Soft skills in chemistry courses: where, when, and how to assess them?

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A recent evaluation of chemistry degrees at Uppsala University, Sweden indicated that soft skills are not routinely assessed even if the report advocates that they are taught as an integrant part of the courses syllabus. This opinion article looks into case examples, strategies, and methodologies to assess soft skills as an integrant part of course assessment. Purposively, assessment strategies in courses dedicated to soft skills teaching and training were avoided.

Keywords: soft skills, assessment, case studies

1. Introduction

Students need soft skills for hard times,[1] is the tittle of Ramachandran opinion column in *The Chemist*. Dr Ramachandran is the Director of Local Sections and career services leader for the Canadian Society for Chemistry, as well as manager of the chemical services at Syngenta Canada. In his column, Ramachandran remarks students' sense of despair, and wonder about their efforts and investment being valued in the real world upon completion of studies. Canadian universities, as most of the European and U.S. counterparts, emphasize their teaching around 'hard' skills even if soft skills training increase considerably students employability, especially in a the current economy landscape. Ramachandran defends that *to succeed in industry, one needs to translate his or her training to be an effective communicator, persuasive presenter, skillful negotiator and efficient problem solver*.

Kechagias defined soft skills or 'emotional intelligence' [2] in *Teaching and Assessing Soft Skills*[3] as intra- and inter-personal (socio-emotional) skills, essential for personal development, social participation, and workplace success (communication, ability to work on interdisciplinary teams, etc.). These skills should be distinguished from technical (cognitive) or hard skills. In this context soft skills relate to training in:

- Communication
- Critical thinking
- Creativity
- Collaboration
- Teamwork
- Entrepreneurship
- Teaching and fostering lifelong learning skills

In Greenberg and Nilssen white paper '*Putting into perspective the priorities and opportunities for teaching collaboration and other soft skills in education'* sponsored by Smart for Wainhouse Research, they survey 1,030 teachers, administrators, parents, and students in the UK (537) and North America (493).[4] When questioned about what should be the focus of education, namely should it be about building skills (creativity, communication, collaboration, and critical thinking) or on ensuring acquisition of knowledge (i.e., information, facts, and data), almost half (46%) of those surveyed believe that education should be an equal mix of skills and knowledge acquisition. 42% defended that building skills are the most important aspect of

education, contrasting with the percentage that believe on an education focused on building knowledge (12%).

Ross and Pagano suggested that soft skills are essential in the 'clockwork' of a Chemical Technology program because they serve as an intermediate/link mechanism that permits learning skills and technical content to work together.[5] Soft skills are greatly appreciated by industrials; leading to high rates of employability. In my opinion, these skills are equally necessary in students aiming for academic and research career, where for example results communication, teamwork, creative/critical thinking are part daily life.

This communication contains a short literature review on soft skills assessment in chemistry courses. The goal is to summarize methodologies to assess soft skills, which have been tested and yielded positive results. Purposely, suggestions and methodologies that are simply on the drawing board were avoided simply because they have not been tried and tested. The communication introduces questions that teachers face when preparing their hard skills courses containing also soft skills. This relates to the when and where soft skills should be introduced, since the why or the importance of such skills in the curriculum was aforementioned. The last part highlights two case studies on the how to assess soft skills in a hard skill subject in a fair and reliable manner.

2. Soft skills: Where? When? How?

It seems clearer that it is in everybody's interest to teach students soft skills. This raises the pertinent questions of WHERE, WHEN, and HOW soft skills should be taught. The WHERE relates to the context in which these 'soft' skills are taught. There are two alternatives, namely as individual courses in the degree or as integrant parts of the existent courses (Integrative Teaching Approach)[6]. The first option is the less preferred one because it does not contextualized or marriages soft with hard skills. Furthermore, separate courses on soft skills often face resistance from some students. A better approach is to integrate soft skills in the courses currently taught. This provides the needed contextualization and marriage between the different type of skills, while engaging students and teaching on the teaching and learning activity.

The next pertinent question is WHEN should soft skills teaching/training should be introduced, more specifically in which year. Since soft skills or emotional

intelligence require a certain emotional maturity of the student, one might think that consensual opinion would be to introduce these skills at a later stage. However, the most consensual opinion is that soft skills should be an integrant part of course syllabus right from the start, i.e., Year 1.

The question remaining is HOW. Quoting Tan and co-workers *it is common to hear teachers say that most students are motivated to learn only because the concepts taught in class are assessed. While there are exceptions, where highly motivated students are willing to learn anything 'out of the syllabus', these are few and far between.*[6b] Two clear aspects stand-out from the above quotation. First, soft skills should be part of courses syllabus, and second, that soft skills need to be assessed. Assessment seems to be the catalyst for students' motivation and engagement, which also provides concrete evidence that soft skills are being taught and learned. This is consistent with requirements set of a student–centered approach to curriculum design.

Starting by the aspect of introducing soft skills into the curriculum, several authors suggested that an industry-academia partnership is the way to go. An industrial perspective is required for a balanced and relevant soft skills introduction into the syllabus; however one cannot ignore the economical reasons behind industrial involvement. For example, seven industrial plant managers taking action and collaborating with the College of Mainland (Texas) developed a two-year Associate of Applied Science degree (AAS) in Process Technology. The degree was established in 1994, after both the college and the plant representatives developed the curriculum by serving on an advisory committee together. After three years, the company reported a remarkable 68% savings in basic training days.[7] Thus, while agreeable as it may be that industry perspective is needed, one should prevent conflict of interests, and that the process of introducing soft skills is hijacked by industrial requirements for employability because as aforementioned soft skills are equally important to students' aiming to establish an academic career.

3. Strategies to assess soft skills: examples

Assessing how well students master soft skills is a hard task, and somehow unnatural to hard science teachers. Most of natural sciences teachers are geared to grade mainly on quantitative problems, short answers to closed-ended questions, and multiple-choice. This is straightforward to grade since there is only a correct answer

as long as the questions are clear. This is significantly different when coming to grade soft skills since there are no unique 'correct answers', leading to subjective and inconsistent judgment calls, which can taint the final grade, and generate student resentment and complains. The challenge in assessing soft skills is to come up with reliable and fair grading criteria, which can be adequately instructed to the students, and use on its own to assess the targeted soft skills. This section suggests two alternative methodologies to assess soft skills. The case examples were picked on the basis of how one can assess soft skills fairly and reliably.

The first methodology is based on Felder and Brent two instruments for reliable and fair assessment of soft skills, namely *checklists* and *rubrics*.[8] A *grading checklist* consists of a form listing the instructor's grading criteria and the maximum points allocated to each criterion. The instructor assigns up to the maximum points for each criterion and totals the points to determine the final assignment grade.[9] A *grading rubric* lists the grading criteria, but in this case the instructor tallies each one on a discrete scale (e.g. 5-4-3-2-1 or 4-3-2-1), and gives brief descriptions of what each numerical rating represents. The overall product grade is determined as a weighted sum of the points given for each criterion, with each weight representing the relative importance of that criterion to the instructor.[10] Felder and Brent suggested that once checklist and/or rubric are done, grading students becomes not only more efficient but also deprived of subjective assessment and judgment calls. The marking itself is then very similar to what happen when assessing hard skills, namely by adding up the scores. The students also know clearly what are they being assessed on and what is the grading criteria.

The second methodology reported by Page on how a problem-based learning approach to chemistry module design helps students develop the skills they need for employment.[11] The Dearing Report[12] highlighted a lack of transferable (soft) skills in undergrad courses in the UK, leading to an almost immediate reaction from UK universities and colleges. For example the University of Reading created a module worth 10 credits in weight and delivered through the first two terms of Year 1. It consists of three major challenges, one loosely based in each area of organic, inorganic and physical chemistry. Interspersed within the challenges are taught sessions on the various routine academic skills first year undergraduates need to develop, such as using library resources and online search facilities, good practice in referencing, citations and avoiding plagiarism, summarizing and presenting

information, writing abstracts, delivering presentations, keeping a laboratory notebook and teamwork.

Summative assessment of the module is based on the various outputs (lab performance, oral presentations, reports, etc.). Since the module relies almost exclusively on teamwork there were some concerns, namely how to manage students who fail to contribute to the teamwork (freeloaders), and how to derive individual marks from teamwork. Teachers devised a formula to alleviate student fears. Firstly, teachers correct each of the team marks following peer assessment of team members. Secondly, they use an algorithm to assess the different contributions of each team member as positive, neutral or negative, which were subsequently converted to scaling factors allowing individual grading from the group mark. The final marks are compared with each student's contribution to module outputs. As with the case of Felder and Brent, the clear grading criteria gave students degree of confidence in the final marks and the process.

4. Personal reflection

Before writing this paper, I was rather confident and even hopeful in finding a large amount of published work on assessing soft skills. After doing my literature search, I realized that this was a naïve expectation, and there is still a lot to be done to suppress the void on soft skills assessment methods. From my search it is clear that everybody agrees that soft skills should be part of the curriculum as early as possible. Furthermore soft skils should be an integrant part of hard skills subjects. There are many studies on how to add these skills to the exiting subjects and even which skills can be introduced in specific courses. However, there is a significant void on soft skills fair and reliable assessment that can be added to students' records, and equally important does not cause students resistance and resentment. Recording that students possess soft skills and fair assessment are important because they can be the catalyst for students' engagement in acquiring such not only soft but also hard skills, making it a win-win situation.

Despite the lack of reports on how to assess soft skills, I managed to find two case studies that did it. They develop rather simple but effective methods/approach to assess students' soft skills devoid of subjective assessment and judgement calls. I think that this is the most important outcome. The biggest fear factor for hard skills

teachers in assessing soft skills relates to the task subjectivity. Therefore, the existence of tested methods reduces this pedagogical dilemma/problem. The compilation of such methods in a succinct and easy to follow format provides a clear added value to teachers facing the task of assessing soft skills.

5. Concluding remarks

In summary, soft skills are necessary for the development of all-rounders chemists to cope in the current fast moving economy both in academia and industry. Soft skills should be part of the curriculum syllabus of existing courses as soon as the students start their academic education and have to be assessed. Teachers should derive grading criteria that ensure reliable and fair assessment, which should be used on its own to assess students' soft skills knowledge.

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References

1. http://www.cheminst.ca/magazine/columns/students-need-soft-skills-hard-times
2. S. A. Schochler, '*Keller ISD: sorft skills assessment for secondary students'* program proposal, University of North Texas, Organizational Change and School Improvement, EDAD 5630 (2014).
3. K. Kechagias, *'Teaching and Assessing Soft Skills'* 1st Second Chance School of Thessaloniki, Neapolis (2011) www.mass-project.org.
4. A. L. Greenberg, A. H. Nielssen, '*Putting into perspective the priorities and opportunities for teaching collaboration and other soft skills in education'* WR Paper 'The role of education in building soft skills' (2014) Wainhouse Research
5. A. D. Ross, T. Pagano, '*Development of a curriculum to teach the 'soft skills' necessary for the future deaf and hard-of-hearing laboratory technician workforce'* Journal of Science Education for Students with Disabilities 13 (2009) 17-28.
6. a) K. S. Tan, C. Y. Heng, Z. Lin, S. H. Tan, *'Teaching school science within the cognitive and affective domains'.* Paper presented at the Global Chinese Conference

on Science Education, Hong Kong SAR, China (2010, December); b) K. S. Tan, C. Y. Heng, Z. Lin, S. H. Tan, 'Imparting Values through Science Lessons' SingTeach pp 7-8 (2011) National Institute of Education, Nanyang Technological University, Singapore.

7. J.H. Payne, C. Williams-Foster, *'Industry and Education: A Winning Combination'* Performance Improvement 36 (1997) 18-20.
8. R. M. Felder, R. Brent, '*Hard assessment of soft skills'*, Chemical Engineering Education 44 (2010) 63-64.
9. Checklist designed by Professor Lisa Bullard, North Carolina State University.
10. a) CATME (Comprehensive Assessment of Team Member Effectiveness), www.catme.org; b) H. Welch, D. Suri, E. Durant, '*Rubrics for Assessing Oral Communication in the Capstone Design Experience: Development, Application, Analysis, and Refinement*',International Journal of Engineering Education 25(2009) 952.
11. E Page, 'Thinking out of the box-skills for work' Education in Chemistry, July 2003, 22-25, www.rsc.org/eic
12. R. Dearing, '*Higher education in the learning society'*, London: National Committee of Inquiry into Higher Education, HMSO (1997).