

ECHEMTEST AS AN EXAMINATION, CONTROL AND TUNING TOOL IN CHEMISTRY EDUCATION

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Abstract

ECheMTest is a web based international test system for chemistry higher education elaborated by the European Chemistry Thematic Network Association. As the member of the association the tests are used at Loránd Eötvös University in Budapest since 2010. In this article we conclude the around 2500 tests written at the level of bachelor graduation between September 2010 and September 2016. The results and the effects of the tests are discussed on the assessment and control of graduating students, on the thematic and methodologic tuning on our BSc in chemistry program and on the possibility of using the tests as a remote entrance examination for applicants on MSc in Chemistry program.

Keywords: international test, chemistry higher education, web-based assessment, program tuning

1. Introduction

European Chemistry Thematic Network is probably the organisation provided the largest impact on chemistry and chemical engineering fields in the tuning of higher education system in Europe (Pinto, 2010). The history of the network is more than 20 years old. An association (ECTNA) was created already at the early stage to develop a sustainable platform and the association was founded by many European projects (ECTN 1-4, EC2E2N 1-2) to broaden the activity on all fields concerning chemical higher education. Different topics were elaborated in working groups, where voluntaries of the more than hundred member universities took part. Many projects were finished with reports and recommendations for the universities, some of them provided excellent trainings for university teachers, there are competitions on different chemistry related topics. Besides them, there are two main projects of ECTNA. One concerns an international accreditation system for chemical higher education, where EuroBachelor, EuroMaster and Chemistry Doctorate Eurolabel qualifications can be

obtained, if the applicant fulfils the standard elaborated by ECTNA (Mitchell 2004, Mitchell 2007). The standard concerns the competences to be obtained, the content of the program, the method of teaching, the assessment procedure and many details up to linguistic requirements. The other main project of ECTNA concerns a test system called EChemTest, where theoretical and classroom-calculation knowledge of chemistry students can be evaluated.

EChemTest was preceded by a project where the core chemistry was surveyed at different universities (Todesco 1998). Thereafter, international groups of experts elaborated several hundreds of test questions on different fields of chemistry at various levels (Mimero and Smith 1996). Levels 1 and 2 refer to pre-university or starting-university knowledge, level 3 refers to end of bachelor studies, while level 4 concerns master education. The most frequently used tests are General Chemistry 1 and 2 (GC1, GC2) and the bachelor ones as Analytical Chemistry (AC3), Inorganic Chemistry (IC3), Physical Chemistry (PC3), Organic Chemistry (OC3) and Biological Chemistry (BC3). The newest BSc level one is related to chemical engineering, while computational chemistry, conservation science and advanced level organic chemistry tests are available at the master level. The latest development is an everyday chemistry that has connection to secondary school teacher education. The initial group leaders are itemized in Ref. (Lagana 1996). The original questions were elaborated in English, but they were translated to many European languages. In some cases, only the demo question sets were translated.

The questions were sorted into easy/medium/advanced categories. The types of the questions span multiple choice questions with one best answer or true/false possibilities and numerical questions. In this report we would like to assess our user activity for level 3 tests in the period of 2010 to 2016, where the construction and the scoring of them are detailed in Table I. The details were fixed by the committees elaborating the question sets. The questions were randomly selected from the corresponding question set and the test takers had 60 minutes.

Table I. The construction and the scoring of the level 3 tests used at Eötvös University in 2010 to 2016

Type	difficulty	number/level	question score/level	total score
AC3	easy/medium/advanced	15/10/5	8/16/24	400
IC3	easy/medium/advanced	15/10/5	1/1/1	30
PC3	easy/medium	10/10	4/6	100
OC3	easy/medium/advanced	15/10/5	2/4/6	100
BC3	easy/medium/advanced	15/10/5	10	300

The data given in Table I are approximate values, they were not strictly used in all cases. The questions were randomly selected by applying other restrictions too, like the questions were sorted into topics and there were rules how to select from the topics. An example of the set-up of an analytical test can be found in the article of Karayannis and Efstathiou (Karayannis and Efstathiou 2011). There were changes during the years, the data in Table I show the last state before the test system was transferred to a new software platform. As users, we had no access to the question sets and the internal settings. Unfortunately, the changes in the operational staff caused some loss of information that cannot be accessed after the shutdown of the old platform. The numbers in Table I were figured out from the scoring documentation obtained after the sessions.

The database and the software is hosted on a server at University of Perugia. The Question Mark (Question Mark®) software was applied till autumn 2016. Recently, the questions have been transferred to the LibreEol open source software (Lagana 2016, Lagana 2018). Parallel to the platform change the previous horizontal organization of the “EChemTest testing centres” was changed to a system, where National Testing Centres are organized (NTC) and the further testing locations at the same country are called Accredited Test Centres. In the new system the English question sets are maintained at the main repository, the responsibility of the other language sets is transferred to the national testing centres. The reorganisation of the previous system was induced by the auto financing system introducing in ECTNA and by the definition of long time responsibilities instead of ad hoc voluntary work. The test schedules are announced by the testing centres and usually they can be written in computer rooms belonging to the universities of the given testing centres. Since communication to the server is managed via internet browsers both for testing centre administrators and test takers, there is a possibility to announce tests outside the testing centres, e.g., in secondary schools interested for GC1-GC2 tests.

The control over the EChemTest system is more fold. ECTN has a standing committee called Virtual Education Committee (VEC) led by Prof. Antonio Lagana. His group provided large efforts into the transfer of the questions to the new LibreEol platform. Even more an EChemTest+ training event was held in Perugia at October 2016 (Lagana 2018). The other organisation is the “Using EChemTest Working Group” of ECTN led by prof. Peter Gartner. The working group has its meetings at the annual ECTN general assembly. The representatives of the testing centres and the responsible persons for the question sets take part on this working group meetings, where both the efforts of the last years and the future of the test is discussed in detail (Gartner 2015-2016).

The use of EChemtest shows an increasing trend. The data to be shown here are discussed in working group meetings (Gartner 2015-2016). The early applications concerned general chemistry tests. It was applied in some cases to measure the difference of the student’s knowledge between at starting the university and after the first or second semester. A comprehensive study was performed by University

of Helsinki, Vienna Technical University and CPE Lyon. At some universities it becomes a regular procedure. In some cases, it is used to define the areas where bridging courses are necessary (Complutense University of Madrid). The newest statistical data are not included into this article (see e.g. Lagana 2018), since we focus on the QM era of the system

General chemistry tests are also taken at secondary schools. It was used in a widespread survey in Austria. They are also used in secondary school competitions organised by universities having test centres, e.g. in Greece and Poland. Subject specific tests are used at many countries connected to a given course. Such applications are regular at e.g. Vienna University of Technology and Complutense University of Madrid. The master level Cultural Heritage test is applied in Aristotle University of Thessaloniki.

The first official inclusion of EChemTest into a BSc programme was at Jagellonian University of Krakow. Here, taking of two level 3 tests are compulsory as a self-study module and honoured by 4 credits. The tests are in English to enhance the international communication. The minimum percentage is 30% to pass (Jagellonian University).

The second official step concerns our university in 2010, where we introduced level 3 tests as an optional possibility to release the BSc in Chemistry students from the written part of their final exam. The success of our pilot application initialized many universities. Especially some Italian universities are solid users of the tests sometimes as a voluntary/compulsory criterion to get the BSc degree (e.g. universities in Bari, Genua, Milan, Naples and Perugia).

Another application of EChemTest is to use it at entrance examination, especially for foreigner students. We introduced it in 2015 as a pilot project for 5 MSc applicants and used it successfully for 22 foreigner students in 2016. The idea is in pilot status at Vienna University of Technology, as well.

If we count the number of students involved in EChemTests, it is around 2 thousand per year. The activity of some other universities is counted in this number over the already cited ones, e.g. Utrecht University and University of Amsterdam.

EChemTest can be used not only as a European measurement tool for theoretical knowledge of students, but also as an indicator of missing fields from curricula. The tests were developed after the initial project on core chemistry and this knowledge is transferred to the selection of the questions. It means, the topics of the questions can be assigned as European standard knowledges, especially for the easy and medium questions. This view point was always present during the evaluation of the questions, it was included inherently by the international composition of the groups.

In this article we report our activity as user of EChemTest. The evaluated time is 2010-2016, because the new software introduced in autumn 2016 is not fully compatible to the old one. It means that the scores in the new system is slightly different, it would be dangerous to mix their statistical data. Even

more, one purpose of this report is to publish some results to use as standards for the tuning of the new platform. We repeat again, that the new activities of the EChemTest user, e.g. on year 2017, can be found in details on the VEC reports of A. Lagana

2. Test activity in Budapest

Institute of Chemistry uses EChemTest as a member of ECTNA since 2010. At the beginning the sessions were provided by the Test Centre in Lyon by prof. Pascal Mimero. From 2012 we are an official Test Centre and we organize our sessions using the EChemTest server in Perugia.

Our connection to EChemTest can be sorted into three activities. The main one focuses on level 3 tests as an optional possibility to release the BSc in Chemistry students from their written part of their final exam. The second one is how to use the topics and results of EChemTest in tuning our educational program. The third one is its use in entrance examination of international students. The most of this paper concerns the first task.

The BSc final exam contains the defence of the thesis, a written exam separately on four disciplines of chemistry and an oral exam on the discipline of the thesis at our university. It is not allowed to take the oral exam for students who obtained less than 40% average on the written part, or who obtained less than 20% at one discipline of the written exam. In 2010 we introduced a regulation, that a student can be released from a part of the written exam, if a minimum 40% percent EChemTest at level 3 has been obtained on that discipline in the last two years. The local and the EChemTest disciplines are paired as inorganic chemistry – IC3, analytical chemistry – AC3, physical chemistry – PC3 and organic chemistry – OC3+BC3 (both are necessary). The tests are written in English. 6 schedules are organized in an academic year. A student is allowed to write a test only in one discipline at a schedule. Unsuccessful tests can be repeated later, the number of the trials in one discipline is not controlled, but it is constrained automatically by the limited number of schedules and the two-years validity of the tests. If someone fails on the final exam, the EChemTests have to be repeated.

The EChemTest is popular among the students despite the English language. At the beginning around 1/4 of the students did not try the tests due linguistic problems. Nowadays only 1-2 students avoid it. Even students learnt another language in secondary school realizes that a chemist should communicate in English, because at many workplaces the documentation language is English even in Hungary, especially in pharmaceutical industry.

The content of the tests is slightly broader than the taught one in our basic courses, but it is still worthwhile to take these tests one by one than to write the local final exam on the four disciplines during one day. It is also promising in the case of EChemTest that failing the test has no consequences. The number of the tests respect the academic years are shown in Table II. The table

does not contain the tests, when from some reason (e.g. broken net, broken authentication, browser mismatches) the test was not performed correctly. Further increase in test numbers is unlikely, since the number of the students starting the BSc was reduced from 150 to 120 in academic year 2013-2014. There is a delay in its effect, because the most of the students, who even gets a degree, manages it in more than the official three years.

Table II. Number of EChemTests respect the academic years

academic year	number of tests	number over 40%	ratio over 40%	number of degrees	degrees×5/successful tests
(2009)-2010	85	40	0.47		
2010-2011	146	73	0.50		
2011-2012	139	78	0.56	36	0.43
2012-2013	288	137	0.48	34	0.81
2013-2014	462	285	0.62	64	0.89
2014-2015	615	371	0.60	74	1.00
2015-2016	548	329	0.60	71	0.93

The ratio of the successful tests converges to 0.6, where successful means more than 40% result. The number of graduates increased drastically in 2013-2014 caused by two effects. One was a revision of our curricula in 2010 (and later in 2013 again), where we allocated more time to the basic chemical knowledge and their practical acquirement. The other one is the popularization of EChemTest that drastically reduced the drop out cases at the written part of the final exam. The last column contains a fictive number, where the number of issued degrees multiplied with the maximal 5 tests is divided with the number of successful tests of the same year. In the reality, we never reached the case when all local tests are substituted with previously done EChemTests. Usually, around 80-90% of the local ones need not be written. The difference is according to the unsuccessful oral part of the final exams concerning around 5-8 students yearly and the expiration of EChemTest achievements.

The histogram of the scores in the last three academic years can be seen in Figure 1. The scores and the further statistical evaluation concerns only the range of September 2012 to May 2016, because we have all details only since we worked as a testing centre in Budapest.

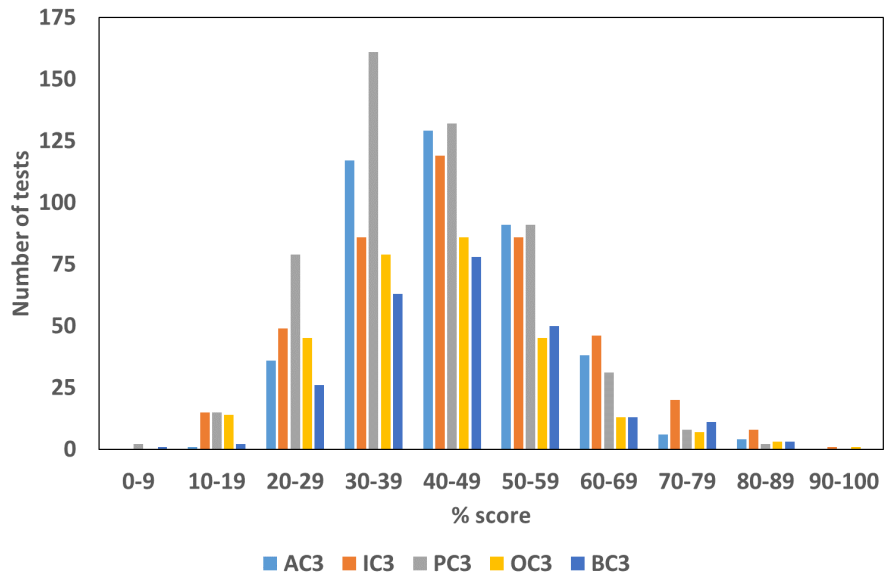


Fig. 1. Level-3 score histogram of EChemTests from September 2012 to May 2016

There are quite often debates on the distribution of marks or scores in education. The construction of a test and the inhomogeneity of the students may cause derivation from Gauss-distribution. To check it we calculated the quantile-quantile plot of the data supposing normal distribution (Figure 2). In this plot the deviation from a straight line indicates the non-normal distribution of the data. One can see, that for most of the tests the normality seems to be a good approximation. The two markers denote the 5 and 95 percentiles of the all data curve. It means, that the deviations of the normality affect only a small part of data mostly the so-called x-outliers. Generally, we can conclude that the test results are normally distributed despite the different scoring shown in Table I.

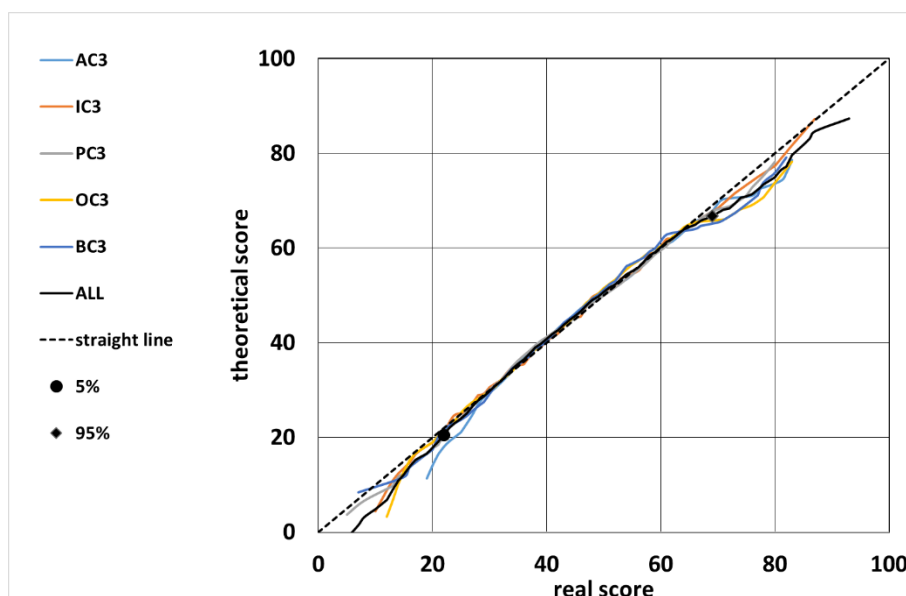


Fig. 2. Quantile-quantile plot to visualize the normality of test results

Since it is possible to repeat a test, many students perform trials to reach the 40%. The repetition of the test is necessary, if someone fails on the final exam. Tests are repeated very rarely to increase the scores over 40%. The histograms of the scores are shown for the best achievements of a student in Figure 3. The distributions are asymmetric with a step at 40%.

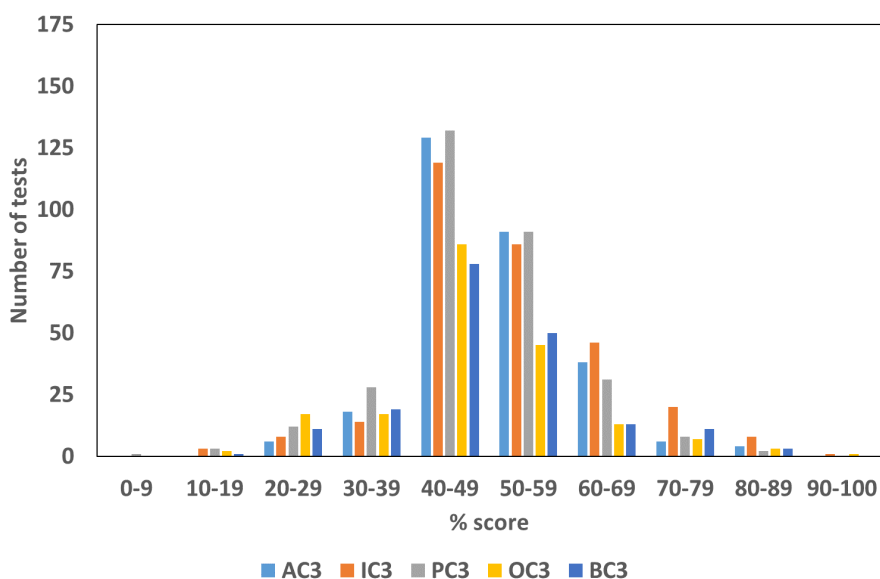


Fig. 3. Level-3 score histogram of EChemTests for the best individual tests from September 2012 to May 2016

Table III contains some statistical data respect the disciplines. The smaller number of BC3 and OC3 tests is due to the delay of the introduction of the BC3 final tests and the coupling of both tests to the local “organic chemistry” discipline. Usually the students leave this part at last. Students having a thesis work in organic chemistry often skip the BC3 and OC3 EChemTests, because they have to study organic chemistry for the oral exam. This way the local written exam on organic chemistry is not troublesome a few weeks earlier.

Table III. EChemTest data respect disciplines between September 2012 and May 2016. Data in parentheses refer to the best achievements of a student.

	AC3	IC3	PC3	OC3	BC3	all

No. of tests	422	430	521	293	247	1913
Mean %	45(50)	45(51)	41(48)	41(47)	44(48)	43(49)
Median %	44(49)	44(50)	40(47)	40(46)	43(47)	42(48)
% (40<=score)	64(92)	65(92)	51(86)	53(81)	63(83)	59(88)
% (50<=score)	33(48)	37(53)	25(43)	24(36)	31(41)	30(45)
No. of average trials	1.45	1.41	1.69	1.53	1.33	1.49

There are no significant differences between the mean score of the tests. The median and the mean of the tests are within one percent in all cases. On contrary, the best test of the students obtained in average 4-7 % more than the first trials. In the reality, the improvement is even better. 51-65% of the test were over 40%. There were no second trials for the cases, where the 40% was achieved in the first case. The number of the trials per student is shown in Figure 4. It can be seen, that 57-77% of the students tried only one time a test. It means, that the average improvement was obtained by around one third of the students corresponding to an estimated 12-21 % score increment during the trials. It means also, that the ratio of the more than 40% scores increased up to 81-92% shown in Table III. In the case of analytical and inorganic chemistry more than 90 % of the interested students were able to pass.

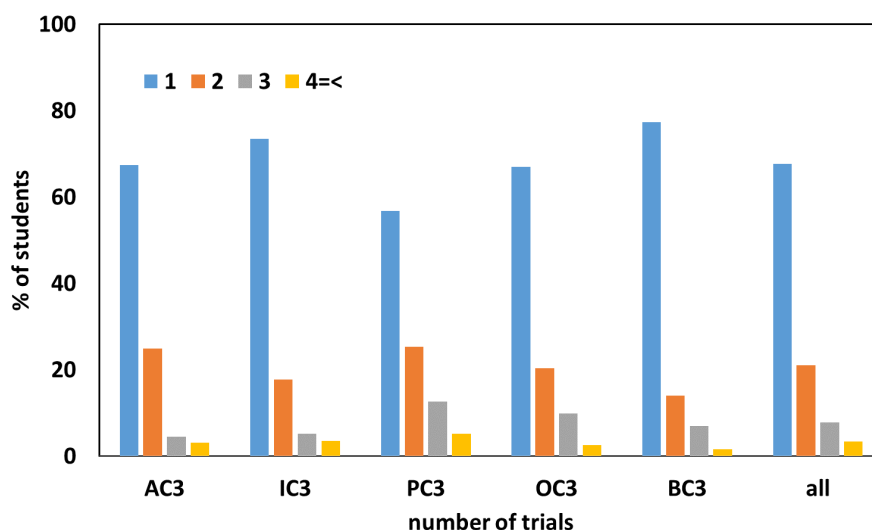


Fig. 4. Distribution of the number of trials/students from September 2012 to May 2016

The last row in Table III shows the number of average trials/student. The low number of BC3 is due to the lack of time, while the high number for PC3 is due to the wish of students to avoid the local

physical chemistry exam. These two cases can be seen in Figure 4 as well for BC3 and PC3. In the case of AC3 and IC3 the most of the students passed not later than in the second trial, while third and higher number of trials were necessary for many students interested in PC3. As a curiosity, we mention that the highest number of trials was 13 (in OC3). It belonged to a foreigner student who was able to absolve (collected the necessary credits), but was able to obtain the degree only a few years later. He waited with the oral exam as long as he passed all EChemTests. More than 3 cases were tried with regular students rarely.

The analytic and inorganic chemistry data are similar. The most of the students passed the 40% limit of these tests (92%). Around two third of the students managed it at first trial, while one third of the students repeated the tests mostly one time to improve their results. The average number of tests/student is 1.45 and 1.41. The final results are quite often over 50% (48% and 53%) from the students' best achievement. Especially in the case of inorganic chemistry it is consequence of our heavy courses on classical inorganic topics. The time evaluation of the tests (all and best ones) can be seen on Fig 5. The only one clearly visible trend is the improvement after academic year 2012-2013.

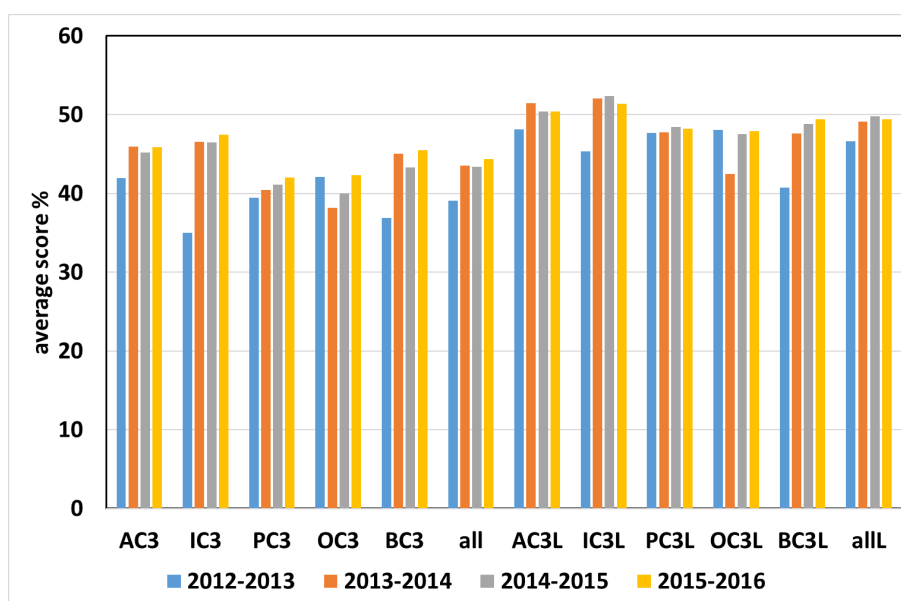


Fig. 5. Average scores/academic years. Left side of the graph refers to all trials, rights side refers to the last achievements of students (legend finishes L)

In the case of BC3 and OC3 tests, the requirement of necessary passing at both tests complicates the discussion. BC3 contains many topics. The classical chemistry of natural organic compounds is a strong part in our curricula, it helps to pass the test, but not with high scores. The biochemistry part is covered in our previous curricula in a semi-optional course, it is compulsory only from last year. The

BC3 test includes modern biosynthetic and bioanalytical methods, too. We have no core courses for these topics in our BSc in Chemistry program. The percentages of OC3 test cannot be discussed straightforwardly. Classical organic chemistry is a solid topic in our training, the structure of our training and the knowledge of the student might not cause the low percentages in the tables. The BC3 and the OC3 tests are tried to take usually in the last schedules before the final exam, when the students have no possibility to improve them. At the end of the year they are rather busy in preparing their thesis. Therefore, they quite often come to these two tests unpreparedly. The time evaluation of OC3 results differs from the other ones. It might be caused by a change in the difficulty of the test, when a new release was appeared. At the beginning the students thought OC3 as an easy one, later on they changed their mind.

The physical chemistry test is an outlier with the high number of repeated tests. The final percentage of passed students is good (86%), but the half of the students manage it at the second or quite often for the third trial (Figure 4.). This test differs from the viewpoint of our basic training, especially in thermodynamics. The test focuses on practical calculations, while our basic course is a theoretical one augmented with calculations to support the theoretical derivations.

3. Test topics to tune programme and enhance self study

Till 2005 we had integrated five-years chemistry program at the institute. In 2006 we divided it into first and second cycle parts according to the regulations. Despite knowing the book about the core chemistry in Europe (ref) we were not able to adopt it because of the structure of the institute, the previous training and the regulations. At the beginning our BSc should contain a two-years long common program of chemistry teachers and chemistry BSc. It caused a rather compressed program with less efforts to deepen the knowledge of the students in practical courses. The third year consisted of semi-optional advanced courses. In 2010 we changed our system to teach less information with more emphasis on deepening it by classroom practices and laboratory work. We put some emphasis during the organization of our courses in the BSc in Chemistry program to cover the most of the fields included in EChemTest. The topics of EChemtTest were used as an international standard concerning core chemistry knowledge. Some previously omitted topics of the EChemTests were included into the programme already in 2010, and even more were realized in the 2013 change of the programme. Courses became compulsory like Biochemistry, Polymer chemistry and Structure determination methods, class room calculation practices got compulsory status in basic science, in analytical chemistry and in physical chemistry. The lecturers were asked to teach more compulsory organometallic chemistry (at least on a descriptive basis), electroanalytics and chemometrics. As it can be seen in Table II, the number of degrees increased drastically without a decrease of the EChemTest performance. It means, the less but more deepened and practiced knowledge resulted a higher number

of graduates without destroying the final quality shown in EChemTest. The reasonable difference in the number of graduates shows, that a careful program can reduce the drop out ratio. The quality of the graduated BSc students is well proved by the student follow up data, 7/8 of our students are embarked on master studies (due to limitations half of them goes to other universities). The remaining 1/8 gets chemical employment mostly within 3 months (Tóth et al. 2016).

The other tuning aspect of EChemTest is the enforcement of self study. The self study was supported by the good information stream between the classes on topics in EChemtest and on the possible self-learning sources. The students recommend each other core chemistry books in English for EChemTest preparation. The self study was even more important in the linguistic field, where the English terminology is mostly comprised on the preparation on EChemTest.

4. Tests as entrance exam to MSc and PhD

The optional use of EChemTest to release the written part of the final exam in BSc in Chemistry remain our major activity in our test centre in the future. As a second application, we used EChemTest at the entrance exam on MSc in Chemistry and Chemistry PhD training for foreigner students. We started a pilot project in 2015, where 5 international applicants on our MSc in Chemistry program were ranked by level 3 tests. They might choose three of the 5 tests AC3, IC3, PC3, OC3 and BC3. They wrote the test at their universities under the control of a staff member of their home university. 4 applicants were able to find responsible staff members. The controllers were very helpful in the organisation of the test place and controlling the test writing. In one case, online control was applied via skype. In some cases, we used the demo version of the test to avoid leaking of test questions. We continued the project in 2016 when 14 MSc and 8 PhD applicants were tested from abroad. The most of the applicants were students from Asia and Africa interested in getting Stipendium Hungaricum scholarship (Tempus Public Foundation). The few ones are not counted here, who cancelled the application due to the existence of an entrance assessment.

The applicants on the Stipendium Hungaricum scholarship were preselected by the sender country. In the case of the MSc the most of them were at least intermediate level student in comparison to the Hungarian level. We had to refuse only one applicant respect to the significantly low average. In the case of the PhD grant many of the applicants finished their second cycle training earlier. Maybe it caused that we had to refuse the half of the applicants. The difference between the two types is shown in Figure 6. It is not mandatory for a PhD student to be good at all fields of chemistry but a basic knowledge can be expected on 2-3 fields. We mention here, that there were 3-4 cases, where the written exams were performed correctly, but the oral communication competencies in English at arriving to the university required 2-3 months improvement.

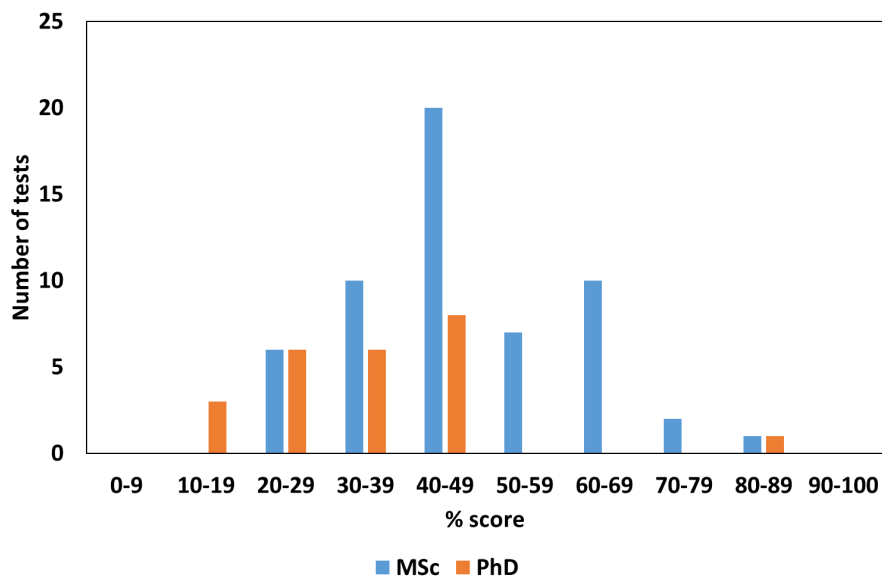


Figure 6. Score distribution of the test written by foreigners in application to MSc and PhD programs.

5. Conclusions

In this paper we summarized our activity connecting to EChemTest at Institute of Chemistry of Loránd Eötvös University. The most of the paper concerns the around 2.5 thousand level 3 test taken as an optional way for the written part of the final exam in our BSc in Chemistry program. As the attitude of the students proved, this optional way is preferred over the traditional written exam, where the knowledge on the 4 disciplines of chemistry are assessed during one day. Here it is possible to take them one by one in two years, in an informal style and without negative consequences of a failed test. The only restriction is the limited number of occasions per semester. Close to all students use this possibility despite the foreign language and the broader theme of EChemTest.

The introduction of the 40% limit to pass was rather random, but the results show that this is reliable. The most of the students are able to achieve it in the first or second trial, or in the case of disciplines where the basic courses are less solid or the local curricula differs from the EChemTest one, on the third trial. In the cases of analytical chemistry and inorganic chemistry 92% of the graduating students pass EChemTest finally, while it is between 80-90% for physical, organic and biological chemistry, where the curricula differ or the time is missing due to the schedule of the final exams.

The overall test results follow normal distribution. The score distribution of the best achievements of the students have a step at 40%, because the students like to work to fulfil a requirement but they are not interested in the extra and not honoured efforts.

The BSc in Chemistry program was tuned two times during the assessed period. Both changes were in order to reduce the theoretical amount of knowledge but to deepen its understanding by class-room and laboratory practices. The changes were in 2010 and 2013. The time evolution in Figure 5 shows, that this caused a slight improvement, as long as it can be foreseen, because the tests are mostly written in the third, or even more in the 4th years. We think, this concepts of “less is more” is one of the feasible answer on the new era of science, when not the access to the information is limited but its understanding. We think, that the solid basic knowledge is the way for understanding and not the superficial broad store of learning.

The topics of EChemTest were directly used in the 2010 and 2013 modifications of the BSc in Chemistry program. The list of courses, their credits and their theme were tuned to cover all important topics of the tests. We tried also to move the ratio of theoretical and practical related (labs, class-room calculations) parts. We have no direct evidence on the success of this tuning, but the students do not complain anymore on the test question that they are out of the fields touched by us.

The self-study aspect of EChemTest seems to be successful in the linguistic area. The most of the students speak English, but they do not learn the chemical terminology in English. Our BSc in Chemistry do not contain courses for that. Surprisingly, except one-two students in a year everybody gets familiar to the terminology at least on the passive level. At the beginning it was rather different.

The newest side of EChemTest in Budapest is its use in entrance exams for MSc in Chemistry in the case of foreigner students. The existence of the bureaucratic absurdity, that visa cannot be supplied for the entrance exam, it can be given only for the registered students of Hungarian universities forced us to perform entrance exam in the home country of the international (mostly Asian and African) applicants. The search for reliable university staff for controlling the tests there works in most of the cases. We introduced this filtering on the PhD school too, where about the half of the applicants have significantly less knowledge in chemistry as it is required in our university.

In the future we would like to continue our activity both on the optional taking out of the written part of the BSc final exam and on the use in MSc entrance exams. Of course, the further use of the test depends on the financial aspects, because self-supporting system of the test might be inevitable. We are hesitating to start the elaboration of the Hungarian test versions for general chemistry tests. We have a rather large set of translated questions in Hungarian partly managed by colleagues at other universities. The targeted age range concerns end of secondary school and first-year BSc students, where linguistic aspects are different. For the first-year BSc students we use a national ranking exam system in order to direct them on bridging courses if necessary.

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