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Chemistry Teachers' Perceptions on Laboratory Applications: Izmir Sample

Burak FEYZİOĞLU
Adnan Menderes University

Barış DEMİRDAĞ
Dokuz Eylül University

Alev ATEŞ
Ege University

İlker ÇOBANOĞLU
Ege University

Eralp ALTUN[a]
Ege University

Abstract

This study aims to reveal to what extent Turkish chemistry teachers use laboratorys effectively and their perceptions on laboratory applications and the factors related to laboratory applications. In this cross-sectional survey, 408 chemistry teachers from the secondary schools in Izmir were given "Teacher Demographic form", "The Scale of Chemistry teachers' perceptions on Laboratory Applications" and "The Questionnaire for the factors effecting Laboratory Applications". The findings revealed that the teachers' perceptions on laboratory applications significantly vary according to their self-efficacy beliefs in laboratory applications, the type of school they graduated, the type of the school they are working at, their experience in teaching, their schools' physical conditions and assesment-evaluation techniques and chemistry program. The type of the experiment they use and the type of their schools are significantly correlated. However, their experiences in teaching, the type of school they graduated, the type of experiment they use are significantly uncorrelated. The teachers from Anatolian high schools mostly choose open-ended experiments while the others form vocational and state high schools choose closed end experiments. It is quite remarkable that all teachers in the survey prefer hypothesis-based experiments.

Key Words

Chemistry Instruction, Laboratory Applications, Teachers' Perceptions.

Having a distinctive role in science curriculum, laboratory activities and experiences are crucial for science learners to comprehend concepts, acquire scientific and problem solving skills, scientific 'habits of mind' as Hofstein and Naaman (2007) stated. Considering this role, the Ministry of National Education (MoNE) in Turkey has been implementing the chemistry curriculum for secondary schools since 2008-2009 academic year including the following goals which are (Talim Terbiye Kurulu Başkanlığı [TTKB], 2007):

• Development of scientific processing skills,

• Attainment of relations between Chemistry-Technology-Community-Environment,

• Developing skills for communication, attitude and value.

Since chemistry is an experimental branch of science, laboratory is the only place that is capable of developing students' scientific processing skills. Laboratory applications should include activities which allow students to make choices with exploratory actions. They should be learner-centered, comprise before and after experiment studies, exciting experiments that are connected with real-life rather than boring experiments (Ayas, Çepni, Johnson, & Turgut, 1997; Feyzioğlu, 2009; Hofstein, Navon, Kipnis, & Mamlok-Naaman 2005; Lei, 2006; Pavelich & Abraham, 1977; Stewart, 1988). In their paper about studies on laboratory applications in several countries, Hofstein and Naaman (2007) reported that laboratory applications aim at developing students' scientific processing skills, problem solving skills, and draw their attention and develop positive attitudes towards scientific approaches according to

a *Correspondence:* Assoc. Prof. Eralp ALTUN, Ege University, College of Education, Department of Computer and Instructional Technologies Education, 35040 Bornova-Izmir / Turkey. E-mail: eralp.altun@ege.edu.tr & eralp.altun@gmail.com. Phone: +90 232 373 3575 Fax: +90 232 373 4713.

objectives of fundamental science education. Garnett, Garnett and Hackling (1995), mentioned that laboratory helps students develop their conceptual understandings, application skills and techniques, interrelations among variables and analyzing skills for chemical analysis and synthesis. They also implied that in order to develop students' research skills which include problem analysis, planning and conducting research, data collection and interpreting findings; laboratory approaches that enable learners active participants need to be followed.

In literature, it is controversial that laboratory applications in science teaching are sufficient and effective. There are several reasons for the ineffectiveness of laboratory applications such as the lack of planning and time (Backus, 2005; Booth, 2001; Hackling, Goodrum, & Rennie, 2001; Hodson, 1990; Jones, Gott, & Jarman, 2000); teachers' low-level attitudes toward laboratory applications, negative perceptions and beliefs (Brown, Abell, Demir, & Schmidt, 2006; Cheung, 2007; Costenson & Lawson, 1986; Roehrig & Luft, 2004; Tanel et al., 2009; Welch, Klopfer, Aikenhead, & Robinson, 1981; Windschitl, 2003) lack of effective and sufficient course materials (Abraham et al., 1997; Costenson & Lawson, 1986; Hofstein & Lunetta,1982; Lawson, 2000; Lechtanski, 2000; Maija, 2005; Renner,1986; Stewart, 1988); large classes (Cheung, 2008; Hofstein, Levi-Nahum, & Shore, 2001; Kipnis & Hofstein, 2007; McNally, 2000; Prades & Espinar, 2010; Singer, Hilton, & Schweingruber, 2006); incomplete readiness of learners' (Hardy, 2003; Hofstein & Lunetta, 1982); problems related to classroom management (Costenson & Lawson, 1986; Deters, 2005; Gallet, 1998; Hofstein & Lunetta, 1982; Jones et al., 2000; Kirschener & Meester, 1988; Welch et al., 1981); lack of security precautions in laboratoryoratories (Deters, 2005; Staer, Goodrum, & Hackling, 1998); excluding laboratory applications performance of learners in assesment (Deters, 2005; Hofstein, Shore, & Kipnis, 2004; Lazarowitz & Tamir, 1994; Lunsford & Melear, 2004; Morgil, Yücel, & Ersan, 2000; Özden & Tekin, 2006).

Another reason for ineffectiveness of laboratory applications is the teachers' incapability of applying effective laboratory application approaches (such as inquiry-based laboratory application). It is reported that teachers do not use such laboratory applications because of relatively more time requirement for learners' designing/preparing experimental procedure, analyzing, interpreting and presenting data (Backus, 2005; Booth, 2001; Cheung, 2009; Costenson & Lawson, 1986; Deters, 2005; Jones et al., 2000; Staer et al., 1998). Another reason is the teachers' lack of sufficient knowledge about laboratory approaches (Furtak, 2006; Gallet, 1998; Hodson, 1992; Lubben & Ramsden, 1998; Nott & Wellington, 1997; Roehrig & Luft, 2004; Wilkinson & Ward, 1997; Welch et al., 1981).

The purpose of this study is to reveal to what extent chemistry teachers make use of laboratorys, how effective they are able to use them, their perceptions on laboratory applications and which factors affect their laboratory applications. Following research questions are investigated in this study:

1. Are there any significant relations between the chemistry teachers' perceptions on laboratory applications' purposes, effectiveness and planning in terms of their self-efficacy beliefs in laboratory applications, the type of the school they are working at, their experience in teaching, the type of school they graduated?
2. Are there any significant relations between their perceptions about their schools' physical conditions, chemistry program, computer based laboratory applications and laboratory's purposes, effectiveness and planning?
3. Are there any significant relations between their perceptions about their self-efficacy beliefs in laboratory applications, the type of the school they are working at, their experience in teaching, the type of school they graduated, their schools' physical conditions, chemistry program, computer based laboratory applications and the type of experiment they use in their courses?

Method

This survey is descriptive in nature and evaluates the chemistry teachers' perceptions on laboratory applications in terms of several variables.

Population and Sample

The population of the study is composed of 463 chemistry teachers employed in secondary schools in Izmir, Turkey in 2008-2009 academic year. A total of 408 chemistry teachers responded all the data collection tools online. Among 22 of them were employed in Science high schools, while 119 of them in public high schools, 138 of them in Anatolian high schools, 88 of them in vocational high schools and 41 of them in other types of high schools in Izmir. 28 of the chemistry teachers have 1 year-5 years teaching experience, while 61

of them have 6-10 years, 104 of them have 11-15 years, 118 of them 16-20 years, 65 of them 21-25 years and 32 of them have 26 or more than 26 years teaching experience.

Instruments

The data collection tools include personal information form, "The Scale of Chemistry teachers' perceptions on Laboratory Applications" and "The Questionnaire for the factors effecting Laboratory Applications".

The Scale of Chemistry teachers' perceptions on Laboratory Applications: This scale consists of 20 items including three factors. The variance explained by the first factor which measures the perceptions about laboratorys' purposes is 31.23% and its Cronbach alpha internal consistency coefficient is 0.92. The variance explained by the second factor which measures the perceptions about effectiveness of laboratory applications is 15.56% and its Cronbach alpha internal consistency coefficient is 0.80. And, the variance explained by the third factor which measures the perceptions about the effects of laboratory applications in planning is 10.88% and its Cronbach alpha internal consistency coefficient is 0.70. The total variance explained by the scale is 57.67%. The items in second and third factors are in negative form. Cronbach alpha internal consistency coefficient of the scale is 0.88. It is 5-point Likert type as *I completely disagree (1), I don't agree (2), I am neutral (3), I agree (4) and I completely agree (5).*

The Questionnaire for the factors Affecting Laboratory Applications: In consequence of literature review, a 44-item questionnaire was developed with six sub-headings as Teachers' self-efficacy, Equipment and Physical Conditions, Laboratory security, Aspects of chemistry program, Assesment-Evaluation System, Computer Environment. For 32 items, the questionnaire is 5-point Likert type as *Always* (1), *Usually* (2), *Sometimes* (3), *Rarely* (4), *Never* (5). Content and face validity studies of the questionnaire were conducted with five experts two of whom are from Assesment-Evaluation and three of whom are from chemistry disciplines and four items were accordingly dismissed. Final version of the questionnaire consists of 40 items.

Data Collection

In order to administer the scales online to the chemistry teachers working in Izmir, a web page was developed and the scales were published (http://www.sanlaboratory.gen.tr/). This web page of the project was announced formally by the Izmir province of MoNE to all high schools in Izmir. The chemistry teachers signed up the web page and accessed the scales between January 14th and March 15th, 2009.

Data Analysis

To reveal possible significant differences between the chemistry teachers' perceptions on laboratory applications in terms of various variables, one-way ANOVA and t-Test were performed. To find out the source of variance, TUKEY and LSD tests and for categoric variables chi-square test were performed.

Results

The teachers' perceptions on laboratory applications significantly vary according to their self-efficacy beliefs in laboratory applications, the type of school they graduated from, the type of the school they are working at, their experience in teaching, their schools' physical conditions and assesment-evaluation techniques and chemistry program. The type of the experiments they use and the type of their schools are significantly correlated however their experience in teaching, the type of school they graduated, the type of experiment they use are significantly uncorrelated. The teachers from Anatolian high schools mostly choose open-ended experiments while the others form vocational and state high schools choose closed-end experiments. It is quite remarkable that all teachers in the survey prefer hypothesis-based experiments.

Another finding revealed that the teachers from Anatolian high schools had significantly more positive perceptions on making laboratory applications than the others. The teachers with 11-15 years of teaching experience have the most negative perceptions, while the teachers with 26 or more years of teaching experience have the most positive perceptions for laboratory applications in chemistry courses. The teachers' perceptions on laboratory applications also vary according to the presence of a chemistry laboratory at their schools, as it is expected from the teachers having a laboratory at school to have more positive perceptions on benefits of laboratory applications than the others.

Discussion

Laboratoryoratories are crucial for making abstract chemistry conceptions concrete. They help students not only acquire scientifical information, but also improve their skills of scientific thinking, observation, creative thinking, comment on situations, data collection and analysis and problem solving (Şahin-Pekmez, 2001). In order to use laboratory effectively, it is essential that teachers should have positive attitudes towards laboratory applications and the laboratory environments they are working in should fulfill the necessary working conditions.

There are some literature records about chemistry teachers' lack of knowledge and laboratory practices. Even if there are well-equipped laboratories, they are not being efficiently used because of the teachers' incomplete knowledge about laboratory equipment (Demirelli, 2003; Ekici, Ekici, & Taşkın, 2002; Korkmaz, 2000; Yeşilyurt et.al., 2004), types of experiments (Aydoğdu, 2003), insufficiency of laboratory conditions, large classes and etc. (Uluçınar, Cansaran, & Karaca, 2004; Yılmaz, 2005, Yurdakul, 2004). For these reasons, the teachers mostly prefer performing demonstration experiments in laboratory (Çallıca, Erol, Sezgin, & Kavcar, 2001; Değirmençay & Çepni, 2001; Eğitimi Araştırma Geliştirme Dairesi [EARGED], 1995; Eggleston, Galton, & Jones, 1976; Gott & Duggan, 1995; Güzel, 2001; Kayatürk, Geban, & Önal, 1995; Nakiboğlu & Sarıkaya, 1999; Üce, Özkaya, & Şahin, 2001). Another factor affecting the type of experiment that teachers use is the teachers' positive attitudes towards laboratory environment. Insufficient physical conditions, overloaded class schedules of teachers and readiness level of learners affect teachers' attitudes towards laboratory applications (Wilkinson & Ward, 1997).

Science educators suggest laboratory applications which lead learners to explore and inquire (Hofstein & Lunetta, 1982; Hofstein et al., 2001; Högström, Ottander, & Benckert, 2010; Hurd, 1969; Reif & St. John, 1979; Kirschner and Meester, 1988; Lunetta & Tamir, 1978; Schwab, 1962). Students are able to observe natural events in computer environment which they cannot observe directly because of these events are too comprehensive, too small, too fast, too slow or too complicated (Singer et al., 2006). Hence, the experiments which are hard to control, dangerous, very expensive and difficult or impossible to conduct in laboratory settings can be simulated in computer environment (Çallıca et al., 2001; EARGED, 1995; Güzel, 2001; Özdener & Erdoğan, 2001; Singer et al., 2006; Şahin-Pekmez, 2001). With the help of computers, the data which are difficult to collect in laboratory settings can easily be gathered in virtual environments which are adapted from real life, also experimental data can be processed fast and safely, large amount of data can be accessed in a short time and an experiment can be repeated as long as it is demanded. It is possible to conduct experiments in a safe learning environment individually or collaboratoryoratively (Akgün, 2005; Demirdağ, 2007; Feyzioğlu, Akçay, & Pekmez, 2007; Kıyıcı & Yumuşak, 2005; Kulik, Bangert, & Williams, 1983; Roblyer, 1988; Singer et al., 2006).

In order to make use of laboratorys effectively which is essential for chemistry instruction, these perceptions of chemistry teachers need to be considered and necessary regulations and developments should be performed in chemistry curriculum and at settings of schools. Chemistry teachers should also be provided with frequent and effective in-service courses. Considering the advances in instructional technology and the needs of teachers and students, highly interactive educational software packages and/or learning management systems which include laboratory applications should be developed. In laboratory applications, students must not only gain knowledge but also develop their scientific processing skills, problem solving skills, therefore these skills should also be assessed as suggested by Lei (2006), Stewart (1988) and Ayas et al. (1997). These objectives of laboratory applications require revision of measurement and assessment techniques in secondary school chemistry courses.

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