Outcomes of the Chemistry Discipline Network Mapping Exercises: Are the Threshold Learning Outcomes met?

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Abstract

The Chemistry Discipline Network has recently completed two distinct mapping exercises. The first is a snapshot of chemistry taught at 12 institutions around Australia in 2011. There were many similarities but also important differences in the content taught and assessed at different institutions. There were also significant differences in delivery, particularly laboratory contact hours, as well as forms and weightings of assessment. The second mapping exercise mapped the chemistry degrees at three institutions to the Threshold Learning Outcomes for chemistry. Importantly, some of the TLOs were addressed by multiple units at all institutions, while others were not met, or were met at an introductory level only. The exercise also exposed some challenges in using the TLOs as currently written.

Introduction

Universities have traditionally been able to determine their own curricula and assessment, but recent changes to the tertiary regulation landscape in Australia require all institutions to show that they meet registration, course accreditation and qualification standards described in the Commonwealth's Higher Education Standards Framework (Threshold Standards) (2011). Although the term "learning outcomes" used in the Threshold Standards is not defined, it is likely that its interpretation will be guided by the Threshold Learning Outcomes (TLOs), developed through the Learning and Teaching Academic Standards project (LTAS) (Lim, 2013). In fact, in her keynote address introducing LTAS (Ewan, 2010), Ewan defined academic standards as

> *...learning outcomes described in terms of discipline specific knowledge, skills and capabilities expressed as threshold learning outcomes that a graduate of any given discipline (or program) must have achieved.* (p. 3)

Hay has written a thorough and very useful introduction to the history of LTAS and the TLOs, including the international and Australian regulatory context in which they were developed (Hay, 2012). He explains the extensive process of consultation that was used in order to achieve acceptance of the TLOs in each discipline. As Hay states,

> *...because the specific regulatory processes associated with TEQSA have not yet been finalized, discipline communities are able to focus on the representativeness and integrity of standards themselves and on their prospective role in quality improvement (as opposed to quality assurance). There is real value in being able to focus attention*

> *on student learning outcomes, and not simply to anticipate ways of massaging and managing standards for a specific regulatory agenda...* (p. 494)

He also asks the pertinent questions,

> *...exactly how is this small number of very carefully worded and comprehensive yet fairly 'slippery' TLOs going to be applied in ways that yield useful, consistent results? Second, and at least as importantly, how are Standards to be assessed.* (p.495)

This project constitutes an attempt to begin to answer the former question for chemistry, for which TLOs were elaborated by the chemistry community during 2011 (Buntine, Price, Separovic, Brown & Thwaites, 2011). These were based on the TLOs for science articulated by LTAS (Jones, Yates & Kelder, 2011). The chemistry TLOs were reordered in October 2012 to match the order of the science TLOs, and their current statement is as follows:

Upon completion of a bachelor degree with a major in chemistry, graduates will be able to:

Understanding the culture of chemistry
1. Understand ways of scientific thinking by:
1.1 recognising the creative endeavour involved in acquiring knowledge, and the testable and contestable nature of the principles of chemistry
1.2 recognising that chemistry plays an essential role in society and underpins many industrial, technological and medical advances
1.3 understanding and being able to articulate aspects of the place and importance of chemistry in the local and global community

Scientific knowledge
2. Exhibit depth and breadth of chemistry knowledge by:
2.1 demonstrating a knowledge of, and applying the principles and concepts of chemistry
2.2 recognising that chemistry is a broad discipline that impacts on, and is influenced by, other scientific fields

Inquiry, problem solving and critical thinking
3. Investigate and solve qualitative and quantitative problems in the chemical sciences, both individually and in teams, by:
3.1 synthesising and evaluating information from a range of sources, including traditional and emerging information technologies and methods
3.2 formulating hypotheses, proposals and predictions and designing and undertaking experiments in a safe and responsible manner
3.3 applying recognised methods and appropriate practical techniques and tools, and being able to adapt these techniques when necessary
3.4 collecting, recording and interpreting data and incorporating qualitative and quantitative evidence into scientifically defensible arguments

Communication
4. Communicate chemical knowledge by:
4.1 presenting information, articulating arguments and conclusions, in a variety of modes, to diverse audiences, and for a range of purposes
4.2 appropriately documenting the essential details of procedures undertaken, key observations, results and conclusions

<u>Personal and social responsibility</u>
5. Take personal, professional and social responsibility by:
5.1 demonstrating a capacity for self-directed learning
5.2 demonstrating a capacity for working responsibly and safely
5.3 recognising the relevant and required ethical conduct and behaviour within which chemistry is practised

While there is increasing interest in the use of learning outcomes (sometimes called learning objectives) in unit and degree design both in Australia (Hay, 2012; Jolly & Humphries, 2003; Kist & Brodie, 2011) and worldwide (Ellington, 1999; Elmgren, Åkesson, Ho, Schmid, Parchmann, Apotheker, Mimero, Namli, Reiners & Towns, 2013; Maher, 2004), little has been published on their retrospective use. Two reports that have appeared cover generic skills in a medicine degree in the UK (Robley, Whittle & Murdoch-Eaton, 2006) and a business degree in the US (Amin & Amin, 2003). In the field of chemistry, the approaches of several institutions in the US to applying in-house learning objectives have recently been described and compared (Towns, 2010). The TLOs for chemistry apply nationally in Australia and thus facilitate comparisons between institutions. However, as Towns (2010) explains, buy-in from academics is important to achieve engagement, and if multiple institutions are to be involved, a community or network of interested academics offers a starting point.

The Chemistry Discipline Network was formed in 2011 (Mitchell Crow, O'Brien & Schultz, 2012), with the major goals of improving tertiary chemistry teaching through better communication between chemistry academics around Australia, and working towards implementing the TLOs for chemistry. Prior to starting work on implementing the TLOs, it was of interest to determine two aspects of current chemistry teaching in Australia:

- what chemistry content is currently being taught, how is it being taught, and how is it being assessed? How similar are the degrees offered at different institutions?
- do the current undergraduate degrees in chemistry achieve the TLOs for chemistry, and if not, which are not met?

The Network has attempted to answer both of these questions by performing two separate mapping exercises on 2011 curricula. The first, termed the snapshot mapping exercise, was completed by 12 institutions and provides a snapshot of content, delivery and assessment of all chemistry units including service teaching of chemistry. The second mapping exercise, the TLO mapping, involved six institutions at the first year level and three across the whole degree, and attempted to answer the second question above. The outcomes of the TLO mapping provide a starting point for revision of content and assessment in order to ensure that all TLOs are addressed across the degree. They are also relevant to institutions not involved in the map, and to other disciplines, because they show which generic TLOs are more difficult to meet. In this report we detail the processes followed, the results of the two mapping exercises and challenges that were faced.

Methodology

Snapshot mapping exercise

The first part of this process was to determine what questions to ask in order to capture a snapshot of the chemistry being taught at universities in Australia in 2011. This stage of the process was partly inspired by the Australian Universities Teaching Committee Report on Biotechnology (Gray, Barnard, Franco, Rifkin, Hine & Young, 2003). In order to determine the amount of emphasis given to the subdisciplines of chemistry, the five categories used by the American Chemical Society (ACS) were initially proposed: organic, inorganic, physical, analytical and biochemistry. In the pilot study, the responses indicated that it was difficult to perform a breakdown into these traditional five subdisciplines for first year chemistry, and so the additional heading "general chemistry" was added. Different respondents may have interpreted "general chemistry" differently, leading to variation in reporting subdisciplines at first year. General chemistry was not used to categorise any teaching beyond first year. In addition to subdiscipline breakdown, delivery, including the numbers of contact hours in different modes, and both the type and weighting of assessment were of interest.

The data were collected in a spreadsheet. As the spreadsheet was being prepared, questions arose that led to further headings being added (such as internal or distance delivery) and some of the headings being more carefully defined (such as on-line assessment to include wikis). The clarifications that were required after initial piloting of the spreadsheet give some indication of the diversity of the chemistry degrees around Australia.

In some cases, judgment was required to determine whether a particular teaching or assessment strategy fitted into the categories chosen. For example, it was decided that optional tutorials without a paid tutor (staff or student) would not be included in contact hours because the number of students attending was likely to be low. These may nonetheless be an important facet of the teaching strategy. Peer Assisted Study Sessions (PASS) (Kelly, 1992) were included because the peer tutors are paid for running these tutorials.

The column headings that were used in the final spreadsheet were:

- Title, brief content description, assigned textbooks, prerequisite requirements;
- Breakdown: percentage of content in the categories of organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry, biochemistry and general chemistry;
- Delivery: lecture, tutorial, field trip and practical contact hours; internal or external students; use of clickers;
- Assessment: percentage of assessment allocated to examinations, practical reports, assignments and presentations; form of practical report; percentage of total assessment conducted in groups, by multiple choice examinations and on-line;
- Approximate number of students, teaching staff.

At 11 institutions, a Network member completed the spreadsheet, while in one case the Project Officer did this using publicly available unit materials from the university website. In almost every case internal consultation and discussion at the institution was required to complete the spreadsheet because few academics are intimately familiar with all aspects of delivery and assessment for all chemistry units offered at their institution, and this information is not usually all publicly available. The spreadsheet was subsequently interrogated for different comparisons of interest and a brief report was released on the Network website (Mitchell Crow & Schultz, 2012).

It became apparent in the early stages of the mapping process that this exercise was an instantaneous snapshot, because many institutions were undergoing curriculum review and reform at the time. For this reason we plan to repeat the exercise in 2014. The changes that occur between 2011 and 2014 will be interesting to examine.

TLO mapping

The current degrees were mapped against the Chemistry TLOs based on stated learning outcomes as well as examination of internal documents including unit outlines and degree descriptions, examination scripts, laboratory manuals, workshops and assignments. Examples of student work were not included in the process. As with the snapshot mapping exercise above, several of the degree programmes were being restructured so the results apply to 2011. Importantly, most institutions have compulsory units for BSc students that are not chemistry units, especially in the first year, which may address some TLOs. These units were included in the TLO mapping exercise (although not in the snapshot mapping described above). The other units that complete the degree programme, which were neither chemistry nor compulsory for the BSc degree (including minors and electives) were not mapped.

The mapping process was carried out in two steps, initially covering first year units. It is important to realise that the TLOs apply to the whole degree, so it was not expected that many TLOs would be addressed, assessed and achieved at first year. Six institutions provided materials from their first year chemistry and compulsory BSc units for evaluation of their ability to meet the TLOs, while three institutions participated for their whole undergraduate chemistry degrees.

Ewan (2010) stated as the first principle of LTAS that academic standards should be expressed as assessable learning outcomes. Thus, in this mapping exercise, a TLO was only considered to be achieved if it was *taught and explicitly assessed*. The mapping process consisted of reading through all materials associated with a particular unit, and using them to decide which of the TLOs were achieved in the unit by comparing assessment items with the wording of the TLOs. The level of achievement of the TLO was initially classified to be either at an introductory or graduate level, but in the final report this distinction was too difficult to retain because the decision would depend in part on how assessment items were marked.

Judgement and interpretation was required to determine whether, for example, a laboratory exercise together with examination questions covering the role of analytical chemistry in quality assurance and in environmental sampling led to achievement of TLOs *1.2 recognising that chemistry plays an essential role in society and underpins many industrial, technological and medical advances* and *1.3 understanding and being able to articulate aspects of the place and importance of chemistry in the local and global community.* The TLOs were met by different institutions in different ways, depending on their subdisciplinary and cross-disciplinary emphases.

One challenge to the methodology was that in several cases the TLOs are worded as two part outcomes, such as *3.2 formulating hypotheses, proposals and predictions and designing and undertaking experiments in a safe and responsible manner*, or *3.3 applying recognised methods and appropriate practical techniques and tools, and being able to adapt these techniques when necessary.* This is discussed further below because it became a result of the study.

The process was imperfect because different institutions have different ways of describing their units, and equivalent documents were not available for every unit at every institution. For the different TLOs, in some cases it was easy and in others, more difficult to determine whether they were achieved in a unit without examples of marked student work. However, the whole process provides a valuable starting point for an evaluation of whether the chemistry degrees enabled students to demonstrate achievement of all of the TLOs.

Results and Discussion

Snapshot mapping exercise

1. Content

Nine of the 12 institutions split enrolment in first year chemistry on the basis of student background; that is, whether students had completed chemistry in high school. An introductory unit offered to students without high school chemistry was in some cases recommended and in others, compulsory for students without any previous chemistry.

The snapshot exercise revealed some significant differences in emphasis of the chemistry degree programmes, particularly at the third year. The content and level at first year was deduced to be similar, because the same four textbooks are used at all 12 institutions and these are similar. Where detail on the content was provided, the similarity of first year chemistry units was confirmed.

Table 1 presents the breakdown of content over the three-year degree into the subdisciplines of chemistry. Not all institutions provided a breakdown for all years and at some, the third year units were all elective.

Table 1: Breakdown of unit content into chemistry subdisciplines by year of degree[a,b]

		% Organic	% Inorganic	% Physical	% Analytical	% Biochem	general chemistry
first year (11)	mean	27	13	36	5	1	19
	range	8-35	0-29	25-50	0-25	0-7.5	0-42
second year (11)	mean	26	19	22	27	1.5	
	range	20-37	13-25	0-38	7-44	0-15	
third year (6)	mean	34	25	23	18	0	
	range	25-70	20-33	0-33	0-25	0	

[a] The number in parentheses in the first column is the number of institutions included in the data.
[b] A year consists of two semesters of teaching.

The first year units were typically very large (from 200 - 1300 students) and included a significant proportion (between 50 - 90%) of service teaching into other degrees based on the numbers continuing into second and third year. In the second year of the degree, the breakdown between subdisciplines was more even; note that only one institution had biochemistry at all in the major. In the third year of the degree, students often had a greater choice over the breakdown of subdisciplines that they study, with some universities offering only a selection of elective units at third year. Of the six universities that did include core units in the third year of a chemistry major, the breakdown is shown. Seven of the institutions had a research project in the final semester, and the subdiscipline emphasis of this project depended on the supervisor and project chosen.

Across the three years, it can be seen that the core units in Australian chemistry degrees were weighted to organic and physical chemistry. Analytical and inorganic chemistry were given less emphasis. Biochemistry was not included in a typical Australian chemistry major. It was taught at seven of the institutions to third level as a minor or elective. Environmental chemistry was taught at nine of the institutions (in combination with atmospheric, aquatic and/or analytical chemistry), but only three taught sustainable chemistry or green chemistry specifically. These units were not in the major but were elective, third year units.

Minors and elective units that could be included in a chemistry degree varied according to the subdiscipline emphasis of the institution, and included nanotechnology or nanoscience, forensic science, industrial chemistry, bioinformatics, medicinal chemistry, materials chemistry and food chemistry. It can be seen from this list that physical and analytical chemistry were likely to be given more emphasis in these minors.

2. Delivery

Great variation in face-to-face activity was found between the institutions mapped. For chemistry units that were part of the chemistry major at each institution, the breakdown of contact hours is shown in Table 2.

Table 2: Mean and range of contact hours according to type by year of degree[a,b]

		total lecture hours	total tutorial/ workshop/PASS hours	total practical hours	total contact hours
first year (12)	mean	76	25	42	143
	range	72-91	0-52	30-60	112-178
second year (8)	mean	99	27	116	242
	range	78-143	0-49	63-192	154-336
third year (8)	mean	100	21	145	267
	range	36-144	0-57	72-276	122-360

[a] The number in parentheses in the first column is the number of institutions included in the data.
[b] The numbers of hours for the two semesters have been added to give the total contact hours per year.

Although the numbers of lecture and practical hours were quite similar between institutions in first year, variation in the total contact hours arose because of the lack of tutorials at one institution. In second and third year, there was even more variation, with one institution having more than double the total contact hours of another.

In the context of practical hours, it should be noted that the previous Royal Australian Chemical Institute (RACI) accreditation process required a minimum of 50 practical hours at first year, 100 hours at second year and 200 hours at third year. Less than half of the institutions satisfied this with units in the chemistry major only. The RACI is moving to an outcomes-based accreditation process, so the numerical values will no longer be as important from 2013.

Unlike the chemistry degree structure at many universities in the United States, most Australian institutions include both theory and practical in every unit, with the exception of research projects and distance education (where lectures are replaced with recordings, and practicals are conducted as a residential block). In this mapping exercise, two institutions had practical-only units along with units without any practicals at second and third year.

Student response systems (clickers) were used at four of the institutions, but even at institutions where they were available, not all chemistry academic staff used them. They were not used beyond first year at any institution. Eight of the 12 institutions offered some form of tutorial assistance after first year. Only two institutions dealt with significant numbers of students in distance education. Field trips were offered by three of institutions at some point in the degree programme, but only as part of elective units rather than core components of the major. This seems a low proportion, given the importance of chemical industries in Australia.

3. Assessment

In order to obtain an overview of the assessment strategies used by different institutions, the mean percentage weighting of each form of assessment in chemistry units was first calculated at each institution. This was to remove inconsistencies that would otherwise result due to the practical-only and theory-only units that are offered at some institutions. The means and ranges of the institutional means thereby obtained are shown in Table 3. Note that within each institution the ranges are much broader, including units with 100% practical assessment and others with 80% weighting on the final examination.

Table 3: Breakdown of mean unit assessment for all chemistry units at 12 institutions

	practical	assignment/ workshop /tutorial	mid semester exam(s)	presentations (poster/oral/vlog)	final exam
mean	28%	16%	4%	2%	50%
range	21-34%	2-41%	0-10%	0-5%	33-70%

Practical assessment was quite consistent across the institutions and is discussed further below, but there was great variation in the weighting of the final examination. Presentations were only used by one institution as part of the assessment in the chemistry major. However, another four did assess a presentation in a minor unit. Team or group work was used as part of the assessment in four institutions within the chemistry major, and at another two institutions in elective chemistry units. Group work constituted 45% of the assessment of one unit, although it was usually far less. Thus, a high percentage of assessment was through examinations, and a low percentage involved group work or presentations (none at most institutions in this study). This is reflected in the results of the TLO mapping (below).

In the first year, assessment by multiple choice (MC) made up a mean of 31% of the total assessment for chemistry units. The range for MC was 10-49% and it was used at every institution. In second year and third year, only five institutions used any MC assessment for any units, with 15% as the maximum in second year and 7% in third year. On-line assessment was used by all of the institutions in the first year, for up to 50% of the total assessment. This total is likely to grow, particularly for large, first year classes. Three institutions used it in later years of the degree.

TLO mapping

For first year, six institutions participated and an initial report was released on the Network website (Mitchell Crow & Yates, 2012). The results of the TLO mapping process for the full chemistry degrees at three institutions are summarised in Table 4.

It can be seen that the four TLOs *2.1*, *3.4*, *4.1* and *5.2* are addressed by more than 5 units at all institutions mapped in this project, and are the only TLOs achieved by more than 5 units. The TLO *2.1* could loosely be called the content TLO, while *3.4*, *4.1* and *5.2* are related to laboratory work - collecting data, documenting procedures and working safely. There are also several obvious gaps in the TLOs. In particular, institution 3 does not address any part of TLO 1 (*understanding the culture of chemistry*), nor *2.2* in any compulsory unit in the chemistry degree. Institution 1 achieves all TLOs except *2.2*, and institution 2 addresses all except *5.3*. In a related study performed at Purdue University (Towns, 2010), the outcomes "identify and handle hazardous materials" (similar to *5.2*), "design experiments that allow hypotheses" (similar to *3.2*), "scientific process" (similar to *1.1*) and "ethics of science" (similar to *5.3*) were recommended to be addressed (because they were lacking) among a list of 17 outcomes in eight first and second year chemistry units. Interestingly, in a study of 21 generic learning outcomes at a medical school (Robley et al., 2006), the learning outcomes "Recognize limitations of research" (similar to *1.1*) and "Demonstrate awareness of ethical aspects" (similar to *5.3*) were the most problematic, with the former not delivered and the latter, not learned. The overlap of these international studies with the outcomes of this project, particularly for TLOs *1.1* and *5.3*, indicate that these TLOs may require extra effort to be properly addressed.

Table 4: Results of TLO mapping for chemistry degrees at three institutions

	Institution 1	Institution 2	Institution 3
1.1 creative endeavour and testable nature[a]	2 - 3 units	2 - 3 units	not achieved
1.2 role in society underpinning technology[b]	2 - 3 units	2 - 3 units	not achieved
1.3 articulate importance locally and globally[b]	4 - 5 units	1 unit	not achieved
2.1 know and apply principles and concepts	> 5 units	> 5 units	> 5 units
2.2 broad discipline impacts other fields[b]	not achieved	2 - 3 units	not achieved
3.1 synthesising and evaluating information	4 - 5 units	2 - 3 units	1 unit
3.2 formulating hypotheses and designing experiments[a]	2 - 3 units	2 - 3 units	4 - 5 units
3.3 applying recognised methods and adapting techniques[c]	1 unit	2 - 3 units	4 - 5 units
3.4 collecting data and incorporating evidence in arguing	> 5 units	> 5 units	> 5 units
4.1 documenting procedures and observations	> 5 units	> 5 units	> 5 units
4.2 presenting information	2 - 3 units	1 unit	1 unit
5.1 self-directed learning	1 unit	2 - 3 units	1 unit
5.2 safe and responsible work	> 5 units	> 5 units	> 5 units
5.3 ethical conduct	1 unit	not achieved	1 unit

Key: Number of units in the chemistry degree achieving the TLO

> 5 units	(darkest shading)
4 - 5 units	(dark grey)
2 - 3 units	(medium grey)
1 unit	(light grey)
not achieved	(white)

[a] Many units assess the second part of this TLO, but fewer assess the first part.
[b] Many units teach parts of this TLO and several units assess certain aspects of it, but fewer units assess this TLO in a broad sense.
[c] Many units assess the first part of this TLO, but fewer assess the second part.

As already mentioned, several TLOs are expressed with two quite distinct parts. In this project we found that for many units, only one of the two parts was covered in some units. For example, the second part of *3.2 undertaking experiments in a safe and responsible manner* and the first part of *3.3 applying recognised methods and appropriate practical techniques and tools* were covered in most chemistry units involving practical laboratory exercises. However, the other parts of each of those TLOs *3.2 formulating hypotheses, proposals and predictions* and *3.3 being able to adapt these techniques when necessary* were not covered unless the experiments had an inquiry component. Each TLO is only achieved when all parts of it have been explicitly assessed, so these TLOs were not met even in units with a large amount of laboratory work, if there was no inquiry.

A further difficulty is that for all parts of TLO 3, the statement is that students are assessed *both individually and in teams* by the four listed approaches. Thus, not only must a degree include, for example, synthesising and evaluating information from a range of sources, but also this must be taught and assessed both individually and in teams. Alternatively, the TLO could be interpreted to mean that some of the components should be achieved individually, and others in teams. The interpretation of these statements requires further work within the chemistry community to elucidate what exactly will satisfy the TLOs.

Units incorporating a self-directed research project are offered in the final semester of the chemistry degree at all three institutions that participated in the full TLO map. Such units potentially cover many of the TLOs that are not well covered elsewhere. Specifically, the TLOs *1.1 recognising the creative endeavour involved in acquiring knowledge, and the testable and contestable nature of the principles of chemistry* and *1.2 recognising that chemistry plays an essential role in society and underpins many industrial, technological and medical advances*, the first part of *3.2 formulating hypotheses, proposals and predictions*, the second part of *3.3 being able to adapt these techniques when necessary*, and *5.1 demonstrating a capacity for self-directed learning* can be met within the framework of a research project. Depending on how the project's results are presented, both parts of the communication TLO 4 may be addressed as well. These TLOs are not all automatically or inherently addressed by a self-directed laboratory research project, but the units offer a good opportunity to address these TLOs if the unit is designed with assessing them in mind.

Conclusions

The two mapping exercises described here have answered some pressing questions about the teaching of tertiary chemistry in Australia, and they have also raised other questions. For example, from the snapshot mapping exercise, knowing that more time was dedicated to organic and physical chemistry, one can ask whether this is the correct approach or whether a more balanced approach to the subdisciplines is warranted. Similarly, one can ask whether biochemistry belongs in an undergraduate chemistry degree.

The TLO mapping exercise indicates that for some TLOs, work needed to be done to ensure that these are achieved in the undergraduate chemistry degree. In particular, teamwork must be assessed and this must include all parts of the problem solving TLO 3. The TLOs *2.2* and *5.3* must be explicitly included in teaching and assessment, and for some degrees, much more attention must be given to understanding the culture of science and chemistry. This exercise also showed that the wording of some TLOs is problematic, such as the two-part items, and that better definition is required for the group and teamwork items.

More importantly, with current assessment practices, a student can graduate having achieved marks of 50% in every unit. Assessment in each unit usually has several components, so it is possible to graduate with a poor understanding of chemistry and without achieving many of the TLOs. This work indicates that a new vision of assessment is required, such as having core items , which must be completed in order to progress. Other assessment items could allow students to demonstrate higher levels of achievement beyond the threshold, and these could lead to better marks, but without the core items students could not progress in their degree or graduate.

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