THE EChemTest® PROSUMER ROADMAP TO THE MARKET

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1) A VIRTUAL COMMUNITY FOR EDUCATION SERVICES

The establishing of a European Chemistry Thematic Network (ECTN) [1] among Higher Education Institutions (HEI)s led to the design and development of a valid *de facto* European standard for harmonized Core Chemistry curricula and of appropriate e-test libraries of Questions and Answers (Q&A)s in General Chemistry (GC) 1 and 2**,** Analytical Chemistry (AC3)**,** Biological Chemistry (BC3)**,** Chemical Engineering (CE3), Inorganic Chemistry (IC3), Organic Chemistry (OC3)**,** Physical Chemistry (PC3)**,** Synthetic Chemistry (SC4) (also called Advanced Organic Chemistry AOC4)**,** Computational Chemistry (CC4) and Cultural Heritage (CH4) (also called Conservation Science (CS4)). To support related activities a non-profit making ECTN Association was also created and registered in Belgium to provide a sustainable future to ECTN initiatives (see http://ectn.eu/about-us/what-is-ectn/). For the same purpose two additional main lines of development were established:

- **telematic assessment services -** This activity was aimed at shifting the ECTN interest from a pure academic approach to a more service oriented one [2]. It led to the establishing within ECTN of the Virtual Education Community (VEC) committee aimed to foster the adoption of innovative networked open and distance digital technologies and the definition of standards for producing, collecting and making shareable the educational material produced by the teachers of the member institutions. A focus of such development was the support to telematic activities aimed to carry out Self Evaluation Sessions (SES)s and assess and certify chemical knowledge at various levels (from compulsory to professional education);

- **collaborative entrepreneurship –** The implementation of activities enabling the running of distributed SESs for both academic and individual purposes prompted the development of a specific collaborative model. To this end a network of Test Centres (TC)s run by ECTN HEIs members was created and a group of academic spinoffs and SMEs operating within them was gathered together to the end of acting as technological and commercial mediators between non profit University research-education initiatives and the innovation market (in other words a network of spinners of application oriented education and research University activities acting as providers of market innovative solutions). In particular, five SMEs did cluster into the DRAG consortium coordinated by Master-UP srl in order to operate in collaboration with the ECTN Association in bringing **EChemTest®** to the market.

2) EChemTest® AS A SERVICE WITHIN THE PROSUMER MODEL

In order to provide the EChemTest® service the LibreEOL software was adopted. LibreEOL was developed in Perugia within the project *DASP (Distance Assessment System for accreditation of competences and skills acquired trough in company Placements,* 1997-2000) in the context of the *Leonardo 2* European initiative [3,4]. The Q&As Libraries were ported from several sources into LibreEOL in 2016 and training events were later arranged. The training events were attended by the experts of the established Test Centres (TC)s who signed also either the ad hoc ECTN Memorandum of Understanding (MoU) or an Intellectual Property Agreement (IPA). Specific checks were performed on the validity of the adopted qualification scheme (see ref. [5]) and the outcomes of the run SESs were analysed in detail (see ref. [6]). Altogether, over 5000 SESs were run for Academic purposes (including admission, graduation, dissemination and European contests) during the biennium 2017-2018.

Typical distributions of the performances measured in Milano (MI) and Krakow (KR) for SESs of level 3 based on a set of 3000 Q&As sampled from Q&A subsets of different difficulty (as discussed in ref. [4]) are reported in ref. [5] in which the decision of the ECTN AC (Administrative Council) to adopt the following qualification scale of scores: ≥ 30 to < 50%, **pass**, ≥ 50 to < 70% **good** and ≥ 70% **excellent** is grounded.

Here we compare in Figure 1 the outcomes of the MI + KR OC3 SESs reported there with the overall outcome of the OC3 EChemTest® SESs run at the University of Perugia (PG) up to date. As clearly shown in the figure, the two results are within the statistical error identical.
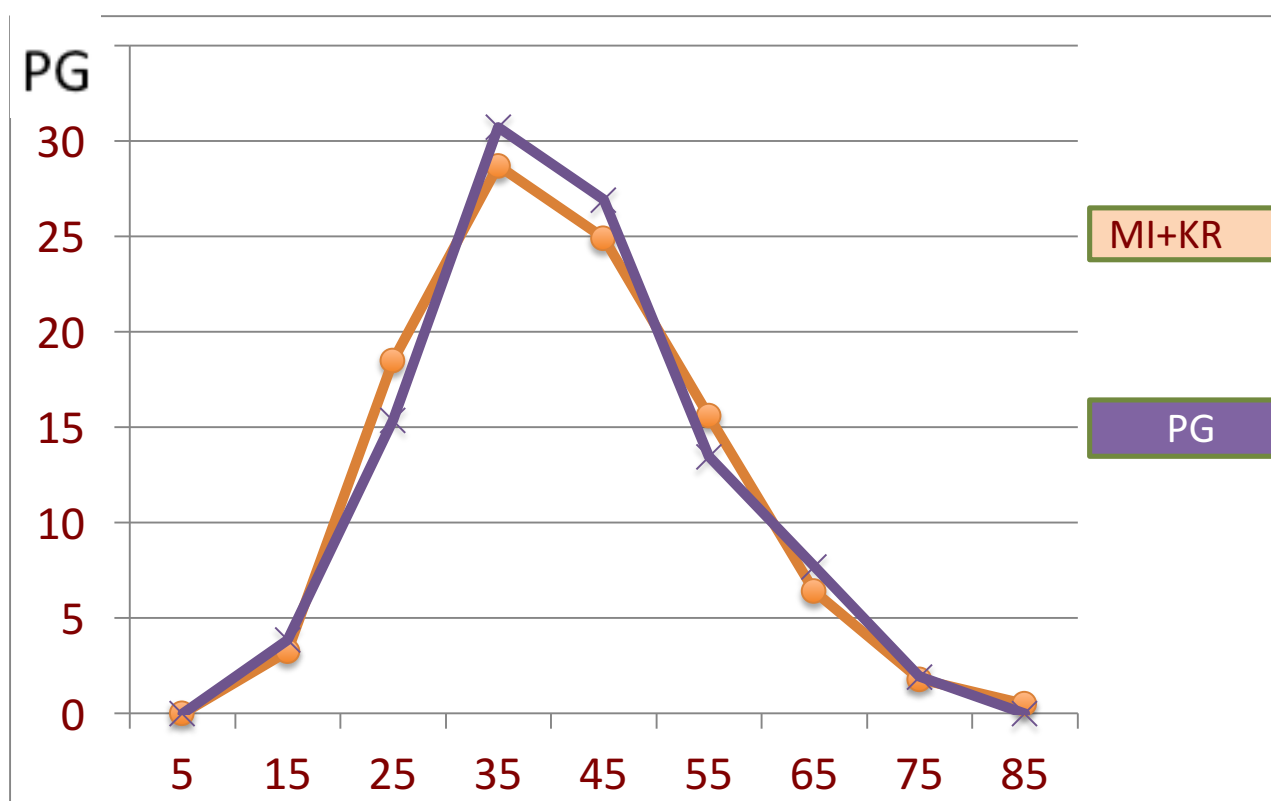

Fig. 1 – Comparison of the OC3 PG and MI+KR per cent scores.

A fundamental innovative organizational feature of EChemTest**®** is the adoption of the Prosumer model (the partner TCs are both users and providers of SESs services provided on a cloud platform [6]) characterized as follows:

- TCs play a strongly active role as academic services providers (e.g. SES management and Q&As development and maintenance) while being also the primary users;
- An unlimited number of TCs of the ECTN member institutions can be added to the existing ones provided that an ad hoc MoU is signed;
- Non academic services (like SESs provided to companies and associations or the issuing of Individual Proficiency Certificates (IPC)s) will be provided by Agencies (like the members of the already mentioned DRAG cluster once they sign the ad hoc agreement with ECTN) via a proper portal to sustain financially the various activities of the ECTN members (see ref. [7]);
- Creation and maintenance of Q&A Libraries, Learning objects, electronic publishing and multimedia tools is strongly encouraged in order to improve the EChemTest® related activities.

3) THE PRESENT ROUTINE USE OF EChemTest® BY THE TCs

The EChemTest® SES runs of the years 2017 and 2018 are almost equally divided in two even blocks. The first block is made by GC SESs while the second block is made of level 3 SESs (apart from 28 CS4 SESs). Per cent usage at different TCs for the year 2018 is given in Table 1. Typically GC SESs are suitably used for assessment and dissemination in Schools and for admission and anti-dispersion academic activities in HEIs. On the contrary level 3 SESs are used either as auxiliary assessment for the Bachelor (especially in their English versions) or for admission to Masters. In particular starting from the largest users (running more than 100 SESs) we have in alphabetical order:

BUDAPEST SESs are used mainly at level 3 including biological chemistry

GENOVA SESs are used as an anti-dispersion measure using a packet of 4 level 3 Libraries (AC3, IC3, OC3 and PC3) and the GC2 one. In particular students regularly passing the exams with an average evaluation of 25/30 can improve their overall Thesis mark of up to one point.

KRAKOW SESs are used half at dissemination GC1 and GC2 level in European contests and enhancement of chemistry image. Another strongly supported library is the "Chemistry for everyday Life" (CEL) that is not included in Table 1 and is used mainly for international students' contests.

MILANO level 3 SESs are largely used at Master admission level although a non negligible fraction of GC Q&As (around 10% of the total) is also used

VIENNA heavily runs Q&As of the GC2 library (no use at all is made of level 3 or 4) for students' admission.

For TCs running less than 100 SESs we have in alphabetical order the following use:

AMSTERDAM and **KAZAN** only level 2 Q&A Libraries for admission

PERUGIA only level 3 libraries for the admission to the thesis work

SIENA only GC2 and OC3 Libraries for anti-dispersion purposes

THESSALONIKI mainly a vocational use of level 4 (CS4) Q&A libraries is made together with an admission use of GC1 and GC2 ones.

In summary **EchemTest**® Q&A Libraries are either of basic nature (GC1 and GC2 at level 1 and 2, respectively, and CEL) or disciplinary (AC3, BC3, CE3, IC3, OC3 and PC3 at Bachelor level 3 and AOC4, CC4, CS4 at Master level 4) although of much lower general use.

GC1 and GC2 address mainly University assessment for access and anti-dispersion activities. At the basic level of Schools and general public (including Life Long Learning (LLL)) preferential use is made of the CEL and GC1 (mostly used by Krakow for ECTN dissemination and advertisement of Chemistry often coordinating other Higher Education Institutions) and GC2 (mostly used for by Vienna for assessment for University access) is made. An extended use of GC2 SESs for University access is made also by Kazan, Vienna, Amsterdam and Genoa. At anti-dispersion level the most used Library is GC2 (although its use is limited). Both GC1 and CG2 Libraries are designed also for certification with particular focus on European mobility (both among Schools and Universities and between Educational Institutions and Companies).

Elective use of Level 3 Libraries is made for assessing the access to Master studies. In this respect the leading Universities are in descending order (Milano, Budapest, Krakow and Genoa). To a large extent, therefore, the use of Level 3 Libraries is internal to the Institution to which the TC belongs. This is also the case of the only truly officially operated Level 4 Library CS4 (Thessaloniki) and, though experimentally, of the other Level 4 Library CC4 (Perugia) of the Theoretical Chemistry and Computational Modelling Erasmus+ Master.

4) THE EXPERIMENTAL USE OF EChemTest® PROFICIENCY CERTIFICATES BY TCs

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The experimental use of Individual Proficiency Certificates (IPCs))s has been activated only by Perugia and Milano. Such use, however, has turned out to be rather different. First of all the fraction of SESs leading to a purchase of IPCs in the year 2018 is 0.5% in Milano and 26% in Perugia. From our understanding, this is related to the fact that while in Perugia the **EchemTest**® SES is undertaken "on a voluntary basis" for the purpose of passing a check in the (preferred) discipline that the student has chosen to work on during his/her the Bachelor thesis studies (and is the main focus of the student work for the final period of the three year degree), in the case of Milano the students need to take the SESs compulsorily for the four main disciplines (AC3, IC3, OC3 and PC3) in order to be admitted to the Master selection colloquium. In other words, while in Perugia the added value of the IPC concerns next **mobility and job recruitment** activities, the only value of the Milano **EchemTest**® SES is internal (the admission to the Master) with the effort being spent on all the four main Q&A libraries of level 3 and has no other explicit added value. Data related to the SES undertaken during the year 2018 is given in Table 2.

TC/LIB	GC1	GC2	AC3	BC3	IC3	OC3	PC3	CS4
AMSTERDAM		100						
BUDAPEST			20	11	23	22	24	
GENOVA		21	21		15	22	21	
KAZAN		100						
KRAKOW	49	24	7		8	8	5	
MILANO	11	1	22		22	22	22	
PERUGIA			4		17	72	7	
SIENA		48				52		
THESSALONIKI	28	25						47
VIENNA		100						

TABLE 1: Per cent of SESs run by the different TCs in the year 2018 divided by type.

4) TOWARDS MARKET AND OPEN MOLECULAR SCIENCE CLOUD

The target of ECHEMTEST+ is to reach the break-even within the year 2021 by leveraging, during the next two years, the resources of the project special funds and revenue-generating activities. The project funds will be employed to fully implement the service production machinery by:

   4a) further implementing ECHEMTEST+ on LibreEOL 2.5 keur/year
   4b) holding the general workshop of TC coordinators (2019) 5 keur to analyze the
   4c) activate the procedures for Q&As libraries maintenance (2020) 5 keur
   4d) fully interfacing ECHEMTEST+ to the CHEM-LEARN PORTAL 2.3 keur/year

However, in order to achieve the break even a decisive boost will have to be given to paid services and, in particular, to IPCs. For this reason further efforts will be paid during the above mentioned 4a-4d activities to collect proposal from Test Centre and Library coordinators to make the **EChemTest®** procedures more efficient and the credit awarding mechanisms more appealing (e.g. see the proposals by G. Toth, http://services.chm.unipg.it/ojs/index.php/virtlcomm/article/view/192).

Particular emphasis will be given also by the VEC to the development of:
- auxiliary educational materials (e.g. learning objects, moocs, movies, etc.) for **EChemTest®** Q&As using innovative technologies enabling the in-house assembling of their multimedia versions and their shared storage in the GLOREP distributed repository;

- of electronic publishing (e.g. by renewing ECTN Newsletter publications, inserting extended versions of selected articles of the Newsletter in Virt&l-comm, composing collaborative e-notes and e-books) and Open Molecular Science cloud databases;
- joint EuChemS-ECTN efforts to further disseminate **EChemTest®** among EuChemS associated members (e.g. by the activation of further Agencies and TCs, joint presence at conferences and events);
- new coordinated statistical analyses, feedbacks collection, advertisement, development and dissemination of **EChemTest®** activities by extensively exploiting data associated with the use of LibreEOL

REFERENCES

1] The evolution of the present project leverages the input and financial support of various other sources like that of the European funding COST Actions D23 and D37, EGEE 3 and IGI.

2] A. Laganà, C. Manuali, N. Faginas Lago, O. Gervasi, S. Crocchianti, A. Riganelli, S. Schanze, "From Computer Assisted to Grid Empowered Teaching and Learning Activities in Higher Level Chemistry Education" in "Innovative Methods of Teaching and Learning Chemistry in Higher Education", I. Eilks and B. Byers Eds, Royal Society of Chemistry, 2009; ISBN 978-1-84755-958-6).

3] O. Gervasi, F. Giorgetti, A. Laganà, Distance Assessment System for Accreditation of Competencies and Skills Acquired Through in-Company Placements(DASP) "INET99: The Internet Global Summit", S.Jose, CA (USA), 1999; http://www.isoc.org/inet99/proceedings/posters/216/index.htm]

4] O. Gervasi, A. Lagana', EoL: a web based distance assessment system, Lecture Notes in Computer Science (ISSN:0302-9743) 3044, 854-862 (2004).

5] K. Szczeponek, A. Michalak, M. Ceotto, A. Laganà, The echemtest® proficiency certificate qualification levels (present Virt&l-comm issue)

6] A. Laganà, O. Gervasi, S. Tasso, D. Perri, F. Franciosa, Lecture notes comput science 10964, 533-548 (2018), DOI: 10.1007/978-3-319-95174-4_42; ISBN 978-3-319-95167-6

7] http://services.chm.unipg.it/ojs/index.php/virtlcomm/article/view/200