The Challenges of Planning, Enacting and Assessing Critical Thinking.

Keywords: Critical Thinking (CT), Curriculum, University, Assessment, Planned, Enacted, Teaching.

Abstract

Developing students' CT (Critical Thinking) is fundamental for students to develop skills for future study and employment. To prepare students for evaluating the changing world, there needs to be planning, enactment and assessment of CT in all fields of study at universities. How are lecturers supporting the development of students' CT? Our findings report on a qualitative case study in a first-year university chemistry course that explored how lecturers planned their teaching and what and how students were taught and assessed in relation to developing CT. In this case, CT was not embedded into planning, enacting and assessing the curriculum, and therefore, there was little intentionality for developing CT. The implications for planning for CT, including changes to assessment are emphasised.

Purpose

This paper focuses on the challenges of aligning the planned, enacted and assessed curriculum to support the development of students' CT. It highlights the importance of curriculum design with aligned assessment so that CT can be developed as part of the student learning outcomes. Specifically, to be effective, CT needs to be embedded in all 3 aspects of curriculum planning, enactment and assessment. Alignment between these aspects is crucial to ensure that the planned curriculum is enacted and assessed to provide evidence that demonstrates if students have learned what was intended (Kurz, Elliott, Wehby, & Smithson, 2010; Ziebell & Clarke, 2018).

Critical Thinking Defined

The definition of CT adopted for this study was from the work of Paul and Elder, Vardi and the published Delphi research project (P. A. Facione, 1990; Paul & Elder, 2008b; Vardi, 2013). The 1990 consensus definition by research experts stated that CT is "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanations of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment" (P. A. Facione, 1990, p. 3). As the definition indicates, CT is not seen as a stand-alone skill, but rather as a combination of a number of processes, higher-order cognitive skills, information and perception, including, but not limited to analysis, inference, evaluation, explanation and interpretation. Additionally, CT is described as a progression of thinking that is intended to lead to a large defensible choice, inference or result rather than a category of thinking (Vardi, 2013). It is also the mode of thinking about any subject, content, or problem in which the thinker improves the quality of his or her thinking by skillfully applying logical reasoning, the structures inherent in thinking, and intellectual standards (Paul & Elder, 2008b).

Infusing Critical Thinking (CT)

There is a growing body of evidence that demonstrates the need to integrate CT into teaching in universities more deliberately and the consequence that active learning (engaged thinking and questioning) promotes CT in students (David & Brown, 2012; Ijaiya, Alabi, & Fasasi, 2011; Malam & Grundy-Warr, 2011; Popil, 2011). CT is promoted and incorporated into many disciplines already to equip students with relevant 21st-century skills (Stone, Duffy, Pinckney, & Templeton-Bradley, 2017). CT is also often linked to concepts, such as deeper learning (Panettieri, 2015) as it can improve and develop evaluative skills so essential for a changing world (Conner, 2014). Additionally, entrance to postgraduate university programs often requires applicants to demonstrate CT skills in the preparation and presentation of their applications. This ability is considered a graduate attribute that is applied to learning outcomes in many universities around the world (Haigh, 2016).

Teaching CT is more effective when it is explicit. Abrami et al. (2008) make clear the positive effects of explicit instruction on the development of CT. Explicit and effective teaching occurs when teachers communicate clearly the structure and purpose of the course, consider precisely what students need, i.e. design the learning experiences according to what students already know and can do and as such is learner-focused (Oyelana, Martin, Scanlan, & Temple, 2018; Tudor, 1993). This includes explicitly aligning and indicating to students the connections between learning objectives, activities and assessments (Abrami et al. ,2008). What the university envisages as important to learn, and how it is to be learned constitutes the 'planned' curriculum. What learning experiences are provided becomes the 'enacted' curriculum. Seitz (2017) emphasised the importance of aligning the intended, enacted, and assessed curricula to achieve the intended goals.

It also seems important to create the conditions necessary within a course for CT to occur. For example, an inquiry mindset on the part of the teacher can demonstrate CT with explicitly identifying aspects (especially questioning) that emphasis CT. Activities such as group discussions, considering case studies or scenarios, or evaluation of research findings to detect reliability and validity, bias etc. and purposeful questioning are all very useful (Vardi, 2013). These types of learning experiences and support from teachers can help to maximise the effectiveness of developing CT. Further, it seems important that lecturers consciously include activities to develop students' CT (Abrami et al., 2008; Kanbay & Okanlı, 2017).

Finding out what students know and can do constitutes the 'assessed' curriculum (Seitz, 2017) and may occur during the course or at the end. Assessment involves an evaluation of what people know and can do (Siles-González & Solano-Ruiz, 2016). Any assessment that focuses mainly on recall of content knowledge encourages memorisation (Stowe& Cooper, 2017). Paul and Elder (1998) argued that an assessment that asks students to 'list', for example, are 'thought-stopping' questions, and this approach does not generate further questions in the students. This argument that the assessment of CT requires a multidimensional approach with open-ended questions was echoed by other scholars (Cheng, Ferris, & Perolio, 2018; Wan & Cheng, 2018). Ideally, a range of opportunities to demonstrate the gamut of skills within the definition above would be provided. Such activities as requiring explanations rather than multiple-choice questions foster CT (Grussendorf & Rogol, 2018) or providing insights from different perspectives. *The Good Practice Guide* (Australian Council of Deans of Science, 2013) has specific examples of assessment in this area.

There is a connectedness that exists among course learning objectives, assessment and university graduate attributes. Crosthwaite et al. (2006) adopted Josh and Lesley's pedagogical model to illustrate this connectedness (Josh & Lesley, 2004). They believed that specific learning objectives can be achieved through learning activities, which can prepare learners for assessment tasks (measured against standards) and can be used to demonstrate the attainment of the graduate attribute. For the graduate attribute of CT, curriculum, instruction and assessment should emphasise the importance of evidence-based research (Lysenko, Abrami, Bernard, & Dagenais, 2015), evaluate the methods and the likelihood of the repeatability of the findings.

The framework for this study was the Paul and Elder CT Framework (Paul & Elder, 2008b, 2009, 2012a, 2012c). The Paul and Elder CT framework was chosen because it provides well-structured, underpinning theories for understanding CT components and what they aim to achieve. Another advantage of this framework is that it has been more widely implemented by higher education institutions globally than other frameworks (Han & Brown, 2013). The framework has a comprehensive approach (Payette & Ross, 2016) and extensiveness with explicit process and examples. In the Paul-Elder framework, there are three components (Foundation for Critical Thinking - Learn the Elements and Standards, 2015; Foundation for critical thinking, 2014; Paul & Elder, 2008b, 2012c; University of Louisville, 2015):

1. Elements of thought (known as the element of reasoning).
2. Intellectual standards.
3. Intellectual traits.

Also, in addition to the Paul and Elder Framework, there are teaching practices that promote CT in students, called *critical thinking indicators*. This study compared the teaching practices of lecturers in this case study to the CT indicators. Ideally, a diverse range of teaching approaches would be used to develop CT skills through promoting the ability to critique and verify information and knowledge (Allamnakhrah, 2013; Alwehaibi, 2012; Jaladanki & Bhattacharya, 2014; Stanley, 2017). Some of these teaching practices include the use of class discussions, problem-based learning, role-plays, peer discussions, evaluation of case studies and explicit instruction (Abrami et al., 2008; Kogut, 1996; Laird, Seifert, Pascarella, Mayhew, & Blaich, 2014; Wan & Cheng, 2018). Numerous researchers have shown that the use of these approaches increases students' CT skills (Heijltjes, van Gog, Leppink, & Paas, 2015; Holmes, Wieman, & Bonn, 2015; Zhou et al., 2013).

Methodology

This study used qualitative interpretivism and document analysis. An interpretivist epistemology was chosen because we wanted to investigate how well the planned, enacted, and assessed curriculum supported the development of CT in a particular context. The case study of a large chemistry first-year course enabled us to combine rich data sets (Crotty, 1998) from eight lecturers' interviews and observations of their teaching and these were triangulated with students' comments. The interpretations were compared with documents that outlined the course aims and content, and as well as an analysis of the assessment items. This study captured the lecturers' and students' realities and challenges to incorporate CT as seen and experienced by them. Ethical approval was obtained from the university that was the subject of this study, and all protocols were followed. Information about the lecturers, students and the university are presented using pseudonyms in order to conceal their identities.

Data sources

Data collection for this study included document analysis and semi-structured interviews with lecturers and students. All participants were volunteers. These allowed the interviewer to use a mix of more or less structured questions, specific to each lecturer and created opportunities to probe the participants' answers (Merriam, 1998). Thematic analysis was applied to all qualitative data obtained. Audio recordings from interviews were transcribed. Nvivo 10 for Windows software was used to organise data by coding into nodes for easy retrieval of the emerging themes (Nvivo 10, 2017). Student focus groups allowed participants to convey their experiences in an individualistic way but bounce ideas off each other as well. The document analysis was undertaken using content analysis of the words used to determine the extent of alignment of the planned and enacted curriculum with the assessment. The keywords in the documents, termed 'verb' throughout the analysis, are reported in Table 1. Following the coding, an interpretive analysis captured vagueness and translated meaning and comparisons between documents.

Findings

The main finding was that there was no purposeful nor direct relationship between the planned, enacted and assessed curriculum. As shown in Table 1, there were a few activities such as questioning and scaffolding, that could have contributed to the development of students' CT. However, even though the lecturers could articulate how important CT was for students, in general, they had not made the connection between what experiences they provided for students' learning and how they were modelling CT processes and practices during their teaching. As a consequence, the model of teaching remained "lecturing" where the chemistry content was transferred, implying that conveying content knowledge was the most important objective. That is not to say that lecturers did not use questioning. Rather, their questioning focused on content and understanding key concepts rather than evaluative-type questions. Very little critique of research, the tentative nature of science nor how bias can be detected, was observed during their teaching. For example, the lecturers stated:

> The way I present lectures has been pretty much fixed for a long time now. I tend to give the same lectures in the same order with the same material, at the same rate, tell the same jokes (Ben)

> To be honest, do we do much to develop CT in our students, probably not? I think that if you present your lectures in a way that shows critical, logical thinking, I guess you hope that that rubs off on the students. But you know, honestly, we're teaching four hundred and fifty, it's just not possible. (Gavin)

> …we're kind of restricted in some ways to those (content areas as listed in the course outline) if we don't get through all the learning objectives. Are these still relevant? Should we put more in? Unless you do a total overhaul and revision, maybe you change the textbook that we're using and that would require a revision of what we do. (Patrick)

These quotations illustrate the general tenor of what lecturers in this course believed was important and therefore what they did. There was little awareness about what they could do to infuse aspects of CT. There were two exceptions to this, for example:

> In my lectures when I put up questions, I don't straight away give the answers. I say, try this first and only after you've tried it will I give you the answer. I give them directions on how to get the answer, if not you're not learning any CT at all. I encourage the students to try to understand things. (Denise)

> With what we do, because everything that we get, we get data and we have to interpret it, we're making observations and then we're knitting things together, and we're thinking about well what does this mean? To do that, we have to have the toolbox behind us, and think out of the box, could it be that or could it be this? We can't make any definitive statements yet because we need more evidence. What can we get? It's (CT) hugely important. (Stella)

The lecturers in this study reported barriers preventing them from adopting more active learning approaches that might support the development of CT. These included pressures to cover the course content, and the consequent lack of overall time, large classes, lack of assistance, students' learning immaturity (although they had not undertaken diagnostic assessments to support this).

The students' focus group provided examples of students' reflections on the enacted curriculum they experienced in their chemistry course. The students did not identify teaching strategies that supported CT. Rather, they expected the university teaching to be lecture-based and content-rich. The students found lectures boring, and they found other ways to understand the content after the lectures. The students reported that realigning and targeting assessments with the course learning objectives would be beneficial, rather than assessments that were not relevant to what they were learning. Some examples of students' reports were:

> I find it harder to take in all the information that Patrick gives out. Like if I study it afterwards, I find it easier to remember. Like during the lecture, I'm like, I don't know what's going on, this is insane. And then a few days later, if I'm studying for his section… random it makes sense. (Student A)

> I think it was Gavin that did the thermodynamics (topic); I couldn't pay attention to him at all. Like I found him very slow like he was the complete opposite of Ben. So I couldn't understand everything he was saying, but I also found him very boring (Student B).

The university graduate attributes document reinforced that CT was an important outcome for all students. Analyses of the course outline document and the examination questions revealed clusters of verbs as shown in

Table 1. These clusters included: ‘rearrange’, ‘circle’, ‘sketch’, ‘which’, ‘draw’, ‘complete’. We used the verbs in the exam questions as a proxy for indicating the questioning difficulty level, as suggested by (Paul & Elder, 1998, 2008). There was a mismatch between the verbs used in the course outline and those used in assessments. According to the Paul and Elder CT framework, CT is a higher level of difficulty demonstrated by discussing different points of view, especially in problem-solving. The analysis of the examination paper showed limited evidence that students’ CT skills were assessed or that there was an aim to assess these skills. As well, the lack of alignment of verbs with promoting CT indicated CT was not a focus for assessment and therefore this course was, as it stood, unlikely to contribute to students’ development of CT skills. Further, it was a surprise to all the lecturers, as revealed in their interviews, that there was misalignment. If attention had been given to the leading verb for each assessment item, the level of difficulty of the questions could have been increased, and the stem of the assessment item could have prompted demonstration of CT. Instead, this analysis found a mismatch between the questions and the course learning outcomes in terms of what was assessed.

Significance

Even though there was wide variation in the teaching practices of these lecturers, none of them could demonstrate how they planned for deliberately integrating nor assessing CT. The lecturers who had a broader view of their role in enabling learning understood the importance of CT but did not translate this into learning experiences for supporting the development of CT within a tertiary chemistry context. They all had a limited understanding of how their teaching could enhance CT. Despite their claims that CT was important, the lecturers’ understandings or beliefs about how people learn and what students needed, was reflected in their teaching. It may be that some of the lecturers had not actually thought much about their teaching practices related to developing students CT. Therefore, they had relatively underdeveloped teaching repertoires because they had never really reflected on or sought advice or external input about this as indicated in the broader study (Kolajo, 2020). The lecturers were unaware that the verbs used in examination questions were not a match with the verbs stated in the learning objectives of the course. However, while some lecturers understood the implication of needing to align assessment with the learning objectives, more changes to assessment items would need to be made to incorporate higher-level thinking skills and the verbs that invoke these.

Based on the findings, chemistry lecturers at this university did not teach CT explicitly and had poor understandings of how to integrate CT. In their defense, they indicated they had not learnt how to do this. If this approach is not changed, it means students may have difficulty questioning assumptions, evaluating claims or engaging in effective decision-making (Grussendorf & Rogol, 2018) and would be disadvantaged in not being supported to develop the graduate attributes aspired to by this university. Professional learning or training for lecturers would support them to incorporate explicit ways to develop CT and include CT in assessments. Further research on the impact of implemented changes on students’ skill development would inform more general interventions for improving the development of CT. The findings reported here are likely to apply to other settings where lecturers have a naive understanding of pedagogy that supports CT.

This study offers a unique contribution to our understanding of the needs of university lecturers to integrate engaging learning approaches to teaching through CT and suggests that lecturers can look beyond the assumption that students will naturally develop CT skills as they progress in their degree courses. It also contributes to the ongoing discussion on implementing CT in higher education and the understanding of how lecturers in first-year chemistry courses understand and have or have not adopted the construct.

Table 1. Assessment Verbs

Learning outcomes	Assumed material	Mathematical preparation	Lecture outline	Learning objectives verbs	Assessment verbs
Develop skills in the critical analysis of chemical information.	The mole concept, relative atomic mass, molar mass, chemical stoichiometry.	Be capable of performing simple numerical manipulations, including cross multiplication.	Atoms and the Periodic Table. Chemical Bonding. Reduction and Oxidation Reactions.	Define, describe, understand, state, use, identify, expand, construct, how, predict, assign, distinguish, decide, calculate, derive, know	Give, circle, estimate, sketch, which, draw, rationalise, complete, balance, write, calculate, what, assume
Develop problem-solving skills in chemistry.	Basic principles of atomic structure; electron configurations; quantum numbers; the periodic table; atomic and ionic radii.	Have knowledge of logarithms and exponentials.	Properties of Gases. Introduction to Thermodynamics. Kinetics. Chemical Equilibrium. Thermodynamics II.	Predict, state, know, estimate, provide, rationalise, calculate, define, explain, list, understand, determine, demonstrate distinctions	Distinguish, explain, describe, rearrange, give, how, define, the difference between, compare and contrast, estimate, why
Enhance applied mathematical skills relevant to chemistry.	The basic principle of the conservation of energy; bond energy.	Have some acquaintance with basic calculus (gradient and differentiation, area and integration).	Aqueous Chemistry. Acid-Base Equilibrium.	Understand, rationalise, know, significance, determine, describe, provide, define, predict, use, classify, calculate, derive, recognise, estimate	Identify
Develop a working understanding of (all the topics for the semester)	Oxidation and reduction.	Be familiar with the use of SI units.			

Table 2. Summary of Lecturers Interview

Case names Characteristics	Denise	Isaac	Patrick	Gavin	Ben	Aaron	Joan	Stella
Teaching Practices	lecture, quizzes	lecture, humour	lecture, occasional questioning	lecture	Lecture	lecture	lecture, questioning	lecture, scaffolding, questioning
Classroom interaction	somewhat	dramatising	Minimal	minimal	minimal	minimal	interactive	Somewhat
Assessment practices	match	never thought of it	mismatch	mismatch	assumption	disagree	assumption	assumption
CT perception	hesitant to training	no to training	no to training	no to training	will not go	not interested	maybe	yes

References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research, 78*(4), 1102-1134.

Australian Council of Deans of Science (2013). *Good practice guide - understanding science*. http://www.acds-tlcc.edu.au/wp-content/uploads/sites/14/2013/01/Science-Good-Practice-Guide-2013-TLO1.pdf Downloaded 29 February 2020.

Cheng, S., Ferris, M., & Perolio, J. (2018). An Innovative Classroom Approach for Developing Critical Thinkers in the Introductory Statistics Course. *The American Statistician, 72*(4), 354-358. doi:10.1080/00031305.2017.1305293

Conner, L. N. (2014). Students' use of evaluative constructivism: comparative degrees of intentional learning. *International Journal of Qualitative Studies in Education, 27*(4), 472-489. doi:10.1080/09518398.2013.771228

Crotty, M. (1998). *The foundations of social research: meaning and perspective in the research process*: Place of publication not identified Sage Publications.

Grussendorf, J., & Rogol, N. C. (2018). Reflections on Critical Thinking: Lessons from a Quasi-Experimental Study. *Journal of Political Science Education, 14*(2), 151-166. doi:10.1080/15512169.2017.1381613

Haigh, M. (2016). Fostering deeper critical inquiry with causal layered analysis. *Journal of Geography in Higher Education, 40*(2), 164-181.

Kanbay, Y., & Okanlı, A. (2017). The effect of critical thinking education on nursing students' problem-solving skills †. *Contemporary Nurse, 53*(3), 313-321. doi:10.1080/10376178.2017.1339567

Kolajo, Y. A. (2020). *Developing critical thinking in a first-year university chemistry course.* (PhD). Flinders University, South Australia.

Kurz, A., Elliott, S. N., Wehby, J. H., & Smithson, J. L. (2010). Alignment of the Intended, Planned, and Enacted Curriculum in General and Special Education and Its Relation to Student Achievement. *Journal of Special Education, 44*(3), 131-145. doi:10.1177/0022466909341196

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from "Case Study Research in Education."*: Jossey-Bass Publishers.

Nvivo 10. (2017). Look through different lenses. Retrieved from https://www.qsrinternational.com/nvivo/what-is-nvivo

Panettieri, R. C. (2015). Can Critical-Thinking Skills Be Taught? *Radiologic technology, 86*(6), 686-688.

Paul, R., & Elder, L. (1998). The Role of Socratic Questioning in Thinking, Teaching, and Learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 71*(5), 297-301. doi:10.1080/00098659809602729

Paul, R., & Elder, L. (2008). Critical Thinking: The Art of Socratic Questioning, Part III. *Journal of Developmental Education, 31*(3), 34-35.

Seitz, P. (2017). Curriculum Alignment Among the Intended, Enacted, and Assessed Curricula for Grade 9 Mathematics. *Journal of the Canadian Association for Curriculum Studies, 15*(1), 72-94.

Siles-González, J., & Solano-Ruiz, C. (2016). Self-assessment, reflection on practice and critical thinking in nursing students. *Nurse Education Today, 45*, 132-137. doi:10.1016/j.nedt.2016.07.005

Stone, G. A., Duffy, L. N., Pinckney, H. P., & Templeton-Bradley, R. (2017). Teaching for critical thinking: preparing hospitality and tourism students for careers in the twenty-first century. *Journal of Teaching in Travel & Tourism, 17*(2), 67-84. doi:10.1080/15313220.2017.1279036

Stowe, R., & Cooper, M. (2017). Practicing What We Preach: Assessing "Critical Thinking" in Organic Chemistry. *Journal of Chemical Education, 94*(12), 1852.

Wan, Z. H., & Cheng, M. H. M. (2018). Classroom learning environment, critical thinking and achievement in an interdisciplinary subject: a study of Hong Kong secondary school graduates. *Educational Studies*, 1-

20. doi:10.1080/03055698.2018.1446331
Ziebell, N., & Clarke, D. (2018). Curriculum alignment: performance types in the intended, enacted, and assessed curriculum in primary mathematics and science classrooms. *Studia Paedagogica*, *23*(2), 175-203. doi:10.5817/SP2018-2-10