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Enhancement of student skills through authentic learning in a continuously assessed module
A Research-in-Progress Report

Authors:

Author 1
Vanessa Murphy, : BSc, PhD, PgDip
School of Chemical and Pharmaceutical Sciences, Dublin Institute of T4echnology

Author 2
Áine Whelan, BSc, PhD
School of Chemical and Pharmaceutical Sciences, Dublin Institute of Technology

Abstract

This paper describes the initial findings from a redesigned module in the School of Chemical and Pharmaceutical Sciences, Dublin Institute of Technology. An authentic learning environment is provided for the module which allows students to work collaboratively in teams to ensure that critical aspects of industrial quality management systems and validation are fully explored. Module activities support the development of graduate attributes that will assist in preparing students for work as professionals in the pharmaceutical and chemical industries. The students' perceptions of their own technical knowledge and skills prior to undertaking the module have been assessed using a survey instrument. The methodology used to re-develop the module and the initial survey results are discussed.

Key words: authentic learning; authentic assessment; graduate attributes; experiential learning; work placement.

Introduction

According to the Department of Education and Skills (2011), in recent times there has been a growing emphasis on the importance of graduate attributes in higher education. This is significant as it not only places emphasis on the application of technical knowledge but also on the so-called "soft skills", which are highly sought-after by employers. In keeping with national strategy, The Dublin Institute of Technology (DIT) has developed its own toolkit outlining a range of desirable graduate attributes (2015) which include producing graduates who are innovators, active team players, excellent communicators, work-related learners and reflective practitioners. By providing an authentic learning environment and associated assessment methodologies, students can develop these skills in addition to increasing their technical knowledge.

Mueller (2011) defines authentic assessment as "a form of assessment in which students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills". In many contexts, a work placement module can be used to fulfil the criteria of authentic assessment as students can apply their knowledge in context in a real-world environment. According to Sheridan and Linehan (2011), work placements can provide "diverse learning experiences" that enable students to gain the "transferable generic skills that employers seek". Unfortunately, due to the time limitations presented by the bachelor degreeconcerned in this article, it is not possible for students to undertake a work placement as part of their undergraduate experience. Therefore, an alternative mode of learning must be sought to ensure that these students can enrich their educational experience through authentic methods. Lombardi (2007) also states that "students say they are motivated by solving real-world problems" and that "they often express a preference for *doing* rather than *listening*". Therefore, it is important to engage students in a way which allows them to actively create knowledge rather than passively obtaining that same knowledge.

Methodology

The research work discussed in this article is currently being carried out in the School of Chemical and Pharmaceutical Sciences in Dublin Institute of Technology by staff involved in teaching the "Pharmaceutical Regulations, Quality Assurance and Validation" module to full-time final year students on the Bachelor in Science (Ord) in Medicinal Chemistry and Pharmaceutical Science. Sixteen full-time, undergraduate students are currently participating in this module at the time of writing. None of these students have completed a work placement as part of their undergraduate programme.

The module was previously assessed using a summative examination, but is now fully continuously assessed. This assessment takes place over a two week period, during which students work exclusively on the assigned material. In week one, background information on various topics is provided using a blend of traditional classroom and workshop formats. These topics include:

- Quality Management Systems
- Validation (Process, Cleaning, Instrument and Method)
- Construction and Interpretation of Control Charts
- Acceptance sampling and process capability
- Root Cause Analysis techniques.

During the project initiation workshop, students are randomly assigned into teams of four. Each team is designated an individual regulated manufacturing or testing environment to which their scenarios and subsequent tasks relate, including: the pharmaceutical industry, the brewing industry, a forensic testing laboratory and a water testing laboratory. The teams are then asked to explore the various roles on teams as well as discussing potential solutions to conflict in team-based situations. Teams also construct a contract which outlines the acceptable behaviours in relation to participation, conduct, communication, meetings, conflict and deadlines. This can serve as a useful document in the event of any issues in the team dynamic, division of labour etc.

Throughout the second week, the teams work collaboratively to progress the various tasks assigned, and function towards a common goal, namely the production of a report and presentation to their managers in the organisation i.e. the DIT academic staff. This report must include recommendations to the management outlining the key elements of the quality system and validation state of various systems within the organisation.

Various authors have identified that evaluation and reflection are essential parts of the authentic learning and assessment process (DeCastro-Ambrosetti & Cho, 2005; Keeling et al., 2013). Therefore, throughout the course of this module, students are also encouraged to behave as reflective practitioners by keeping a blog of their experiences. Once the module has been completed, students can then draw on their blog posts to construct a reflective essay which fully explores their feelings and experiences before, during and after taking part in the module.

When developing this module, Herrington et al.'s (2010) nine elements for the creation of an authentic learning environment were kept in mind. This approach was also utilised by Duignan et al. (2015) in Sligo Institute of Technology during the development of an industry-facilitated workshop to prepare students for employment in the pharmaceutical and related industries. Herrington (2010) lists the following principles for providing an authentic learning environment.

Authentic Context: The module is devised to mirror the type of situations encountered in a regulated environment whereby students must work collaboratively as a team to deliver an authentic output in the form of recommendations or a report/presentation the management team.

Authentic activities: The assigned tasks are complex and representative of those tasks encountered in a regulated manufacturing or testing environment. Students must define the acceptable conditions under which their team would operate, as well as managing the time and resources

available to them. They need to source relevant information, critically evaluate this information and present their findings in a coherent and professional manner.

Access to expert thinking and modelling of processes: Students are given the opportunity to closely interact with their peers as well as the module lecturers. According to Vygotsky's social development theory (1978), social interaction precedes development. When students interact with a "more knowledgeable other" (MKO) i.e. someone who has a better understanding or a higher ability level than the learner with respect to a particular task or concept, their own learning is enhanced. In the case of this module, in addition to their peers, students also have access to academic staff members that have worked in highly regulated manufacturing and testing environments.

Provide multiple roles and perspectives: Initially, students are required to identify the roles best suited to their own abilities within the team e.g. implementer, coordinator, specialist. In addition to this, they must assume the role of employees in a regulated environment working collaboratively as part of a cross-functional team.

Support collaborative construction of knowledge: Completion of the survey following participation in the module will confirm whether students fully recognise the benefits of collaborative learning. However, initial survey results would seem to indicate that students prefer working as part of a team rather than by themselves.

Promote reflection to enable abstractions to be formed: Students are encouraged to behave as reflective practitioners through the use of a blog and construction of a reflective essay. Again, student reflection on their own knowledge and capabilities is assessed through the survey instrument. Their perceptions and knowledge before and after participation will be assessed in a further article.

Promote articulation to enable tacit knowledge to be made explicit: Students are encouraged to brainstorm ideas and discuss the tasks using mind-maps and other tools. This allows them to determine the extent of the information which they already have and to identify the gaps in knowledge that need to be addressed.

Provide coaching and scaffolding by the teacher at critical times: Students are supported at all times through this module. Scaffolding of background material is achieved through lectures and workshops in week one of the module. Students are initially provided with clear instructions on each

task, expected project deliverables and timelines for completion. During the second week of the module, academic staff members are available to provide a supporting role to students by guiding and encouraging them through the tasks.

Provide for authentic assessment of learning within the tasks: Students are assessed based on the deliverables outlined in Figure 1. Marks are assigned on both an individual and team basis, depending on the component. Students are also required to carry out a confidential peer evaluation of their team-mates' contribution in comparison to their own perceived performance.

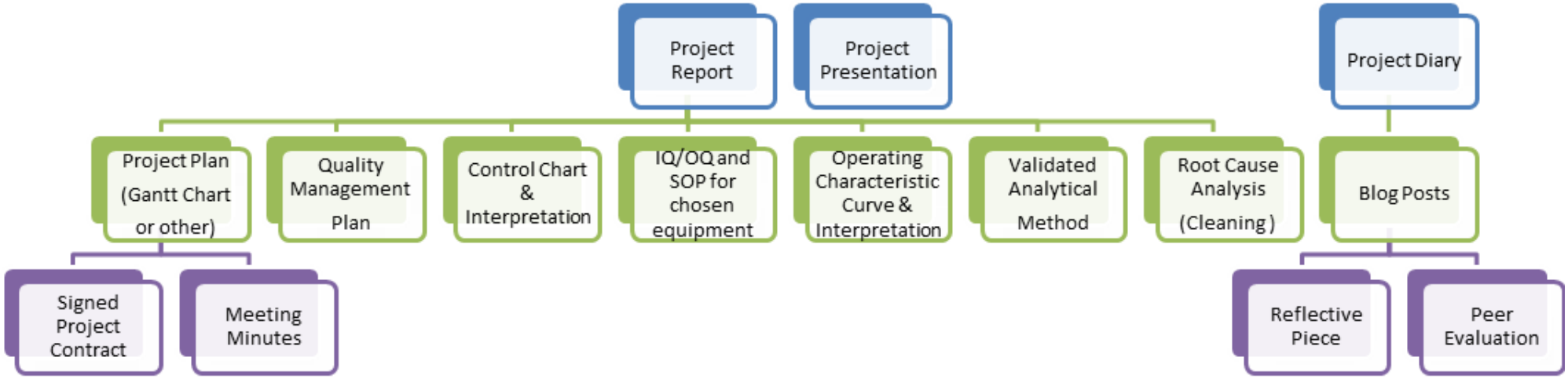

Figure 1. Project Deliverables

Evaluation: Survey

This study uses a survey instrument to assess the student's perceptions of their technical knowledge in relation to the module topics as well as their own competencies. The survey was distributed to the students prior to any information on the module being provided. The survey was divided into 2 main categories: 1) Technical Knowledge and 2) Professional Development. The professional development section was further broken down into a) Teamwork, b) Communication, c) Presentation skills, d) Organisational Skills, e) Research Skills, f) Reflective Practice. The survey included 41 items which were ranked using a Likert scale. This allowed students to express a level of agreement with each of the statements (1- low level of agreement with the statement i.e. "strongly disagree", 5- high level of agreement i.e. "strongly agree". This initial study primarily used quantitative analysis techniques with a qualitative analysis carried out for the open-ended questions. The data was processed using Microsoft Excel®. Fourteen completed surveys were returned (n=14), which were then assigned quantitative codes for analysis. The results of these questions are presented in the following tables, where the mean (n=14), and standard deviation are given. The survey also posed a number of open-ended questions relating to the students' feelings regarding aspects of the project about which they felt particularly nervous or motivated.

Results

Results are summarised under the categories related to the questions asked i.e. technical knowledge and professional development skills. Quantitative data items were categorised and mean responses to the Likert scale rating (1-5) were calculated for all questions to indicate the students' degree of agreement with each statement. Table 1 outlines the results relating to technical knowledge while the various categories relating to professional skills are summarised in Table 2-7.

Table 1: Technical Knowledge	**Mean (n=14)**	**SD**
I have a good understanding of Quality Management in regulated environments	3.54	0.78
I understand the difference between Quality Assurance and Quality Control	3.23	0.73
I am aware of the responsibility of employees for maintenance of Quality Standards	4.07	0.62
I am familiar with the construction and use of control charts	2.85	0.80
I am aware of how validation is carried out in regulated environments	3.38	0.96
I am familiar with root cause analysis techniques/methods	2.77	0.83
I understand the use of single sampling and double sampling plans	2.92	0.95
I am familiar with the use of Standard Operating Procedures	4.07	0.73
I am aware of the parameters that should be tested prior to use of a new instrument	3.43	1.02
I understand that different parameters are evaluated when carrying out different types of methods	3.93	0.83
I appreciate how knowledge gained in class can be applied in regulated environments	4.43	0.65

Table 2: Teamwork	Mean (n=14)	SD
I prefer to work by myself	3.29	0.99
I prefer to work as part of a team	3.79	1.05
I am happy to take on tasks & responsibilities to help my team reach its objectives	4.43	0.51
I feel confident expressing my opinions in group situations	4.07	0.73
I am confident that I could give examples of my teamwork skills in a job interview	4.36	0.93
I am aware of strategies to resolve conflicts in a group/team	3.93	0.92
I am happy to lead a team	3.50	0.94
I am aware of different roles in a team	4.54	0.52
I can engage with others in a respectful & constructive manner, even if I do not have a personal relationship with them	4.50	0.52

Table 3: Communication	Mean (n=14)	SD
I feel confident explaining scientific concepts to students in my class	3.79	0.80
I feel comfortable speaking in groups of my peers	3.86	1.10
I have the ability to listen attentively when other people speak	4.50	0.52
I feel comfortable speaking in front of my lecturers	3.50	0.65
I am confident at preparing written reports	4.36	0.63

Table 4: Presentation	Mean (n=14)	SD
I feel nervous before a presentation	4.64	0.63
I need to use notes during a presentation	4.00	0.88
I am confident that I can present scientific information clearly and in an organised way to different audiences	3.50	0.76
I feel more confident in a group presentation	3.86	1.03
I feel more confident presenting alone	2.64	0.93

Table 5: Organisational Skills	Mean (n=14)	SD
I can manage my time and plan my workload effectively	3.64	0.63
I am good at prioritising the most important tasks	4.14	0.77
I am able to manage several tasks at once	3.64	0.93
I am able to meet task deadlines	4.64	0.50
I demonstrate appropriate attention to detail	4.07	0.47
I am able to keep accurate records of work done	4.29	0.61

Table 6: Research Skills	Mean (n=14)	SD
I am able to source information from a variety of academic sources	4.07	0.83
I am able to critically evaluate information from these sources	3.79	0.89
I can effectively summarise information obtained from academic sources	3.79	0.58

Table 7: Reflective Practice	Mean (n=14)	SD
After completion of a project, I reflect on what went well	3.86	0.77
After completion of a project, I think about how to improve for the future	3.64	0.50

Preliminary Discussion of Survey Results

From the results presented in Table 1, students perceive their own knowledge as being strong in certain technical aspects, particularly around the use of quality standards (mean = 4.07), standard operating procedures (4.07) and method validation parameters (3.93). This may be due to the fact that they are briefly introduced to these topics as part of a chemical control and regulations module in their second year. It is envisaged that this prior learning will be further developed through participation in this module, with a greater emphasis placed on the application of knowledge in real-world scenarios. In other cases, students report little or no prior knowledge of the topic e.g. control charts (2.85), root cause analysis (2.77) and sampling plans (2.92). Survey response after the module will be used to determine whether the students perceive positive learning outcomes for these items.

Another learning outcome of the module should be for the students to develop a deeper insight into industry structures and practices, in addition to gaining a greater appreciation of the links between Quality Management Systems and product quality. These are important outcomes as the students already agree (4.43) that they can appreciate how knowledge gained in an academic setting can be applied in regulated environment.

When questioned on their team-work skills (Table 2), it was evident that, overall the students preferred to work as part of a team (mean of 3.8) rather than by themselves (3.3). However, one respondent strongly agreed that they preferred to work by themselves (5 on the scale) while a further 43% agreed (4 on the scale) with this statement. This may be due to their prior negative experience in teams or due to their perception of the potential pitfalls associated with teamwork. It is envisaged that effective teamwork will be a major competency developed through participation in this module, so it is anticipated that this result will be positively affected by the students' experience in their new teams.

It is also interesting to see that although students may not be friendly with particular individuals, that they agree that they still have the ability to work effectively as part of a team. This is an extremely important quality as workplace environments demand that employees are adaptable to different team dynamics and environments.

The responses given for communication skills (Table 3) indicated that students were marginally more comfortable at speaking in front of their peers rather than in front of their lecturers with respective means of 3.86 and 3.50. An important skill that students must achieve is the ability to communicate effectively with a range of audiences, so this gap will be addressed during the module. When questioned about their perceived competence in preparing written reports, 43% of the respondents strongly agreed while 50% agreed that they were confident in this skill. This perceived confidence more than likely arises from their prior experience in preparing laboratory reports and will require development through the preparation of more detailed submissions as part of this module.

When asked about their presentation skills, results (Table 4) 92% of respondents concurred that they felt nervous before a presentation, (71% strongly agree; 21% agree). These findings correlate well with the responses from the open ended questions where students were asked if there were any aspects about which they felt particularly nervous. In this case, 67% of the survey respondents explicitly said that felt particularly nervous about presenting the team findings at the end of the module. Of those surveyed, it was also found that 64% of students considered themselves to be reliant on notes/ cards during a presentation. These primary results give some indication that their communication skills in a team-based context are more positively perceived by students than those in the context of presentations. Therefore, in order to support their professional development, a focus on presentation skills and public speaking can be incorporated as part of the module.

Students, when questioned about their perceived organisation skills (Table 5), particularly felt that they had a strong ability to meet task deadlines (Mean= 4.64). It is likely that this confidence comes from working on individual projects/reports in their undergraduate career. However, working as part of a team requires much greater management and cooperation to ensure that there is an equitable division of labour to allow all team members to meet the required deadlines. Two other important points where students felt confident in their skills were in the areas of *attention to detail* (Mean= 4.07) and the ability to keep *accurate records of work done* (Mean= 4.29). Demonstration of these aptitudes is hugely important in the pharmaceutical industry and other regulated environments. However, it is unlikely that students, despite their own perceptions, would currently demonstrate the level of attention to detail and record keeping demanded in tightly regulated industries and testing environments. Therefore, as part of this module, it will

therefore be important to re-emphasise the importance of these skills with the students and re-evaluate their perceptions following completion.

Information in Table 6 shows that, prior to commencement of the module, students are confident in their ability to source information from a variety of academic sources (Mean =4.07) and to critically evaluate (Mean= 3.79) and summarise (Mean = 3.79) this material. These skills will be further developed during the module as students are tasked with identifying information relevant to the assigned tasks and developing this material into a coherent and easily-understandable format.

According to the survey responses in in relation to reflective practice (Table 7), students agree that they reflect on what went well following completion of a project (Mean=3.86). They do however, appear to think slightly less about how to make improvements for future projects (Mean= 3.64). As part of the initial module workshop, students are provided with background information on reflection as a tool for project and process improvement. They are also introduced to Kolb's experiential learning cycle (1984) as detailed in Figure 2. This process allows for practitioners to reflect on lessons learned through concrete experience and to modify their behaviour/actions to affect a different future outcome.

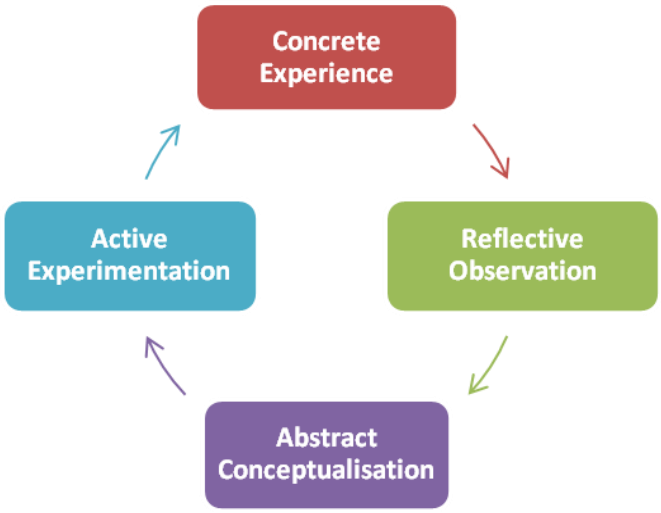

Figure 2. Kolb's Experiential Learning Cycle

Throughout the module, students are encouraged to develop their skills as reflective practitioners through the use of a blog. Their ability to identify lessons learned and improvements for the future will be demonstrated through the production of a reflective essay drawing on their previous blog entries.

Conclusions to date:

The methodology for the development of continuously assessed experiential learning module has been described in this paper. Initial survey results have given an indication of the students' perception of their

own technical knowledge and soft skills prior to commencement of the module. A subsequent paper, also utilising a survey instrument with the same student cohort, will be used to compare the effectiveness of this module on the students' perception of their skills.

Reference List

DeCastro-Ambrosetti, D. and Cho, G. (2005). Synergism in learning: A critical reflection of authentic assessment. *The High School Journal*, 89(1), pp. 57-62.

Department of Education and Skills (2011). *National Strategy for Higher Education to 2030. Report of the Strategy Group*. Available at: http://www.hea.ie/sites/default/files/national_strategy_for_higher_education_2030.pdp

Dublin Institute of Technology (2015). Graduate Attributes Toolkit. Available at: http://www.dit.ie/teaching/graduateattributes/ [Accessed 01 May 2016]

Duignan, G., Breen, A. and Heneghan, M. (2015). Engaging With Industry in the Classroom Through the Use of Online Technology. *Higher Education in Transformation Conference*, Dublin, Ireland, pp.225-237.

Herrington, J., Reeves, T. C. & Oliver, R. (2010). *A guide to authentic e-learning*. New York: Routledge.

Keeling, S.M., Woodlee, K.M. & Maher, M.A. (2013). Assessment is not a spectator sport: Experiencing authentic assessment in the classroom. *Assessment Update*, 25(5), 4-5, pp. 12-13.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development* (Vol. 1). Englewood Cliffs, NJ: Prentice-Hall.

Lombardi, M.M. (2007). *Authentic Learning for the 21st Century: An Overview. Educause Learning Initiative,* 1, 1-12. Available from: http://net.educause.edu/ir/library/pdf/eli3009.pdf

Mueller, J. (2011). *Authentic assessment toolbox*. Available from: http://jfmueller.faculty.noctrl.edu/toolbox/ [Accessed 30 April 2016]

Sheridan, I. & Linehan, M. (2011). *Work Placement in Third-Level Programmes*, CIT Press, Bishopstown, Cork, Ireland.

Vygotsky, L. (1978). *Mind in society. The development of higher psychological processes*. Cambridge: Harvard University Press.