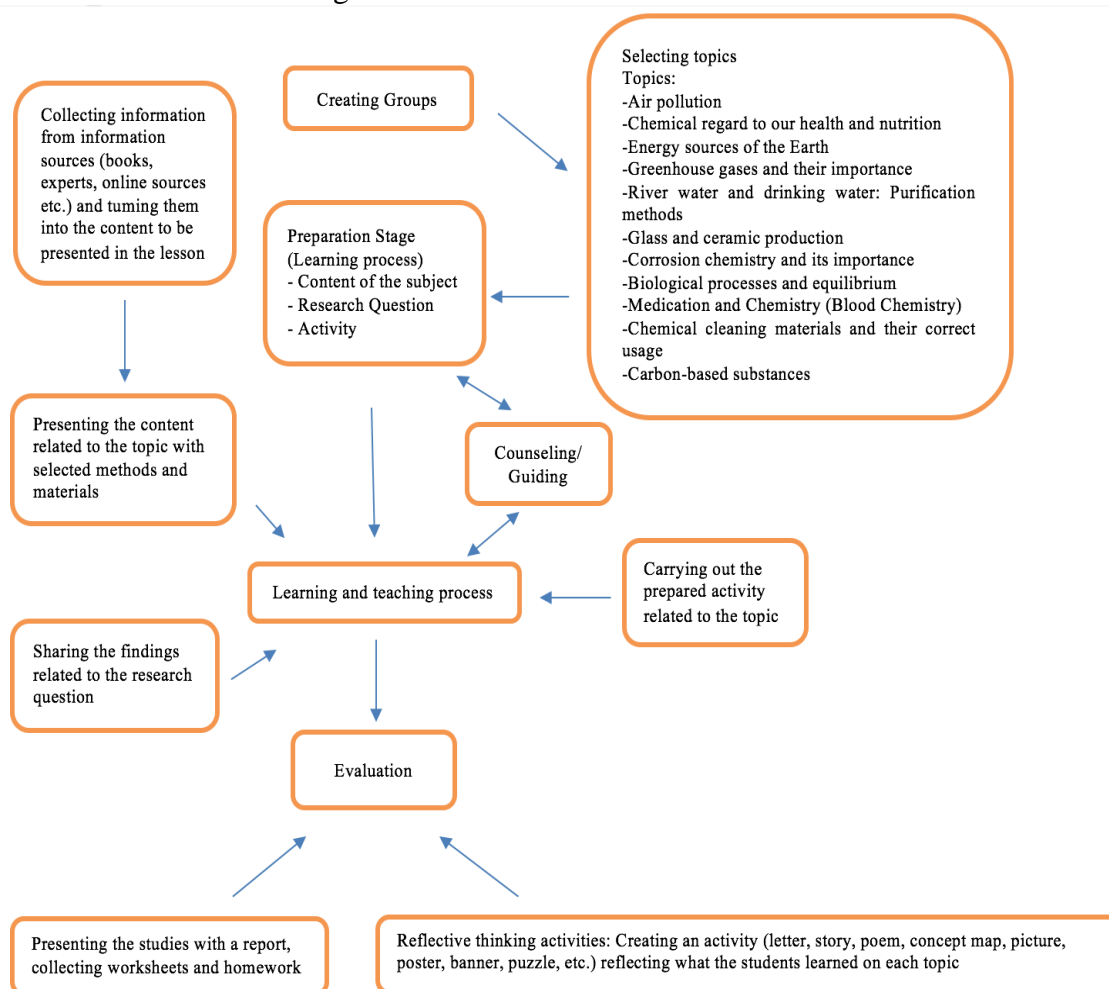


Figure 1: Learning by Teaching (LbT) for Special Topics in Chemistry Class

In this method, the teacher is responsible for teaching the ways of accessing knowledge and for internalising it. The teacher's role includes, but is not limited to, suggesting content areas to teach, suggesting instructional methods and activities, providing materials, helping students to effectively prepare, observing the actions and reactions during the preparation stage, interfering when there are potential problems and making sure that each student learns the concepts. The teacher should stand at the back of the class during lessons. The teacher should only step in when problems arise between the students, or when misunderstandings or mistakes take place. Another role of the teacher is to evaluate both individual students and the learning progress of the whole class. Some methods to undertake the evaluations are observing students' performances and providing feedback on activities, reports and assignments. The role of the teacher in the implementation of this method can be summed up as a guide or a facilitator (Grzega & Schöner, 2008; Karakaya, 2007; Skinner, 1994; Lernen durch Lehren, 2015).

During the implementation of the method, there are certain expectations for the students. The students should teach a topic that they decide on or one recommended by the teacher. The students form groups of three ideally. The students should ensure the engagement of their classmates and communication between everyone and follow a clear teaching methodology. The students are not expected to just present on the topic. That is why the LbT method should not be confused with students' presentations or explanations. In this method, students are not responsible for conveying a message or a topic to their classmates. They are responsible for specifying and implementing their own methods and instructional strategies to teach the topic to their classmates. Also, while teaching, the students should ensure that they are motivating their classmates, drawing in their attention and checking for their understanding of the topic and the concepts they are teaching. To do this, they should use different strategies rather than solely present the topic to their friends (Ahmed, 2013; Grzega & Schöner, 2008; Lernen durch Lehren, 2015). In this method, the students are directly responsible for both learning and teaching. Learning takes place both in the preparation and teaching stages (Aslan, 2015). To apply this method, the students should consider themselves as learners and teachers simultaneously, taking the responsibility of learning and research and learn by themselves (Karakaya, 2007). This might prove that this method can be particularly useful at the undergraduate level as well as in teacher education programmes.

METHODOLOGY

The sequential explanatory method was followed in this study, one of the mixed methods research designs (Creswell, 2013, p.15). In this methodology, both qualitative and quantitative data are essential (Robson, 2015, p. 199). In the sequential explanatory method, first, the quantitative data is analysed and interpreted and then is further explained by analysis of qualitative data (Creswell, 2013, p. 15). So, these two stages follow a certain order. The results of the quantitative data are explained together with qualitative data and all results are unified in the conclusion section of the study (Creswell, 2013, p. 15; Robson, 2015, p. 204).

This study focussed on the LbT method in a Special Topics in Chemistry course. The effect of this method on pre-service science teachers' attitudes towards chemistry was investigated in two consecutive stages: 1) collecting and analysing quantitative data, 2) collecting and analysing qualitative data to better interpret the results. The study was conducted in the academic semester of Fall 2015 for 14 weeks covering 11 different topics.

a) Participants

In total, 49 pre-service science teachers participated in the study; they were students of the science education programme in a public university in Turkey. The ages of the participants ranged from 19–22, with both females (n=31) and males (n=18). All of the pre-service science teachers take the course Special Topics in Chemistry. In the science education programme, the courses related to chemistry are as follows: General Chemistry I and General Chemistry Lab I are in the first semester, General Chemistry II and General Chemistry Lab II are in the second semester, General Chemistry III (Analytic Chemistry) is in the third semester, General Chemistry IV (Organic Chemistry) is in the fourth semester and Special Topics in Chemistry is in the fifth semester. Special Topics in Chemistry was purposefully chosen for this study because of its content relationship between science, technology, society and environment (STSE). It is thought that if pre-service science teachers' understanding and recognition of the relationships among STSE in the context of chemistry is provided with a better understanding of the importance of chemistry by them then this situation will affect their attitudes towards chemistry.

The science education programme is in total an eight-semester programme. After pre-service science teachers complete the programme, they will have a certificate to teach science to 5th through 8th grade students. Pre-service science teachers must take science content (e.g. Physics, Chemistry and Biology), pedagogical content knowledge and general culture courses to graduate from the science education programme.

b) Data Collection Tools

Attitude towards Chemistry Scale (ATCS)

The quantitative data of the study was collected with the ATCS to understand the effect of LbT on pre-service science teachers' attitudes towards chemistry. It was developed by Geban, Ertepinar, Yılmaz, Altın and Şahbaz (1994). This scale was chosen because it has been used in numerous studies (Akgun & Deryakulu, 2007; Can, 2012; Can & Boz, 2012; Erdem, 2015; Kaya & Geban, 2011; Kurbanoglu & Akim, 2010; Kingır, 2011; Kingır & Aydemir, 2012; Yuksel & Geban, 2014). In total, the scale includes 15 items placed on a five-point Likert scale. The statements that the scores correspond to are 'strongly agree' 5, 'agree' 4, 'undecided' 3, 'disagree' 2 and 'strongly disagree' 1. Among the items, five are negative statements, and ten are positive. The negative statements were reversed in the coding process. Possible scores may range between 15 and 75. Higher scores in the ASTC mean more positive attitudes towards chemistry. The Cronbach alpha reliability coefficient of the scale for this study was .90. The scale was used as a pre-post measure. Some items of the ATCS are the following:

- (1) Chemistry is an area that I love.
- (2) I like reading books related to chemistry.
- (3) Chemistry does not have a very important place in daily life.
- (4) I like solving chemistry problems.
- (5) I would like to learn more about chemistry topics.

Focus group interview

The focus group interview was conducted to understand how the LbT method affects pre-service science teachers' attitudes towards chemistry. The interview was undertaken with 11 pre-service science teachers; one pre-service science teacher was selected from each group. They were identified randomly and then asked if they would volunteer for the interview. All

participants agreed to volunteer for the interviews. The interview questions were finalised by the opinions of two experts. The interview questions are listed below:

- Did the LbT method you used in Special Topics in Chemistry class cause any change in your attitudes towards chemistry?
- If your answer is yes to the first question, can you please define/describe the change(s)?

The focus group interview lasted 65 minutes. The interview was voice recorded and then analysed. During this analysis, the recording was transcribed verbatim and then its accuracy was controlled. Data was analysed using content analysis. First, coding was completed based on the concepts obtained from the interview. Following this, themes were created to organise codes under certain categories and to interpret the collected data (Strauss & Corbin, 1990). To ensure consistency among the codes, three experts coded the data. Two of them were experienced faculty members in qualitative analysis and one was a researcher. The reliability of the focus group interview data was calculated. The formula recommended by Miles and Huberman (2015, p. 64) was used which can be noted as follows: $\text{Reliability} = \frac{\text{Agreement}}{\text{Agreement} + \text{Disagreement}}$. According to the results, the reliability was found to be .75. Since the results were above .70, it was concluded that reliability is ensured (Miles & Huberman, 2015, p. 64).

c) Implementation

In the implementation of the LbT method, the stages presented in Figure 1 were followed. These stages are explained here in order:

- 1) Forming the groups and selecting the topics: This is the first stage. Before this, the teacher (researcher) gave information to all students (pre-service science teachers) on the content and significance of the Special Topics in Chemistry class. This was followed by the teacher asking the students to form groups of 4 or 5; the teacher did not interfere with this process. After the groups were formed, the teacher introduced the topics to the class. Then the groups were asked to select the topic they wanted to teach. Every group selected a different subject (e.g. air pollution, energy sources of the Earth, greenhouse gases and their importance). When all groups made their choices, a timeline was created for the whole semester.
- 2) Collecting information on the selected topic and organising the information to present in class: At this stage, the students conducted detailed research. The sources that they used were the library, the internet and experts on the selected topic (e.g. environment, chemistry, biology, physics). Informal learning environments (e.g. detergent factory, glass factory, solid waste treatment plant, drinking water treatment plant) and experts in these settings also acted as knowledge sources. The students discussed the knowledge gained in the research process and the part that should be included in their teaching. They also decided on the techniques, methods and approaches (e.g. 5E model, argumentation, concept cartoons, computer-supported teaching, informal learning environment, six-hat thinking technique) to be used for teaching. During these discussions, the teacher was directly involved occasionally. At other times, the students first agreed on a decision and then evaluated it together with the teacher. Following this, they finalised their lesson design. The teacher guided the students on teaching methods and activities and on how to reach knowledge sources. The teacher was helpful in accessing the necessary materials, responding to the questions coming from the students and supporting them in solving problems.
- 3) Presenting the topic selected with different instructional methods and materials: At this third stage, the students implemented the lesson design they created in the previous stages. During the implementation, the teacher waited at the back of the class; their only role was observation. The teacher observed from the perspectives of both the teaching student groups and the students in the classroom. The teacher interfered when there were problems, or when

misunderstandings and/or mistakes arose between the teaching student group and the rest of the class.

4) Constructing the research questions on the topic selected, investigating and presenting the answers: This stage exists in both the second and third stages. The teaching student group formed significant research questions and performed an investigation to answer their questions. The students discussed and agreed on the research question and on the appropriate methods to investigate the question. Following this, the students had a face-to-face or an online discussion with the teacher on the significance of the research question and on the feasibility of their plan for investigation. Through this, the students completed this stage. The students then shared their research question and their findings during their teaching. Some of the research questions that the students created were presented as follows:

- How is the drinking water supplied to our city?
- What are some characteristics of the drinking water?

To answer these research questions, the students contacted the local government to access information on drinking water. After this, they visited the dam where the drinking water came from. They observed and video recorded the processing of the water in the dam so that it became drinkable. They also obtained documents depicting the features of drinking water and its parameters. The students used the data they collected as well as the video footage in their teaching.

- What is the chemical cleanser usage behaviour of the residents in our city?

To answer this research question, the student performed many steps. They interviewed residents of different ages and gender on how they used chemical cleansers and what they paid attention to while using them. All interviews were recorded. They also collected survey data with 40 pre-service teachers on which cleansers are used and what is important in using them. This was followed by visits to the city health and environment boards to gain information on previous and current research on chemical cleanser usage of city residents. The information collected from these steps was shared in the class in the following way: First, the students presented some of the selected interviews, and through a whole-class discussion, identified the chemical cleanser usage behaviours. Then, the data collected from the rest of the interviews and the survey was shared with the class. Based upon these sets of data, the students indicated various standards for ideal healthy chemical cleanser use compared to actual behaviours. Lastly, they shared information on the research conducted by official authorities.

5) Preparing and implementing activities on the topic selected: This stage exists in the second and third stages as well. The students prepared activities to deliver their topic more clearly and also to attract their classmates' attention better. As in the fourth stage, the teacher facilitated and guided the group work of the students. Communication with the teacher was both face-to-face and online. The students implemented the activity in the most appropriate part of their lesson. Some of the activities performed by the students included demonstrations with simple materials (e.g. experiments on air pollution and global warming), role plays, competitions, debates, use of QR codes, designing and presenting materials. These activities helped in the topic better understanding of the topic by the class.

6) Reporting the implementation, collecting the worksheets and the assignments: At this stage, the teaching students prepared and presented a report on all the stages to the teacher. They were informed of the preparation of such a report at the beginning of the study. With this knowledge, they started working on their report during the early stages of the study. This enabled the students to monitor themselves as they progressed through the stages. The teacher collected the worksheets, assignments and materials for the implementation in this sixth stage as well.

7) Reflective thinking activities: Creating an activity reflecting on what the whole class learned on each topic (e.g. letter, story, poem, concept map, picture, poster, cartoon, flyer, puzzle): At this final stage, the whole class was asked to prepare an activity on what they learned at the end of each implementation. This activity was an assignment for the students. They prepared a different activity each week on the topic of that week. The teacher collected these assignments the next week. The teacher evaluated the assignments and provided feedback to the students.

In the implementation of these six stages, all members of the teaching student group were active. They all practised teaching and shared responsibilities among themselves. Thus, all students engaged in teaching with a shared responsibility. While the student group was teaching, their classmates completed their respective parts. They prepared their assignments as planned each week.

FINDINGS

In this section, quantitative and qualitative data, which were obtained from the research, are given. Quantitative data was obtained with the ATCS. The scale was used as a pre-post measure. The scores of the pre-service science teachers before and after the implementation were compared with the Paired Samples t-test. The Paired Samples t-test is used to determine whether there is statistical evidence that the mean difference between paired observations on a particular outcome is significantly different from zero (Büyüköztürk, 2009, p. 67–68).

Table 1. *T-test results of the pre- and post-scores of the ATCS*

	N	X	SD	df	t	p
Pre-test	49	55.22	9.77	48	-5.488	.000*
Post-test	49	63.69	7.31			

*p<.01

The examination of Table 1 indicates that with the implementation of LbT method, there was a positive increase in the pre-service science teachers' attitudes towards chemistry ($t(48)=-5.488$, $p<.01$). The average score of the pre-service science teachers from the survey increased from 55.22 to 63.69 following the implementation. Another noteworthy point is that there was a decrease in the standard deviation. This finding shows that the LbT method positively increased pre-service science teachers' attitudes towards chemistry.

To determine the effect size of the significant difference between the pre- and post-scores, the eta square value η^2 was calculated. Effect size, or η^2 , presents how much the independent variable or the factor accounts for the total variance of the dependent variable. The values .01, .06 and .14 are interpreted as small, medium and large effect sizes respectively (Büyüköztürk, 2009, p. 44). In this study, the dependent variable is the attitude towards chemistry and the independent variable is the LbT method. To calculate the eta square, the formula suggested by Büyüköztürk (2009, p. 69) for t-tests for dependent groups was used. According to the results, the eta square value was found to be .38. When this result is examined together with the above information, it can be concluded that the LbT method has a large effect on the significance difference between the average scores obtained before and after the implementation. The quantitative data analyses revealed that the LbT method has a positive effect on pre-service science teachers' attitudes towards chemistry.

In this study, qualitative data was obtained through the focus group interview. All pre-service science teachers participating in the focus group interview answered yes to the first question, 'Did the LbT method you used in Special Topics in Chemistry class cause any change in your attitudes towards chemistry?' For responses to the second question, 'Can you please define/describe the change(s)?', two themes can be seen in Table 2.

Table 2. Pre-service science teachers' views on the effect of learning by teaching on their attitudes towards chemistry

Themes and codes	Frequency of codes (f)
a. Cognitive	20
1. Importance/Awareness	8
2. Interest	4
3. Curiosity	3
4. Comprehensible	3
5. Meaningful	2
b. Affective	8
1. Enjoyable	4
2. Love	2
3. Valuable	2

Table 2 makes it clear that the 11 pre-service science teachers who attended the focus group interview explained how the LbT method affected their attitudes with two major themes: cognitive and affective. They focussed on five codes under the theme cognitive. In this respect, they explained the change in their attitudes with the importance of chemistry/awareness, interest towards chemistry topics, curiosity about chemistry topics, thinking that chemistry is understandable and that it is meaningful. An important point to note is that the code importance/awareness has a higher frequency than any other code. Some of the statements made by the pre-service science teachers are presented below:

"I didn't like chemistry and I always was unsuccessful. But with this implementation, I realised that I started to understand better. And most importantly, I gained an awareness of chemistry." (S1, male, code a1)

"In order to teach the topics to our classmates, we learn by experiencing and with making connections with real life. I believe that these helped me realise how important chemistry is as a discipline." (S4, female, code a1)

"I learned how to look at things. I believe there is a difference between looking at things and then seeing and understanding them. I think I learned how to see and understand. And this created an interest towards chemistry and eagerness to learn chemistry." (S5, male, code a2)

"In our classes, we only listened and no connections were made after the class is over. But in this class this semester, we started discussing the chemistry topics after the class. This was because we started to develop an interest towards chemistry topics more." (S10, male, code a2)

"Before these implementations, chemistry topics never caught my attention. I was not curious and so I did not read on chemistry. But now, whenever I see a headline on a chemistry topic in a journal or a newspaper, I am curious to read it." (S3, female, code a3)

"It was difficult for me to understand chemistry topics. With this Special Topics in Chemistry course, I realised that chemistry topics are comprehensible. I noticed I should not be afraid and that they can be understood easily. I believe that these implementations in our class contributed a lot to my thinking." (S8, female, code a4)

“I think the most important part of a class is its meaning for the students. When the students do not find the content meaningful, they cannot understand it. With the implementations we had, chemistry content became more meaningful to me.” (S11, male, code a5)

The second theme, affective, consists of three codes. For this theme, the pre-service science teachers stated that the change in their attitudes is linked with finding chemistry enjoyable, loving chemistry and thinking chemistry is valuable. The code enjoyable has a higher frequency than any other code. Some of the statements made by the pre-service science teachers are presented below:

“At first, I was afraid to teach chemistry. I was questioning why we do this and I thought no need. But then these implementations showed me that there is no need to be afraid. Chemistry is very enjoyable indeed.” (S6, female, code b1)

“If we carried on our lessons in the traditional way where we didn’t have this kind of responsibility, I would never realise how enjoyable chemistry is. I noticed that chemistry is not boring at all, it is very enjoyable.” (S9, female, code b1)

“I started loving chemistry after having these implementations in class. Previously, I had no love for chemistry.” (T7, male, code b2)

“I developed a new perspective. While I was teaching the chemistry content to my classmates, I felt that chemistry is very valuable. I think that making an effort to teach to my friends made it more valuable for us.” (S2, male, code b3)

DISCUSSION and CONCLUSION

The quantitative data analysis of this study showed that the LbT method used in a Special Topics in Chemistry class has an effect on pre-service science teachers’ attitudes towards chemistry and that there is a positive progress in their attitudes. Supporting this, qualitative data analysis explained this progress with cognitive and affective themes and the codes that fell under them. One reason for this could be that the LbT method enabled each pre-service science teacher to have a different experience. The steps for the implementation of the method show that each step provides the pre-service science teachers with a wide range of experiences on chemistry (e.g. inquiry, hands-on activities related to real world objects and events, social interaction, communication, group work, group performance, teaching experience). These experiences might have increased the complexity of pre-service science teachers’ attitudes towards chemistry. Since the complexity of attitudes or their components depend on the number and variety of the factors they include (Güney, 2013, p. 230), it can be inferred that the LbT method increases the number and variety of factors included in attitudes towards chemistry. In line with this, it can also be specified that the complexity of the pre-service science teachers’ attitudes increased as well. An increase in the complexity of attitudes implies an increase in its strength (Güney, 2013, p. 230; Yüksel, 2006, p. 104).

The strength of the attitudes expresses the sum of the strengths of all attitude components. The strength of these components can vary. However, the total strength of the attitude mostly relies on the strength of the affective component (Güney, 2013, p. 229). The qualitative data on the attitudes of pre-service science teachers from the effect of LbT mostly accumulated under the cognitive theme. However, there were still some views that existed under the affective theme. Based on these findings, it can be stated that the affective component of pre-service science teachers’ attitudes towards chemistry is gaining strength through the LbT method. This results in an increase in the overall strength of pre-service

science teachers' attitudes as explained above. The pre-service science teachers' statements on finding chemistry important and their awareness of the importance of chemistry can also be linked with the overall significance they attach to it. The importance of the attitude object for the individual has an impact on the individual's attitude towards the object (Güney, 2013, p. 229). The fact that pre-service science teachers find chemistry important might be concluded to have a positive effect on the strength of their attitudes towards chemistry.

The effect of the LbT method on pre-service science teachers' attitudes towards chemistry can be evaluated in the context of experiences the pre-service science teachers had with the attitude object. It is known that experiences with the attitude object may result in the formation of attitudes (Güney, 2013, p. 236). So, from the perspective of experiences, it is inferred that the LbT method enables pre-service science teachers to have a direct connection with chemistry. The pre-service science teachers are going through an experience where they can connect with chemistry directly via the LbT method. This experience might change the pre-service science teachers' connection with chemistry into a repeated and accumulated one impacting their attitudes towards chemistry. Based on the quantitative data in this study, it can be stated that this impact is, in fact, an increase in the intensity of the attitudes (Yüksel, 2006, p. 103).

Another perspective to evaluate is the effect of the LbT method on pre-service science teachers' attitudes, which can be the knowledge gained on the attitude object. Individuals tend to construct a belief system by combining their previous knowledge with the new knowledge they attain (Güney, 2013, p. 235; Yüksel, 2006, p. 102), which results in judgements about the attitude object such as positive-negative, good-bad, or sufficient-insufficient (Güney, 2013, p. 235). The changes in individuals' knowledge levels have a critical role in the construction of their belief systems (Güney, 2013, p. 235). Based on the views of the pre-service science teachers, it can be inferred that the LbT method created changes in their knowledge levels. Some of the pre-service science teachers stated that they started thinking chemistry as being meaningful and comprehensible after the LbT process. Since individuals have attitudes towards objects that have psychological meaning to them (Güney, 2013), their ideas on meaningfulness and comprehensibility of chemistry might contribute to their attitude development towards it.

The effect of the LbT method on pre-service science teachers' attitudes towards chemistry is evaluated from the different perspectives above. When these perspectives are examined, it can be stated that the LbT method positively increases pre-service science teachers' attitudes towards chemistry. This conclusion supports the study which stated that active learning and student-centered pedagogy improved student attitudes (Armbruster, Patel, Johnson, & Weiss, 2009) and it shows that the LbT method can contribute to one of the most important goals of chemistry education, which is developing students who have positive attitudes towards chemistry. The pre-service science teachers need to have positive attitudes towards chemistry to create such attitudes for their future students in their teaching. Teachers have a critical role in developing attitudes towards any discipline (e.g. chemistry) (Kumar, Krishna & Rao, 2004, p. 36). In line with this, it is significant that pre-service science teachers have a positive attitude towards the discipline they will teach in their in-service teaching. One way to make this possible is in the pre-service science teachers' learning processes before they start teaching, such as going through the teaching experiences shown in this study. The findings of this study demonstrate that the LbT method can provide this in teacher education programmes.

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Local Wisdom-Based Science Learning Model through Reconstruction of Indigenous Science to Improve Student's Conservationist Character

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ABSTRACT

The implementation of local wisdom-based science learning model through reconstruction of indigenous science is hoped to improve student's conservationist character. Through this model, student will be familiarized with science and local wisdom to improve their existing conservationist characters. Characters measured in this study were religiousness, tolerance, politeness, responsibility, and patriotism. Purpose of this study was to know the result of indigenous science reconstruction through implementation of local wisdom-based science learning model, and the effect on student's conservationist character. This is a descriptive research. Result of the study is reconstructed indigenous science of Samin tribe who has high respect toward conservation value, especially land conservation. The use of local wisdom-based science learning model through reconstruction of indigenous science is proved to improve student's conservationist character from low to good visibility.

Keywords: Local Wisdom, Science Learning, Indigenous Science, Conservation

INTRODUCTION

Natural science is a "knowledge which acquirement requires learning and proving" and "overarching knowledge and truth about law of nature which can be proved through scientific method". In this regard, science refers to a systematic ways to acquire knowledge by the means of observation and experimentation in order to understand nature's phenomena (Yulvianto, 2011).

According to the stated definition, science subject mastered should be able to internalize the value of the science and incorporate it into their everyday life. One indicator of this being happened in the love and preservation of biodiversity and environment as well as characterizing the science's value. However, preliminary observation showed a disheartening result as none of that has happened yet.

Science concept has not been implemented completely by the students, indicated by non-Characterized of the beneficial scientific attitude. Myriad of environmental problems ranging from floods, droughts, flash floods, forest fire air pollution, and water pollution are



manifestation of those problems. These made catastrophes bring suffering to the people and hinder the country development (Suastra, 2010).

Universitas Negeri Semarang (Unnes) as a part of higher education sector plays an important role in the development of character building into the students. Character building education developed in the Unnes is based on environmental conservation (Handoyo & Tijan, 2010). There are 8 conservationist characters taught in Unnes i. e. religiousness, honesty, concern, tolerance, democracy, persistence, and politeness. The eight prime characters taught here is hoped to develop other superior characters such as fairness, responsibility, and patriotism.

In science learning, character development comes from good understanding about the subject material, and observation is a solid ground for science learning process. In practice, a learning model is required to ensure the implementation of observation. A meaningful and contextual observation should be done and arise from student's immediate environment, especially the ones with cultural and local wisdom content. Experiential learning is considered as an effective way of educational approach (Alkan, 2016).

Local wisdom is a human effort to use the moral and cognition to act and behave regarding issues or phenomena in certain scope. The etymological definition derived from the word wisdom which means the capability of using one mind and moral to act and behave regarding certain object and issue (Ridwan, 2007).

Local word here specifically refers to limited interaction space with particular value and system. Within this space exist patterns human interaction, among themselves and with the physical environment. A real life setting is an interaction space with patterns of relationship which ultimately invokes the birth of values. In times, the value becomes the reason and moral guidance to which the society adhere (Ridwan, 2007).

Sibarani (2013) stated that local wisdom is indigenous knowledge and value which has served as a traditional guiding code of conduct in the society. The local wisdom is the community's wisdom or local genius deriving from the lofty value of cultural tradition in order to manage the community's social order or social life. Also, local wisdom is the value of local culture that has been applied to wisely manage the community's social order and social life.

Sibarani (2013) concluded that local wisdom are indigenous knowledge and local genius which stems from the honorable culture and tradition that has been long served as a social guidance in order to advance the society. Local wisdom might come in the form of indigenous knowledge, indigenous crafts, local genius, local resource, local social-process, local norm, and local culture.

Local wisdoms became inseparable constituent in ethnosience course. In science major curriculum, ethnosience course discuss about the nature and scope of ethnosience, importance of ethnosience, development of ethnosience content, ethnosience learning concept, ethnosience perspective as research focus in education, reconstruction of Javanese indigenous science, as well as conservation on the perspective of local wisdom.

In ethnosience learning, local wisdom-based science learning model is conducted through reconstruction of indigenous science existed in society. Indigenous science is a part of social construct in society which has and still believed to be true. Indigenous sciences endure the test of time through generations, while the society witnessed and experienced the truth and adaptations (Suastra, 2005).

Reconstruction of indigenous science is a rearranging of concepts found in indigenous science transcribed into contemporary science. Suastra (2005) stated that indigenous science differs from contemporary science in which indigenous science exist in the form of concrete knowledge, while contemporary science has transcended in to theories, principles, concepts, and peer reviewed reproducible laws which has stand the test of scientific community.

Implementation of local wisdom based scientific learning model through reconstruction of indigenous science is hoped to improve student's conservationist character. The use of the model will familiarize the student with the science content emerged from local culture. The characters being measured are religiousness, tolerance, politeness, responsibility, and patriotism.

Purpose of this study is to describe the result from reconstruction of indigenous science by using local wisdom-based science learning model, as well as knowing the effect of the implementation of the said learning model on improving student's conservationist character.

METHODS

This is a descriptive study. Object of the study is the reconstruction process of indigenous science performed by student in the ethnoscience course, along with the improvement of conservationist character. This study takes place in Science Department, FMIPA Unnes, for four months.

This study design comprises of four phases, i.e. planning, execution, observation, and reflection. Data collection was as follows: 1). Indigenous science was reconstructed from the result of student's observation on local culture which then transformed from indigenous science into contemporary science. 2). Conservationist character data was gathered by using conservationist character questionnaire. The questionnaire has been validated before data collection. According to Hadi (2001) a non-test instrument should be validated to check its construction validity.

Data collected were then analyzed. Student's ability in reconstructing indigenous science was score with range 10-100. Conservationist character measured at the start and at the end of the program were analyzed and confronted with the categorization on Table 1.

Table 1. *Categorization of student's character measurement*

Percentage	Criterion
25-43	Not visible
44-62	Low visibility
63-81	Good visibility
82-100	Strong visibility

FINDINGS

In ethnoscience course students were asked to carry out observation on certain community. Information or materials often used in everyday life are easier to comprehend (Cimer, 2007; Schonborn and Bogeholz, 2009). Students then asked to reconstruct indigenous science material observed, to be transformed into contemporary science. There are several observation theme analyzed, i. e. Indigenous science of Samin Tribe from Pati, Central Java, salt making process in Rembang, and batik painting in Pekalongan. Student's performance in reconstructing the indigenous sciences were then scored, with mean result of 86. Minimum requirement was stated that 70% of the students should score 75 at science reconstruction.

One example of reconstruction result on indigenous science of Samin Tribe from Sukolilo Pati, Central Java. Reconstruction result is described on Table 2.

Table 2. *Indigenous Science Reconstruction Result of Samin Tribe*

No	Questions	Interview result	Reconstruction
1.	Why does people of Samin Tribe loved soil so much?	<i>I love the soil and land for it is like my mother. It provides me.</i>	Importance of soil as substrate/ Land conservation
2.	Why does most of Samin people works as farmer?	<i>Because farmers are their own boss. Who grows and reap their owns, not disturbing other's properties.</i>	Keeping the balance of the ecosystem
3.	What fertilizer does Samin Tribe people used most?	<i>We use our own compost which we made</i>	Soil conservation and environmental preservation
4.	Why do Samin people choose to use compost as fertilizer?	<i>Because it is more economic and yield as good result as industrial fertilizer</i>	Content and advantages of organic fertilizer
5.	Do you use stove or fireplace for cooking?	<i>We use stove with biogas fuel</i>	Renewable bio-energy
6.	We all know the Semen Vs Samin movie, in which we understand that Samin Tribe loved the environment. What does Samin Tribe think about the development of cement factory?	<i>We opposed the development of cement factory, because it will pollute the land.</i>	Discussion about limestone and its function
7.	What is the norms and taboo in Samin Tribe daily life?	<i>Envy, jealousy, defamation, stealing</i>	It is prohibited to do badly, taking other party's properties is a sign of conservationist character.

Table 3 below describes the improvement of conservationist character on certain aspects. Data was gathered at the beginning of the semester and at the end of the semester after they observed and reconstructed the indigenous science of several societies.

Table 3. *Improvement of student's character*

Characters	Before (%)		After (%)	
Religiousness	64	Good visibility	71	Good visibility
Tolerance	50	Low visibility	70	Good visibility
Politeness	54	Low visibility	64	Good visibility
Responsibility	59	Low visibility	68	Good visibility
Patriotism	61	Low visibility	84	Strong visibility
Mean	58	Low visibility	71	Good visibility

DISCUSSION and CONCLUSION

Reconstruction result based on Table 2 can be elaborated further. First, loving the soil implicitly means the tendency toward soil conservation. Arsyad (1989) stated that one purpose of land conservation is to minimize land erosion. Land conservation can also mean the customization of land use to the land type so it can retain its everlasting use. Young (1989) defined land conservation broadly, consisting of erosion control and maintaining fertility. Land conservation is management strategies to prevent soil erosion from the land surface caused by physical, chemical and biological changes in the form of overuse, salinity, acidification, or other contaminants.

Common strategy usually comprises of: selection of land covering vegetation, erosion prevention, salinity regulation, acidity control, and enhancing soil organism diversity, soil remediation and mineralization. Other strategy specialized in agriculture are: farming without land cultivation, cultivation of contoured land, windbreak barrier formation, plants rotation, and use of natural fertilizer.

Strategies above suits the daily live of Samin People who are capable traditional farmer. In this regard their naturalistic view extends to their refusal of the cement factory development on their land. They feared activity of cement factory will pollute the neighboring Kendeng Mountains.

Second, farmers are their own bosses, reaping what they sowed, never take anyone else's properties. This implicitly means keeping the balance to the ecosystem. They have adopted pacifist stance and chose to be a farmer in order to live a quiet and simple life. However they take a pride on their way of life, stating that farmers need not to bow to anyone. They are their own bosses. They thought that other jobs and profession requires servicing other people, in which farming does not requires it. Samin people also observed Nandur culture in which people grow plants which explicitly a conservation effort.

Third, using self-made compost fertilizer. Explicitly correlates with land conservation and environmental care in accordance with strategies discussed on the previous point. Samin farmer chose natural compost fertilizer over chemical fertilizer. This fact is beneficial for the soil, while natural compost contains fair amount of nutrients compared to chemical fertilizer, it possess remedial properties for the soil. Compost improves physical properties of the soil such as its permeability, porosity, structures, and ion retaining capability. Compost consists of decaying organic material produce by decomposing leaves and organic waste. Decomposition could be accelerated by introduction of decomposer.

Fourth, economic and yield the same amount of produce as chemical fertilizer. This particular indigenous science highlights the understanding of Samin Tribe on the quality and economy of compost fertilizer. To the farmers, compost fertilizer comes with several advantages: a) Preserving the soil by avoiding chemical fertilizer and pesticide; b) Avoiding the entrance of the said chemical agents into human's food; c) Promoting green lifestyle in the food and nutritional product, making people aware of the value of organic food; d) Abstinence from fertilizer and pesticide reduced the production cost of the crops (Roidah, 2013).

Fifth, using stove with biogas fuel. It shows the implementation of renewable bio-energy principle. The use of cow waste processed to produce biogas is a win-win solution as the process removes waste and greenhouse gas and turns it into energy source. Another use of bovine waste is as a material to make compost fertilizer. This means less chemical fertilizer being introduced to the environment. Again this is beneficial to the ecosystem as well as to the human.

Biogas is a product of anaerobic bacteria metabolism. During the cooking process of compost fertilizer, the bacteria undergo fermentation reaction. Gas produced consists of CH_4 and CO_2 . If the composition of CH_4 exceeds 50% then the gas is highly flammable.

Cow sewage biogas naturally consists of 60% CH₄. Ideal temperature for fermentation is around 30°C (Junaedi, 2002).

Sixth, refuse cement factory due to fear of environmental damage. In this point we will have to discuss the properties of the karst and limestone which is the raw material of cement. Karst is a German terminology with Slavic root which means barren rocky land (Adji, 2006). This is common name for rocky lands with soluble carbonate constituent. Ford and Williams (1992) specifically defined karst as land patch with certain hydrology characteristics and formed and fashioned by the combination of soluble rocks with well developed secondary porosity. Karst mountains in Sukolilo are the source of water in hydrology cycle which provides water for Samin tribe's rice farm.

Seventh, Tabooed are envy, jealousy, defamation, and stealing. Samin tribe prohibited its members to do evil or bad mouth the tribesmen. This is a characteristic of a conservationist. Through reconstruction process proposed by Sudarmin (2014), it implied that people of Samin understand the importance of conservation in their daily life.

Based on discussion above, there are several scientific concepts that can be learned from local wisdom of the Samin Tribe from Pati. Samin tribe actually stereotyped as a tribe with negative image, refusing the modernization, and talks out their heart without much filtering (Sunadi, 2013). After the reconstruction process, it is revealed that Samin tribe is actually more advanced than the stereotypes given to them. One blazing example of this is the use of biogas as fuel. Whereas the rest of the nation has not even known yet about biogas, Samin tribesmen are already processing the sewage of their cattle as fuel. Other manifestation of this is the soil quality which is untainted by chemical fertilizer and pesticide.

Observation of indigenous science was carried out by groups of students, as learning society. The concept caters to belief that learning in group is better than individual learning. Khusniati (2012) stated that implementation of learning society develops certain characters such as teamwork, tolerance, politeness, democracy, adherence to social norm, and responsibility. Fitriani et.al. (2016) stated that student's direct involvement in learning process makes a more meaningful learning experience which will yield better result in student. Meaningful learning is very important for student (Gunes, et al., 2015; Bezen, et al., 2016). The students will achieve meaningful learning by forming a link between the new information and the existing information (Hakim, et al., 2016).

According to Table 3, there are significant improvements on student's characters before and after taking the ethnoscience course. It is safe to assume that this improvement is due to the observation and science reconstruction activity the student underwent during the course. All religiousness characters shows significant improvement. We hypothesized that developing religiousness took longer time and are embedded stronger inside the students.

Tolerance, politeness and responsibility character improved one level from *low* to *good visibility*. This is the direct effect of science reconstruction activity underwent by the students which familiarized the student with local wisdom and environment. Sibarani (2013) stated that local wisdom are indigenous knowledge and local genius which stems from the honorable culture and tradition that has been long served as a social guidance in order to advance the society.

Local wisdom based learning model requires the student to observe the local wisdom on exotic groups of people. Some of the selected subjects are indigenous science of Samin Tribe from Pati, Central Java, salt making process in Rembang, and batik painting in Pekalongan. Observation process followed by reconstruction is proved to be effective in enhancing student's characters. Result from this activities shed light into student's understandings about local wisdoms starting from conservation effort, to social norm and code of conduct. Samin

tribe whom were stereotyped to be out of date and rude actually is advanced and teaches an honorable moral code.

This finding is in accordance with Suastra (2005) who found that knowledge, believes and experience of traditional community are potential assets as learning material and development of science curriculum. In traditional society, children explore and immersed in indigenous science way before they are introduced to contemporary science. Sibarani (2013) found that local wisdom can improve student's characters.

The use of this learning model is hoped to help ever last local wisdom as Indonesian heritage. This is in tone with Parmin et. al. (2016) whom found that modernization could erode the local wisdom among the rampage of foreign culture, unless certain learning models are developed and implemented to counter this trend, and to bring back Indonesian students to their root.

Conclusion


According to the discussion above, some conclusion arise: 1) result of indigenous science reconstruction were obtained, notable example is the local wisdom of samina tribe which held a noble value of soil conservation. 2). By using local wisdom-based science learning model which involves reconstruction process, student's conservationist character is improved significantly from *low* to *good visibility*.

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Evaluation of Values, Beliefs and Norms of High School Students on the Conservation of Biodiversity

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ABSTRACT

This research evaluates the values, beliefs and norms on conserving biodiversity amongst Turkish Cypriot high school students and the results are compared according to gender and class year individually. The data was collected from 506 students via a value-belief-norm questionnaire. According to the results of this questionnaire, it is observed that the Turkish Cypriot high school students pay more attention towards the “self-administration” value, believe that their responsibility towards protecting the local and global biodiversity is more than their perception of talent to manage it and their personal norms regarding the conservation of biodiversity is very similar to each other. Furthermore, it can be concluded that gender and grade does have an effect on the values, beliefs and norms on preserving biodiversity.

Keywords: Biodiversity, value-belief-norm, high school students.

INTRODUCTION

Due to the human activities, the biodiversity of Cyprus is under threat (CBD, 2010, 2014; Zachariadis, 2012). The human beings have violated the biodiversity for its economic value and the resources have been destroyed (Halkos and Tzeremes, 2015; Cardinale et. al. 2012; Charalambides and Nisiforou, 2012). Over exploitation of biodiversity services from the ecological, social and economic aspects in local, regional and global scales (Mass et. al 2016; Newcome et. al., 2005) have imposed a pressure on biodiversity diminishing the diversity. Yet, biodiversity means the variety of life (Colwell, 2009; Çepel, 2007). While biodiversity provides various benefits in terms of carbon storage, recreation, tourism, pharmaceuticals, food, fuel, aesthetics, it also has ecological, social and economic value (Laurila-Pant, 2015; Edwards and Abivardi, 1998). Therefore; for the conservation of biodiversity, people should have basic some knowledge on biodiversity and its value, behave accordingly (Charalambides and Nisiforou, 2012) and make decisions that are appropriate for their environment (Lopez and Cuervo-Arango, 2008). Since it is considered that environmental problems can not solely be prevented by technical solutions, the understanding and interpretation of behaviour and decisions causing environmental problems as well as pro-environmental behaviour are deemed to be significant (Liebe, 2010). One of the theories



explaining pro-environmental behaviour and decisions is “Value Belief and Norm Theory” (Stern, 2000).

Value-Belief-Norm (VBN) theory was developed by Stern et.al. According to Stern, the environment is directly or indirectly affected by the behaviour of individuals due to their desired comfort, mobility, power and status. Stern (2000) noted that the types of behaviour indirectly affecting the environmental change are much bigger and effective than direct behaviour. Since indirect behaviour may impose a pressure for social change (Stern et al., 1999), for instance, deforestation has a direct impact on environment; national environmental tax policy has an indirect impact. Caluri and Luzatti (2016) emphasize that VBN postulates a special focus onto mechanisms that involve the value-system and judgemental rationality of individuals. Value-Belief-Norm Theory is based on the Norm-Activation Model (NAM) and New Ecological Paradigm Theory (Stern et al., 1999). In particular VBN theory is influenced by the Altruistic Behaviour Theory (ABT). Altruistic behaviour has a positive or negative impact among other individuals of society. Thus, altruistic behaviour is accepted provided that it meets the personal norms, has positive outcomes on the others and individuals take responsibilities resulting from their behaviour (Ibtissem, 2010). In the VBN theory of Stern et al., the three variables as values, beliefs and personal norms are successively related and affect the behaviour (Figure 1) (Klößner, 2013; Grot and Steg, 2009; Stern, 2000). Values facilitate in filtering the environmental decisions to avoid the perceived outcomes in environmental decisions and reflecting the filtered decisions as behaviour (Lopez and Cuervo-Arango, 2008). Values are affected through pro-environmental norms on pro-environmental behaviour (Grager, 2012; Abrahamsa and Steg, 2011). Beliefs are values that help us evaluate the good-bad and the right-wrong (Prager, 2012). According to NAM, the beliefs are crucial on the pro-environmental behaviour via personal norms (Onwezen et al., 2013; Zhang et al, 2013). Beliefs comprise of awareness of consequences and ascribed responsibility (Ibtissem, 2010). The awareness of consequences promotes the development of the ascribed responsibility (Borsch et al., 2014). Ecological beliefs present beliefs about the relationship between human and environment (Lopez and Cuervo-Arango, 2008). Awareness of consequences and ascribed responsibility impact personal norms (Han, 2014; Zhang et al., 2013): Personal norm are individual moral conviction about concerning whether personal behavior is right or wrong (Onwezen et al., 2013).

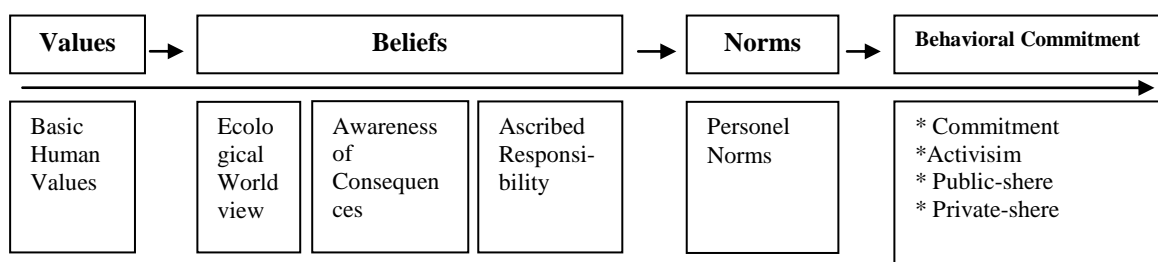


Figure 1. Model based on VBN Theory in terms of adolescents' commitment to protect Biodiversity (Menzel, 2007).

Pursuant to literature, the value-belief-norm model had been used in the series of research in order to explain its impact on pro-environmental and ecological behaviour. For example, Lopez and Cuervo-Arango (2008) working on ecological behaviour theory introduced in a study conducted with 403 individuals that live in a small town in Spain that personal norms, altruistic values and ecological beliefs have positive impact on ecological behaviour while denial of obligation has negative impact. In another study, it was found out that behaviour of energy conservation is affected by value beliefs and personal norms (Ibtissem, 2010). In a part of their study, Abrahamsa and Steg (2011) studied energy use and

intentions to reduce energy consumption, value-belief-norms theory. In the study, value-belief-norm variables were important indicators of energy use and intentions to reduce it. Studies have shown that in order to encourage individuals to form pre-environmental behaviour, it is of great importance to understand psychological factors that affect their willingness to shift environmental manners into action (e.g. Steg et al., 2011; Steg and Groot, 2010). Also individual characteristics are known to have an impact on the pro-environmental behaviours, and psychological factors (Tarrant, 2010). The behaviour of individuals are affected by the personal elements (physiological, psychological, intelligence, perception, thought, belief, need etc.), environmental factors (culture, religion, traditions, customs, social norms, family etc.) and their settings (education, work/occupation, income, status etc.) (İbicioğlu et al., 2009). The education programs proposed for the solution of global environment problems shall be developed by taking the personal elements of individuals, environmental factors and their settings into consideration.

Because it is a complex construct with ecological, economical and social dimensions, biodiversity has become a challenging topic (Randler, 2008). Therefore, the opinions of students as the future decision makers are important to talk about a general disposition to act to protect biodiversity. Individuals' decisions are associated with psychological factors such as beliefs, norms (Routhe et al., 2005). Furthermore constructivism in challenging educational topics comes about through change in thinking (Tarrant, 2010). In this process, psychological factors play a big role. In previous studies it was emphasized that psychological factors with all the ecological, economic and social dimensions had crucial roles in environmental education and in more effective teaching (e.g. Sarıbaş et al., 2016; Menzel & Bögeholz, 2009; Dervişoğlu, 2007; Randler et al., 2005). It is a fact that, this issue related to changing biodiversity with all its dimensions and the psychological factors in learning and teaching this subject has not yet been studied in TRNC.

The aim of this study is to evaluate the values, beliefs and norms of students in TRNC on the conservation of biodiversity and compare the results with gender and class years. For this purpose, the following questions were asked:

- What are the value-belief-norms of students towards the conservation of biodiversity?
- Do the value-belief-norms of students towards the conservation of biodiversity vary on the basis of gender and class year?

It is hoped that this study contributes to better programming, provides learning environments, and guides the teaching staff

METHODS

a) Research Method

This research is designed in accordance with the screening model. The screening model defines the conditions, processes, structures and practices. Therefore the model collects, analyses, explains and interprets the existing data (Howett & Cramer, 2011). In this study, the value-belief-norm scales were taken as dependent variables while gender and class years as independent variables. When examining sixth grade students' nature of science concepts Khishfe ve Abd-El-Khalick (2002) indicated the reason that they chose to use interpretive research as "the present study is interpretive in nature and focused on the meanings and participants ascribed to the emphasized aspects of nature of science" (p. 557). The purpose of this research approach is to produce many explanations and interpretations about human experience.

b) Population and Sample

The population of this research is the high school students in TRNC during the first semester of 2014-2015 academic year. Due to the limitation in reaching the whole population,

sampling was used through random sampling method. Three types of high schools were chosen (college, general high school, and Anatolian high school) before the application, the curricula of selected school were reviewed through random sampling method. Then, the students from 8 high schools as 4 colleges, 3 general high schools and 1 Anatolian high school participated to the research for the random sampling. Therefore, the sample of this research is 506 volunteer students from tenth, eleventh and twelfth grades. Among the students, 57,5% were female (291) and 42,5% (215) male students. 16,0% (81) were 10th grade, 35,8% (181) 11th grade and 48,2% (244) were 12th grade students.

c) Data Collection Tool

The questionnaire prepared on the subject of Endangering and Conserving of Biodiversity was used. It included Value-Belief-Norm scales and personal information are included in the questionnaire. The personal information section of the questionnaire covers the problems related with gender, age and grade of participants. The scales were developed by Menzel (2007) and adapted by Dervişoğlu (2007) into Turkish. Menzel (2007) adapted the value, belief and norm scales into the biodiversity context either by shaping original scales or restructuring the agreed scales. Menzel adapted Schwartz's Portrait Values Questionnaire (2005; PVQ) into the biodiversity context. The questionnaire assesses the value types as "Self-direction", "Power", "Universalism", "Achievement", "Security", "Stimulation" and "Benevolence". The Cronbach's alpha values of these 7 value types vary between ,521 and ,760. The belief scale, structured by Menzel, is comprised of ascribed responsibility and perception of talent and is graded in 4-point Likert scale with 8 items. It is evaluated from global and local contexts. The Cronbach's alpha values of ascribed responsibility and perceived abilities to reduce threats were calculated as ,797 and ,846 respectively. In the norm scale, Menzel inspired the studies of Stern (1999) and Widegren (1998) in the context of biodiversity. The personal norms scale has 4 items and was graded in 4-point Likert scale. The personal scale has also been organized in the way to be evaluated from global and local contexts. The scale reliability in TRNC sample was calculated as ,81.

d) Data Analysis

The frequency, percentage, average, standard deviation, Mann-Whitney U and Kruskal H Wallis techniques were used for the data generated from questionnaire filled out by selected high school students. Before the analyses, the data was subjected to the Kolmogorov-Smirnov test for normality and the distribution was found as not normal.

FINDINGS

a) Findings on Human Values

The results from the answers of high school students participated in the research are shown in Figure 2.

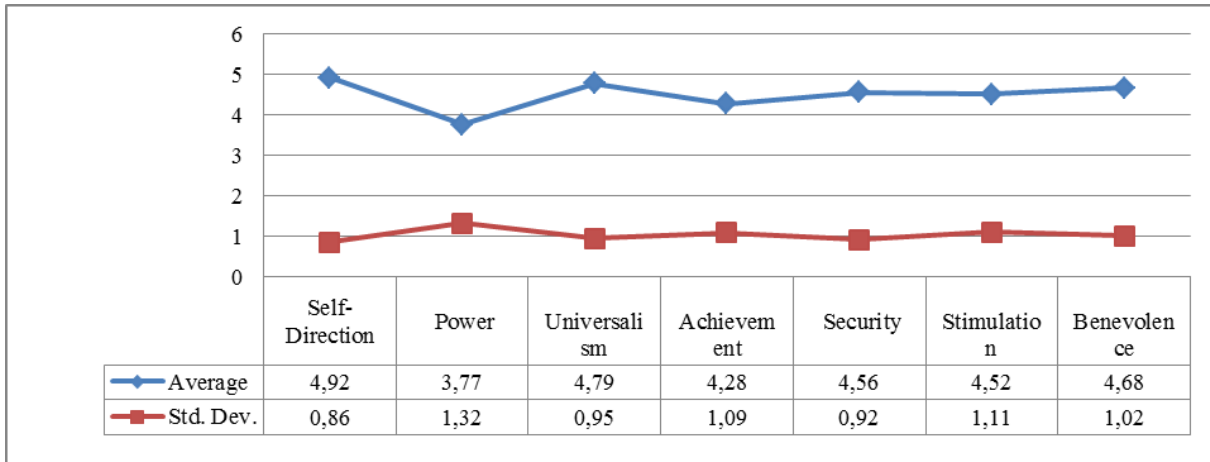


Figure 2. The Averages on Basic Human Values

In consideration with the Figure 2, the averages for the answers given by the students towards the basic human values vary between $3,77 \pm 1,32$ and $4,92 \pm 0,86$. The highest value type is the self-direction that is under being open to change (Average= $4,92 \pm 0,86$). The lowest value type is the power value under the self-enhancement (Average= $3,77 \pm 1,32$).

As seen from the Figure, another type of value under openness to change is the stimulation value and high school students have considered it as “like me”. Another value under the self-enhancement value is the value of achievement and high school students have considered the achievement value (average= $4,28 \pm 1,09$) as “like me”. The high school students considered the universalism (average= $4,79 \pm 0,95$) and benevolence (average= $4,68 \pm 1,02$) that are under the value of getting beyond oneself as “like me”. Similarly, the high school students considered the security value that is under the value of conservation approach as “like me” (average= $4,56 \pm 0,92$).

b) Findings on Beliefs

The results for the answers given by the high school students who participated to the research upon the beliefs as one of the variables of VBN theory are shown in Figure 3 within the global and local context.

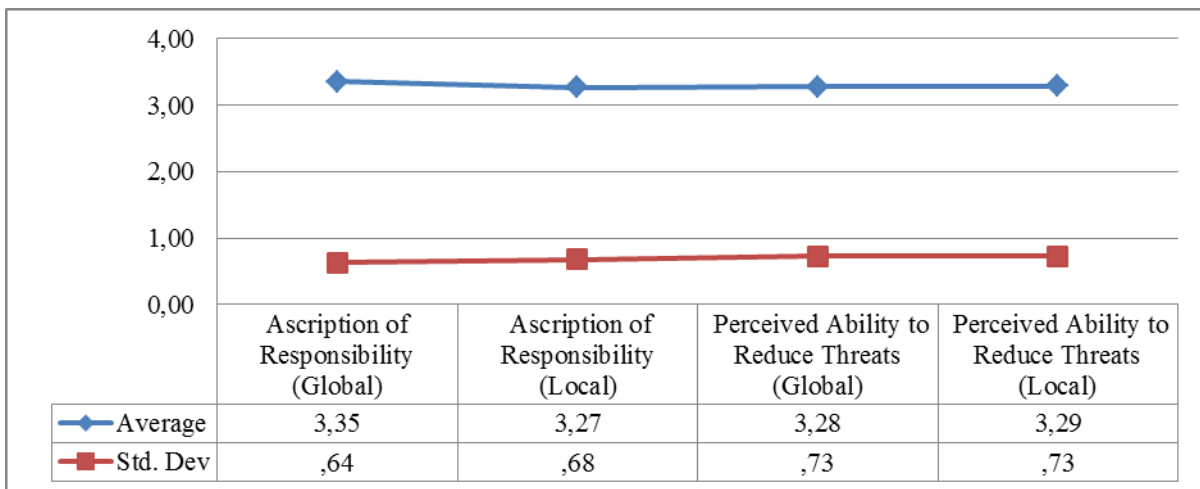


Figure 3. The Averages on Beliefs

In consideration with the Figure 3, the averages of high school students for the ascribed responsibilities regarding the conservation of local and global biodiversity and perceived abilities to reduce global and local threats vary between $3,35\pm 0,64$ and $3,27\pm 0,68$. The averages of ascribed responsibility and perceived ability to reduce threats are close. High school students assessed the global ascribed responsibility (average= $3,35\pm 0,64$) and local ascribed responsibility to reduce threats (average= $3,27\pm 0,68$) as “Agree”. Similarly, they assess the globally perceived ability to reduce threats (average= $3,28\pm 0,73$) and locally perceived ability to reduce threats (average= $3,29\pm 0,73$) as “agree”.

c) Findings on Personal Norms

The results for the answers provided the high school students that participated to the research upon the norms within the VBN theory are shown in Figure 4.

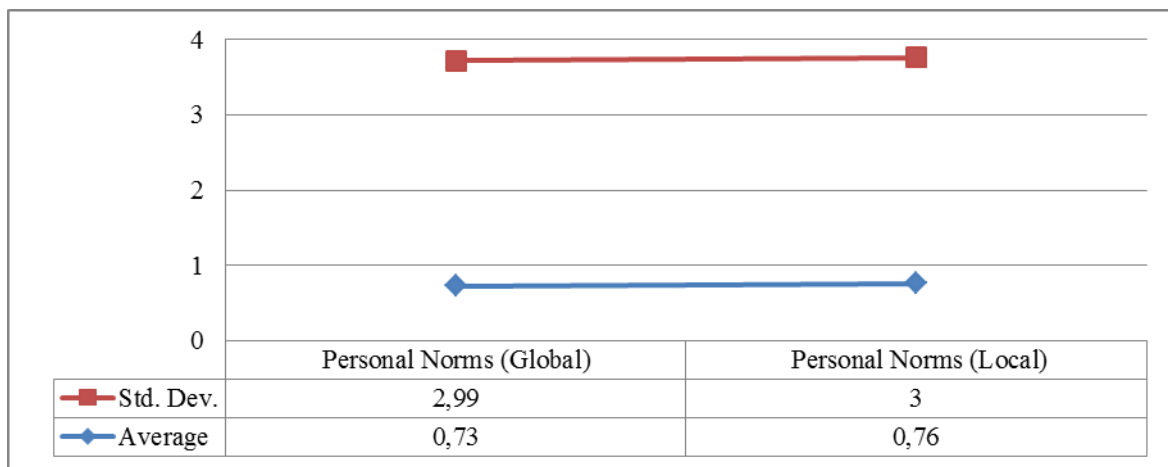


Figure 4. The Averages on Personal Norms

When we examine the Figure 4, we can observe that the averages of personal norms regarding the conservation of global and local biodiversity are close as shown above. High school students evaluated the personal norms concerning the conservation of global (average= $2,99\pm 0,73$) and local (average= $3,00\pm 0,76$) biodiversity as “neither agree nor disagree”.

d) The Effects of Gender on Human Values

The effects of gender on universal human values of high school students were evaluated and the results were given in Table 1.

Table 1. The Effects of Gender on Human Values

Dependent Variables	Gender	N	Mean rank	U	Z	P	Impact
Self-direction	Female	291	269,61	26593,5	-2,90	,00	Significant
	Male	215	231,69				
Power	Female	291	231,20	24792,0	-4,00	,00	Significant
	Male	215	283,69				
Universalism	Female	291	281,95	23004,0	-5,10	,00	Significant
	Male	215	215,00				
Success	Female	291	256,15	30510,0	-,48	,63	Non-significant
	Male	215	249,91				
Safety	Female	291	260,43	29266,0	-1,24	,21	Non-

	Male	215	244,12				significant
Stimulation	Female	291	273,99	25321,0	-3,68	,00	Significant
	Male	215	225,77				
Benevolence	Female	291	280,89	23312,5	-4,92	,00	Significant
	Male	215	216,43				

Pursuant to the Table 1, the impact of gender on the self-direction, power, universalism, stimulation and benevolence values were found as ($p < ,05$). This impact is considered as significant in favour of females. In other words, the values of self-direction, power, universalism, stimulation and benevolence are significant and higher compared with males. However, there is no impact of gender on the success and safety values. ($p > ,05$).

e) The Effects of Gender on Belief

The effects of gender on the ascribed responsibilities of high school students regarding the conservation of global and local biodiversity and the perceived abilities to reduce global and local threats were evaluated and given under Table 2.

Table 2. Impact of Gender on Belief

Dependant Variables	Gender	N	Mean rank	U	Z	P	Impact
Global Ascribed Responsibility	Female	291	268,57	26896,0	-2,74	,01	Significant
	Male	215	233,10				
Local Ascribed Responsibility	Female	291	275,19	24970,5	-3,93	,00	Significant
	Male	215	224,14				
Global Perceived Ability to Reduce Threats	Female	291	270,78	26253,0	-3,15	,00	Significant
	Male	215	230,11				
Local Perceived Ability to Reduce Threats	Female	291	271,92	25922,0	-3,37	,00	Significant
	Male	215	228,57				

In accordance with the Table 2, the effects of gender on the ascribed responsibilities of students for the conservation of global and local biodiversity and perceived abilities to reduce global and local threats are significant ($p < ,05$). Pursuant to mean ranks, the ascribed responsibility of female students towards the conservation of global and local biodiversity and perceived ability to reduce global and local threats is higher than male students.

f) The Effects of Gender on Personal Norms

The effects of gender on the personal norms of high school students regarding the conservation of global and local biodiversity was evaluated and the results are given in Table 3.

Table 3. The Effects of Gender on Personal Norms

Dependent Variables	Gender	N	Mean rank	U	Z	P	Impact
Global	Female	291	265,58	27767,50	-2,18	,03	Significant
	Male	215	237,15				
Local	Female	291	266,82	27406,50	-2,40	,02	Significant
	Male	215	235,47				

In consideration with Table 3, the effects of gender on the personal norms regarding conservation of global and local biodiversity is significant ($p < ,05$). According to the mean

ranks, the personal norms of female students regarding the conservation of global and local biodiversity are higher than male students.

g) The Effects of Grade on Values

The effects of grades on the universal human values of high school students was evaluated and the results are given in Table 4.

Table 4. The Effects of Grade on Universal Human Values

Dependent Variables	Grade	N	Mean rank	sd	X ²	P	Impact
Self-direction	10. grade	81	231,89	2	2,44	,30	Non-Significant
	11. grade	181	253,06				
	12. grade	240	261,00				
Power	10. grade	81	269,36	2	10,12	,01	Significant (11.grade-12.grade)
	11. grade	181	275,09				
	12. grade	240	232,22				
Universalism	10. grade	81	244,64	2	11,71	,00	Significant (11.grade-12.grade)
	11. grade	181	227,51				
	12. grade	240	275,72				
Achievement	10. grade	81	259,35	2	,44	,80	Non-Significant
	11. grade	181	256,76				
	12. grade	240	249,14				
Security	10. grade	81	244,25	2	,68	,71	Non-Significant
	11. grade	181	259,74				
	12. grade	240	251,94				
Stimulation	10. grade	81	258,49	2	,20	,90	Non-Significant
	11. grade	181	250,10				
	12. grade	240	254,37				
Benevolence	10. grade	81	263,08	2	1,07	,59	Non-Significant
	11. grade	181	245,04				
	12. grade	240	256,60				

When considering Table 4, it can be concluded that the effect of grade on the universalism and power values of high school students is significant ($p < .05$); whereas it is not significant on self-direction, achievement, stimulation, benevolence and security values ($p > .05$). This effect is between the 11th and 12th grade students with regards to power and universalism. The mean ranks of 12th grade are lower than 11th grade students for power value type (mean rank 12th grade=232,22, mean rank 11th grade=275,09); while the mean ranks of 12th grade are higher than 11th grade students in universalism (mean rank 12th grade=275,72; mean rank 11th grade=227,51).

h) The Effects of Grade on Beliefs

The effects of grade on the ascribed responsibilities of high school students regarding the conservation of global and local biodiversity and the perceived abilities to reduce global and local threats were evaluated and given under Table 5.

Table 5. The Effect of Grade on Belief

Dependent Variables	Grade	N	Mean Rank	sd	X ²	P	Impact
Global Ascribed Responsibility	10. grade	81	212,20	2	26,72	,00	Significant (12.grade-11.grade) (12.grade-10.grade)
	11. grade	181	226,15				
	12. grade	240	287,50				
Local Ascribed Responsibility	10. grade	81	218,32	2	27,66	,00	Significant (12.grade-11.grade) (12.grade-10.grade)
	11. grade	181	222,07				
	12. grade	240	288,50				
Global Perceived Ability to Reduce Threats	10. grade	81	244,57	2	29,66	,00	Significant (12.grade-11.grade)
	11. grade	181	211,48				
	12. grade	240	287,64				
Local Perceived Ability to Reduce Threats	10. grade	81	207,27	2	44,10	,00	Significant (12.grade-11.grade) (12.grade-10.grade)
	11. grade	181	215,26				
	12. grade	240	297,21				

In consideration with Table5, the effects of grade on the ascribed responsibility regarding the conservation of global and local biodiversity and perceived ability to reduce the global and local threats is not significant ($p < ,05$). The correlation for the effect among the groups was evaluated. According to the mean rank, the ascribed responsibilities of 12th grade students for the conservation of global and local biodiversity are higher than any other grades (Global: mean rank12thgrade=287,50, mean rank11thgrade=226,15; mean rank10thgrade=212,20; Local: mean rank12thgrade=288,50, mean rank11thgrade=222,07; mean rank10thgrade=218,32). Additionally, the perceived ability to reduce threats of 12th grade students regarding the global biodiversity loss are higher than 11th grade students; for the local biodiversity loss, the perceived ability to reduce threats of 12th grade students are both higher than 11thgrade and 10thgrade students. (Global: mean rank12th grade=287,64, mean rank11th grade=211,48; Local: mean rank12th grade=297,21, mean rank11th grade=215,26; mean rank10th grade=207,27).

i) The Effect of Grade on Personal Norms

The effect of class year on the global and local personal norms of high school students was evaluated and the results are given in Table 6.

Table 6. The Effect of Grade on Personal Norms

Dependent Variables	Grade	f	Mean Rank	sd	X ²	P	Effect
Global	10. grade	81	220,98	2	11,22	,00	Significant (12.grade-11.grade) (12.grade-10.grade)
	11. grade	181	239,04				
	12. grade	240	275,02				
Local	10. grade	81	220,06	2	6,49	,04	Significant (12.grade-10.grade)
	11. grade	181	250,22				
	12. grade	240	267,03				

DISCUSSION and CONCLUSION

The island of Cyprus is quite rich in biodiversity and it is the common interest of the people to protect biodiversity. In this respect, the Turkish Cypriots' values, beliefs, and norms related to the protection of biodiversity were studied. The research was carried out through value-belief-norm theory in order to explore and understand pro-environmental behaviour. The first result generated from the study within the framework of VBN is concerned with the universal human value types of students towards the conservation of biodiversity. The high school students in TRNC attach much more importance to the value type of "self-direction". Namely, "self-direction" value of students is more effective than "universalism", "benevolence", "power", "achievement", "security" and "stimulation". When other environmental behaviour studies were examined, some found out the effect of enhancement values (e.g. power) on environmental behaviour were discovered, as in research carried out by Abrahamsa and Steg, 2011). Some others, on the other hand, introduced that the impact of self-transcendence values (e.g. universalism) which are stronger on environmental behaviour (e.g. Dervişoğlu, 2007; Menzel, 2007; Şenel and Hazer, 2007). According to the structure in the value theory of Schwartz, the participants of this study find the value under being open to change more significant; the participants of other related studies give the value under going beyond oneself importance. Openness to change and self-development is related with the individual interests and characteristics of individual; whereas in the going beyond oneself and conservation approach, there is an impact of an individual through his/her relations with other. In other words, the values of individuals that the interests cannot be estimated beforehand are under the openness to change values, and contradict with the protective approach value axis (Schwartz, 2012). As a result this implies that the own interests of high school students in TRNC who participated to this study are more important from the perspective of their priorities. It is also possible that students' self-values affect behaviour related to the protection of biodiversity.

Another result generated from the research relates to the beliefs of students on the subject of the conservation of biodiversity. According to this study, the ascribed responsibilities of students regarding the conservation of global and local biodiversity are higher than their perceived abilities towards the minimization of global and local biodiversity. Beliefs are associated with the general condition of the biophysical environment. Therefore, the ecological beliefs are crucial on the pro-environmental behaviours in terms of awareness of consequences and awareness of responsibility (e.g. Han, 2014; Lopez and Cuervo-Arango, 2008). Meanwhile, previous studies support the idea that beliefs and values affect behaviour taken with pro-environmental intent (e.g. Caluri and Luzzati, 2016; Eide, 2013; Tarrant, 2010). In this respect, it is expected that ecological belief can affect the intent to protect biodiversity.

The other result from this research is about the personal norms, which are the last elements of the VBN theory. The personal norms of students regarding the conservation of global and local biodiversity are close. This result related to personal norms are very vital among high school students in the protection of biodiversity (e.g. Griskevicius, 2008; Harland et al., 2007). Studies show that personal norms determined by awareness of the consequences and ascribed responsibility have an impact on pro-environmental behavior (Brosch et al., 2014; Pradeep, 2012; Lopez & Cuervo-Arango, 2008; Thøgersen, 2006).

This study reflects that gender, and grade have impact on the value-belief-norms related to conservation behaviour of biodiversity. Considering the results concerning the correlation between value types and demographic characteristics of students for the conservation of biodiversity, gender has an impact on all values except achievement and security values. While female students were found to give more importance to self-direction, universalism, stimulation and benevolence values in the conservation of biodiversity; male students

attached more importance to the value of power. Another outcome is about the significant impact of class year on universal human values. 11th grade students care more about power value than 12th grade students; while giving universalism value type less importance. When we compare demographic features and ascribed responsibilities and perceived abilities to reduce, we can see that the gender and grade level have impact on the ascribed responsibilities of students for the conservation of global and local biodiversity and their perceived abilities for the minimization of global and local biodiversity loss. Female students have higher ascribed responsibilities for the conservation of global and local biodiversity and their perception of talent for the minimization of biodiversity loss than male students. It is possible to conclude from the data that female students have more extensive ecological belief than male students. Similarly, pro-environmental beliefs of students vary depending on their class years. The ascribed responsibilities and perceived abilities of 12th grades are higher than 11th grade students. The personal norms of female students concerning the conservation of biodiversity are higher than the male students. Similarly, the personal norms of college students are higher than of students from Anatolian high school and general high school; they are higher compared with the general high school students in the local context. When compared in terms of class years, the personal norms of 12th grades students are higher than that of 10th and 11th grade students in global context; whereas they are higher than 10th grade students only in the local context. These results are in line with other studies (e.g. Yıldız & Selvi, 2015; Gök & Afyon, 2015; Abrahamse and Steg, 2011; Tarant, 2010; Alnaçık, 2010; Vaske et al., 2001) which indicate the moderate effect of demographic features on value-belief-norms, environmental knowledge and pro-environmental behavior.

The educators may take these independent variables into consideration and include the activities that would have positive impact on the environmental behaviour, values and environmental perception. Different teaching methods may be recommended to be used by the teachers in order to teach the conservation of biodiversity and importance of sustainability. Personal norms of students towards the conservation of biodiversity have been analysed. The correlation between the norms of biodiversity conservation and social norms of students may be studied in a future research which can examine how individuals incline towards protecting biodiversity and the theory of planned behaviour (TPB) (Ajzen, 1991) which explains how the psychological mechanism functions.

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Chemical Literacy of Teaching Candidates Studying The Integrated Food Chemistry Ethnoscience Course

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ABSTRACT

This research aimed to describe the chemical literacy of teaching candidates studying the integrated food chemistry ethnoscience course. The research sample comprised teaching candidates studying chemistry in a teachers' education program in Central Java, Indonesia. In this descriptive research method, data was collected by using a chemical literacy test in narrative form regarding material integrated ethnoscience carbohydrates that have been declared valid by experts with a reliability of 0.81. The results revealed that the content aspects of students' average chemical literacy achievement amounted to 31.8% included in the low category. Similarly, for science literacy achievement scores in the process domain, the indicators identifying scientific questions of 3.20 evaluate and design a scientific investigation of 2.26 and identify the scientific evidence of 2.95 from a maximum score of 5.0. These students' chemical literacy achievement is also in accordance with the results of the analysis of student explanations on selected chemical concepts that are seen mostly in the category of partially correct answers. Therefore, it is necessary to improve the quality of learning that explicitly integrates aspects necessary to improve students' chemical literacy.

Keywords: Ethnoscience, integrated food chemistry ethnoscience, chemical literacy.

INTRODUCTION

Chemistry is a science that deals with the properties of the material, the material structure, material composition, bonding that occurs in the material, material changes, as well as the energy involved in turning these materials (Kelter, Mosher, & Scott, 2009). Informally, the meaning of chemical or chemicals is often limited to the materials produced by the chemical industry, even though the chemicals needed by humans are more than that. Therefore, understanding the chemical explanation is highly important to most people because to understand the chemistry helps people to understand their daily lives and the



environment (Celik, 2014). However, as a concept involving daily-life phenomena, applications relating to the environment are often associated with chemical literacy skills of teaching-candidates. This is evidenced by the Programme for International Student Assessment (PISA) data achievement indicating that the scientific literacy of Indonesian students is still very low (Rahayu, 2016). PISA's test of their literacy revealed that in 2006, Indonesia was ranked 50th out of 57 countries; in 2009, 57th out of 63 countries; in 2012, 64th out of 65 countries; and in 2015, 66th out of 74 countries.⁹

Chemical literacy is one of the essential elements that must be developed in education. It is defined as the capacity to use chemical knowledge, to identify questions, and to draw conclusions on the basis of the evidence in order to understand and help make decisions about the natural world and human interaction with nature (Cavanagh, 2008). Chemical literacy relates to people of all ages, all levels of both science and non-science education. According to Gilbert and Treagust (Lin, 2009), there are many aspects of chemical literacy that have direct applications in daily life, thus allowing a person to be a better citizen and to understand the report and discuss chemistry and chemicals; it can also solve daily environmental issues such as decrease in the quality of air, water and soil, ozone layer depletion, acid rain, corrosion, and global warming. Many chemicals are closely related to human life and are very helpful in solving problems related to daily life, such as food, beverages, medicines, bleach, cleaners, room deodorizers, vehicle, land, air, and household appliances. Thus, understanding the chemical explanation is very important to most people because it has practical applications in daily life.

Chemical literacy involves several components (Shwartz, Ben-Zvi; & Hofstein, 2005), such as the following:

1. Understand the chemical properties, norms, and methods, i.e., how the chemist worked and how the produced products are accepted as scientific knowledge;
2. Understand the theories, concepts, and models of chemistry. Subjects situated on a theory involving broad applications;
3. Understand how chemistry and chemistry-based technology relate to each other. Chemistry is trying to produce an explanation of nature, whereas chemical technology seeks to change the world itself. Concepts and models produced by the two fields have a strong relation, and thus, mutually influence each other.
4. Appreciate the impact of chemistry and chemical technology associated with the community. Understanding the nature of chemical phenomena that are applicable. Produce changes or variations to the better phenomenon by changing the world we see.

Future chemistry learning should be relevant to the settlement of social issues (Holbrook, 2005). If the learning approaches of scientific literacy develop scientific knowledge in various aspects of life, looking for solutions, on the basis of local advantages and social-science decision, it is the same with learning chemistry. As the nature of chemistry learning is a product and a process, chemical literacy requires knowledge not only of science concepts and theories but also of the general procedures and practices associated with scientific inquiry. The low contribution to the success of citizens' scientific learning caused by the release of their science lessons from the social context only focuses on a mastery of the material and the use of improper assessment so that the students were only prepared to master the knowledge (National Research Council / NRC, 1996). In lessons, students should know the relevance of learning science in daily and social life. Scientific learning in school should be directed toward the understanding of how important science is when it is associated with the community in the past, present, or future. Future scientific learning is necessary to keep a balance/harmony between the knowledge of science itself, with the generation of scientific attitudes and ethnosciences values existing and developing in society (Marks & Eilks, 2009), which applies the problem-oriented model and uses social sciences in order to improve the

scientific literacy of students in Germany. Therefore, students' sociocultural environment needs to be given serious attention for developing science education in schools, including original science that can be useful for life (Suastra, Tika, & Kariasa, 2011). This is consistent with the view of present-day science education reform that stresses the importance of science education for improving social responsibility.

Good chemistry learning is chemistry learning to make students understand the concepts of chemistry that make up a branch of science, using chemical theories to explain natural phenomena; this can also help students solve problems and make decisions on the basis of chemistry concepts that have been received. To gain chemical knowledge, one must have a realistic view of the chemistry (Shwartz, Ben-Zvi, & Hofstein, 2006). Someone with knowledge of chemicals should also know the basic objectives of chemistry, including the chemical principle that teaches us to understand the phenomenon that is macroscopic, microscopic, and symbolic, as well as to investigate the chemical dynamics of the process and energies changes in the reaction. Such literates should appreciate and be able to use the knowledge in their daily lives. If students do not have a good interest in and understanding of chemistry, they will face difficulty in understanding the overall nature in the future. Therefore, an increase in scientific literacy and chemistry in school is significant to future prospects (Kelly, 2007).

As scientific literacy is a broad concept, mastery of chemistry will affect the quality of life. Individual achievement in science/chemistry knowledge and skills will have implications of their readiness to face the utilization of advanced technology in the future (OECD, 2009). This is consistent with the statement of (Glenn & Janusa, 2010) that described chemistry a powerful motivation for developing technology that can make someone's life better, easier, and cheaper. A person with scientific literacy is able to use this knowledge in daily life (Shwartz, Ben-Zvi, & Hofstein, 2006) (Anelli, 2011). Scientific literacy is able to prepare students as responsible citizens and as sensitive to surrounding issues. This is due to the scientific literacy emphasis on decision-making about social issues if the terms of the scientific knowledge have been obtained and problems can be solved using that knowledge (Murcia, 2007) (Gunstone, 2014)

Till date, research on chemical literacy has been largely based on the same study with scientific literacy measurement (Bond, 1989) (Shwartz, Ben-Zvi, & Hofstein, 2006). But many years ago, Bond provided sufficient pressure to support the understanding of the atomic theory, the concept of the mole, radioactivity, or other fundamental chemistry concepts (Bond, 1989). Chemical literacy has been suggested to have a characteristic in which the materials must be attributed with examples in daily life, and it should also be extracted chemical concepts connection with the information you've obtained the students through print and electronic media (Mann & Treagust, 2010). Hirca, Celik, & Akdenis also expressed the need for context relating to the actual problems that occur in the community.

If scientific literacy is the focus of science education chemical literacy is the focus of chemistry education (American Association for the Advancement of Science [AAAS]. , 1993), (NRC, 1996). Study of science literacy by AAAS in 1993 and NSES (NRC, 1996) has been used as a framework for the science of the 21st century that has been widely applied in various countries through curriculum development, model learning, and assessment form (Wei & Thomas, 2005) (Shwartz, Ben-Zvi, & Hofstein, 2006) (Millar, 2006) (Bybee, Mc Crae, & Laurie, 2009) to prepare the students for global challenges.

The result development measurement (Shwartz, Ben-Zvi, & Hofstein, 2006) is used to measure the level of literacy of students, including their skills of defining key concepts of chemistry, using the understanding of chemical concepts to explain phenomena, and understanding every article about the chemistry based on terms of scientific literacy.

The teacher's role is very vital to become one of the important components that determine the students' success. Student success in learning is largely determined by the ability of teachers to teach. Therefore, a teacher must have a strong ability in chemical literacy, as well as other knowledge and the skills to guide and direct students so that they have high scientific literacy. It has been appropriately stated that a teacher should support the development of chemical literacy in order to allow students to construct meaning in scientific literacy (Shwartz, Ben-Zvi, & Hofstein, 2005). Given the important role of teachers as agents of learning, the teaching candidates must have high chemical literacy skills as their skills certainly affect future learning. If chemical literacy is low, it is feared that the implementation of teaching chemistry is less than optimal. Teachers with a low level of scientific literacy cannot be expected to develop science-literate people or implementing the curriculum effectively so that the university curriculum should improve the literacy level of scientific literacy teacher candidates (Bacanak & Gökdere, 2009).

A research was conducted to determine the extent of chemical literacy of the teaching candidates. On the basis of the formulation of the problem, the following research question can be proposed: What is the chemical literacy of teaching candidates in the domain of science content and process? The results of chemical literacy analysis are valuable information for the lecturer in order to prepare appropriate learning strategies for fostering chemistry literacy for chemistry teaching candidates.

METHODS

The method used in this research is a descriptive method; the research is directed to collect data about the actual condition. As a method to uncover the candidates' chemistry literacy, in the aspects of knowledge/content, processes, and attitudes, the research was conducted at the lecture entitled "Chemical Food Ingredients integrated ethnosciences." This course aims to introduce the component-based food ingredients ethnosciences of the Java community and make the teaching candidates aware of the positive sides of the cultural heritage of the Javanese society relevant to be maintained in the face of various challenges of the times. Through these efforts, teaching candidates are expected to learn of the conditions of the community and making capital in improving the meaningfulness of learning more open.

The study was conducted in one of the education workforce education institutions of Central Java. Subjects in this study comprised fourth-semester students of chemical food ingredients courses in the academic year 2015–2016, amounting to 148 people (84% women and 16% men). They were grouped into high-, medium-, and low-achievement categories on the basis of the semester GPA 3. Their GPAs range 0–4. The calculations revealed that the value average GPA to be 3.31 and SD to be 0.217733. Of the 148 teaching candidates, 29 were in the high category (GPA >3, 53), 110 were in the medium category (GPA between 3.09 and 3.53), and 9 were in the low category (GPA <3.09).

Instruments used to test chemistry literacy in the context of Javanese culture, among others related to the culture of making palm sugar is traditionally making salted eggs, palm oil processing and *Gatot & Tiwul* as food knowledge characteristics of local wisdom in Central Java have been developed (Sumarni, Sudarmin, Wiyanto, & Supartono, 2016a) (Sumarni, Sudarmin, Wiyanto, & Supartono, 2016b). Test item refers to the form of test questions developed by Witte & Beers (2003) and Schwartz, Ben-Zvi, & Hofstein (2005) to reveal the students' chemical literacy skills and competency in content domain. Aspects which revealed, among other things: a) to recognize chemical concepts, b) define some key concepts, c) use their understanding of chemistry concepts to explain phenomena and d) use their knowledge in chemistry to read or analyse the information given in a passage (Thummathong & Thathong, 2016). Sample questions for the literacy test are listed in Appendix 1. In this research, we used 30 test items in a narrative form, consisting of 10 items related to

carbohydrates, 10 items related to fats, and 10 items related to proteins. Each item's test scores differed but highest score limit of each topic was 100.

Problem literacy test chemical used for data retrieval has been declared invalid by 3 experts chemical materials, chemistry lecturer foodstuffs 3, and 3 expert measurements and evaluation. A small scale and a large scale test were also conducted to determine the response of the students and the faculty considering that the users against the chemical literacy test questions were developed as a reference for revising the product. On the basis of trial results, either limited or broad scale, several revisions have been made by the advice of the test item validator and user feedback. The internal consistency reliability (Cronbach's alpha) of the assessment instrument is 0,81.

In the implementation of data retrieval, all students are provided a set of chemical literacy problem to be solved within as long as 120 minutes. Data were analyzed using quantitative descriptive analysis. The analysis was performed by calculating the scores obtained on each topic, then on average. The minimum score-limit was decided as 64, which refers the students' chemistry literacy scores, defined by minimum completeness criteria present in the sample, concerning the subject of chemistry food ingredients.

RESULTS AND DISCUSSION

1). Chemical literacy test results per domain content

Student chemical literacy in the content domain can be seen in Figure 1 and Table 1.

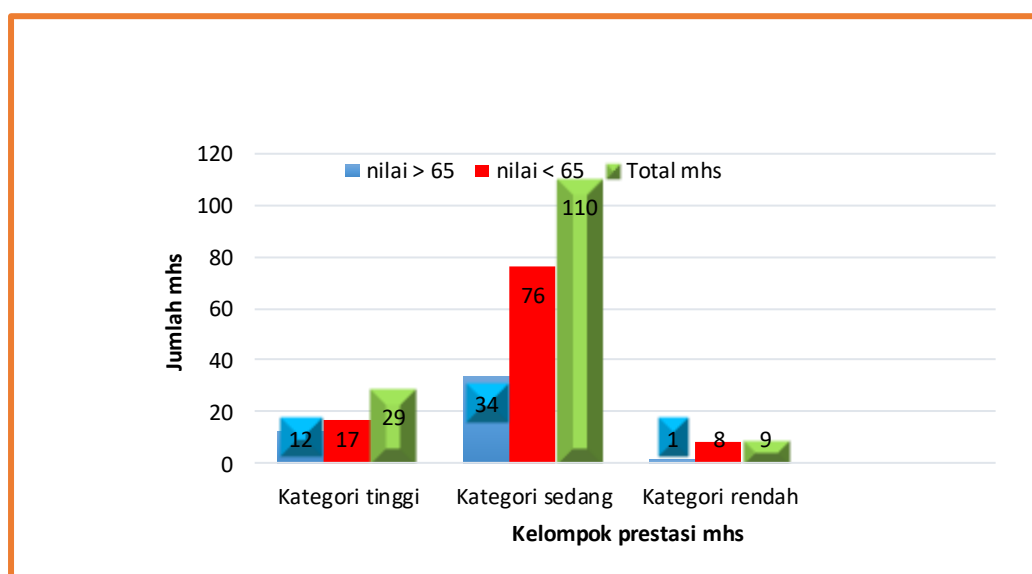


Figure 1. Number of students with chemical literacy in the content domain (N = 148)

Figure 1 shows that there are still many teaching candidates who do not have chemical literacy. Of the 148 candidates, only 47 (31.8%) had chemistry literacy in the context of content, while the remaining 101 (68.2%) did not have such literacy. Judging by student achievement and creating a row of high-, medium-, and low-achievement group, the number of candidates surpassing the minimum criteria (>65) was 12, 34, and 1 student (8%, 23%, and 0.8%), respectively. Similarly, the terms of the average value of chemical literacy in each of the groups still showed capabilities far below the standards set (Table 1).

Table 1. The mean value of chemistry student literacy in the content domain

o.	Groups of student achievement	The mean value of chemical literacy achievement in the content domain
	High	53
	Medium	46
	Low	40

2) The results of tests per domain competence chemical literacy

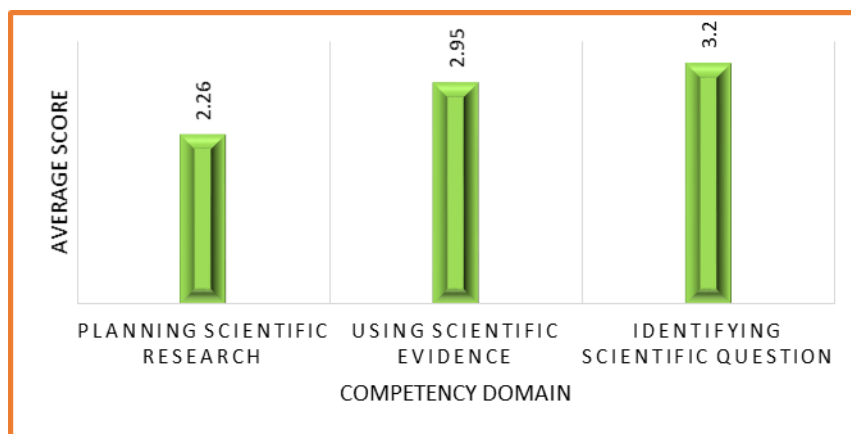


Figure 2. Mean value of scientific literacy achievement in competency domain (n = 148, the maximum score 5.0)

Results of the analysis of student explanations related to the selected chemical concepts data can be classified into true answer, partially true answer, and false answer, as shown in Table 2.

Table 2. Results of students explanation in concepts of chemistry

Concept	Type of explanation	True	Partially true	False
Photosynthesis	Molecular	11	24	19
	Macroscopic	26	50	18
	Total	37	74	37
Chemical reaction	Molecular	20	10	13
	Macroscopic	41	44	20
	Total	61	54	33
Carbohydrate	Molecular	-	13	-
	Macroscopic	44	75	18
	Total	44	86	18
Evaporation	Molecular	12	32	16
	Macroscopic	32	22	34
	Total	44	54	50
Monosaccharide	Molecular	1	5	1
	Macroscopic	39	74	28
	Total	40	79	29
Disaccharides	Molecular	-	-	-
	Macroscopic	32	66	50
	Total	32	66	50
Carbohydrates test	Molecular	-	-	-
	Macroscopic	29	58	61
	Total	29	58	61

1) Chemical literacy on domain content

Figure 1 indicates that the results of the course for three semesters particularly with regard to the basic concepts of chemistry have, however, been able to equip students to be chemical literates. Some evidence suggests that teaching candidates who have passed have not demonstrated the ability of scientific literacy (Çepni & Bacanak, 2002), which is possible because the learning they receive does not associate with the content of science and daily life. Similarly, the terms of the average value of the chemical literacy in each of the groups still showed capabilities far below the standards set (Table 1). Table 1 shows that the group with a higher understanding of the concept is better than the low group. This is possible because the high-achievement group had thinking skills of analysis and its long-term memory retention is better than medium- and low-achievement group.

2) Chemical literacy in domain competence

In the domain of competence, Figure 2 shows that the mean achievement for all indicators has not yet reached the level of success (score >3.5). However, the aspects of not achieving the identifying scientific questions or not explaining the phenomenon scientifically aligned with the study's results (Celik, 2014) that of the 112 teaching candidates, only 56% give the correct explanation related to functional literacy, that most students have very limited knowledge about the concept, and that most of their explanation are only partially right and are on a macroscopic level. In his thesis, Bacanak shows that the average results of two scientific literacy tests applied to prospective science teachers were 54.30% and 59.10% (Bacanak, A., 2002). Therefore, teaching candidates of science must enhance their chemical scientific literacy in order to raise the level of scientific literacy of future generation.

The achievement of scientific literacy in the domain process for identifying/recognizing scientific questions indicators, as depicted in Figure 2, shows the highest score compared with the other two aspects but has not reached the stipulated minimum score of >3.5. This suggests that although the chemical knowledge already acquired by students started from since secondary education and went up till college, which should ideally enhance their chemical literacy, it has not made them chemical literate as expected. This further reinforces the results of the PISA findings that science learning in Indonesia has not succeeded in improving the scientific literacy skills in the aspects of content, the context of the application of science, the science, and the attitudes. PISA results in 2012 revealed that Indonesia ranked 64th out of the 65 participating countries, with an average score of 382 scientific capabilities (OECD., 2013)

We modelled the literacy level from the lowest to the highest. No changes were found in the low level of the sense of competence or capabilities (*low level*) and the highest level was an already complex ability (*high level*) (Bybee, 1997). Having good chemical literacy means not panicking while facing issues in chemistry and appropriately judging and determining proper action as per the concepts of their chemical knowledge. A person with chemical literacy can become the link between the content and context of chemistry, resulting in scientific decisions.

The results in Table 2 indicate that most students have very limited knowledge about the concept. Most of their explanation is partly true and is at the macroscopic level. Except for the explanation of the chemical reaction, the explanation provided by the students was partly true and partly false. For the process of photosynthesis, a partially correct explanation, even though it contains a chemical reaction. For example, one student explained as follows: "Cassava is formed from the reaction of photosynthesis that occurs in cassava. The reaction of photosynthesis occurs because of their gas CO₂ and water." This explanation is categorized as partially true because it does not refer to the concept of photosynthesis and does not clarify that the reaction of photosynthesis was the reaction of the formation of carbohydrates that

occur in chlorophyll when their gas CO_2 from the air and the water are absorbed through the roots with the help of sunlight to the equation as follows: $\text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 (\text{glucose}) + \text{O}_2 (\text{g})$. Due to the responses including chemical symbols, the explanation is considered molecular. Another explanation is an example of the bitter taste in cassava that saved in a few days: "Oxidation is the interaction between compounds in cassava with oxygen in the air so that the chemical structure of substances changed after the interaction." In actuality, the correct explanation is as follows: "In certain circumstances, especially when oxidized, glycoside toxins are formed in cassava, which in turn form cyanide (HCN). The cyanide leaves a bitter taste. The sweet tuber produces at least 20 mg of HCN per kilogramme of fresh tubers and 50 times more tuber that tastes bitter." They mostly can answer the question by mentioning concepts that match the content, such as compounds HCN as toxic compounds, carbohydrate testing with Lugol; they also believe that they are familiar with these concepts but only 56% of them explain correctly.

A considerable gap exists between the knowledge of the students and the application; numerous students who know and remember the subject matter are unable to use their knowledge (Semiawan, 2000). This happens because their learning presented facts, knowledge, and then the law, and thus, it is usually memorised and not associated with empirical real-life experiences. This has been proved; there are many teaching candidates who do not understand the depth of the concepts in chemistry, especially in the matter of carbohydrates, even though these concepts are closely related to their daily lives. In the concept of simple sugars/saccharides, there are still many students who have been unable to determine the chemical and structural formulas of carbohydrates. In writing compilers of carbohydrates, they experience difficulty while changing the name of the compound to the chemical formula and turn the chemical formula into a compound name instead.

As for the functionality or usability of carbohydrates, in general, the students were able to write it in full. The same thing happened when asked to write the chemical equation. However, many students face difficulty in explaining the process of carbohydrate formation in plants. Many students have been unable to explain the concepts in carbohydrates because, so far, the lecturer considers that these concepts have been "acknowledged" by students, and thus, even the students were already feeling out of the concept. Interviews with some of the students revealed that they are still facing trouble due to ethnosciences-based questions that they have never encountered and are still uncommon to them. According to the students, in a test or examination on the subjects or course, questions only focused on memorization of concepts, applying the formula and almost never associating it with its application in daily life, especially the ethnosciences-based questions.

From these findings, other contributors emphasize the importance of chemical literacy controlled by the teaching candidates as literacy is chemically related to various aspects of life and to the activities of people of all ages. Literacy is chemically related to people of all ages and thus, it needs to be increased to achieve higher chemical literacy (Lin, 2009). Obtaining a student's knowledge depends on the students' thinking while getting a learning experience associated with understanding the concept of previously owned.

Referring to the results of the chemical literacy analysis of teaching candidates, a lecturer should provide a briefing during the learning process in the classroom. During the learning process, the lecturer must use a scientific approach to train students, should observe and ask stages, and students should be trained in identifying scientific issues such as **making questions related to the scientific phenomenon** that is delivered by lecturers. This can also enhance the students' skill in explaining phenomena scientifically and using scientific evidence. This is because both these capabilities need to be trained at the stage of associating or processing the data and communicating during the implementation phase of learning. Students' ability to identify evidence should also be trained at the **stage of collecting**

information or experimenting. At this stage of associating, lecturers have to guide each group in processing and analysing the results of experiments that have been conducted and in attracting and **communicating conclusions** on the basis of experimental data. At the data-processing stage, students are trained to use scientific evidence (experimental results) to explain scientific phenomena and communicate conclusions based on the data they collect.

Learners' increased scientific literacy is characterised by their ability in creative thinking and problem-solving challenges and making personally and socially responsible decisions (Holbrook & Rannikmae, 2009). Similarly, the result obtained by Marks & Eilks, applies the model of problem-oriented and uses social sciences to get the results of increasing science literacy among learners. The relevance of learning chemistry in daily life according to Holbrook can be checked in the following stages: 1) how teaching should be reconsidered, 2) the relevance of the subject material in people's lives and how it directly engages learners, 3) the structure of the teaching shows concern for the lives of the people, leading to better learning, and 4) the structure of the chemical material that is not only in theory.

CONCLUSION

On the basis of the results this research and discussion, it can be concluded that teaching candidates' chemistry literacy achievement in the content domain has reached as much as 31.8%, literacy achievement while scores of chemical science to process domain recognize scientific questions of 3.20, evaluate and design a scientific investigation by 2.26 and identifying the scientific evidence by 2.95 of a maximum score of 5.0. Thus, it is known that the chemical literacy of teaching candidates is still low. Candidates' chemistry literacy attainment is also in accordance with the results of the analysis of student explanations of selected chemical concepts that mostly show partially correct answers.

Therefore, in view of the above discussed aspects, we suggest the following to increase chemistry literacy of teaching candidates: (1) emphasis on a curriculum that involves the importance of the development of chemistry literacy for students, (2) teachers' chemistry skills in particular can design learning programs using local potentials in their respective regions, and (3) the scope of the material comprising the basic concepts of chemistry should be discussed; emphasis should be not only on content of chemistry but also on the context, process, and attitudes. This is highly important due to the assessment of literacy chemicals according to PISA not only including content but also including Context, Knowledge (knowledge of science and knowledge about science), as well as attitudes. Learning should use a scientific approach (PBL, IBL) associated with ethnosciences. In practice, the learning can be carried out independently and under guidance. Learning should be conducted independently, especially on things that are simple and familiar to them, including ethnosciences. And lastly, guided learning (classroom-learning) should be conducted for a rather complex matter, especially in solving daily-life problems.

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Appendix 1

Example Test instrument

GATOT AND TIWUL, POPULAR FOOD OF INFERTILE AREA

Food knowledge characteristics of local wisdom in Central Java, Indonesia



Source: <https://www.google.co.id>

Figure 1. *Gatot and Tiwul* as food knowledge characteristics of local wisdom in Central Java, Indonesia

Food shown in the Fig. 1 is an example of local wisdom special food, people called it *Gatot* and *Tiwul*, local food made by *gaplek* (dried cassava) that is popular in Gunung Kidul and is consumed from Gunung Kidul in Yogyakarta, Indonesia to Pacitan Regency, East Java. The name *Gatot* came from *Gagal Total* due to the failure of gaining rice or *white Gaplek*, while *Tiwul* came from the production process called *pathi di awul-awul*.

Cassava is a yearly tropical and subtropical clump. Its root is well-known as main food and its leaves as a vegetable.



Source: <https://www.google.co.id>

Figure 2. Cassava and harvested cassava.

Mr. Surani, a cassava farmer from Gunungpati said that the production process of *gaplek* is very easy; cassava root, called *Pohung* in Javanese is harvested, peeled, and dried. The drying is done by *Gaplek* makers by drying it in the sunlight. In the drying process, the cassavas are laid in a narrow field without any coverage all day and night long. Dried *gaplek* was mashed as flour and can be stored for a month and can be used as delicious *Tiwul*.

Based on Ngatini's story, there are two kinds of *Gaplek*. First *Gaplek* is white and commonly made as flour or *Tiwul*, and the second *Gaplek* is black and made as *Gatot*. According to Mr Surani, initially, it was just white *Gaplek*, but because of the bad process of drying (rain factor), they got black *Gaplek*. They feel pity if the *Gaplek* is thrown to the garbage, then *Gatot* was appeared and become popular to the society.



Source: <https://www.google.co.id>

Figure 3. White and black *gaplek* as ingredients to make local wisdom special food of Central Java, Indonesia

Answer all of these questions.

From the passages above, it is showed that cassava is a yearly tropical and sub-tropical clump. Its root is well-known as main food and its leaves as a vegetable.

1. a) Scientifically explain how roots and leaves of those cassavas can be made from its plant. Write down the occurred reaction similarity (Explain scientific phenomena) **Score 4**
 b) Through arrow diagrams equipped by picture and label, draw the growing and developing of the process of cassavas' roots and leaves in its tree (design scientific investigations) **Score 6**
2. From the farmers' experience, cassava is one of the food ingredients that is not durable. In the fresh condition, it can only survive for three days. If it is saved more than three days, the root will become blue and brownish and will taste bitter. Farmers said that do not choose the cassava if there are blue parts in it because it is poisonous. Is it true? Give logical answer! (science process of conclusion evaluation) **Score 4**
3. Carbohydrate had been tested in the laboratory of fresh cassava, *gaplek*, and some other food ingredients with the result in the following Table 2.

Table 2. The test results of carbohydrate

No	Food Ingredients	Colors		Information
		Before Yodiumize	After Yodiumize	
1	Banana	Yellowish	Rather purple	Rather thick
2	Rice	White	Rather purple	Thick
3	White tofu	White	White	-
4	Biscuit	Brown	Violet	Quick
5	Flour	White	Purple	Thick
6	Potato	Yellowish	Purple	Rather Pale
7	Fresh cassava	Yellowish	Purple	-
8	Gaplek	Yellowish	purple	-

- a) From the experiment result above, why did the tested white tofu not turn purple? (cause and effect law) (science concept comprehension demonstration) **Score 3**
- b) Write down your conclusion related to the experiment result above! (science process of making conclusion) **Score 3**

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Outdoor Learning Model through Fieldwork to Improve Physics Achievement in Dynamic Fluid

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ABSTRACT

This study aimed to describe the impact of the outdoor learning model on physics achievement for dynamic fluid. In this study, the outdoor learning activities were conducted through fieldwork. Fieldwork is one form of outdoor learning activities that emphasizes direct experience of students on the object being studied to link the theory to practice and improve students' skills in observation, measurement, data collection, and analysis. This study was a field trial test of physics learning model through observation to 32 students on the eleventh level physics class of senior high school in Yogyakarta Indonesia academic year of 2014/2015 as respondents. These were much divided into eight groups to do any fieldwork activities. The physics teaching and learning instructions consist of syllabus, lesson plans, worksheets, and four core competencies of assessment instruments. The instruments of data collection formed self-assessment sheet for spiritual attitudes, observation sheet for social attitudes, instrument test for physics knowledge, and observation sheet for skills. The instruments assessed the achievement of four core competencies of physics learning outcomes through fieldwork based outdoor learning. The data collected were analyzed by descriptive approach. The study states that the outdoor learning model through fieldwork which implemented can improve the core competencies of learning outcomes in dynamic fluid with the percentage of achievement of each competency is as follows: the competency of spiritual attitudes is 98%, the competency of social attitudes is 92%, the competency of physics knowledge is 78%, and the competency of skills is 92,5%.

Keywords: Outdoor learning model, fieldwork, physics achievement, dynamic fluid.

INTRODUCTION

Outdoor Learning characteristics, namely: (1) learning is done outdoors, but some aspects can be done in the classroom as an explanation of basic concepts and preparation of materials; (2) emphasis on experiential learning and learning process, namely action learning, learning by



doing, learning through experience, and learn through discovery and exploration. One of the principles experiential learning in which students are actively involved in the learning process, such as asking questions, investigating, experimenting, curiosity, problem solving, responsibility, being creative and construct meaning. Students engage intellectually, emotionally, socially both interpersonal and intrapersonal and physical; (3) involves a good multi-sensory sight, touch, smell, hearing, taste, and intuition and involves three aspects of cognitive, affective, and motoric learning; (4) emphasis on relationship between human and natural resources (Priest, S., 1986).

Based on the field observations, only a minority of student active and pay attention to the physics learning process. Most of the students tend to be passive and give less enthusiastic response to physics learning. Outdoor learning is learning activities in the wild environment or activities outside the classroom that are enjoyable. Outdoor learning helps students develop thinking skills, develop an awareness of the complexity of the real world, and understand the relevance of learning materials in schools with everyday life. Outdoor learning can be a new learning experience which is more enjoyable, relaxed, and avoid saturation. Jones, S. (2010) as president Association for Science Education states in his report that fieldwork indicates all educational activities from early years through to post-16 which take place outside the classroom and make use of the outdoor natural and built environments. The School Garden Program (SGP) and evaluate its influence on primary school 5th grade curriculum mathematics objectives, such as formation and interpretation of figures, tables and graphs has been conducted by ÇEPNİ, S. et al (2013). It was understood that SGP is an effective program for the formation and interpretation of figures, tables and graphs and was especially found to be effective for male students and students with high visual and mathematical intelligence.

In addition, a multi-sensory experience outside the classroom helps students retain or recall of knowledge more effectively. Several studies have shown results that support this idea. The results of three case studies of Environmental Studies Programs (ESPs) in Canada have findings offering further documentation of the benefits of integrated ESPs, including increased student engagement, learning experiences that are practical and relevant to students' lives, experiential learning that is memorable and opportunities for development of social and interpersonal skills (Breunig, M. et al, 2014). Andersson & Ohman (2015) stated that outdoor experiences in outdoor education practices have relations with moral attitudes towards nature. Outdoor adventure education (OAE) is widely recognized for its ability to elicit personal and social development for its participants. However, the methodology highlights the need for carefully selected samples, use of an appropriate questionnaire and control of numerous variables (Scrutton, R. A., 2015). The nature-based learning is an increasingly popular type of early childhood education. Accordingly, the use of nature as a setting and a resource for learning was studied. Findings indicate that nature is utilized as setting, as resource and as educator within children's learning and this holds true within different countries. Local, social, and cultural contexts exert influence on pedagogical practice and implications for practice based upon these are given (MacQuarrie, S. et al, 2015). The present study explores the outcomes of teaching empathy and critical thinking to solve environmental problems. A community-based research methodology was used to understand the formation of empathy and critical thinking. The findings reveal a significant benefit in using empathy strategies to engage students regarding the thinking processes involved in solving environmental problems. Using these elements as teaching techniques for environmental education courses can be very helpful in reaching the aims of creating a sustainable citizenry (Ampuero, D. et al, 2015).

Dillon et al. (2006), in the *School Science Review* found strong evidence indicating that the fieldwork (outdoor learning) if it is well understood, planned adequately, and taught well this will offer students the opportunity to develop knowledge and skills and will add their experience. Fagerstam (2012) stated that students become active when taken to the outdoor learning. This is the same as that mentioned by Fagerstam & Blom (2012) in his study of teaching biology and mathematics that during the interview the group of outdoor learning was more evident in recalling the subjects, while the indoor learning unclear and confused in the given subjects. Students enjoy learning a new atmosphere and a pause from their daily routines was always learning in the classroom. Moreover, the interaction among students increased during outdoor learning process and most students showed a positive feeling in the learning process. In the research of Fagerstam (2012) the others mentioned that the outdoor teaching and learning improved collaboration among students and participation in group work. Outdoor teaching and learning improved relations between teachers and students and improved communication in the group work. Outdoor teaching has the potential to explain the learning material using a natural approach (the proximal nature). Results of research conducted by Okada et al (2013) with the aim of observing the effect of in-depth outdoor experience to the students' attitude to nature showed that children who were in the intensive group (outdoor deeper experience) obtained a significantly improved positive attitude towards nature when compared with children in the less intensive group (less deeply experience). Research conducted by the American Institutes for Research (2005), entitled "Effects of Outdoor Education Programs for Children in California" concluded that based on the average results of the assessment between learners and teacher assessment, elementary school students who took the program of science education in the outdoors demonstrated achievement of personal and social skills higher than the group of students who did not follow the program, especially at the point of problem solving. Clear evidence that outdoor learning increases knowledge and understanding of the natural world and environmental systems and processes related to responsible attitudes towards the environment. Outdoor learning can connect learners with their environment, their community, their society, and themselves (Higgins, P. et al, 2002).

The benefits of the study are as follows:

1. For schools, obtaining a product of physics teaching and learning instructions that conform to the fieldwork-based outdoor learning model for dynamic fluid material. The teaching and learning instructions consist of syllabus, lesson plans, worksheets, as well as instruments to assess the achievement of four core competencies that include spiritual attitudes, social attitudes, knowledge, and skills.
2. For teachers and researchers, this study can be used as materials to develop outdoor learning models based on fieldwork in other subject matters.
3. For students, providing a different learning experience through outdoor learning model based on fieldwork and providing opportunities to develop attitudes, knowledge, and skills.

In this study, the outdoor learning activities are directed to fieldwork. Fieldwork is one form of outdoor learning activities that emphasize direct experience of students on the object being studied to link theory to practice and improve students' skills in observation, measurement, data collection, and analysis. About study of the role of fieldwork in learning, Rickinson, M. et al. (2004: 20) concluded that the fieldwork has a positive impact on long-term memory due to the impressive nature of fieldwork activities. In the affective domain, fieldwork impacts on the development of individual and social skills. Cognitive and affective domains mutually influence each other in the learning process. The implementation of outdoor learning model through

fieldwork in physics learning needs preparation of teaching materials, location, materials and tools used in the field work, and learning equipments. Teaching materials used in this study is dynamic fluid because the material is suitable learned through fieldwork activities outside the classroom and the availability of facilities in the school environment. It has a source of tap water in every front yard of class that supporting the learning process.

METHODS

a) Participants

This study was a field trial on the development of the outdoor learning model through fieldwork (Thiagarajan, S., 1974). The field trial used a set of teaching and learning instructions and data collection instruments. The study was conducted through physics learning by observation to 32 students of the eleventh level physics class of senior high school in Yogyakarta Indonesia academic year of 2014/2015 as respondents from February to March 2015. The participant was much divided into eight groups to do any fieldwork activities. The physics teaching and learning instructions consisted of syllabus, lesson plans, worksheets, and assessment instruments of four core competencies. The instruments of data acquisition formed self-assessment sheet of spiritual attitudes, observation sheet of social attitudes, instrument test of physics knowledge, and observation sheet of skills. Through the instruments the achievement of four core competencies in physics learning with outdoor learning model was measured through fieldwork. The data collected were analyzed by descriptive approach.

b) Teaching and Learning Instructions

1. Syllabus

According to the Regulation of the Minister of Education and Culture of the Republic Indonesia Number 65 Year 2013 on the Standard of Primary and Secondary Education Process, syllabus was used as a reference in the development of the implementation plan of teaching and learning. The syllabus at least contains the identity of subjects, school identity, core competencies, basic competencies, subject matter, lesson plan, assessment, time allocation, and learning resources. The syllabus used in this study is consistent with the national curriculum that is known Curriculum-2013 (Regulation of the Minister of Education and Culture of the Republic Indonesia, 2012).

2. Lesson plan

Lesson plan was developed from the syllabus to guide the learning activities of students in an effort to achieve the basic competency. Learning steps in the lesson plan in this study were adapted to the outdoor learning model through fieldwork supported by group discussion method.

3. Student worksheet

Student worksheet is developed on the basis of the learning objectives that were adapted to the outdoor learning model through fieldwork.

c) Data Collection Instruments

The instruments used in this study consists of the followings.

1. Validation Sheet

This sheet was used to determine the feasibility of the developed products, so the instruments which were made should measure what we want to measure. The validation instruments were

performed by expert (lecturers) and practitioner(teachers). In this study, the validation sheet contained aspects that should be assessed using a rating scale. Every score in the assessment criteria was described in the assessment rubric for each instrument validated.

2. Self-Assessment Sheet for Spiritual Attitudes

Self-assessment sheet was used to measure the aspects of spiritual attitudes. The statements in the self-assessment of the spiritual attitudes were described from the spiritual dimensions adapted from the basic competencies. The scale on this questionnaire was Guttman Scale, that is 'Yes' or 'No'. The statements in the self-assessment sheet were formulated from aspects of the spiritual attitudes: ideologically dimensional, experiential, intellectual, consequential, and ritual.

3. Observation Sheet for Social Attitudes

The observation sheet was used to measure the aspects of social attitudes of the students during learning activities took place. The rubric of indicators were observed on the basis of the dimensions of social skills that were peer relationships, self-management, academic ability, compliance, and assertive behavior.

4. Physics Knowledge Test (Pretest and Posttest)

Physics knowledge test was used to measure the cognitive aspects of physics achievement of dynamic fluid. The pretest was conducted to determine students' initial knowledge about dynamic fluid, while the posttest was conducted to measure students' knowledge about dynamic fluid after getting outdoor learning activities through fieldwork. In this study, the test consisted of 20 multiple choice items with five options about the characteristics of ideal fluid, the concept of flow, the law of continuity, the application of the principle of continuity in real life, the principle of Bernoulli, and the application of Bernoulli law in technology.

5. Observation Sheet for Skills

The observation sheet was used to measure the students' skills in conducting fieldwork activities. The components of skills should be observed are preparing, observing, measuring, analyzing, and communicating.

6. Questionnaire for Students Response The questionnaire was used to get response of the students to the learning model implemented. All statements in the questionnaire related to the contribution of the outdoor learning model through fieldwork in providing the learning experiences with concrete objects, in providing the opportunity to interact with peers and teachers, as well as its contribution to increase the interest and motivation of the students.

FINDINGS

Validation

Data analysis included analysis of the feasibility of learning tools and instruments of research and analysis of the achievement of core competencies. Feasibility of data collection devices and instruments obtained from the lecturer and practitioner validation. Validation aimed to evaluate the teaching and learning instructions and the data collection instruments (Thiagarajan, S., 1974). The results of the validation by two validators to the teaching and learning instructions and the data collection instruments are described in Table 1.

Table 1 The Results of Validation of Teaching and Learning Instructions and Data Collection Instruments.

Teaching and Learning Instructions and Data Collection Instruments	Average score from two validators	Criteria
Syllabus	3.42	Very good
Lesson Plans	3.58	Very good
Worksheet	3.50	Very good
Spiritual attitudes assessment sheet	3.50	Very good
Social attitudes assessment sheet	3.13	Good
Skills assessment sheet	3.13	Good
Questionnaire of students response	3,33	Very Good
Physics test (pre-test and post-test)	4	Very Good

Based on Table 1, it means that all instructions and instruments can be used to collect research data.

Achievement of the Core Competencies

Spiritual attitudes

Spirituality is the conviction in conjunction with the God. Reveals that spirituality as the concept of the two dimensions of the vertical and horizontal dimensions. The vertical dimension is one's relationship with God, and the horizontal dimension is one's relationship with oneself, others, and the environment. The spirituality as something that multidimensional, ie existential dimension which focuses on the objectives and the meaning of life and religious dimension which focuses on a person's relationship with God (Mickley et al, 1992), (Stoll, 1989).

The first core competency is spiritual attitudes (Mickley et al, 1992), (Stoll, 1989) measured with self-assessment sheet filled out by each student. The Achievement of Spiritual Attitudes is presented in Table 2.

Table 2 The Achievement of Spiritual Attitude Competency

Aspects	Dimensions	Level of Achievement(%)
Religious	a. I believe that the universe and everything in it is a creation of God	100
	b. I believe that the pressure of the fluid and the speed of the fluid interplay is the will of God	100
	c. I submit the results of the work / exams to God when I have prayed and attempted with a maximum	100
Experiential	a. I was afraid of cheating during exams	100
	b. I know that cheating is a sinning action	97
Intellectual	a. I understand that by science, humans can exploit natural resources and use it in technology	100

	b. I understand that the fluids (air, gas, water) play an important role for the sustainability of life on Earth	100
Consequential	a. I use a fluid (water, gas) with an efficiency	88
	b. I contribute to protecting the environment as a form of gratitude	100
	c. As a form of gratitude for having understood the dynamic fluid, I help any friend who had difficulties to understand the material.	84
Ritual	a. I pray before starting the lessons in earnestness	100
	b. I pray after finishing the lessons in earnestness	97
	c. I express the gratitude for all the gifts of God according to my religion with oral	100
	Achievement	98

Based on Table 2, each dimension of the spiritual aspects has a percentage of achievement greater than 75%, which means the spiritual aspect has been achieved and the whole subject of research have reached a minimum mastered criteria with very good category (Borich, 1994: 385).

Social attitudes

Social attitudes associated with the social skills of the individual that builds social attitudes. Social attitudes could be described of how one uses social skills that they have. According to describes of social skills, namely: (1) attitude required learners to interact well with another people, (2) demonstrate that proper social attitudes repeatedly and consistent, (3) the interaction between two or more persons involving an action. The interaction is positive, effective, and valued by the community Jessica & Johnny (2009: 61), Young, E. L. et al (2012: 64).

Analysis of the achievement of the second core competency, namely social attitudes was done using data obtained from the observation sheet at the first, second, and third meetings. The average achievement of every aspect of the social attitudes derived from three times observations are presented in Table 3.

Table 3 *The Achievement of Social Attitudes Competency.*

Aspects	Level of Achievement (%)
Cooperation	95.3
Tolerance	93.8
Manners	95.9
Academic ability	87.0
Discipline	92.2
Responsibility	94.3

Assertive behavior	84.4
Average achievement	92.0

Based on Table 3, every aspect of the social attitudes shows a percentage greater than 75%, which means that every aspect of social attitudes has been achieved with an average percentage of achievement for all aspects of 92%. In addition, as many as 97% of research subjects have achieved a minimum criteria of completeness, namely the level of achievement which is categorized as very good and good proportions as presented in Figure 1.

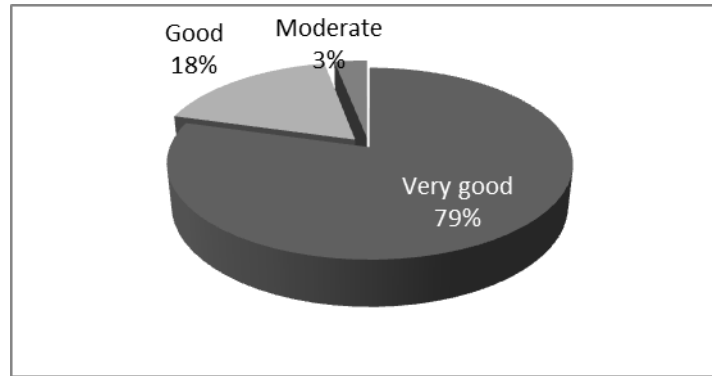


Figure 1 The Proportion of Social Attitude Achievement

Based on the results of the analysis it can be stated that the outdoor learning model through fieldwork can be used to achieve the competence of social attitudes.

Physics knowledge

Physics knowledge that be achieved is dynamic fluid which are steady or laminar flow, turbulent flow, continuity equation, debit, Bernoulli's law, the application of Bernoulli's law, pitot tube, venturimeter pipe, Torricelli theorem.

The reliability of the physics instrument test was determined by using the ITEMAN program 3:00 and was interpreted according to Triton (2006: 248). Analysis of the achievement of the third core competency, namely physics knowledge was done using data obtained from the results of the pre-test and post-test. The results of pre-test and post-test of dynamic fluid material are presented in Table 4.

Table 4 The Achievement of Dynamic Fluid Material

Analysis	Pretest	Posttest
Lowest score	10.53	52.63
Highest score	57.89	94.74
Average score	37.17	80.76
Standard deviation	11.02	10.99
Number of not mastered (%)	100	21.9
Number of mastered (%)	0	78.1

Based on Table 4, the improvement of the physics competency of dynamic fluid material can be known through the standard gain which is 0.7 being a high category (Hake, 2012: 1).

In the form of a bar chart the increasing average score of the cognitive ability test are presented in Figure 2.

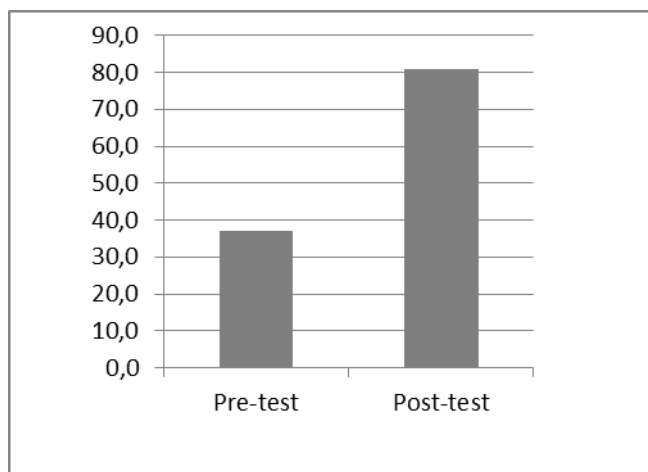


Figure 2 The Average Score of Cognitive Ability Test

In addition, the post-test results show the percentage of students who achieve a minimum of mastered criteria, it is 78.1%. This shows that the overall grade achieves good knowledge competence.

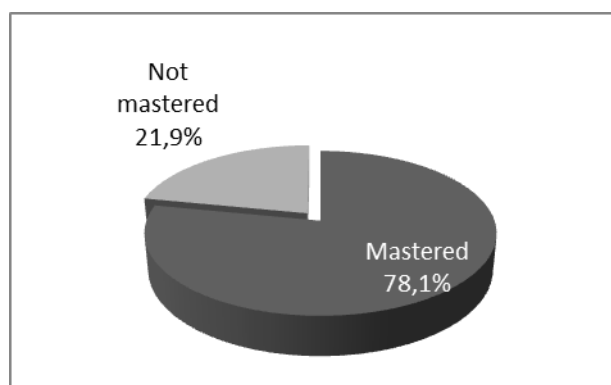


Figure 3 The Proportion of Physics Knowledge Competence

Skills

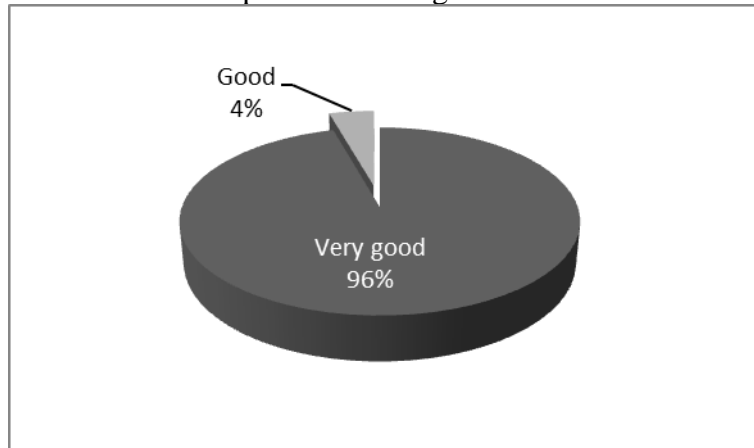
Skills are the abilities to complete the task. In Indonesia regulation about the standard of teaching and learning process, the skills acquired through some activities i.e. observing, asking, trying, reasoning, describing, and creating in accordance with the competency in each subject.

Analysis of the achievement of the fourth core competency, which is the skills in conducting fieldwork outside the classroom was done using data obtained from the observation sheet. The average achievement in every aspect of the skills assessed by three times observations is presented in Table 5.

Table 5 *The Achievement of Skills*

Aspects	Level of Achievement (%)
Preparing	96.9
Observing	92.7
Measuring	91.7
Interpretating	94.8
Communicating	86.5
Average Achievement	92.5

Based on Table 5, each of the aspects of skills assessed by three observations shows that the average percentage of achievement is greater than the passing grade 75%. This means that the student's skills in doing fieldwork achieved very good category (Borich, 1994: 385). In addition, all the aspects reached a minimum of mastered criteria. This can be achieved because the activities of fieldwork were carried out in groups with each group consists of four students, so that everyone in the group gets their respective duties and in turn they help each others in the group. The achievement of skills is represented in Figure 4.

**Figure 4** The Proportion of Skills Achievement

So, it can be concluded that the outdoor learning model through fieldwork can be used to achieve students' skills.

This study also collected data about students' response to the developed model. Based on the analysis, the students showed a very good response and positive comments on the learning model implemented. A statement of students that shows the most positive response is that physics learning through fieldwork outside the classroom may make learning physics become fun and enjoyable. The results of this study indicate that by the implementation of outdoor learning model through fieldwork, this gives students the opportunity to socialize, to develop skills and help to connect theory with practice related to the application of dynamic fluid in everyday life.

DISCUSSION

The results of this study evidently to be in line with several previous studies. The American Institutes for Research (2005: 37-38) concludes that students who take the program outside the classroom science education show higher achievement in solving the conflict,

concern for the environment, and understanding the concept of knowledge after the program. Spending time outdoor environments on young children's plays and responses to challenging environmental features supported the importance of accumulated experience and social context for the development of confidence in the face of risk, individual exploration and positive social support and engagement with peers (Whittington et al, 2016). Williams, C. et al (1999: 4) have studied the effects of fieldwork on student achievement and motivation in science education. These study states that fieldwork, especially fieldtrip improve understanding on the subject matter, increase understanding in development of students' skills of data collection, analysis, personal skills, and relationship between students and teachers. Other research on the effect of outdoor teaching and learning on the skills and attitudes of students in junior high school indicates that fieldwork activity has positive effect on academic achievement and motivation of learners. Showed that group outdoor learning is more evident in the recall of subjects rather than group indoor learning. Moreover, the interaction between students increased during outdoor learning process and all students showed a positive feeling in the learning process (Stephens & Block 2012).

Nature is important to children's development in every major way that are intellectually, emotionally, socially, spiritually and physically (Kellert, 2005). Benefits of Connecting Children with Nature reported by NC State University there are positive impacts include the following: supports creativity and problem solving (Kellert, 2005), enhances cognitive abilities (Wells, 2000), improves academic performance (American Institutes for Research, 2005), reduces attention deficit disorder (ADD) symptoms (Kuo & Taylor, 2004), increases physical activity (Bell & Dymont, 2006), improves nutrition (Bell & Dymont, 2008), (Waliczek, & Zajicek, 2006), (Morris & Zidenberg, 2002), (American Academy of Ophthalmology, 2011), improves eyesight (American Academy of Ophthalmology, 2011). improves social relations (Burdette & Whitaker, 2005), improves self-discipline (Taylor, Kuo & Sullivan, 2001), reduces stress (Wells & Evans, 2003).

ALKAN, F. (2016) stated that the experiential learning is an effective approach on academic achievement and scientific process skills. The impact of experiential learning on other variables can be identified. Study used meta-analysis method reviews the findings of the studies on the effectiveness of the inquiry-based science education comparing with traditional learning. showed that the inquiry-based science education had a positive and higher levels of effects of students' academic achievement. It was also found that this specific teaching and learning method had a positive and medium level of effect on their science process skills and attitudes towards science. It was found that the inquiry-based learning method used in science education had much more significant effects on student achievement rather than on their science process skills and their attitudes towards science in contrast to the traditional teaching method (AKTAMIÅ, H. et al, 2016). The effect of science activities designed by inquiry-based approach was investigated by ÖZDEMİR & IŞIK (2015). The study concludes with recommendations for further investigations to signify and overcome the barriers challenging the prospective teachers' adaptations and practices of science process skills and inquiry strategies. The effect of attitudes and behaviours towards environment of 4th grade students of environmental education based on interdisciplinary approach found that points for attitude and behaviour towards environment of students show significant difference for the benefit of first group among the groups. These facts showed that interdisciplinary approach is more effective than traditional method in the attitudes and behaviours towards environment of the students (HAMALOSMANOĞLU & GÜVEN, 2014).

CONCLUSION

From this research can be resulted a guidebook of outdoor learning management model through fieldwork to improve physics achievement in dynamic fluid material. Based on the result of assessment by validators consist of a physics lecture and a high school teacher declared that all of teaching and learning instructions eligible used for physics learning activities so that learners are able to achieve core competencies in dynamic fluid material.

Based on the analysis and discussion can be concluded that the outdoor learning model through fieldwork can be applied to achieve the core competencies in dynamic fluid material for senior high school students. The level of achievement for each core competency is as follows: the first core competency i.e spiritual attitudes is 98%, the second core competency i.e social attitudes is 92%, the third core competency i.e knowledge is 78%, and the fourth core competency i.e skills is 92.5%.

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National and International Advances in Physics Education in the Last Three Years: A Thematic Review

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ABSTRACT

For research areas to advance, researchers are required to carry out studies that are in line with the inadequacies in the field and to have a grasp of the studies in the field. One of the most important means of identifying inadequacies in a field is to review studies between certain years. In this sense, it is important to analyze the publications of significant journals in physics education. The purpose of this study is to conduct a thematic review of the literature related to physics education studies in certain journals published within the scope of Social Sciences Citation Index in 2013-2015. The articles obtained from the literature were analyzed using a generated matrix. The matrix consists of general specifications (type of journal, years and demographic properties) and content sections (aims, research methods, variables, samples, physics subjects and results). According to the findings, in terms of physics concepts, the studies were conducted mostly on the concept of energy and included mostly undergraduate student participants. Regarding the results, it is suggested, both in physics and science education studies, that materials that are to be used with approaches, such as context-based learning, inquiry-based learning, and argumentation-based learning, need to be enhanced and that additional studies that investigate the effects of these approaches on learning environments are needed.

Keywords: Journal; physic education; thematic review; three years.

INTRODUCTION

The development of any field depends on the area of research, educational applications and the theoretical and practical innovations brought to the field. In this case, the development is subjected to the comprehension of the present status in the relevant field, and starting from this, to the identification of the innovations brought to the field. In other words, in order to ensure that the field will be updated continuously, it is important to realize the drawbacks and the defects in the present situation or the gaps in the field and to promote alternatives to solve these deficiencies. Researchers also need to be in line with evolving databases to stay up to date by following scientific works such as theses, articles, and books published via various editorial boards (Gilbert and Trudel 2004). In these scientific works, it is shown that numerous researchers mutually structure the issues related to historical research for the



development of the relevant area and their implications and the latest approaches brought in the field and their implementation in practice (Lin, Lin and Tsai 2014). In this structuring process, researchers publish their findings in academic journals or books and provide a communication network between scientists by sharing information with other scientists (Cohen and Manion 1990; McDermott and Redish 1999; Tsai and Lydia Wen 2005). To ensure communication among scientists and to put forth the present status, an outline of the data gathered from different research investigations is required at regular intervals (Gilbert and Trudel 2004; Hofmann 2001; Karamustafaoglu 2009). This may evolve in two ways. The first is an evaluation of the results obtained from a study by other researchers, and the second is a review of previously published studies of a specific field under distinct categories, including certain periods of time (Bacanak, Degirmenci, Karamustafaoglu and Karamustafaoglu 2011; Byra and Goc Karp 2000; Cohen, Manion and Morrison 2007; Silverman and Skonie 1997). In particular, to ensure a clear visibility of the final status in the relevant field, it is important to systematically analyze the publications in academic journals at certain intervals and to present them periodically to notify researchers. Within this framework, it can be stated that a systematic analysis of the published articles in physics education is also important.

Silverman and Ennis (1996) divided physics education into three subfields, namely, physics teaching, teacher training and physics curriculum. The study of curricula/programs in physics investigates the sub-topics and factors that affect physics education; studies concerning teacher training investigate the training of prospective physics teachers and the improvement of this training; studies concerning physics teaching, on the other hand, investigate the improvement of teaching methods, techniques and strategies and how these are applied in practice to improve the quality of physics education (Anderson and Barnett 2013; Chatoupis and Vagenas 2011; Chen, Chang, Lai and Tsai 2014; Dega, Kriek and Mogese 2013; Guisasola, Almudi and Zuza 2013; Kulo and Bodzin 2013; Lemmer 2013; Leuchter, Saalbach and Hardy 2014; Liu, Ryoo, Linn, Sato and Svihla 2015; Martinez, Perez, Suero and Pardo 2013; Uzunboylu and Asiksoy 2014). Physics education teacher training focuses on the processes (teachers' class structure, student and teacher operations during the lesson, etc.), the social dynamics (learning environment and teacher-student or student-learner interactions) and learning outcomes (motor skills, attitudes, knowledge, etc.) (Silverman and Ennis 1996; Silverman and Skonie 1997). As for the physics education teaching, studies seem to primarily focus on the teaching methods and cognitive levels (Kayhan and Koca 2004; Uzunboylu and Asiksoy 2014).

In a literature review, Byra and Goc Karp (2000) analyzed the qualitative research methods used in physics education studies. Silverman and Skonie (1997), on the other hand, analyzed published studies focusing on the physics education teaching in terms of the various variables. In another study, Silverman (1987) investigated the research methods and trends in research topics of doctoral dissertations published in physics education in 1975-1984. As a result of this research, he stated that half of the published dissertations compare teaching methods, some researchers lacked systematic observations in spite of their focal points on comparing teaching methods, and most of these researches did not take place in an informal school context. However, since 1984, there has not been a literature review of the studies directly focusing on physics education (Silverman and Manson 2003). Instead, literature reviews have concentrated on the investigation of physics education in distinct sub-fields rather than the general analysis of physics education studies. There has not been a recent general literature study on physics teaching. The study will review the literature in six journals with a high influence in physics/science education and that are within the scope of SSCI in 2013-2015. In this respect, the purpose of this literature review is to evaluate the physics education studies in the following journals: *Journal of Research in Science Teaching*,

Science Education, Studies in Science Education, International Journal of Science Education, Journal of Science Education and Technology.

Review Focus Questions

The focus questions for our review of the literature are as follows:

1. What are the general features of the studies and authors?
2. What are the aims of the studies in physics education?
3. What research methods, variables, samples and concepts are used by the studies in physics education?
4. What results are found by the studies in physics education?

METHODS

A thematic review of physics education studies carried out in the last three years is available in this study. A literature review is an analysis of systematically gathered visual and audio works of a particular topic, such as writings, documents, maps, pictures, photos, etc. (Author 2014). A meta-analysis, on the other hand, is a method used to reach a synthesis considering the results of these studies by taking into account the studies of a particular purpose or a subject (Buyukozturk, Kilic Cakmak, Akgun, Karadeniz and Demirel 2012). A thematic review is was selected for this study because thematic reviews provide, by using a thematic matrix, the identification of each study, the set of general trends and the display of the characteristics of each study clearly by indicating the differences and the similarities (Calik, Ayas and Ebenezer, 2005; Kurnaz and Calik 2009). This study is focused on the analysis of each article individually and the identification of the trends in the field. For this purpose, the matrix developed by Authors (2015) is used to analyze physics education studies. The final version of the matrix is used after some additions and extractions. The matrix used in this study includes two fundamental themes: general features and content features. General features include journal name, years of the studies and demographic properties (number of authors and author nationality). Content features include aims, research methods, variables, samples, physics subjects and results.

Within the scope of this study, six journals with a high influence in physics education were selected. These journals, which are included in social sciences citation index (SSCI), are as follows: Journal of Research in Science Teaching, Science Education, Studies in Science Education, International Journal of Science Education and Journal of Science Education and Technology. However, in the last three years, there have not been any physics education Studies in Science Education. For these selected journals, first, the relevant physics education studies were downloaded. There were 279 articles published between 2013 and 2015. Because of the challenge of analyzing the articles and because an in-depth analysis was not possible, the year range was restricted, and studies in 2013-2015 were selected for the review. As a result of the literature searches, 132 articles were found in these journals over the last three years. However, during the analysis, some articles were found to be irrelevant, and in total, 70 articles were analyzed. During the article review, it was noted whether physics or physics terms were present in the article titles or in the key words. Despite all the literature searches, it is natural that some of physics education studies went unnoticed. This situation, which arose while literature searching the studies, is among the limitations of the study. The physics education articles found in the literature searches are marked as (*) in the bibliography section. These studies were generally used in the discussion section; however, studies that were not used were marked as (**) in the bibliography. The 70 articles that were found were analyzed using the revised matrix. The data that was obtained was analyzed using descriptive statistical methods (frequency and percentage) and a content analysis method. A descriptive analysis is generally used in the general features section of the matrix, and a content analysis is used in

the content features section of the matrix. In the process of the content analysis, at first, the data obtained from the studies were coded, and later, applicable codes were brought together to form themes. Frequency and percentage (%) rates regarding the generated codes and themes were calculated.

FINDINGS

In this section of the study, general and content features are stated. The findings related to general features and context features.

1. What are the general features of the studies and authors?

Frequency and percentage values related to physics education studies in the six journals analyzed within the research content are shown in Table 1.

Table 1. *Data regarding the publishing years of the studies*

Publishing Year	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
2015	15	21.4	-	-	2	2.9	-	-	17	24.3
2014	10	14.3	5	7.1	2	2.9	3	4.3	20	28.6
2013	16	22.9	8	11.4	5	7.1	4	5.7	33	47.1
Total	41	58.6	13	18.6	9	12.9	7	10.0	70	100.0

In Table 1 is showed that The International Journal of Science Education contained 41 physics education studies, while the Journal of Science Education and Technology contained 13 studies in the field. The frequency and percentage values related to the distribution of physics education research in the last three years are given in Table 1. As a result of the analysis, for 2013, 33 articles were found, for 2014, 20 articles were found, and for 2015, 17 articles were found.

Table 2. *Data regarding the number of authors of the studies*

Number of Authors	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
1	4	5.7	1	1.7	-	-	1	1.4	6	8.6
2	18	25.7	7	10.0	2	2.9	1	1.4	28	40.0
3	11	15.7	1	1.4	4	5.7	1	1.4	17	24.3
4	6	8.6	2	2.9	2	2.9	3	4.3	13	18.6
5	1	1.4	2	2.9	-	-	1	1.4	4	5.7
6	1	1.4	-	-	1	1.4	-	-	2	2.9
Total	41	58.6	13	18.6	9	12.9	7	10.0	70	100.0

The numbers of authors are shown in Table 2, and the countries of the authors are shown in Table 3. Table 4 shows that 8.6% of the studies have a single author, 40.0% have two authors, 24.3% have three authors, 18.6% have four authors, 5.7% have five authors and 2.9% have six authors. Table 5, on the other hand, shows that the physics education research was carried out by 38.40% Americans, 8.9% English, 7.9% Germans, 5.8% Spanish and 4.2% Israelis. Only one physics education research study was conducted in Turkey.

Table 3. Data regarding the countries of the authors

Countries of the authors	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
America	28	14.7	14	7.4	15	7.9	16	8.4	73	38.4
England	15	7.9	2	1.1	-	-	-	-	17	8.9
Germany	12	6.3	-	-	3	1.6	-	-	15	7.9
Spain	7	3.7	4	2.1	-	-	-	-	11	5.8
Israel	-	-	8	4.2	-	-	-	-	8	4.2
Austria	2	1.1	1	0.5	4	2.1	-	-	7	3.7
South Africa	5	2.6	-	-	1	0.5	-	-	6	3.2
France	3	1.6	-	-	2	1.1	-	-	5	2.6
Singapore	4	2.1	1	0.5	-	-	-	-	5	2.6
Swedish	5	2.6	-	-	-	-	-	-	5	2.6
Canada	3	1.6	-	-	1	0.5	-	-	4	2.1
China	-	-	-	-	-	-	4	2.1	4	2.1
Brazil	4	2.1	-	-	-	-	-	-	4	2.1
Taiwan	-	-	3	1.6	-	-	-	-	3	1.6
Cyprus	3	1.6	-	-	-	-	-	-	3	1.6
Netherlands	3	1.6	-	-	-	-	-	-	3	1.6
Greece	2	1.1	-	-	-	-	-	-	2	1.1
Ethiopia	-	-	-	-	2	1.1	-	-	2	1.1
Hong Kong	-	-	-	-	2	1.1	-	-	2	1.1
Norway	-	-	-	-	-	-	2	1.1	2	1.1
Italy	2	1.1	-	-	-	-	-	-	2	1.1
Brunei	2	1.1	-	-	-	-	-	-	2	1.1
Turkey	-	-	1	0.5	-	-	-	-	1	0.5
Portugal	-	-	-	-	-	-	1	0.5	1	0.5
Zambia	1	0.5	-	-	-	-	-	-	1	0.5
Chile	1	0.5	-	-	-	-	-	-	1	0.5
Lebanon	1	0.5	-	-	-	-	-	-	1	0.5
Total	103	54.2	34	17.9	30	15.8	23	12.1	190	100.0

2. What are the aims of the studies in physics education?

Table 4. Data regarding the aims of the studies

Theme	Code	f	%	f	%
Investigating the efficiency of Method/Technique	The efficiency of using simulation	3	4.3	17	24.3
	The efficiency of inquiry-based learning	3	4.3		
	The efficiency of video game technology	1	1.4		
	The efficiency of TGA-based interactive animation	1	1.4		
	The efficiency of language variation	1	1.4		
	The efficiency of writing-teaching activities	1	1.4		
	The efficiency of mind- maps	1	1.4		
	The efficiency of trite threat	1	1.4		
	The efficiency of sequential learning materials	1	1.4		
	The efficiency of collaborative learning model	1	1.4		
	The efficiency of small group argumentation	1	1.4		
	The use of thought experiments	1	1.4		

	The efficiency of blended learning model	1	1.4		
	Analysis of the cases for the use of metaphor	2	2.9		
	Analysis of teacher discourse	2	2.9		
	Analysis of teacher's emotional state/attitude changes	2	2.9		
	Analysis of in-class scientific discussions	2	2.9		
	Analysis of the cases regarding uncertainty/certainty /accuracy of the input	1	1.4		
Case Definition	Identifying the pedagogical basis of ideas	1	1.4	16	22.9
	Analysis of teachers' classroom experiences	1	1.4		
	Analysis of the resolution process of physics problems	1	1.4		
	Analysis of the cases regarding the formation of critical relation	1	1.4		
	Analysis of blended professional development course	1	1.4		
	Analysis of teachers' perception of physics/methods they use	1	1.4		
	Identifying student's understanding of the subject (motion, speed, etc.)	4	5.7		
	Investigating conceptual learning (mechanics, simple circuit, energy etc).	4	5.7		
Research studies	Investigating the noesis of online troubleshooting activities	1	1.4	14	20.0
	Investigating virtual and hands-on laboratories	1	1.4		
	Studying on eliminating misconceptions	1	1.4		
	Investigating student skills of the nature of science	1	1.4		
	Investigating the effect of literature on professional development	1	1.4		
	Investigating language use	1	1.4		
	Identifying student views (speed change, light emission etc).	3	4.3		
	Identifying/comparing the levels of learning	2	2.9		
	Investigating the factors affecting physics/chemistry intake	2	2.9		
Survey	Expectations/perceptions of females/males regarding physics education	2	2.9	13	18.6
	Investigating gender differences in physics	1	1.4		
	Investigating expectations from physics	1	1.4		
	Investigating the reasons of the reduction in the number of physics reading	1	1.4		
	Investigating the relationship between gender and academic achievement	1	1.4		
	Designing activities for evidence/theory	1	1.4		
	Designing enhanced science program	1	1.4		
	Evaluation of contextual-based course for data analysis	1	1.4		
Material Design	Designing materials for the use of temsiltriarchic model	1	1.4	10	14.3
	Designing conceptual framework for physics concepts	1	1.4		
	Experiment design	1	1.4		
	STEM model design	1	1.4		
	Designing two-stage measuring tool	1	1.4		
	Designing scale for reasoning	1	1.4		

Anayzing the relation of epistemology, sociology, learning (theoretical)	1	1.4		
Total	70	100.0	70	100.0

Table 4 shows the data regarding the aims of the physics education studies in the reviewed journals. The aims of the studies are included under the headings as investigating the efficiency of methods/techniques, case definition, research studies, survey and material design. Efficiency of simulation use was performed in 4.3% of the studies, and efficiency of inquiry-based learning was performed in 4.3% of the studies. It was also observed that 2.9% of the cases related to metaphor use, 2.9% dealt with changes in teachers' emotional state/attitude, 2.9% were on in-class scientific discussions, and 2.9% were on teacher discourse. Moreover, the data show that 5.7% of the studies were carried out to identify the students' understanding of the subject, and 5.7% were to investigate conceptual learning. Of the physics education studies, 4.3% focused on identifying student views, 2.9% on identifying/comparing levels of learning, 2.9% on investigating the factors affecting physics/chemistry intake, and 2.9% on perceptions/expectations of males/females of physics education.

3. What research methods, variables, samples and concepts are used in the studies in physics education?

Table 5. Data regarding research methods

Research Method	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
Experimental/empirical design	5	7.9	2	3.2	2	3.2	-	-	9	14.3
Quasi-experimental design	1	1.6	2	3.2	3	4.8	2	3.2	8	12.7
Mixed method	4	6.4	4	6.4	-	-	-	-	8	12.7
Material desgin (follow-up)	6	9.5	1	1.6	-	-	-	-	7	11.1
Qualitative research	5	7.9	1	1.6	-	-	1	1.6	7	11.1
Survey mehod	4	6.4	1	1.6	-	-	1	1.6	6	9.5
Case study	2	3.2	1	1.6	1	1.6	2	3.2	6	9.5
Descriptive (scale development)	3	4.8	-	-	-	-	-	-	3	4.8
Multiple case study	1	1.6	-	-	1	1.6	-	-	2	3.2
Multi level model	2	3.2	-	-	-	-	-	-	2	3.2
Phenomenographic research	2	3.2	-	-	-	-	-	-	2	3.2
Comparative case study	-	-	-	-	1	1.6	-	-	1	1.6
Litarature review	-	-	-	-	-	-	1	1.6	1	1.6
Design-based research methodology	-	-	1	1.6	-	-	-	-	1	1.6
Total	35	55.6	13	20.6	8	12.7	7	11.1	63	100.0

Table 5 shows that the research methods used in studies include experimental/empiric method (14.3%), quasi-experimental design (12.7%), mixed methods (12.7%), material design (follow-up) (11.1%) and qualitative research methods (11.1%). The methods preferred by the studies published in the International Journal of Science Education include the following: material design (follow-up) (9.5%), experimental/empirical design (7.9%) and

development Factors affecting selection	course										
		1	1.2	-	-	-	-	-	-	1	1.2
Total		53	64.6	1 2	14. 3	10	12. 2	7	8.5	82	100. 0

The data regarding the variables/themes in the physics education studies are given in Table 6. As shown in the table, though the variables/themes are represented in similar numbers in the qualitative and quantitative studies, there are relatively more quantitative studies. The efficiency of a method used in quantitative studies seems to be the most investigated topic. In addition, 18.3% of the studies investigated the effectiveness of a method on conceptual understanding, 4.9% investigated learning, 2.4% investigated motivation, 2.4% investigated misconceptions and 2.4% investigated metacognition. Also, in some quantitative studies, among the basic variables are identifying the relationship between demographic features and learning outputs (4.9%) and designing measuring tools (3.7%). Qualitative studies, on the other hand, focus on student insights/understanding (7.3%), the use of material (6.1%), and learning environments (4.9%).

Table 7. Data regarding the sample sizes in the studies

Sample Size	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
0-30	11	16.9	2	3.1	4	6.2	1	1.5	18	27.7
31-100	4	6.2	2	3.1	1	1.5	3	4.6	10	15.4
101-200	4	6.2	5	7.7	2	3.1	-	-	11	16.9
201 and more	17	26.2	4	6.2	2	3.1	3	4.6	26	40.0
Total	36	55.4	13	20.0	9	13.8	7	10.8	65	100.0

Some study groups and samples in the physics education studies consisted of 201 or more participants (40.0%), 0-30 participants with (27.7%), 101-200 participants (16.9%) and 31-100 participants (15.4%). Of the studies published in the International Journal of Science Education, 26.2% had 201 or participants, and 16.9% had 0-30 participants. Of the studies in the Journal of Science Education and Technology, 7.7% consisted of 101-200 participants, while 6.2% of the studies in the Journal of Research in Science Teaching consisted of 0-30 participants. The studies in Science Education, on the other hand, were conducted with 31-100 or 201 and above participants in 4.6% of the cases.

Table 8. Data regarding the types of samples

Type of samples	IJSE		JSET		JRST		SE		Total	
	f	%	f	%	f	%	f	%	f	%
Teacher	6	7.2	3	3.6	2	2.4	1	1.2	12	14.5
Teacher Candidates	5	6.0	-	-	-	-	1	1.2	6	7.2
Master Student	1	1.2	-	-	-	-	-	-	1	1.2
Undergraduate	10	12.0	4	4.8	4	4.8	1	1.2	19	22.9
High School Student	11	13.3	2	2.4	1	1.2	3	3.6	17	20.5
Primary/ Middle School Student	8	9.6	5	6.0	2	2.4	2	2.4	17	20.5
Student	3	3.6	1	1.2	-	-	1	1.2	5	6.0
Department	3	3.6	1	1.2	2	2.4	-	-	6	7.2
Total	47	56.6	16	19.3	11	13.3	9	10.8	83	100.0

As shown in Table 8, 22.9% of the studies included undergraduate student participants, 20.5% had high school students, 20.5% had primary/middle school students and 14.5% included teachers. Of the studies published in the International Journal of Science Education, 13.3% included high school students and 12.0% undergraduate students. Moreover, 6.0% of the studies in the Journal of Science Education and Technology included primary/secondary school students, 4.8% of the studies in the Journal of Research in Science Teaching included undergraduate students, and 3.6% of the studies in Science Education included high school students.

Table 9. Data regarding the physics concepts in the studies

Physics Concepts	0-30		31-100		101-200		201 ve üzeri		Total	
	f	%	f	%	f	%	f	%	f	%
Energy	-	-	2	4.4	4	8.7	6	13.0	12	26.1
Force and motion	1	2.2	-	-	2	4.4	3	6.5	6	13.0
Electricity	-	-	2	4.4	2	4.4	1	2.2	5	10.9
Magnetism	-	-	-	-	2	4.4	2	4.4	4	8.7
Speed	1	2.2	-	-	1	2.2	-	-	2	4.4
Light	1	2.2	-	-	-	-	1	2.2	2	4.4
Mechanics	-	-	-	-	1	2.2	1	2.2	2	4.4
Atomic physics	1	2.2	-	-	-	-	1	2.2	2	4.4
Thermodynamic	1	2.2	-	-	-	-	1	2.2	2	4.4
Bolye's law	-	-	1	2.2	-	-	-	-	1	2.2
Simple machines	-	-	1	2.2	-	-	-	-	1	2.2
Optics	-	-	-	-	1	2.2	-	-	1	2.2
Ohm's law	-	-	-	-	1	2.2	-	-	1	2.2
Pressure	-	-	-	-	-	-	1	2.2	1	2.2
Sound	-	-	-	-	1	2.2	-	-	1	2.2
Theory of relativity	-	-	1	2.2	-	-	-	-	1	2.2
Color	-	-	-	-	-	-	1	2.2	1	2.2
Float and sink	-	-	-	-	-	-	1	2.2	1	2.2
Total	5	10.9	7	15.2	15	32.6	19	41.3	46	100.0

Table 9 shows the relationship between the physics concepts and the number of participants. In the analyzed studies, 26.1% focused on energy, 13.0% on force and motion, 10.9% on electricity, and 8.7% on magnetism. However, some studies were not included in this table due to a lack of specific physics concepts. Also, it was not possible to analyze some studies in terms of this variable because they did not focus on a specific physics concept in the survey or qualitative studies such as questionnaires. Of the studies of the energy concept, 13.0% consisted of 201 or more participants and 8.7% had 101-200 participants. For the force and motion concepts, on the other hand, 6.5% consisted of 201 or more participants and 4.4% of 101-200 participants. In addition, 41.3% of the studies were carried out with 201 or more participants with and 32.6% with 101-200 participants. In this sense, it is clear that in general, the physics concepts were studied with multiple participants.

4. What results are found by the studies in physics education?

Table 10. *Data regarding the results of the studies*

Theme	Code	f	%	f	%
Cognitive Aspect	Positive effect on conceptual understanding	7	12.3	2	38.6
	Teaching concepts positively	4	7.0		
	Providing better learning	4	7.0		
	Increase in success	2	3.5		
	Providing in-depth learning	1	1.8		
	Supporting the teaching of difficult concepts	1	1.8		
	Positive effect on data analysis	1	1.8		
	Negative effect of difficult concepts on learning	1	1.8		
	Unattainable distinction between macroscopic and microscopic definitions of concepts	1	1.8		
Increase in discussion skills	1	1.8			
Case Definition	Differences in age-related learning	2	3.5	6	28.1
	Males' preference in physics more than females	2	3.5		
	Differences in teacher's lecture	2	3.5		
	Effect of teacher experiences on teaching/method	2	3.5		
	High school students' uncertainty of job selection	1	1.8		
	Differences in students' problem-solving processes	1	1.8		
	Effect of teachers' physical and social cues on participation to the lesson	1	1.8		
	The effect of school type on physics intake	1	1.8		
	Males are better at trite threats	1	1.8		
	Females are less experienced in physics	1	1.8		
	Differences in physics teaching according to programs	1	1.8		
Necessity of proficiency in concept teaching	1	1.8			
Efficiency of methods	Effectiveness of metaphors	2	3.5	9	15.8
	Positiveness of teaching through modeling	1	1.8		
	Effectiveness of inquiry	1	1.8		
	Importance of pedagogy for critical thinking	1	1.8		
	Learning effect of pedagogical studies	1	1.8		
	Utilization of activities	1	1.8		
	Effectiveness of laboratory on physics teaching	1	1.8		
	Effectiveness of mind-maps	1	1.8		
Correlational Relations	Connection between school mark and success	1	1.8	6	10.5
	Connection between gender and success	1	1.8		
	Connection between motivation and level of physics	1	1.8		
	Connection between reasoning and decision-making	1	1.8		
	Connection betw. teacher competence and conceptual understanding	1	1.8		
Association of critical potential with the subject	1	1.8			
Affective aspect	Positive effect on emotional states	1	1.8	4	7.0
	High level of student satisfaction	1	1.8		
	Positive attitude development	1	1.8		
	Increase in motivation.	1	1.8		
Total		5	10	5	100.
		7	0	7	0

Table 10 shows the main results obtained from the physics education studies. The data are grouped under themes of cognitive aspect, case definition, efficiency of methods, correlational relations and affective aspect. The results obtained from the studies show a positive effect on conceptual understanding (12.3%) and on concept teaching (7.0%), the provision of better learning (7.0%) and an increase in success (3.5%). The results also show differences in age-related learning (3.5%), males' preference for physics over females' (3.5%), differences in teachers' lectures (3.5%), the effect of teacher experiences on teaching/method (3.5%) and the effectiveness of metaphors (3.5%).

DISCUSSION and CONCLUSION

According to the findings obtained from this study, 42 studies on physics education were published in the *International Journal of Science Education* and 13 in the *Journal of Science Education and Technology*. However, there have not been any publications in *Science Education* that were directly related to physics education. These journals that have the most impact in science/physics education field focus on science education studies. Looking at the number of articles published in these journals, the *International Journal of Science Education* publishes 18 issues per year and 7 articles on average in each issue; the *Journal of Science Education and Technology* publishes 6 issues per year and 10 articles on average in each issue; the *Journal of Research in Science Teaching* publishes 10 issues per year and 4-5 articles on average in each issue; and *Science Education* publishes 6 issues per year and 3 articles on average in each issue. In this sense, it is normal that the number of publications in physics is, at this state, parallel to the total number of articles of these journals in the analyzed year range. As it is understood, it is an expected result that the *International Journal of Science Education*, which publishes 126 articles on average per year, has the highest number of physics education studies. Considering the studies in *Science Education*, the purpose of the journal is to publish review articles of the highest quality that provide analytical syntheses of research into key topics and issues in science education. Therefore, it is thought that the journal includes review studies in science education; however, these studies are not within the aforementioned years.

Analyzing the distribution of the physics education studies according to the years, in 2013, there were 34 articles; in 2014, 20 articles; and in 2015, there were 17 articles. It is observed that while the physics education studies are the highest in 2013, in 2014, there was a decrease in the number. Although the number was the lowest in 2015, it was not possible to reach all studies due to unpublished issues from this year, so in this sense, this number may be much higher in 2015. Karamustafaoglu (2009) stated that there was an increase in the number of published articles in physics education between 2005-2011 in the journals he analyzed as a part of his study. In this sense, the contribution of the studies to literature for field training becomes crucial, and an increase in the number of articles is therefore expected. Though there are differences in our study in the number of physics education articles according to the different years, 25-30 physics education articles were published on average in the analyzed journals. Uzunboylu and Asiksoy (2014) stated that the number of articles during different years were quite close to each other in their study in which they investigated physics education research between 2008-2012.

As it is understood, the physics education articles analyzed in the study generally consisted of two authors, followed by three or four authors. Bacanak et al. (2011), who analyzed science education articles in terms of the number of authors, and Uzunboylu and Asiksoy (2014), who did the same type of analysis in physics education, stated that the studies mostly consisted of one or two authors. In this sense, as a result of our study, it can be stated that there are more studies conducted by two authors than studies conducted individually or by groups. According to the findings obtained from in our study, the vast majority of physics

education studies are conducted by American citizens. One of the most important reasons for this situation is that America constitutes various states, and outstanding universities are located in these states. In parallel with this, it is thought that a lot more publications come out of these scientifically advanced states, namely America. It is observed that, after America, physics studies are conducted by the citizens of England, Germany, Spain and Israel. The situation is thought to arise from the fact that these countries value academic studies and that they have various specialist researchers. However, there is only one physics education study carried out in Turkey that appears in these journals. In this sense, it is sad that Turkey has a single physics education study in these journals that ranks among the most important indices. The fact that there are far fewer articles from countries such as Chile, Lebanon, Portugal and Turkey shows that these countries have limited contributions to the literature through these journals. In this sense, it can be stated that countries with more publications, such as America and England, contribute far more to the field through these journals. However, the crucial point is that all countries are known to conduct academic studies in physics education. On the other hand, it is thought that there may be fewer physics education studies in these journals due to the limited publications of some countries such as Turkey.

The analysis of physics education studies in the journals used in this study include the following aims: investigating method/technique efficacy, case definition, research studies, survey and material design. In this sense, it can be stated that most of the studies focus on case determination, designing activities, and the short- and long-term effects of these activities on conceptual understanding and change. The effectiveness of simulation use (Chen et al. 2014; Dega et al. 2013) and the effectiveness of inquiry-based teaching (Kulo and Bodzin 2013; Liu et al. 2015) were investigated in physics education studies. In this sense, it is observed that simulation and animation, which gained importance with the advance of technology, are also emphasized in physics education studies. Moreover, an inquiry approach, which occupies an important position and has ongoing importance, is also frequently studied in physics education research. In this sense, it can be stated that simulations and inquiry are the most used methods in physics education on the basis of teaching methods. In addition to this, the aims of the physics education studies were specified as identifying students' understanding of the subject (Guisasola et al. 2013; Lemmer 2013) and investigating conceptual learning (Ding, Chabay and Sherwood 2013). Moreover, physics education studies place an emphasis on identifying student views (Hast and Howe 2013a). In this sense, it becomes crucial to investigate participant perceptions, views or conceptual understandings of a particular situation or concept. A remarkable point here is that the studies conducted on misconceptions (Helm 1980; Yildiz and Buyukkasap 2006), on analyzing the effect of constructive learning (Akdeniz and Akbulut 2010; Thomaz and Gilbert 1989), and on focusing on achievement (Halloun 1996; Wambugu and Changeiywo 2008) which were frequently studied in previous years, seem to have decreased. On the other hand, enriched materials and teaching designs, of which educational technologies become a part, have started to gain importance. For instance, these types of materials include web-based materials, simulation-based materials, video game-based materials, and 3D materials. In this sense, within the theoretical framework of material design, the studies based on a single theory have become limited, while enriched or blended materials have gained importance.

It is observed in physics education studies that the methods used include experimental/empirical methods (Kukliansky and Eshach 2014; Neumann, Viering, Boone and Fischer 2013; Shemwell, Chase and Schwartz 2015), quasi-experimental designs (Akpınar 2014; Chen, Hand and McDowell 2013; Fung and Yip 2014), mixed methods (Peppler and Glosso 2013), material designs (Howe, Ilie, Guardia, Hofmann, Mercer and Riga 2015; Vieira and Kelly 2014) and qualitative research methods (Danielsson and Warwick 2014; Emig, McDonald, Zembal-Saul and Strauss 2014; Velentzas and Halkia

2013). As it is understood, the most preferred research method in physics education studies is the experimental method or quasi-experimental design. Uzunboylu and Asiksoy (2014) stated in their studies that quantitative methods, including the experimental method, are the most used methods in physics education articles. Moreover, it is thought as a result of our study that mixed methods are also increasingly becoming important, and they will be used more in the future. Moreover, it can be stated that in the studies, qualitative methods were not preferred as much as quantitative methods. Looking at this issue by journal, the International Journal of Science Education used material designs (follow-ups), experimental/empirical designs and qualitative study methods as research methods in their published studies. In this sense, the physics education studies in this journal were carried out with the aim of designing materials that are in line with a model or approach and implementing activities related to this. While mixed methods were preferred in the studies in the Journal of Science Education and Technology, quasi-experimental designs were preferred in the studies in the Journal of Research in Science Teaching. In the physics studies in these journals, on the other hand, the quantitative research methods were usually the focus. Moreover, the studies in Science Education were carried out as quasi-experimental designs and as case studies. It is also found that in some studies in these journals, the method section was not specified.

In the studies related to variables/themes in physics education studies that though the variables/themes in the qualitative and quantitative studies were similar to each other, there were quantitative studies. The efficacy of a method was mostly investigated through quantitative studies. This situation seems to be normal in parallel with research methods used in studies and the generally used experimental method. In physics education studies, the effectiveness of the methods on conceptual understanding (Anderson and Barnett 2013; Leuchter et al. 2014; Martinez et al. 2013), learning (Geller, Neumann, Boone and Fischer 2014; West and Wallin 2013), motivation (Mujtaba and Reiss 2013), misconceptions (Martinez-Borreguero, Pérez-Rodríguez, Suero-López and Pardo-Fernández 2013), and metacognition (Thomas 2013) were investigated. Looking at the variables/themes, conceptual understanding and learning are at the forefront. In this respect, conceptual understanding takes the place of achievement, which was frequently used in previous years. Conceptual understanding has come to the foreground in parallel with the aim of providing meaningful learning related to daily life, which is among the main goals of teaching programs. In this sense, it is thought that conceptual understanding, instead of achievement, should be regarded as a variable in the studies. Moreover, in some quantitative studies, main variables include identifying the relationship between demographic features and learning output (Adamuti-Trache, Bluman and Tiedje 2013) and designing a measuring tool (Sakschewski, Eggert, Schneider and Bögeholz 2014; Taasobshirazi and Farley 2013). In the process of designing a measurement tool, the former tools in the literature, such as attitude and motivation, have been replaced by the tools regarding the 21st century skills or more cognitive gains. The studies are focused on metacognition, reasoning or designing two-stage scales. Moreover, as a result of the analysis of the physics education studies, it can be stated that studies of overall attitude have been replaced by the identification of attitudes towards specific methods. Qualitative studies, on the other hand, are focused on student insights/ understanding (Décamp and Viennot 2015; Lancor 2014; Yerushalmi, Puterkovsky and Bagno 2013), the use of material (Rutten, van der Veen and van Joolingen 2015) and learning environments (Kuo, Hull, Gupta and Elby 2013). Studies are generally focused on identifying participant insights in physics concepts such as velocity, speed, or energy. In this sense, carrying out in-depth studies related to physics concepts and identifying how these concepts are perceived are among the frequently used subjects.

An analysis of the samples and study groups in physics education research shows that some studies include 201 or more participants (Bøe and Henriksen 2013; Chu and Treagust

2014; Jeppsson, Haglund and Amin 2015; Sasson and Cohen 2013; Tsurusaki, Calabrese Barton, Tan, Koch and Contento 2013), 0-30 participants (Eshach, Wu, Hwang and Hsu 2014; Harlow, Bianchini, Swanson and Dwyer 2013), 101-200 participants (Berger and Hänze 2015) and 31-100 participants (Lancor 2015). In this sense, though there are differences in the number of participants, the studies mostly include 201 or more participants. In this sense, if quantitative studies are to be carried out in these journals, comprehensive studies with greater numbers of participants are required. The physics education studies were conducted with the participation of undergraduate students (Brookes and Etkina 2015; Close and Scherr 2015; Darrah, Humbert, Finstein, Simon and Hopkins 2014; Goertzen, Brewe and Kramer 2013), high school students (Bigozzi, Tarchi, Falsini and Fiorentini 2014; Marchand and Taasoobshirazi 2013; Tiberghien, Cros and Sensev 2014), primary/middle school students (Oon and Subramaniam 2013; Papadouris and Constantinou 2014), and teachers (Hazari, Cass and Beattie 2015; Ritchie et al. 2013; Taylor and Booth 2015). Uzunboylu and Asiksoy (2014) state in their study that physics research was conducted with the participation of secondary school students, teachers and students of the faculty of education. This study was also conducted frequently with undergraduate students.

Physics education studies frequently focus on the subjects of energy (Cheong, Joharib, Said and Treagust 2015; Dreyfus, Gupta and Redish 2015; Seraphin, Philippoff, Parisky, Degnan and Warren 2013), force and motion (Fulmer, Liang and Liu 2014; Hast and Howe 2013b), electricity (Peppler and Glosson 2013) and magnetism (Shemwell et al. 2015). Energy, force and motion, electricity and magnetism are among the mostly studied subjects. Similarly, Uzunboylu and Asiksoy (2014) confirmed that mechanics and electrical physics subjects are studied more than other subjects. They thought that this resulted from the fact that these concepts are critically important both for the participants' learning and for the future. Moreover, in sciences, physics consists of abstract concepts that are difficult to perceive. Thus, subjects such as energy, force and motion, are among the most frequently taught subjects because they are abstract. It is observed that physics concepts are generally studied with numerous participants. Our analysis shows that the electricity and force and motion concepts were generally studied with 201 or more participants. This situation is thought to arise from the fact that the data obtained from numerous participants at the stage of concept perception and learning are crucial for generalizability.

The main results obtained from the physics education studies are grouped under themes of cognitive aspect, case definition, effectiveness of methods, correlational relations and emotional aspect. The results confirm that conceptual understanding (Anderson and Barnett 2013; Ding et al. 2013) and concept teaching (West and Wallin 2013) fostered better learning (Sin 2014). There is also a strong emphasis on conceptual understanding and cognitive development. In this sense, the studies investigating the effects of designed materials and methods on cognitive gains of the participants maintain their importance. However, these studies focus on conceptual learning, rather than achievement. In addition, our results show that there were differences in age-related learnings (Hast and Howe 2013a), and in teacher lectures (Jawahar and Dempster 2013), that males' preference for physics was greater than females' (Gill and Bell 2013), and that the metaphors were effective (Dreyfus et al. 2015). A remarkable point here is the in-depth investigation of some cases (gender, age etc.) that were stated generally by literature search studies. In this sense, it is considered important for research to investigate the reasons for the general cases stated in the literature searching studies and to obtain profound information regarding these cases.

Recommendations

In these physics education studies, the publications were published mostly by the citizens of America, England and Germany. The countries of Turkey, Portugal, Chile and Lebanon, on the other hand, each published a single study. It is necessary for each country to carry out research in parallel with the development of their educational systems and to increase publications in the journals regarded as important in the literature.

As Soslu (2013) indicates, practical activities and teaching methods are both effective; in addition, it is important to organize various activities, including novice approaches and methods. Studies for designing interactive simulations and 3D materials and checking their effects are important, and there are deficiencies in this matter in the field. Thus, it is necessary to conduct studies related to enhanced web-based materials in the era of increasingly growing educational technologies. Moreover, while the studies that ground their theoretical framework on a single theory in material development have become limited, enriched or blended learning approaches that include more than one method have gained importance. As a result, both physics education and more general science education studies are expected to examine the enhanced materials that are used with approaches such as context-based learning, inquiry-based learning, argumentation-based learning and investigating the effects of these methods in learning environments. Conceptual understanding, which has frequently appeared recently, continues to gain importance and is in the process of being better understood by researchers. Moreover, the studies regarding 21st century skills, which have become crucial in education in recent years, seem to be rare, and therefore, examining these types of studies would be significant for the literature.

As interdisciplinary approaches are becoming increasingly crucial, it is suggested that researchers from various departments (physics-chemistry-biology-mathematics and engineer, sociologist, philosophy etc..) carry out joint research. In conclusion, the studies were conducted on the participants' perceptions of the main physics concepts and on how the participants make sense of these concepts. In these studies, in-depth information was obtained and detailed results were stated. It is important to increase these types of studies and to study the physics concepts that have not been worked on. Moreover, the prominent diversity issue needs to be reflected in physics education studies, and studies regarding diversity need to be conducted.

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Analysing the Feedback that Secondary School Science Teachers Provide for Student Errors that Show Up in Their Lessons¹

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ABSTRACT

The aim of this study is to reveal the feedback that secondary school science teachers provide for the student errors that show up during their lessons. Six different science teachers were observed throughout 90 sessions of science lessons for sixth and seventh grade in six different units as unstructured with this aim. The case study method was used within the study. Based on the data obtained from the study, feedback that the teachers provide for the students' errors was collected under 10 separate titles, and these titles are: 1. Saying just 'wrong', 2. Giving another student the right to speak, 3. Asking the question again, 4. Giving the answer directly, 5. Explaining the answer directly, 6. Investigating the reason for the mistake, 7. Correcting the incomplete or erroneous part of the answer, 8. Giving clues to student leading, 9. Repeating the answer of the student, 10. Ignoring the student answer. It was concluded from the study that science teachers most often make use of the third type feedback and least often use the last type. It is recommended that feedback provided for the mistakes should be systematically structured by conducting studies similar to this study in places which have different sociocultural structures and different class levels.

Keywords: Science lessons, science teachers, student errors, feedback types

INTRODUCTION

The studies on science education highlight the fact that constructivist learning theory provides a useful and functional framework for achieving the aims of science education and brought new practices into teaching (Ministry of National Education [MoNE], 2005). Constructivist learning theory suggests that students make sense of a new situation and acquire new information through using their existing knowledge (Çepni, Akdeniz and Keser, 2000). According to constructivist learning theory, knowledge is actively constructed by an individual (Matthews, 2002). In this process, teachers guide and help students to construct the knowledge. The constructivist learning theory can be successful in condition that teachers play their roles actively and productively (Kan, 2007). In their study, titled "The role of science teachers in [the] constructivist approach", Akpınar and Ergin (2005) indicated that



science teachers should first determine the prior knowledge of students relevant to the subject through written tasks, by asking questions in the classroom, through interviews, group discussions or by paying attention to the vocabulary that students use when talking about that subject before the teachers give start to lesson, because the new information to be given would not mean anything without eliminating any misconceptions, incomplete or disorganized knowledge of the students may already have. One of the fundamental aims of science education is to make sure that students understand scientific concepts and use them correctly (Yağbasan and Gülçiçek, 2003). In order to achieve this aim, the misconceptions and incomplete knowledge of students should be replaced with scientifically correct knowledge. In this regard, science teachers should take student errors into account and try to minimize them. An “error” is described as an observable performance which differs from an expected “correct” performance (cited by Fisher and Lipson, 1986 from Fredette and Clement, 1980). In the same vein, misconception is described as a concept that students develop as an alternative to scientific concepts (Tekkaya, Çapa and Yılmaz, 2000) or any scientifically inaccurate idea that takes the mental place of a concept, or understanding, perceiving or using a concept in a way that conflicts with its scientific meaning (Treagust, 1988; Tezcan and Şimşek, 2008). The errors can be defined as the result of misconceptions (Li, 2006; Zembat, 2010). In other words, a misconception is a type of perception that systematically produces errors (cited by Zembat, 2010 from Smith, diSessa and Roschelle, 1993).

In the education environment, students are generally the practitioners of a task (or relevant errors) while the teacher is the assessor who observes whether the task is done correctly or whether there are errors or not. It can be said that it is an indirect aim of teaching to help students notice their own errors and correct them (Fisher and Lipson, 1986). In their study, entitled “The nature of error in the process of science and its implications for the teaching of science”, Mermelstein and Young (1995) attributed an important role to errors in science and in the learning process and emphasized that errors were tools for exploration among scientists and students.

In studies carried out on student errors, researchers argued that errors are opportunities in the learning process rather than negative indicators requiring specification and correction (Englehardt, 1982; Confrey, 1990; O’Connell, 1999) and they are too important to be ignored in the learning process (Borasi, 1994, 1996; Santagata and Stigler, 2000; Santagata, 2004, 2005; Heinze, 2005; Bozan and Küçüközer, 2007; Ding, Li, Piccolo and Kulm, 2007; Ding, 2007; Heinze and Reis, 2007; Schleppebach, Flevares, Sims and Perry, 2007; Baştürk, 2009; Doğan Fırat, 2011; Türkdoğan, 2011). On the other hand, students can understand a concept better through their errors (Fisher and Lipson, 1986). Though errors are regarded as a natural part of the learning process, student errors are not considered positively by adults (Heinze, 2005). Errors are associated with negative feelings for many teachers and students (Heinze and Reiss, 2007). It is known that teachers get angry at students who make simple errors while making a definition or using a term in subjects that they consider to be easy (Heinze, 2005).

The science curriculum, which was put into practice in 2013–2014 education year, includes “an assessment and evaluation understanding aimed to provide continuous feedback in order to monitor and guide students during the process; determine their learning difficulties and support meaningful and permanent learning is adopted” (MoNE, 2013). The biggest difference of the new science curriculum as compared to the previous ones is the principles adopted in relevant to formative assessment even though they are not explicitly stated in this curriculum (Bulunuz and Bulunuz, 2013). Formative assessment requires determining and interpreting the current situation of students and using the obtained results to increase their performance in the learning process (Harlen, Gipps, Broadfoot and Nuttall, 1992). In this

process, students are provided feedback about their deficiencies and errors. Thus, they get an opportunity to recover their deficiencies and correct their mistakes (Baki, 2008). In the literature, there are studies on how teachers provide feedback on student errors (Santagata and Stigler, 2000; Santagata, 2002, 2004, 2005; Boz, 2004; Erdoğan, 2005; Baştürk, 2009; Türkdoğan, Baki and Çepni, 2009; Doğan Fırat, 2011; Türkdoğan, 2011; Türkdoğan and Baki, 2012; Türkdoğan and Baki, 2013; Çubuk, 2013). Though there are a lot of studies on the reactions that teachers give to student errors, there is still a significant need for more research in this area (Ball, Lubienski and Mewborn, 2001). The MoNE (2013) adopts a measurement and evaluation approach to provide continuous feedback to support meaningful and permanent learning. However, there is no research has been found in the literature on how science teachers give feedback on student errors in their lessons. This study is the first study to be performed in this area.

In Turkey, behaviourism (the behavioural learning approach) was practised for many years. In behaviourist approach, errors are perceived negatively and so they should be eliminated because they manifest as a result of confusion (Gagatsis and Kyriakides, 2000). It is also known that teachers avoid any discussion of the errors that students make (Santagata, 2004). The constructivist learning theory introduces a completely different perspective on the role that errors play in the learning process. The constructivist learning theory suggests that student errors are necessary and indispensable parts of the learning process (Santagata, 2002). Thus, teachers can handle errors as the marks of the diagrams that should be recreated in construction processes of students and develop suitable strategies in order to facilitate this process (Palinscar and Brown, 1984). When the international and national literature examined, it is seen that there is not any study on the feedback provided by science teachers for student errors. For this reason, it is necessary to perform a study on the feedback that science teachers provide for student errors appeared in their lessons. Thus, the present study aims to determine the types of feedback provided by secondary school science teachers for the student errors in their classrooms.

METHODS

In the present study, the qualitative research method of the case study was applied, intended to analyse the feedback that science teachers provide for student errors that appear in their lessons. The purpose of the case study is to collect comprehensive, systematic and detailed information about each case that is thought to be interesting (Patton, 2002). The situation to be investigated in case studies may involve individuals (teachers, students, administrators, etc.) activities, programmes, groups, policies, actions or behaviours (Mc Millan and Schumacher, 2001). In the study, an embedded multiple case study design was preferred, according to the categorization made by Yin (2003), for the feedback provided by different science teachers on the student errors that appeared in their lessons in different units comprising physics, biology and chemistry—the three main science courses—are taught. Each case handled in the embedded multiple case study and included in the present study can be studied by being divided into various subunits (Yıldırım and Şimşek, 2006).

The Study Group

In qualitative research, purposive sampling is employed in order to make possible to understand and investigate a phenomenon in detail in comparably small samples (Patton, 1990; Creswell, 2007). The purposive sampling method used in qualitative research is useful on many situations in exploring and explaining phenomena and cases (Yıldırım and Şimşek, 2006). One of the purposive sampling methods is maximum variation sampling. In this method, the aim is to find out whether there are common or shared phenomena in cases that

indicate variation, rather than creating a variation to make a generalization and to demonstrate different dimensions of the programme according to this variation (Yıldırım and Şimşek, 2006). The qualitative research is generally carried out in detail with small samples chosen for the purpose (Patton, 2002). In this study, because the sample group consisted of six science teachers and only the feedback with respect to student errors was examined, purposeful sampling was preferred. All teachers in the studied group work in schools located in the city centre. In Table 1 below, information is given about the teachers who took part in the study group.

Table 1. *Characteristics of the teachers included in the study group*

Teacher	Gender	Age Range	Faculty	Major	Years of Professional Experience	Educational Background
T1	Male	40–45	Faculty of Education	Chemistry Education	20	Bachelor's Degree
T2	Male	35–40	Faculty of Science	Physics	16	Master's Degree
T3	Male	30–35	Faculty of Education	Science Education	11	Bachelor's Degree
T4	Male	35–40	Faculty of Education	Science Education	10	Bachelor's Degree
T5	Male	30–35	Faculty of Education	Science Education	10	Bachelor's Degree
T6	Male	30–35	Faculty of Education	Science Education	5	Bachelor's Degree

Data Collection

In qualitative research, data are collected in four different ways, including observation, interview, document analysis and audio-visual materials (Creswell, 2003). In the present study, the data were collected through unstructured observations carried out by the researcher during the instruction of science lesson. In the study, the unstructured observation technique was employed because it was aimed to analyse the feedback provided for the errors of students appeared in science lessons. While the observations were carried out, the researcher was in the classroom as an observer only and did not get into any dialogue with the students or the teacher. Thus, the observation was carried out adopting the non-participant observation approach.

Data Collection Process

The data for this study were obtained by observing six different teachers in six different schools during the 2013–2014 academic year. In the observations carried out during the data collection process, no differentiation was made among units or subjects; observations were carried out about the subject that the teacher was teaching that particular day in a classroom or laboratory. Since the observations were unstructured, the researcher tried to write down all the teacher-student dialogues that occurred during the lesson. A total of 90 lesson hours were

observed by the teachers in the scope of the study. (This study is based on a doctoral dissertation, in which 80 lesson hours were observed in the pilot study. However, the 90 hours of data collected in the original study were used here). In addition to the notes taken by the researcher, all the data within the scope of the study were recorded with a voice recorder. Thus, data could be collected and transferred to the computer environment without missing anything.

Data Analysis

Within the scope of the study, six science teachers were observed while they were teaching six different units. The data obtained as a result of these observations were transcribed by the researcher. As feedback provided by teachers for student errors is analysed in the study, the feedback for the errors was extracted from the data that were put on paper; codes, categories and themes were created and given names. For the purpose of presenting the findings, students were coded as S1, S2, S3 and teacher as T. After the codes and categories were determined, two different faculty members in the science education department and three different science teachers were contacted and asked to repeat the categorization on this subject. The categorizations made by the faculty members and teachers were mainly the same as those made by the researcher, and the differences were discussed and a compromise was reached on the whole. Feedback types which is “Type 1, Type 2 ...” is the theme, “Saying that it is just wrong”, “Repeating the question” one of the coding. The researcher categorized 40 random dialogues and presented them to faculty members and science teachers. Of these, 36 dialogues have been classified with consensus on the classification.

Content analysis requires the analysis of the collected data in detail to make possible to identify themes and dimensions that were not obvious beforehand (Yıldırım and Şimşek, 2006). For the reliability calculation, the formula suggested by Miles and Huberman (1994) was used ($\text{Reliability} = [\text{Number of Agreements} / (\text{Agreements} + \text{Disagreements})] \times 100$). In this process, 36 out of 40 codes created by the researcher through content analysis were accepted by two faculty members and two science teachers who are experts on qualitative research. With regards to the suitability of the codes in the study, researchers reached an agreement by $(36/40) \cdot 100 = 90\%$. The reliability was calculated based on the codes and found to be 80%, which proved the study to be reliable (Miles and Huberman, 1994; Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz and Demirel, 2014).

FINDINGS

Based on the data obtained during the study, the types of feedback that science teachers provided for the student errors are gathered under 10 different titles. The feedback types obtained in the study are given in Table 2.

Table 2. *Feedback Types*

Feedback Types	Feedback	Explanation
TYPE 1	Saying that it is just ‘wrong’	
TYPE 2	Giving chance to speak to another student	
TYPE 3	Repeating the question	
TYPE 4	Giving the correct answer	

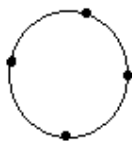
TYPE 5	Explaining the answer	-The answer is explained by the teacher, -The answer is read from the coursebook, -The answer is read from the workbook,
TYPE 6	Asking the reason for the error	-Asking questions about the error
TYPE 7	Correcting/completing the wrong/missing part of the answer	
TYPE 8	Giving a clue to the student (guiding)	
TYPE 9	Repeating the exact answer of the student	
TYPE 10	Ignoring the answer of the student	

Example of Feedback Type 1

Dialogue 1:

01...T: Let's show the electron configuration of ${}_{20}\text{X}$ atom

01...S1:

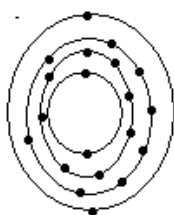


02...T: This part is wrong. First orbital can hold only two electrons.

03...S1:



04...T: It's right. First orbital holds two electrons and the second one holds eight electrons.



In the dialogue given above, the teacher directly said that the student's answer was wrong in line two and gave feedback Type 1.

Example of Feedback Type 2

Dialogue 2:

01...T: What path does a ray of light sent from an environment with a [low] density to a very dense one follow?

02...S1: It goes far from the normal.

03...T: Merve?

04...S2: It comes closer to the normal.

In the dialogue given above, the teacher gave another student the chance to speak in response to the wrong answer given by the first student in line two and used feedback Type 2.

Example of Feedback Type 3

Dialogue 3:

01...T: Let's think of a food chain consisting of green plants, grasshoppers, frogs, snakes and hawks. What does it mean if the number of grasshoppers increases in this food chain?

02...S1: Frogs eat a lot of green plants.

03...T: What does an increase in the number of grasshoppers mean?

04...S2: It means that snakes will eat more frogs and there will be left no frog[s] in the chain.

In the dialogue given above, the teacher repeated the question for the student in line three and used feedback Type 3.

Example of Feedback Type 4

Dialogue 4:

01...T: Imagine that you are on a bridge and watching the fish in the water. Do you think you would see the fish closer or further than the real?

02...S1: Further.

03...S2: Further.

04...T: You would see them closer.

In the dialogue given above, the students responded as seen in line two and three to the question asked by the teacher in line one, and the teacher directly gave the right answer, using feedback Type 4.

Example of Feedback Type 5

Dialogue 5:

01...T: When we talk about "Black Sea fish", what concept do you think of?

02...S1: Population.

03...T: Black Sea fish [do] not constitute a population. There are several types of fish in [the] Black Sea, [aren't] there? There are many types of fish in the sea. So, what should we say instead? We should say "Black Sea anchovy" so that it can constitute a population.

In the dialogue given above, a student gave a wrong answer to the teacher's question in line one and the teacher explained the answer in line three, using feedback Type 5.

Example of Feedback Type 6

Dialogue 6:

01...T: Is squeezed orange juice 100% pure?

02...S1: It is.

03...T: Why?

04...S1: Because there are no additives in it.

05...S2: It is pure because it contains no additive[s].

06...S3: It is not pure because they add hormones in it.

07...S4: I think it is a mixture.

08...S5: We don't add anything in it.

09...S6: It is not pure because there are other things in it. So, it's a mixture.

10...T: Yes, there are different things in it such as vitamins, minerals and water. Check out what we have even in drinking water.

In the dialogue given above, the teacher asked a student the reason for the (wrong) answer in line three and thus used feedback Type 6.

Example of Feedback Type 7

Dialogue 7:

01...T: Did we say what happens when the light encounters with a substance that we talk about in our previous lesson? Do you remember what happens?

02...S1: It reflects.

03...T: It may reflect. But that's not that it definitely does. What else?

04...S2: It may absorb.

05...T: It may absorb and?

06...S3: The light may pass through the substance.

07...T: In a transparent environment, it may pass through.

In the dialogue above, the incomplete answer given by a student in line two was corrected by the teacher. Thus, the teacher used feedback Type 7.

Example of Feedback Type 8

Dialogue 8:

01...T: [Why] is the sky blue?

02...S1: Because the light reflection and scattering make it look blue.

03...T: You are almost there.

04...S2: The blue colour of the sky is about clouds.

05...S3: It is because of the sun. The sun reflects the blue light.

06...S4: The light from the sun hits substances in the sky and reflects blue light.

07...S5: The white light in the sky appears blue due to the blue light in the ocean.

08...T: It has become very confusing. The atmosphere does not actually have a colour. It is about light scattering. The air molecules in the sky scatter the blue colour and its shades more than other colours—that's why the sky looks blue.

In the dialogue given above, the teacher gave a clue to the students in line three, using feedback Type 8.

Example of Feedback Type 9

Dialogue 9:

01...T: Have we compressed the air in the syringe? Yes. Well, why is it compressed?

02...S1: Force causes pressure.

03...S2: Because of pressure.

04...T: Because of pressure.

05...S3: That's because the void is filled.

06...T: Because the void is filled.

07...S4: That's because no air is left.

08...T: Because no air is left.

09...S5: That's because it's compressed from both sides.

10...T: Because it's compressed from both sides. Now, let's try to leave out the air and compress the liquid. I try to compress the liquid, but I can't. So, what does it show about liquids?

In the dialogue given above, the teacher repeated the students' answers exactly in lines four, six and eight, using feedback Type 9.

Example of Feedback Type 10

Dialogue 10:

[Prompt]: In the “Granular Structure of the Substance” unit, you learned that molecules are very tiny granules and cannot be seen with the naked eye. So, is it possible that the movement you have seen is caused by one molecule only?

A: (students answer the question given in the paragraph above).

01...S1: You said when we were learning molecules that...

02...S2: This movement cannot have been caused by one molecule because solids are packed fairly close and the particles can move only when they come together.

03...T: Yes, let's go on.

In the dialogue given above, the teacher ignored the student's answer in line three, using feedback Type 10.

All types of feedback used by the teachers during the study are given on Table 3.

Table 3: *The distribution of feedback used by the teachers within the scope of the study*

TYPES OF FEEDBACK USED										
TEACHERS	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10
T1	1	-	5	1	2	-	5	-	-	-
T2	7	-	16	16	9	11	9	7	1	1
T3	-	1	14	2	6	4	-	3	5	-
T4	2	1	10	2	3	11	2	2	2	-
T5	-	1	6	4	9	5	2	2	7	1
T6	1	2	8	2	14	2	3	3	-	-
TOTAL	11	5	59	27	43	33	21	17	15	2

When Table 3 is examined, it is seen that science teachers used feedback Type 3 the most within the scope of the study, while feedback Type 10 was used the least.

DISCUSSION, CONCLUSION AND IMPLICATIONS

As a result of the study, it was seen that the feedback used the most by the teachers was feedback Type 3 (Repeating the question) while feedback Type 10 (Ignoring the answer of the student) was used the least. It was also seen that there were differences in the feedback types that teachers used. For example, while the Ö2 teacher uses the third and fourth types of feedback most often, the Ö6 teacher has used the fifth type of feedback the most. In other words, the type and frequency of feedback that each teacher used was different.

The feedback of primary school mathematics teachers provided for student errors was investigated in the study carried out by Türkdoğan (2011). As a result of the study, the feedback given by mathematics teachers was gathered under six titles which are 1. Ignoring the error or accepting it as a correct answer, 2. Giving the answer, 3. Telling them their error, 4. Creating a contradiction, 5. Simplifying and 6. Association. The feedback category three in this categorization created by Türkdoğan (2011) is similar to feedback Type 1 in the present study. Also, feedback Type 10 in the present study is similar to feedback category one in the study carried out by Türkdoğan. Even though “Giving the answer” among the feedback types created by Türkdoğan (2011) can be found in the categories used in the present study, the feedback types such as “Creating a contradiction”, “Simplifying”

and “Association” are not encountered in this study. It is considered that such feedback types that are not encountered in this study were created especially for mathematics lessons. On the other hand, the most of the feedback was not about concepts in mathematics lessons, while the most of the feedback provided by science teachers consisted of answers to student errors relevant to scientific concepts.

In the study carried out by Çubuk (2013) on the feedback provided by mathematics teachers for student errors, the feedback types were gathered under the three categories of “direct”, “indirect” and “unresponsive” feedback. “Telling the error directly” would be placed under “direct” feedback, similar to feedback Type 1 mentioned in the present study, while “Giving the answer” would be considered “indirect” feedback in the study by Çubuk (2013), similar to feedback Type 4 in the present study. “Giving clues” under the “Giving the answer” category is similar to feedback Type 8 in the present study. In the study carried out by Çubuk (2013), “Asking the student to explain his/her answer” is a division of the “Questioning” subheading of the main “indirect feedback” category, and is similar to feedback Type 6 in the present study. Lastly, “Repeating the same operation” under the “Implying that the answer is wrong” subheading under the main “indirect feedback” category is similar to feedback Type 3 in the present study.

As for the feedback “Telling the students what to do” under the main “Correction” category in the study carried out by Çubuk (2013), this type was not encountered in the present study. It is possible that this feedback type was developed particularly for mathematics lessons. Similarly, the feedback “Creating a contradiction” and “Drawing students” attention to the structure of the questions in the study by Çubuk (2013) are not encountered in the present study, probably because of the above-mentioned reason.

In the study carried out by Köğçe (2012) in which the feedback types used by mathematics teachers in their lessons were examined, two of the teachers in the study group indicated that they could give feedback for student errors by teaching the relevant points repeatedly, whereas the other teacher said that he/she would give feedback that would help the students control their errors. These feedback types employed by mathematics teachers are similar to the feedback Types 4 and 6 in the present study.

In the study carried out by Odabaşı-Çimer, Bütüner and Yiğit (2010) with the aim of determining the feedback types used by elementary school teachers in mathematics lessons, it was indicated that most of the verbal feedback used by the teachers in the study group was evaluative, while very little of it was descriptive. It was also pointed out that the descriptive feedback used by teachers was not useful in terms of showing students where they made an error or how they could reach the correct answer but just included telling them the correct answer. It can be said that this feedback type is similar to feedback Type 4 mentioned in the present study.

In the study carried out on the feedback types given to pre-service mathematics teachers within the scope of mathematics lessons on the characteristics of feedback based on usefulness, sensitivity, privacy, keeping in mind dimensions and on the feedback types that pre-service mathematics teachers preferred, Çabakçor, Akşan, Öztürk and Odabaşı-Çimer (2011) pointed out that pre-service teachers were provided feedback in the form of notes, praise, clues, corrective feedback or confirmation feedback when they were also given questions to prove or given the answers for the parts they could not complete. Among this feedback, ‘Confirmation’ and ‘Giving the answers for the parts they couldn’t complete’ are similar to feedback Types 1 and 7 mentioned in the present study.

In the study carried out by Santagata (2002), the feedback given by teachers for student errors was examined and categorized as follows: 1. Correction, 2. Giving a clue to the same student, 3. Repeating the question, 4. Asking the reason, 5. Giving a clue to another student, 6. Repeating the question indirectly, 7. Choosing the correct answer, 8.

Asking the answer to the class, 9. Another student gives the answer before the teacher and 10. Others. The similarities and the differences between the feedback types named in the study carried out by Santagata (2002) and the ones used in the present study can be summarized as follows: 'Correction' is similar to feedback Type 7 in the present study, 'Giving a clue to the same student' is similar to feedback Type 8, 'Repeating the question' is similar to feedback Type 3, 'Asking the reason' is similar to feedback Type 6 and 'Choosing the correct answer' is similar to feedback Type 4 used within the scope of the present study. There are differences among the other feedback types. Accordingly, it is seen that the feedback given by teachers for student errors is mostly similar. However, there might be some differences in the feedback types both because the content of the lessons was different and the societies where the studies were carried out had some specific differences. The feedback categories eight, nine and 10 from those created in the study by Santagata (2002) are not encountered in the present study, while the feedback categories three and six are gathered under one type in the present study.

In the study carried out by Schleppenbach et al. (2007), the feedback provided by Chinese and American teachers for student errors was investigated and the answers that teachers gave just after student errors were gathered under one group (Group 1) while the questions the teachers asked after student errors were gathered under another group (Group 2). Thus, one group of feedbacks consisted of general feedbacks given by teachers while another consisted of questions only. The feedback listed under Group 1 and 2 are as follows:

Group 1:

- i.) Telling the students that their answers are wrong
- ii.) Giving the correct answer
- iii.) Ignoring the error
- iv.) Explaining or guiding
- v.) Students correct their errors immediately

Group 2:

- i.) Repeating the question
- ii.) Explaining the question
- iii.) Asking the student to add something to the answer
- iv.) Asking for precision
- v.) Paraphrasing the question
- vi.) Asking the student to explain

There are great similarities between feedback Type 1 used within the scope of the present study and the first statement in Group 1 created by Schleppenbach et al. (2007), as well as between feedback Type 4 and the second statement; between feedback Type 10 and the third statement; between feedback Type 8 and the fourth statement in Group 1 mentioned above. In addition, feedback Type 3 and 'Repeating the same question', 'Explaining the question' and 'Paraphrasing the question' under Group 2 in the aforementioned study can be considered the same type of feedback. However, the other statements under Group 2 are not encountered in the present study.

According to the results of the present study, it can be said that there exist different types of feedback even though there are similarities among the feedback types provided by teachers in different subjects and in different countries. However, the fact that all the aforementioned studies focused on mathematics lessons, while there have been no such studies in science, is the biggest difference of the present study. The other studies were carried out on one subject only in mathematics lessons, while the present study encompassed different units in physics, chemistry and biology under the umbrella of

science, and the feedback was provided accordingly. Thus, it may account for the differences among the feedback types.

In the science curriculum (2003), teachers assume a facilitating and guiding role in the learning and teaching process while students assume the role of an individual who researches the source of knowledge, asks questions, explains and discusses. On the other hand, the role of a teacher is to facilitate learning by guiding students in the learning process. To facilitate their learning, a teacher should both encourage students to think about, discuss and analyse alternative ideas suggested and guide students at every occasion so that they can construct scientifically correct knowledge by their own (MoNE, 2006). According to the data obtained in the present study, the three types of feedback that teachers used the most frequently are 'Repeating the question', 'Giving the answer directly', 'Asking the reason for the error'. Thus, it is considered that teachers do not give students enough opportunity think about, discuss and analyse alternative ideas. In the constructivist approach, students take responsibility for their own learning and develop their thinking skills (Koç and Demirel, 2004). So, it is thought that students are not given a chance to construct new knowledge themselves, with these types of feedback. The frequent use of the feedback type defined as 'Giving the answer directly' prevents the effectiveness and productivity of the 'exploration' stage in the 5E learning cycle model based on the constructivist approach. Accordingly, it cannot be said that science teachers exactly guided student learning. In the study carried out by Atila (2012), it was found that the teachers taking part in the study did not precisely explain how they could guide learning and thus did not have the desired constructivist approach. In this regard, it is possible to say that the results of the present study are parallel to the results of the study carried out by Atila (2012). It was also indicated in the study carried out by Atila (2012) that 'Creating cognitive contradiction'—one of the important components of constructivist approach—was hardly ever done during the lessons by the science teachers. Thus, it can be said that the feedback provided by the science teachers within the scope of the present study was not used to create a cognitive contradiction, either. On the other hand, in constructivist learning environments it is suggested that teachers ask and find out how the learner builds these structures and forms the basis for knowledge before making any statement about the accuracy or wrongness of the knowledge structures (Yurdakul, 2008). For this reason, it can be said that teachers should focus on how a student reaches wrong conclusions when they encounter student errors. They should create contradictions in the knowledge structures that learners construct (Yurdakul, 2008). From this perspective, it is seen that the teachers in the present study did not sufficiently use the feedback methods that would cause a cognitive contradiction. In the study carried out by Türkdoğan (2011), it was demonstrated that mathematics teachers did not make sufficient use of feedback that would create cognitive contradictions, which is in parallel to the results of the present study. It was also indicated in the study carried out by Çubuk (2013) with secondary school mathematics teachers that feedback aimed at creating a cognitive contradiction was employed very infrequently, which is compatible with the results of the present study.

The results obtained within the scope of the study can be summarized as follows:

1. The types of feedback and the frequency of use differ from teacher to teacher.
2. Some of the feedback methods generally provided in mathematics lessons, such as 'Causing the students to fall into contradiction' or 'Simplifying' have not been encountered in science lessons.

The implications suggested based on the results of the study are as follows:

1. In the present study, it is seen that teachers mostly used feedback Type 3, categorized as 'Repeating the question' for student errors. This means that they took the easy way out, because it is not right to deprive students of an 'exploration' environment or

to not give them the chance to ask questions in the learning process where the 5E learning cycle model is adopted generally. Consequently, teachers should include ‘Showing them alternative situations’, ‘Asking them to reconsider’ and ‘Creating a hypothesis and retesting it’ in their feedback.

2. The feedback types provided by teachers for student errors are affected considerably by the sociocultural structure. In our country, there are regions and areas with different cultural and demographic structures. This situation affects students’, parents’ and even teachers’ perspectives on errors and thus on the feedback provided. In new educational approaches, parents, students and even teachers should be taught that an ‘error’ is something acceptable and is not seen as a result of teaching but as something that occurs during the learning process.

3. The present study was carried out with science teachers teaching in secondary schools in the Erzurum Province. It is suggested that the study should be implemented ‘n different times and in different schools with different teachers that can be selected across different regions and areas, because different sociocultural structures affect the feedback types provided for student errors. Also, similar studies should be carried out in science; thus, the errors and feedback types in the field of science can gain a more systematic structure.

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From Editorial Board

This current issue, (Volume 14 Number 2), embraces seven articles of different areas in science education. These articles report important conclusions, some of which are outlined here. These are: (i) Expert judgment and trial field-testing data confirm the feasibility and effectiveness of using the iTutor program to improve students' mastery of physics concepts . (ii) Analyzing the studies helped researchers make appropriate decisions about the research processes and observe trends in STEM-focused researches. (iii) The developed teaching materials of NPC (materials of natural product chemistry) were feasible because of their validity, practicality, and effectiveness and were able to increase students' life skills. (iv) Although the students were in Energy System Engineering Department, they still had many misconceptions about renewable energy. (v) The chemistry curriculum placed more emphasis on the knowledge of science and investigative nature of science. The examination questions mostly stressed investigative nature of science and science as a way of thinking. (vi) It is possible to say that REACT strategy is more efficient than the Ministry of National Education's curriculum for student achievement and conceptual change. (vii) Before students starting learning force concept, teachers can administer vector test to elicit students' prior knowledge of vector.

Happy reading!

On behalf of Editorial Board Members

Prof. Dr. Salih CEPNI

Editor-in-chief