IRANIAN UNIVERSITY STUDENTS' PERCEPTION OF CHEMISTRY LABORATORY ENVIRONMENTS

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Abstract. This article reports the development, validation and application of a Persian version of the Science Laboratory Environment Inventory (SLEI). The SLEI was carefully translated into Persian and field tested with a sample of 311 Iranian university students in 21 chemistry laboratory classes. Confirmatory factor analysis proved that the Persian version of SLEI is a valid instrument. Further exploration showed that the instrument exhibited internal consistency reliability for both its actual and preferred forms. Comparison of Iranian university students' scores on actual and preferred forms of the questionnaire revealed that students were not satisfied and preferred a more positive chemistry laboratory environment on all scales. The results will be of significance for chemistry educators to create more efficient, constructive, creative, critical and democratic chemistry laboratory environments. The work is distinctive since it is the first learning environment study delving through chemistry laboratory classrooms in Iran.

Keywords: chemistry laboratory environment, SLEI, learning environments research, satisfaction

Introduction

An important and valid source of information regarding the efficiency of science laboratories can be obtained by using measures that assess students' perceptions of the laboratory learning environment. The need to assess the students' perceptions in the science laboratory was first approached by a group of science educators in Australia (Fraser et al., 1993), that developed and validated the Science Laboratory Environment Inventory (SLEI). The SLEI has five scales (each with seven items) and the five response alternatives are Almost Never, Seldom, Sometimes, Often and Very Often. This instrument was found to be sensitive to different approaches to laboratory work and in different science disciplines such as biology or chemistry laboratory learning environments (Hofstein et al., 1996; Fisher et al., 1999).

The SLEI has been used in several studies conducted in different parts of the world. One comparative study examined students' perceptions in six countries: UK, Nigeria, Australia, Israel, USA, and Canada (Fraser & McRobbie, 1995). Fraser et al. (1993) in Australia found that students' perceptions of the laboratory learning environment accounted for significant amounts of the variance of the learning beyond that due to differences in their abilities.

In spite of internationalization of learning environment studies and vast arrays of research in science laboratory learning environments, few studies could be located that report some explorations regarding Iranian students' perceptions of their learning environments. This study, after validating a Persian version of the SLEI, tries to delve into Iranian university students' satisfaction with their chemistry laboratory learning environments. It also tries to spot the chemistry laboratory environment dimensions that lead to Iranian university students' dissatisfaction. The work is unique since it is the first of its type in Iran.

Field of learning environments research

The pioneering works of two American scholars, Rudolf Moss and Herbert Walberg paved the way for the field of learning environments research. Through the evaluation of the Harvard Physics Project, Walberg & Anderson (1968) developed the Learning Environment Inventory (LEI). Working in a quite separate field, Moos developed a number of social climate scales, including those for use in correctional institutions (Moos, 1968) and psychiatric hospitals (Moos & Houts, 1968). These instruments led to the development of the Classroom Environment Scale (CES) (Trickett & Moos, 1973).

Interest in the concept of learning environments then spread. Fraser (1998a) states that the quality of the classroom environment in schools is a significant determinant of student learning and students' positive perceptions of learning environments will pave the way for better and deeper learning. Numerous research studies have shown that student perceptions of the classroom environment account for appreciable amount of variance in learning outcomes, often beyond that attributable to background student characteristics (Dorman, 2001).

Decades of research in the field of learning environments have led to the development of a variety of economical, valid and widely-applicable questionnaires for assessing students' perceptions of classroom environments. There are now hundreds of researches which explore learning environments at various grade levels (primary, secondary, tertiary) and in a variety of contexts and classrooms including science and mathematics, chemistry, computer, biology, geography, physics and language.

Studies on science and mathematics classroom environments have a long tradition in the field and studies such as Yang et al. (2002), Wolf & Fraser (2008), and Aldridge &

Fraser (2000) focused on science and mathematics learning environments with the aim of promoting these environments. Chemistry classroom environments have also been the target of exploration in different studies (e.g., Hofstein et al. 1979; 1996; McRobbie & Fraser. 1993; Wong et al. 1997; Riah & Fraser, 1998). Studies such as Soerjaningsih et al. (2001), and Maor & Fraser (1996) provide insightful ideas about the nature and promotion of computer classrooms environments. Among the rest, Moss & Fraser (2001) and Fisher et al. (1995) focused on biology classroom environments. Geography is another subject area which has been explored in a number of learning environment studies (e.g., Fraser & Chionh 2000). Psychosocial environments of physics classrooms have also been the subject of studies such as McRobbie et al. (1997) and Terwel et al. (1994).

This study is among those ones that report evaluation, exploration or promotion of chemistry laboratory learning environments.

The growth of learning environment studies can also be viewed from another perspective. Interest in learning environments spread from the USA to The Netherlands where it was picked up by Theo Wubbels and colleagues (Wubbels & Brekelmans, 1997; 1998; 2006; Wubbels & Levy, 1993), and to Australia, where it was carried forward by Barry Fraser (Fraser, 1998a,b, 2007). Learning environment research has since spread further afield to Asia (Fraser, 2002; Quek et al., 2005) and South Africa (Aldridge et al., 2006).

One of the most significant contributions of Wubbels and colleagues in The Netherlands was the development of the Questionnaire on Teacher Interaction (QTI) (Wubbels et al., 1997) because interpersonal relationships between students and teachers are such important aspects of the learning environment (Wubbels & Brekelmans. 1998).

In Australia, Fraser and colleagues initially elaborated the Individualized Classroom Environment Questionnaire (ICEQ) (Fraser, 1990), but this was followed by other widely used instruments such as the Science Laboratory Environment Inventory (SLEI), Constructivist Learning Environment Survey (CLES) and the WIHIC (Fraser. 1998b).

In Asia, the study of learning environments has been undertaken in Indonesia (Soerjaningsih et al. 2001), Taiwan (Aldridge et al., 1999), Singapore (Khoo & Fraser, 2008; Wong et al., 1997), Brunei (Scott & Fisher, 2004), Korea (Kim et al., 2000; Lee et al. 2003), Japan (Hirata & Sako, 1998), India (Koul & Fisher, 2005), and Thailand (Puacharearn, 2004). It should be noted that this study is the first learning environment research concerning chemistry laboratory settings in Iran.

Chemistry laboratory settings

Laboratory activities have long had a distinctive and central role in the science curriculum and science educators have suggested that many benefits accrue from engaging students in science laboratory activities (Lunetta, 1998; Hofstein & Lunetta, 2004).

It is true that very often research has failed to show a simplistic relationship between experiences provided to the students in the laboratory and learning science (Hofstein, 2004). However, sufficient data do exist to suggest that the laboratory instruction is an effective and efficient teaching medium to attain some of the goals for teaching and learning science. Appropriate laboratory activities can be effective in helping students construct their knowledge (Tobin, 1990; Gunstone, 1991), develop logical and inquiry-type skills, as well as problem-solving abilities. They can also assist in the development of psychomotor skills (manipulative and observational skills). In addition, they have a great potential in promoting positive attitudes and in providing students with opportunities to develop skills regarding cooperation and communication. In this respect the science laboratory is a unique learning environment. Thus, it has the potential to provide science teachers with opportunities to vary their instructional techniques and to avoid a monotonous classroom learning environment (Hofstein, 2004).

Appropriate laboratory activities can be effective in promoting cognitive skills, metacognitive skills, practical skills, and attitude and interest towards chemistry, learning chemistry, and practical work in the context of chemistry learning (Hofstein, 2004). In addition, it is clear that providing students with authentic and practical learning experiences has the potential to vary the classroom learning environment and thus to promote students motivation to study chemistry.

This study tries to explore students' perceptions of chemistry learning environments and aims to provide science educators with students' perspectives about these laboratory environments. The results could be of great importance in creating more learner-centered, innovative, creative, critical and democratic chemistry laboratory environments.

About the SLEI

The SLEI was developed to assist researchers and teachers to assess science laboratory learning environments (Fraser & McRobbie, 1995). The initial version of the SLEI contained 72 items altogether, with 9 items in each of eight scales. However, extensive field-testing and instrument validation later led to a more economical and valid final version with 35 items, with 7 items in each of five of the original scales. Each item's response alternatives are Almost Never, Seldom, Sometimes, Often, and Very Often. The scoring direction is reversed for approximately half the items. A typical item in the actual form of the Student Cohesiveness scale is: "Students in this laboratory class get along well as a group." The wording of the preferred version is almost identical except for the use of such words as "would." For example, the item "Our laboratory class has clear rules to guide student activities" in the actual version is reworded in the preferred version to read "Our laboratory class would have clear rules to guide student activities."

SLEI assesses five dimensions of the actual and preferred climate of science laboratory classes at the upper secondary school and higher education levels. Noteworthy features of the SLEI include its consistency with the literature, specific relevance to science laboratory classes, salience to science teachers and students, and economy of administration and scoring time.

The SLEI was field-tested and validated with cross-national samples consisting of 3,727 upper secondary school students in 198 classes and 1,720 university students in 71 classes from six countries (Canada, Australia, USA, England, Israel, and Nigeria). Item and factor analyses led to a refined version with satisfactory internal consistency reliability and factorial validity in both its actual and preferred versions.

The five scales of the SLEI include Student Cohesiveness, Open-endedness, Integration, Classroom Norms, and Material Environment. Student Cohesiveness assesses the extent to which students know, help, and are supportive of one another; Open-endedness assesses the extent to which laboratory activities emphasize an open-ended, divergent approach to experimentation; Integration assesses the extent to which laboratory activities are integrated with non-laboratory and theory classes; Classroom Norms assesses the extent to which behavior in the laboratory is guided by formal rules; and Material Environment assesses the extent to which laboratory equipment and materials are adequate. By writing new items and rewriting existing ones, the authors redefined and modified scales selected from inventories for non-laboratory settings to suit them to science laboratory classes. They based further revisions of items on reactions from colleagues with expertise in questionnaire construction and in science teaching at the secondary and higher education levels, paying careful attention to suit item each for measuring both actual and preferred classroom environments.

Development of the Persian version of SLEI

A contextual, rather than textual, translation of the original version of the SLEI was undertaken. Since the study is just concerned about chemistry laboratory, the phrase "science laboratory" in the original SLEI was translated into "chemistry laboratory" in the Persian version.

Since the original instrument was designed for Western students, with all statements in English, careful translation and back translation as suggested by Brislin (1970) was carried out. After translation into Persian, an independent person who was fluent in both English and Persian conducted a back translation into Persian to investigate whether or not the translation had captured the original meaning. The Persian version of the SLEI has five scales with seven items per scale. All items are scored on a five-point frequency scale with Almost Never representing the most negative perception and Almost Always representing the most positive perception.

The Persian version of the SLEI was then distributed among 311 (M= 81 and F=230) Iranian university students in 21 laboratory classes in four universities. Among these 21 classes, six were related to Islamic Azad University of Arsanjan, five to Islamic Azad University of Abadeh, six to Shiraz University and four to Islamic Azad University of Marvdasht. With regard to age, most of the participants were from 19 to 22 (N=225); however, a few aged more than 23 (N= 38) were also present. With regard to years of study and major, students were mainly freshmen and sophomores and were studying different fields including biochemistry, biology, genetics, nuclear engineering, physics, and chemistry.

In general, students in Islamic Azad University of Arsanjan formed 29.26 percent (N=91), Islamic Azad University of Abadeh 19.61 percent (N=61) and Shiraz University 23.79 percent (N=74) and Islamic Azad University of Marvdasht 27.33 percent (N=85) of the whole sample. The number of students in each class ranged from 12 to 19.

Field testing and validation of the Persian version of SLEI

The students' responses to the Likert scale including almost never, seldom, sometimes, often and very often alternatives, were scored 1, 2, 3, 4 and 5 respectively. The data were analyzed through SPSS and various analyses were conducted to check factorial validity and internal consistency reliability of the Persian version of SLEI.

Before conducting factor analysis, the strength of the inter-correlations among the items should be investigated (Pallant, 2005). If the items of the questionnaire are measuring the same underlying trait they shall correlate with each other. For inspecting the inter-correlation among the items, the correlation matrices for actual and preferred forms of the Persian version of SLEI were provided. Tabachnick & Fidell (2001) and Pallant (2001) recommend an inspection of the correlation matrix for evidence of coefficients greater than 0.3. Few correlations above this level may make factor analysis inappropriate. There is no exact criterion concerning the number of coefficients above 0.3 but the number of coefficients greater than 0.3 was not limited in the correlation matrices provided for two forms of the Persian version of SLEI.

Two statistical measures were also generated by SPSS to help assess the factorability of the data: Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Pallant, 2005). For the factor analysis to be considered appropriate, the Bartlett's test of sphericity should be significant ($p<0.05$). The KMO index ranges from 0 to 1 and the minimum value for a good factor analysis is 0.6 (Tabachnick & Fidell, 2001).

The KMO index was higher than 0.6 (.753 and .873 for actual and preferred forms respectively) and the result of the Bartlett's test of sphericity was significant ($p<0.05$). These two measures also attested to the factorability of the data for factor analysis.

Factor analysis

One of the most important considerations in the field of learning environment research is the choice of unit of analysis. In the present study, validation of data has been provided for the individual as unit of analysis. Use of the individual as the unit of analysis can provide spurious results because an unjustifiably small estimate of the sampling error is employed in tests of statistical significance (Dorman, 2001).

By using SPSS, principal component analysis with varimax rotation led to the generation of orthogonal factors. Past research suggested that the SLEI had a five-factor structure. This number of factors was retained for the Persian version of SLEI and confirmatory factor analysis was used.

The results of factor analyses for actual and preferred forms are provided in Table 2 and Table 3 respectively. Loadings of less than 0.30, a commonly used cut-off, have been eliminated. As it can be seen from Tables 1 and 2, all items load strongly on their hypothesized scale. There are two exceptions, however. Items number 4 and 18 in the preferred form have loadings greater than 0.30 on scales other than a priori assigned scale. Nevertheless, overall, this study provides support for the a priori five-factor structure of the final version of the Persian version of SLEI; nearly all items have a factor loading of at least 0.3 on their a priori scale. It is acceptable to maintain all 35 items of five scales in this questionnaire for further analysis.

Table 1. Factor Loadings from Confirmatory Factor Analysis (for the Actual Form of the SLEI)

ITEM	Factor Loading				
	SC	OP	IN	CN	ME
A1	.726				
A2	.693				
A3	.459				
A4	.596				
A5	.619				
A6	.543				
A7	.653				
A8		.329			
A9		.504			
A10		.373			
A11		.664			
A12		.754			
A13		.492			
A14		.797			

A15			.694		
A16			.727		
A17			.559		
A18			.705		
A19			.814		
A20			.698		
A21			.782		
A22				.678	
A23				.737	
A24				.673	
A25				.616	
A26				.678	
A27				.652	
A28				.714	
A29					.693
A30					.735
A31					.543
A32					.753
A33					.435
A34					.624
A35					.382

Table 2. *Factor Loadings from Confirmatory Factor Analysis (for the Preferred Form of the SLEI)*

ITEM	Factor Loading				
	SC	OP	IN	CN	ME
P1	.763				
P2	.626				
P3	.715				
P4	.764		.304		
P5	.688				
P6	.454				
P7	.544				
P8		.697			
P9		.742			
P10		.576			
P11		.723			
P12		.485			
P13		.727			
P14		.740			

P15			.775		
P16			.781		
P17			.673		
P18			.635	.393	
P19			.655		
P20			.718		
P21			.720		
P22				.705	
P23				.692	
P24				.509	
P25				.489	
P26				.583	
P27				.710	
P28				.751	
P29					.728
P30					.811
P31					.453
P32					.712
P34					.542
P35					.583

Internal consistency reliability of the Persian version of SLEI

Table 3 reports the internal consistency (alpha reliability coefficient) for the validated 25-item version of the Persian version of SLEI, with separate reports for actual and preferred forms and for the use of the individual student as the unit of analysis. Table 3 suggests that each scale of the Persian version of SLEI has acceptable internal consistency in all cases.

Table 3. Internal Consistency Reliability (Alpha Coefficient) for Actual and Preferred Forms and for Individual as the Unit of Analysis

Scale	Alpha Reliability	
	Actual Form	**Preferred Form**
Student Cohesiveness	.64	.71
Open-endedness	.67	.74
Integration	.78	.85
Classroom Norms	.85	.85
Material Environment	.76	.81

Differences between actual and preferred learning environment

Data collected using the Persian version of SLEI were used in a research application involving investigation of whether there were differences between students' actual and preferred classroom environment scores on the scales of Student Cohesiveness, Open-endedness, Integration, Classroom Norms , and Material Environment.

The average item mean and average item standard deviation were calculated for each actual and preferred scale of the refined the Persian version of SLEI for the individual as the units of analysis.

The five pairs of scores were computed through SPSS for conducting different paired-sample t-tests between the scores of the same scales of the actual and preferred forms. The results of these paired-sample t-tests are provided in Table 4. As it is clear, there are significant differences ($p<0.05$) between scores on Student Cohesiveness, Open-endedness, Integration, Classroom Norms , and Material Environment dimensions in the actual and preferred classroom environments.

Overall the results reported in this section clearly reveal that students preferred a more positive classroom environment than the one that they perceived as being actually present in terms of the five dimensions of Student Cohesiveness, Open-endedness, Integration, Classroom Norms, and Material Environment. These differences between students' actual and preferred environments in our study in Iran are consistent with past research which has explored the congruence between actual and preferred environments in a number of countries around the world (Fisher et al. 1995; Yarrow et al. 1997; McLeod & Fraser, 2010).

Table 4. The Results of Different Paired-sample T-Tests between the Scores of All Participants on the Five Dimensions of Actual and Preferred Forms

		PAIRED DIFFERENCES					t	df	sig. P<0.05
		Mean dif	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	SC(Actual) - SC(Preferred)	-3.80	5.21	.29	-4.38	-3.21	-12.86	310	**.000**
Pair 2	OP(Actual) – OP(Preferred)	-3.66	4.24	.24	-4.14	-3.19	-15.23	310	**.000**
Pair 3	IN(Actual) – IN-(Preferred)	-4.80	6.02	.34	-5.47	-4.12	-14.04	310	**.000**

Pair 4	CN(Actual) – CN(Preferred)	-6.51	6.07	.34	-7.19	-5.84	-18.93	310	**.000**
Pair 5	ME(Actual) - ME(Preferred)	-4.02	4.73	.26	-4.55	-3.49	-14.97	310	**.000**

Conclusion

The first purpose of this article was to report the development and validation of a Persian version of the SLEI. The SLEI was carefully translated into Persian and was field tested with a sample of 311 students in 21 classes. The questionnaire exhibited strong factorial validity and internal consistency reliability in its actual and preferred forms.

The second purpose of the study was to compare Iranian university students' actual and preferred perceptions of their chemistry laboratory learning environments. Past research (Fraser, 2007) was replicated in that Iranian university students preferred a more favorable classroom learning environment on all scales (Student Cohesiveness, Open-endedness, Integration, Classroom Norms, and Material Environment) than what they perceived to be actually present.

Laboratory instruction can play an important role in the scientific competence of students. It is an effective and efficient teaching medium to attain some of the goals for teaching and learning science. Previously no study was available to reveal what is going on in laboratory classroom environments in Iranian universities. This study, as the first one, shows that the situation is not that good. Change and improvement are necessary if we aim to create laboratory environments in which students are encouraged to construct their own knowledge. If we want to promote positive attitudes among students and to provide them with opportunities to develop skills regarding cooperation and communication, changes are required. This study is of great help for those educators who want to create democratic, critical, student-centered, and efficient chemistry laboratory environments.

Hitherto the unavailability of any Persian classroom environment questionnaire to assess chemistry laboratory learning environments has hampered learning environment research in these classrooms. Hopefully, the Persian version of the SLEI provided in Appendix A will both motivate and facilitate the growth of learning environment research in chemistry laboratory learning environments in Iran. In particular, there is scope for future research with the Persian version of the SLEI which replicates common lines of past research such as: using learning environment scales as dependent variables in studies of determinants of classroom environment (Aldridge & Fraser, 2008); investigation of associations between student outcomes and classroom learning environment (Wong et al., 1997); use of learning environment criteria in assessing educational programs (Martin-Dunlop & Fraser, 2008; Wolf & Fraser, 2008); and combining qualitative and quantitative methods in learning environment research (Aldridge et al., 1999); using feedback on students' perceptions of actual and preferred learning environment to direct improvements in classrooms (Aldridge et al., 2004; Yarrow et al., 1997).

This study was a response to the lack of learning environment research in chemistry laboratory settings in Iran. By reporting data specifically for an Iranian sample, it paves the way for future research on chemistry laboratory learning environment in Iran.

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APPENDIX: The actual and preferred forms of the Persian version of SLEI

Note: Items number 1, 6, 11, 16, and 21 are related to Integration scale, items number 2, 7, 12, 17, and 22 are related to Open-endedness scale, items number 3, 8, 13, 18, and 23 are related to Integration scale, items number 4, 9, 14, 19, and 24 are related to Classroom Norms scale and items number 5, 10, 15, 20, and 25 are related to Material Environment scale.

The actual form of the Persian version of SLEI

تقريبا هميشه	غالبا	گاهي اوقات	به ندرت	تقريبا هرگز	
					1. دانشجويان در كلاس هاي آزمايشگاه شيمي به خوبي در قالب گروه به فعاليت مي پردازند.
					2. دانشجويان در كلاس هاي آزمايشگاهي اين فرصت را دارند تا در مورد علايق خود تحقيق كنند.
					3. فعاليت هاي كلاس هاي آزمايشگاهي هيچ ارتباطي با مباحث موجود در كلاس هاي شيمي ندارند.
					4. كلاس هاي آزمايشگاهي قوانين شفافي براي راهنمايي دانشجويان دارند.
					5. در زمان انجام آزمايشات، آزمايشگاه بسيار شلوغ است.
					6. در كلاس هاي آزمايشگاه شيمي دانشجويان فرصت ناچيزي براي شناخت يكديگر دارند.
					7. در كلاس هاي آزمايشگاه شيمي، از ما خواسته مي شود تا براي حل مساله داده شده، خودمان ازمايشات را طراحي كنيم.
					8. كارهاي انجام شده در كلاس هاي آزمايشگاه شيمي با موضوعاتي كه در كلاس تئوري شيمي مطالعه مي كنيم ارتباطي ندارند.
					9. كلاس هاي آزمايشگاه شيمي بيشتر غير رسمي بوده و قوانين خاصي در آنها حاكم نيست.
					10. تجهيزات و موادي كه دانشجويان براي انجام فعاليت هاي آزمايشگاهي نياز دارند، به راحتي موجود مي باشد.
					11. دانشجويان در كلاس هاي آزمايشگاه به يكديگر كمك مي كنند.
					12. در كلاس هاي آزمايشگاه شيمي، دانشجويان گوناگون داده هاي گوناگوني را براي حل يك مساله جمع آوري مي كنند.

					13.كلاس هاي تئوري شيمي با كلاس هاي آزمايشگاه شيمي ادغام مي شوند.
					14.از دانشجويان خواسته مي شود تا از قوانين خاصي پيروي كنند.
					15.آزمايشگاه ظاهر مناسب و آبرومندي ندارد.
					16.دانشجويان در كلاس هاي آزمايشگاه شيمي به خوبي همديگر را شناخته و با هم آشنا مي شوند.
					17.به دانشجويان اجازه داده مي شود تا فراتر از فعاليت هاي ازمايشگاهي معمول رفته و آزمايش هاي دلخواه خودشان را انجام دهند
					18.در طي فعاليت هاي آزمايشي از تئوري هاي گفته شده در كلاس شيمي استفاده مي كنيم.
					19.در كلاس هاي آزمايشگاه شيمي اصول ايمني خاصي حكم فرماست.
					20.تجهيزات آزمايشگاهي وضعيت نامناسبي دارند.
					21.دانشجويان در كلاس هاي آزمايشگاه شيمي مي توانند روي كمك يكديگر حساب كنند.
					22.در كلاس هاي آزمايشگاه شيمي، دانشجويان آزمايشات گوناگوني را انجام مي دهند.
					23.موضوعات بحث شده در كلاس هاس تئوري شيمي با موضوعات كار شده در كلاس هاي آزمايشگاه شيمي كاملا متفاوت هستند.
					24.در كلاس هاي آزمايشگاه شيمي قونين كمي وجود دارد كه دانشجويان موظف به پيروي از آنها هستند.
					25.آزمايشگاه شيمي شرايط فيزيكي مناسبي ندارد. فضاي گرفته اي داشته و تابستان ها گرم و زمستان ها بسيار سرد است.
					26.زماني زيادي طول مي كشد تا بتوان با كسي در كلاس هاي آزمايشگاه شيمي آشنا شد.
					27.در كلاس هاي آزمايشگاه شيمي اين استاد است كه در مورد بهترين راه انجام آزمايشات تصميم مي گيرد.
					28.كارهايي كه در كلاس هاي آزمايشگاه شيمي انجام مي دهيم به درك بهتر ما از تئوري هاي گفته شده در كلاس هاي تئوري شيمي كمك مي كند.
					29.قبل از شروع آزمايشات استاد نكات ايمني را براي دانشجويان توضيح مي دهد.
					30.آزمايشگاه شيمي محيط جذابي براي كار كردن و انجام فعاليت هاست.
					31.در كلاس هاي آزمايشگاه شيمي دانشجويان همكاري خوبي با يكديگر دارند.
					32.دانشجويان در مورد بهترين راه پيش بردن آزمايشات تصميم مي گيرند.
					33.كار در آزمايشگاه شيمي و بحث هاي گفته شده در كلاس تئوري شيمي هيچ ارتباطي با هم ندارند.
					34.كلاس هاي آزمايشگاه شيمي در مقايسه با كلا س هاي ديگر با قوانين شفاف تري كنترل و مديريت مي شوند.
					35.آزمايشگاه شيمي فضاي كافي براي كار فردي و يا گروهي را دارا مي باشد.

The preferred form of the Persian version of SLEI

تقريبا هميشه	غالبا	گاهي اوقات	به ندرت	تقريبا هرگز	
					1. دانشجويان در كلاس هاي آزمايشگاه شيمي مي بايست به خوبي در قالب گروه به فعاليت بپردازند.
					2. دانشجويان در كلاس هاي آزمايشگاهي مي بايست اين فرصت را داشته باشند تا در مورد علايق خود تحقيق كنند.
					3. فعاليت هاي كلاس هاي آزمايشگاهي مي بايست هيچ ارتباطي با مباحث موجود در كلاس هاي شيمي نداشته باشد.
					4. كلاس هاي آزمايشگاهي مي بايست قوانين شفافي براي راهنمايي دانشجويان داشته باشند.
					5. در زمان انجام آزمايشات، آزمايشگاه مي بايست شلوغ باشد.
					6. در كلاس هاي آزمايشگاه شيمي دانشجويان مي بايست فرصت ناچيزي براي شناخت يكديگر داشته باشند.
					7. در كلاس هاي آزمايشگاه شيمي، مي بايست از ما خواسته شود تا براي حل مساله داده شده، خودمان ازمايشات را طراحي كنيم.
					8. كارهاي انجام شده در كلاس هاي آزمايشگاه شيمي مي بايست با موضوعاتي كه در كلاس تئوري شيمي مطالعه مي كنيم ارتباطي نداشته باشند.
					9. كلاس هاي آزمايشگاه شيمي مي بايست بيشتر غير رسمي بوده و قوانين خاصي در آنها حاكم نباشد.
					10. تجهيزات و موادي كه دانشجويان براي انجام فعاليت هاي آزمايشگاهي نياز دارند، مي بايست به راحتي موجود باشد.
					11. دانشجويان در كلاس هاي آزمايشگاه مي بايست به يكديگر كمك مي كنند.
					12. در كلاس هاي آزمايشگاه شيمي، دانشجويان گوناگون مي بايست داده هاي گوناگوني را براي حل يك مساله جمع آوري كنند.
					13. كلاس هاي تئوري شيمي مي بايست با كلاس هاي آزمايشگاه شيمي ادغام شوند.
					14. مي بايست از دانشجويان خواسته مي شود تا از قوانين خاصي پيروي كنند.
					15. آزمايشگاه مي بايست ظاهر مناسب و آبرومندي داشته باشد.
					16. دانشجويان در كلاس هاي آزمايشگاه شيمي مي بايست به خوبي همديگر را شناخته و با هم آشنا شوند.
					17. مي بايست به دانشجويان اجازه داده مي شود تا فراتر از فعاليت هاي ازمايشگاهي معمول رفته و آزمايش هاي دلخواه خودشان را انجام دهند
					18. در طي فعاليت هاي آزمايشي مي بايست از تئوري هاي گفته شده در كلاس شيمي استفاده شود..
					19. در كلاس هاي آزمايشگاه شيمي مي بايست اصول ايمني خاصي حكم فرما باشد.
					20. تجهيزات آزمايشگاهي مي بايست وضعيت مناسبي داشته

باشند.					
21.دانشجويان در كلاس هاي آزمايشگاه شيمي مي بايست بتوانند روي كمك يكديگر حساب كنند.					
22.در كلاس هاي آزمايشگاه شيمي، دانشجويان مي بايست آزمايشات گوناگوني را انجام دهند.					
23.موضوعات بحث شده در كلاس هاس تئوري شيمي مي بايست با موضوعات كار شده در كلاس هاي آزمايشگاه شيمي كاملا متفاوت باشد. .					
24.در كلاس هاي آزمايشگاه شيمي مي بايست قوانين وجود داشته باشد كه دانشجويان موظف به پيروي از آنها باشند.					
25.آزمايشگاه شيمي مي بايست شرايط فيزيكي مناسبي داشته باشد. فضاي گرفته اي نداشته و تابستان ها گرم و زمستان ها بسيار سرد نباشد.					
26.مي بايست زماني زيادي طول نكشد تا بتوان با كسي در كلاس هاي آزمايشگاه شيمي آشنا شد.					
27.در كلاس هاي آزمايشگاه شيمي استاد مي بايست در مورد بهترين راه انجام آزمايشات تصميم بگيرد.					
28.كارهايي كه در كلاس هاي آزمايشگاه شيمي انجام مي دهيم مي بايست به درك بهتر ما از تئوري هاي گفته شده در كلاس هاي تئوري شيمي كمك كند.					
29.قبل از شروع آزمايشات استاد مي بايست نكات ايمني را براي دانشجويان توضيح دهد.					
30.آزمايشگاه شيمي مي بايست محيط جذابي براي كار كردن و انجام فعاليت باشد.					
31.در كلاس هاي آزمايشگاه شيمي دانشجويان مي بايست همكاري خوبي با يكديگر داشته باشند.					
32.دانشجويان مي بايست در مورد بهترين راه پيش بردن آزمايشات تصميم بگيرند.					
33.كار در آزمايشگاه شيمي و بحث هاي گفته شده در كلاس تئوري شيمي مي بايست هيچ ارتباطي با هم داشته باشند.					
34.كلاس هاي آزمايشگاه شيمي در مقايسه با كلا س هاي ديگر مي بايست با قوانين شفاف تري كنترل و مديريت شوند.					
35.آزمايشگاه شيمي مي بايست فضاي كافي براي كار فردي و يا گروهي را دارا باشد.					

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