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A longitudinal view of students' perspectives on their professional and career development, through optional *Business Skills for Chemists* modules, during their Chemistry degree programme

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Employers regularly cite a lack of commercial awareness and other transferable skills in new graduates. To address this issue, we developed a suite of employability-focused modules (or courses) under the umbrella of *Business Skills for Chemists*; The modules were, and continue to be, optional for all Chemistry undergraduates, with one 10-credit module (of 120 credits per year) for each undergraduate year of study. A context based learning approach and group work was taken in each case, to introduce students to a wide range of industrially focused experiences.

A retrospective longitudinal qualitative study of three students who took all three modules during their degree was undertaken to better understand students' experience of the modules, and the impact on their career decision-making. This research was undertaken to gain greater insight than the regular student feedback obtained at the end of each module.

During the modules and at the end of the degree, students identified that the modules had helped them to develop a wide range of skills and capabilities. Reflection is an essential component of the learning experience, ensuring that the students not only experience a skills-rich curriculum, but also have the ability to reflect upon and derive benefit from their experiences. The modules had also been prominent in their career decision-making, by introducing the students to a wide range of career options for Chemists, through the curriculum.

Introduction

The development of students' transferable skills is essential during a degree programme. This is clearly articulated in the Quality Assurance Agency benchmark statements for Chemistry (QAA 2014) and in the Royal Society of Chemistry's accreditation framework (RSC 2017). Of relevance to this intervention, the QAA benchmark statements (QAA 2014) explicitly refer to:

- Communication skills, covering both written and oral communication with a variety of audiences;
- Information location and retrieval skills, and the ability to assess the quality of information accessed;
- Basic interpersonal skills, relating to the ability to interact with other people and to engage in team working;
- Time management and organisational skills;
- Other relevant professional skills such as business awareness.

Similarly, the RSC accreditation framework refers to the development of professional skills (RSC 2017):

- Communication skills;
- Scientific writing, data presentation, referencing literature;
- Ethical responsibilities
- Sourcing of information
- Team working
- Time management and organisational skills

Traditionally, the solution was to include a 'skills module' within the degree programme, however these were often ineffective because they lacked chemistry context, and therefore students did not recognize them as part of their core learning of the subject (Tomlinson 2012). Similarly, Hill et al. (Hill, Overton, Thompson, Kitson & Coppo 2018) noted that students are not always aware of the skills that they are developing through the curriculum. Additionally, a study by Hanson and Overton (2010) examined the skills that were typically developed in a chemistry degree, contrasted with the skills that employers seek. There was a mismatch, particularly with respect to development of transferable skills. A study by Gallo-way (2017) found that students particularly valued developing skills such as teamwork, problem solving, and organisational or time management, among other chemistry-related skills.

One solution is to embed context or problem based learning into the degree programme, thus providing students with a more authentic learning experience. Authentic learning is a term that is used to describe learning by doing (Pearce 2016) that takes place in a realistic, or simulated real-world context. Four components of authentic learning are (Rule 2006):

1. Problems that mimic the work of professionals;
2. An aspect of inquiry or open-ended learning;

3. Students engage in a community of learning;
4. The students direct the learning.

An authentic learning pedagogy was used in the development of the courses that are referred to in this chapter. This approach was adopted to give students experience of realistic, workplace tasks and to hopefully increase engagement by means of intrinsic motivation, where autonomy and purpose would be key drivers (Herzberg, 1968; Pink, 2018).

The value of context-based and problem-based learning is well documented (Belt, Leisvik, Hyde & Overton 2005; Seery, 2015). An article by Overton and Randles (2015) cites many examples of where PBL is used in chemistry education successfully.

We developed a suite of three 10-credit context-based modules (or courses) under the umbrella of *Business skills for Chemists*; one for each 120-credit year of a three year UK undergraduate Chemistry degree. The aims of the modules were to increase students' commercial awareness and business acumen (Wilkinson & Aspinall 2007), provide students with an opportunity to develop the transferable or professional skills specified by the QAA and the RSC, and provide an opportunity to reflect on their experiences. All three of the modules were set in the context of the chemical industry, each having a different focus. All of the modules included guest speakers with a range of career profiles within the chemical sector. The skills that were intended to be developed through the modules were:

- Communication
- Information retrieval
- Teamwork
- Persuasive skills
- Commercial awareness

The first-year module focused on employment in small to medium enterprises (SMEs), an often overlooked sector for students seeking employment (Pugh 2017). The SME case study formed part of a career planning module, and provided students with the opportunity to select an existing company, then enact the role of employees of that company whilst completing an extended activity considering the most promising commercial opportunities for their chosen company. Students worked in allocated teams, made decisions about the opportunities over a period of weeks, and then presented their preferred opportunity, as a group, to their line manager, enacted by the module leader.

The second year module focused on new product development in a chemical-related business, taking a product from concept through to market (Pugh 2014). This module introduces students through industry-led workshops to intellectual property, marketing, scale up, legislation, project management and other commercial considerations. Students are assigned groups, given a project brief and meet on a weekly basis to work on their project. Weekly sessions are scheduled, although students are expected to arrange meetings with each other outside of the scheduled slots. Each group presents their proposal to the 'board of directors,' en-

acted by the module team, as a pitch at the end of the module. They also prepare a group portfolio of their work.

The third year module was developed in collaboration with the university's student business start-up unit, and is entrepreneurial in nature. Students are asked to find a piece of chemistry research that has potential for commercialisation or societal benefit and relates to the Royal Society of Chemistry's priority areas (RSC, no date), and develop a business case. At the end of the module, the students present a pitch to 'a team of investors,' enacted by the module team and external panel members, and also submit a business plan.

The modules were designed to be progressively more challenging. The first was very prescriptive, based on existing businesses and information was provided to students. In the second, the students were assigned a project brief for a new product development in a specified sector but they had to find their own information. In the third, the students had the freedom to choose their own area of research and design their own product. This increased level of autonomy was commensurate with their level of study and experience.

Throughout all of the modules, students work in teams. Their assessment consists of a group report, a group presentation, and an individual reflection on their experience. The approach to reflection followed the Kolb learning cycle which progresses from having an experience, to reflecting on that experience, conceptualising what has been learned, then putting it into practice in the future (Stice 1987). Students are introduced to reflection in a taught session before the end of the module in each case. There will be repetition for students who have taken more than one module, but as there are no prerequisites, it cannot be assumed that all students have previously learned about reflection in earlier years.

Reflective essays were included because it is not enough for students to just participate in skills-rich activities. They need to have the opportunity to critically reflect upon their experience in order to derive benefit from it (Harvey 2005). Reflective practice is used widely for self-development in medical education (Riley-Douchet 1997), but less so in the physical sciences. The author believes that the benefits of reflection are two-fold for students. Firstly, they gain experience in articulating their experiences and the skills that they have developed, which is a useful skill for future interviews. Secondly, it encourages self-evaluation and identification of strengths and weaknesses, which will be useful if students are to become lifelong learners, capable of identifying their own development needs.

Student feedback on the modules has generally been positive in all cases. The majority of students enjoy the modules and particularly that they have an opportunity to shape their own learning and have some autonomy in their work. The students describe working in a team as a mixed blessing. Some students have a really excellent team where everyone works well together; others do not. Overall, even when students did not enjoy the experience, they valued the skills that it allowed them to develop for the future. Through their reflections, they often state that these modules are the only place where they get to develop such skills. The feedback for the third year module has 100% satisfaction consistently. However,

as these students have normally taken the second year module, they have a much better understanding of what is required and are used to this way of working.

Anecdotally, there is also evidence that the modules in years one and two have helped students to secure a year in industry, although it would be hard to demonstrate that this is causal, given that they are optional modules. Through the reflective essays, many of the students talk about how the modules have helped with their career decision-making.

Typically, 33-40% of the cohort of BSc Chemistry students takes the modules in years one and two, and around 20% in year three. The drop off can be explained to some extent by the fact that some of the students from year three are spending a year in industry as their third year instead.

Methodology

This paper focuses on the way that students articulate and derive benefit from their learning experiences. The research received ethical approval from the University of Leeds. (MEEC-13-017, April 2018)

The qualitative research involved two aspects: a focus group, and analysis of historic reflective essays. Three students who had taken all three modules took part in a focus group at the end of their degree programme to discuss their experiences. The students also gave the researcher permission to review their original reflective essays from each of the three modules. After the focus group had taken place, each of the students' submissions were reviewed in turn, and in chronological order to make sense of their perspectives at different points during their degree. In each case, the reflective essay was written at the end of first semester in each year of study. A retrospective longitudinal approach was chosen because students can change the way that they narrate their decision-making over time, as described by Cleaves (2011) and so this approach also examined if the students changed their minds or narrated their experiences differently over time. A focus group was chosen rather than interview as individual perspectives had already been captured through the reflective essays and the author was also interested in the way that the students interacted with each other during the discussion. There was evidence during the discussion that the focus group helped the students to make further sense of their experiences through the group discussion.

The students have been given the pseudonyms Lara, Mark and Gina. All three students were just about to graduate and were awaiting results from their undergraduate BSc Chemistry programme when the focus group took place. The undergraduate Chemistry degree consists of a common core, with organic, inorganic and physical chemistry, mostly taught in a traditional lecture-based format with unseen written exams and weekly homework as the main forms of assessment. The programme also has a large practical element through each of the three years (around 25% of the programme). In each year, students have a small amount of

credit (typically 10-20%) for optional modules. These options are normally taken within Chemistry although broader subjects are permitted.

Each of the case studies was considered in turn, taking into account information gleaned from their reflective essays and their responses during the focus group discussion. Thematic, rather than chronological, analysis of the essays and the transcript was based on the following themes:

1. Why did they choose the 'Business Skills for Chemists' pathway?
2. What were the benefits?
3. What were the challenges?
4. What was the impact on their future career decision-making?

Results and discussion of case studies

Three case studies are presented.

Case study 1: Lara

Lara studied BSc Medicinal Chemistry. The Medicinal Chemistry programme follows the common core of the Chemistry programme, but with some additional specialist modules. During the year one module, from her essay, Lara was wholly positive about group work and appreciated the value of working in a team. All members of her team were committed and worked well together. During the course of the module, Lara was "put off working for an SME... due to high responsibility and high visibility in a small business." However, she recognised that, "You would need to have good team work skills" and, "your ideas would be heard by everyone, which could be both an advantage and a disadvantage."

There was definitely a change of tone after the second year module. Lara's opening statement in her essay was, "Group work can be a struggle." She found the team frustrating at times but she assumed a leadership role to get the team back on track. This resolved the initial issues. Lara stated that she wants to be a drug designer, and related this to the good presentation skills she was developing through the module. She said that the module, coupled to some of her co-curricular activities, helped to increase her confidence, and that she would need confidence as a drug designer, "if I think I have made a particularly important discovery, I will have to possess the confidence to present the results." There was also evidence of Lara envisaging herself as a drug designer in the future. ,

Overall, Lara highlighted that the module, "Helped me to acknowledge my strengths and weaknesses and given me chance to improve upon them."

After the completing the third year module, there were some similarities with the second year experience, in that the group work proved a struggle, especially at the beginning of the project work. However, in this reflective essay, Lara focused

much more on the wider benefits of the module, for example, “It has allowed me to become more competent in an assessment centre situation. Having done a mock presentation before... I felt much more comfortable presenting.”

The third year module presented additional challenges, in that the students had to generate their own idea, rather than being given a product brief, “We found it really difficult to knuckle down to an initial idea.” Once again, Lara took on a leadership role within the team, “I decided to solve the problem by delving into my own interests [in healthcare, and related to co-curricular activities]... and the rest of the group were happy to get started.” This was then supported by research to find the appropriate technology. The initial aims of the modules were not to develop research skills, but this has been an unintended and unexpected benefit, with several students highlighting how they have improved their research skills through the modules, and for a real purpose, rather than just for the sake of an assignment. There was also clear evidence of commercial awareness being developed through the process, “We would know for sure that our product would be in demand, which is vitally important for business.” There was also evidence of the learning experience being authentic in that Lara envisaged herself in a professional role, “So that is how we became a healthcare company.” There was also evidence that the module was allowing students to develop higher order learning in accordance with Bloom’s Taxonomy (Bloom 1956), particularly creating knowledge, “I enjoyed creating and developing our idea.”

Teamwork was discussed further, with Lara recognising that each member of the team can make a big difference, and she found this really motivating. Lara identified that patience is an area that she needs to develop, although she hadn’t originally realised this. She felt let down by other team members, and this was set against a backdrop of her own life being very busy with various commitments, but she still found the time to do the work. However, despite frustrations, she always sought to encourage others.

By this time, Lara had changed her career aspirations, and stated that she wanted to become a clinical scientist, and made no reference to the earlier ambition of being a drug designer.

At the time of the focus group, Lara said that she originally chose the modules because of the nature of the assessment, “I liked... the presentation, the self reflection and the portfolio was a better way than the stresses of exams for me.” She thought it was good to find out what it is like in industry, and to develop presentational skills for when they go into industry. The module also opened her eyes to career opportunities for Chemists.

Lara said that she opted to take the second year module because she had enjoyed the first year module and thought it would be similar, and the content was quite interesting, “It’s just nice to see the reality of what goes on.” Lara also liked that the module gave her the opportunity to talk to people from industry, “Because we don’t get the opportunity in really any other modules to do that.” This wasn’t something that she had mentioned during any of the reflective essays. She also highlighted the importance of developing presentational or teamwork skills, which

they don't do in other modules. "It just throws in a whole different new skills set that's kind of refreshing."

Lara mentioned that she liked, "Making sure that everyone is organised." This theme cropped up in her second year and third year reflections, and also when she talked about her co-curricular activities. Lara also identified learning new skills in the field of marketing, such as SWOT (strengths, weaknesses, opportunities and threats) and PESTLE (political, economic, social, technological, legal and environmental) analysis. Again, Lara demonstrated the development of her commercial awareness, "You've already got the demand, and you can shape it that way. You know it works and people are going to want to buy it if it works."

In the focus group, Lara said that she was quite open-minded about careers, although she had found the role of 'clinical scientist' in the National Health Service (NHS) that interested her. However, as she was just finishing university, "I'm not sure I'm 100% ready to just be thrown into a lab situation. So I've been thinking about teaching English in Spain." She is also considering going into teaching. It's an interesting point that maybe students aren't always ready to commit to a career path immediately after finishing their studies, and they want the time and space to make their decisions. She highlighted also that she liked being around people, so that would be a consideration in a career choice. She added that in the past she had shadowed people who worked in careers she had considered, but this had tended to put her off. One of the issues highlighted was that the options for a chemistry graduate are really broad, so it can be difficult to home in on what they want to do. Her view was that this was generally how most of her friends felt about careers too. "I think it's definitely more unusual that some knows 100% that I'm going to apply for this, I'm going to do this kind of thing."

Lara's closing comment was "All the modules... they've just provided a really good range of things to do and it's been really interesting for me."

Case Study 2: Mark

Mark studied BSc Chemistry. Mark identified in his essay that during the first year module, his project team didn't hold enough group meetings, so everything was rushed at the end and not well summarised. He also felt that he wasn't well prepared for the presentation and that he would plan ahead better in the future. Through the module, Mark recognised that he lacked experience to put on his CV, so said that he would seek out more opportunities in the future. We will return to this point later.

Mark identified at the end of the module that he now had a greater understanding of the value of deadlines and time management, "if we'd started out earlier and set clearer goals, and then set up the meetings to summarise everyone's work... so none of the group feels panicked or under pressure [for the presentation]."

Mark highlighted that the skills he'd developed were, "More of a change in attitude to group projects and how I can apply my skills to make me a better team player."

After the second year module, Mark set the scene in his essay with his previous experiences of workshops throughout his education, which had made him apprehensive. He was used to, "Improvising on the spot so this module was vastly different as I had to prepare weeks in advance learning knowledge about my topic." Mark chose to take responsibility for the technical aspects of the project, "I thrive on telling facts and figures as well as mechanisms."

Again, Mark identified that the module was an opportunity for authentic learning, "This type of work, which is closest to an actual job." Mark then went on to say that often it is not the skill set, but the mind set that is important for success in a project such as this. Also, Mark related this to a future career, where the depending on the nature of the role, he would need to learn to adapt and evolve his skill-set.

By the third year essay, Mark identified that his attitude had improved significantly, and said, "I took the module based on taking the previous module, and to further increase my knowledge of business as a whole." He also hoped to increase his confidence and to improve commercial awareness; this latter point was evident in a number of comments that he made, for example, "There's a fine balancing act to make an idea financially viable," and "This helped turn it into a manageable debt which was done by introducing capital to pay for all the initial stages." In general, these are not topics that a chemist would consider during their undergraduate programme. Mark said that he struggled with the initial research but grew in confidence once he'd read into things more deeply. He got better at organising his priorities and improved his own writing skills by working as part of a group. He said that the group worked well together. Mark did not make any reference to his career decision-making.

At the end of Mark's degree, in the focus group he said that he hadn't put any great thought into taking the business skills modules. He didn't know what he wanted to do at that point and thought, "business skills, handy." There was also the added benefit that the module didn't have an exam. The fact that the modules didn't have exams was part of the reason for choosing the business skills options throughout the degree. "I definitely needed one less exam, just so then I can cope." The opportunity to learn about the chemical industry was also cited as a reason for choosing the second-year module, "maybe I wanted to be more in-depth into what chemistry in industry is like and what basically is the market for it."

Mark said that he'd never been apprehensive about working in a group and tends to "edge my way in" and take on a leadership role. In second year, he said he wanted to relax a bit and as he was with a group of friends, they all managed to split the work evenly. This raises an interesting question about whether students should be assigned groups (as in this case) or be allowed to choose to work with friends. There are pros and cons to either, but we have tended to allocate groups as this more closely replicates the workplace. Mark felt that the modules have

strengthened his skills with working with people and to behave more professionally. He also learned how to network.

During the focus group discussion, Mark said that he learned which areas of business he liked and disliked, “I wanted nothing to do with marketing pretty much.” He also said this has influenced his career thinking, “I don’t want to deal with like marketing, advertising and all of that. I’d rather be in with the science and know what I know. I just want to be the person that’s in the labs.” Throughout the conversation, Mark reiterated this point several times. He also said, “I might want to be the person that explains the science to the business person, but that’s probably as far as the business for me would interact.” It is really useful for a student to be exposed to different aspects of business at this stage in their learning – they can get a flavour for what they do and do not like. In each of the modules, Mark opted to take “the science role.” Mark also took on the finance role, “I did the finance one, my god, that was annoying... Finance is not my thing.” Lara added to the focus group discussion by referring to another team member, Joe. “He made up for your finance, and then you helped with the science side of it.” There was a sense that whilst the students assigned themselves specific roles, there was a lot of interaction between the different functions throughout the project; in fact, this was necessary for the project to be delivered successfully as all the roles were interrelated.

Mark demonstrated commercial awareness through comments that were made during the discussion, for example: “Ah this thing is as cheap as chips now, where you can probably do this as a feasible business idea.” And, “It was a decent make up and we could make a profit within the first year.” There was also evidence of authentic learning taking place during the third year module, “I wish we could make this now” indicating that the process had seemed real and immersive, and that an actual physical product was, in his eyes, a viable outcome for the project.

In terms of career plans, Mark recalled that when he first went to University he was thinking of a career in making anti-cancer complexes, because there is a big demand for healthcare drugs, but the complexity of the science had put him off.

However, after completing his final year research project, he is now wanting to go into a career in metallurgy, “Mainly just because of the project that I’ve done, like that was the most enjoyable thing of the whole degree for me... If there’s a business for it, I’m going to find it.” It is valuable for students to have a wide range of experiences during their degree programme; not just for enjoyment, but to help them to consider their possible career options. Also, it is not always an option for students to gain meaningful work experience during their studies, for a variety of reasons, as Mark explains, “I’ve only got the bare minimum work experience because I’ve always had to work to get my grades... so applying for a part time job in between that as well as being there for my disabled parents as well, that’s kind of hard.” It is vital that the curriculum provides the opportunities that students will need to be successful post graduation. The co-curricular opportunities are not an option for everyone and so cannot be relied upon for wider skills development. Mark’s final comments were, “I’m glad that I know the business side is not what I want to do, it’s narrowed down what I actually want.” An im-

portant message in this statement is that students don't necessarily need to enjoy something, or think that it is the career choice for them, for them to derive benefit from the experience. Although Mark didn't enjoy aspects of the project (i.e. finance), it did give him a valuable experience in being able to narrow down areas of work that did not interest him.

Case Study 3: Gina

Gina was also studying BSc Medicinal Chemistry. Gina said in her essay that her first year experience was a positive one. All of her group members were enthusiastic and organised. She said that working with strangers definitely developed her communication skills. Making group decisions was easy because, "We all got along well and had similar ideas." The module required a greater level of organisational skills than she had encountered previously, and needed the students to organise meetings outside of the scheduled classes in order to complete the work. The group made decisions quickly so didn't need to meet often, however, this led to an unexpected issue of needing to recap each time they met. A possible solution identified for future work by Gina would be to hold shorter but more regular meetings.

Gina particularly enjoyed the presentation, especially as she had not done many beforehand. Plenty of practice both alone and with the group, ahead of the assessment, meant that she felt confident delivering the presentation. "Practising as a group was vital in order to ensure smooth handovers and succinct presentation was delivered." Gina felt that overall the module had given her a good insight into what SMEs are and the challenges they face, and on a personal level increased her confidence in working in a group and giving presentations.

In her second essay, one of the key reasons why Gina chose to take the second year module was to develop skills in organisation, group work, presenting, and communication. Additionally she wanted to gain an insight into how a new product is developed. At the time, she wished to work in pharmaceutical development.

Working in a group with people she did not know did not faze Gina as she had got used to working and interacting with strangers since moving to university. However, she did say, "This was probably the most complex and demanding task I have had to complete when working with a group of unknown people." She felt that the whole group got on well and were equally motivated to complete the project. One of the biggest challenges they found as a group was finding a time when they were all free to meet, due to a heavy timetable and other co-curricular and work commitments. This is something that course designers need to consider when projects are introduced that require students to work together outside of scheduled classes. To address this issue, at least partially, the students divided up the project requirements and delegated them to different members of the team. They also set up an online group chat to enable exchange of ideas remotely. This was an effective way of progressing the project, but not without its problems, "In hindsight, I feel that we shouldn't have delegated each section of the project so

early... it meant that each person only got to look in depth at one area of the project. I feel I would have learned more from the project if I had the opportunity to research in most, if not all, areas... It may have been easier for each of us to complete our own area of the project if we had greater understanding of what the others were doing." This point illustrates the difference between a team and a group. A team is more integrated and creates a more synergistic effect.

Gina felt that the presentation went well, "I clearly and confidently communicated our marketing strategy to the board." However, she noted that the group didn't deal with the questions well, with everyone trying to answer all questions, "and this seemed quite unprofessional." She reflected that the group should have also devised a strategy for dealing with the questions.

After the module, Gina's understanding of how to create a viable product had grown. Additionally, the module had an impact on her career thinking, "I had never studied marketing before, but it is something that I am now keen to learn more about." Gina also makes reference to her future self, "As a pharmaceutical development scientist, I may have to work on projects similar to this," which indicates an authentic learning experience, and one that is helping students to make career choices. The only downside that Gina identified was not being able to gain in depth knowledge in all aspects of the product development, but that is the nature of a team project, and more closely resembles the workplace.

By third year, Gina decided to take the module because she had enjoyed the second year module. She identified that she wanted to develop teamwork, presentation, and organisational skills. The second year module had sparked an interest in marketing for Gina, and she hoped to learn more about this area of business.

She also liked that they had more creative control over the project, compared to year two. However whilst the creative control was attractive, it proved very challenging during the early weeks of the project, "Choosing from such a vast range of ideas proved more difficult than expected. Some group members were negative towards every idea yet not coming up with any themselves." At this point, Gina took leadership of the group and suggested everyone come up with one idea each for the next meeting, to pitch to the rest of the group. The groups were not given any instructions about how they should structure themselves, or how they should make decisions. It is interesting to observe that in most groups, a leader emerges at some point, particularly if there are challenges.

Again, the work was delegated to different team members, and Gina set up a group chat, "Because I knew that this would be an effective way of working." However, they held regular meetings to ensure that everyone was involved with all aspects of the project. It was good to see that Gina had reflected and learned from her previous experience of a similar project. In the previous year, Gina felt that everything was rushed at the end, so this time they created "a rough plan of when things needed to be completed by." It was good to see that they put their project management training from second year into practice. Even more pleasing was that this skill is also being used for other activities, "This is a method I use frequently to manage my own time, but the first time I had applied it to a group."

Overall, Gina felt she had developed her organizational skills, time management and communication skills in a team. Interestingly, Gina did not identify time management as a skill to develop at the start of the module. She also noted that she had reflected on previous experiences and applied the learning to this module, “I was also able to reflect on what was successful in the second year and apply this to the project this year. As a result, the project was more professional than work I had completed previously.”

In her essay, Gina summarised her career planning by saying that she was considering starting her own business in the future and felt that “I have gained an excellent insight into what I would need to do in order to make this a reality.”

At the end of the degree, during the focus group Gina said that she chose the first year module because she was planning to do a placement year and, “It would help get your CV done” but also found the module useful. She felt that it had opened her eyes to career opportunities, and especially to SMEs, “Because I’d never really thought about those sorts of companies before.” She found, “the biggest challenges were working with others, but enjoyed that they got to do group work.” Also, she emphasised that in other modules, there is no group work, “Actually [group work] is quite a useful skill when you go into a job.” The biggest challenge for the group work was finding time to communicate with each other.

Gina also talked again about learning about advertising and marketing, “It was just a bit more variation” and gave her an alternative career option, “I don’t want to work in a lab, but I’ve learnt that I want to work with people.” She also identified that she had an interest in business (and not necessarily chemistry business). This was an interesting contrast to Mark who definitely did not want to go into business. She noted that the module gave them the opportunity to communicate science to a different audience, “Explaining the science in like a simplified way.”

She didn’t like being assigned a project brief in second year so much, as she didn’t find the topic engaging, “Effluent water treatment, and it was, no offence, so boring.” However, the group recognised that they needed to think outside the box to make it more interesting. She really enjoyed being able to pick their own project in third year because they could, “Personalise it a bit more.” In hindsight Gina did not initially mention the challenge that the group had faced in identifying a product in third year. After further discussion about why the second year module is more structured, she said “I totally got that because then this year was like, Oh my God, we’ve just got to think of something out of thin air.”

Gina said that she enjoyed doing the marketing aspects, and that she volunteered to take on this role in the third year. She liked to find engaging ways to present to people; also using social media to communicate to a wider audience. A student creating a social media profile for a fictional product demonstrates the level of engagement with the task.

Gina reaffirmed that she did not want a career that involved working in a lab, but would be interested in science communication, “where I can do outreach, and that sort of thing.” She plans to apply for the Wellcome Trust internship programme, but is in no rush, as she hasn’t had time to fully think about her future career or make any applications, “I work on the weekends and I’m at Uni in the

week so...” She felt that there was no rush, and happy to waitress for a while once she had graduated and had more time to think about what she wanted. All the participants thought that this was common among the BSc students but the Masters students are more likely to have career plans confirmed.

On reflection, Gina felt that the modules had, “Opened up our eyes to other careers without really having to go out of your way to look for them... and then sparked an interest and you can go and look yourself a bit more.” She went on to say that this didn’t generally happen with any of their other modules, “It’s like hard to imagine how other than working in a lab how these things could apply elsewhere, but this is the only module that actually says there is other things as well that aren’t so science.”

Outcomes of intervention

The case studies provided a detailed perspective on how the students narrate their own experiences and derive benefit from those experiences. Here, I will reflect on the four themes that were outlined at the start of the methodology, namely:

1. Why did they choose the ‘Business Skills for Chemists’ pathway?
2. What were the benefits?
3. What were the challenges?
4. What was the impact on their future career decision-making?

The students did not appear to give a great deal of thought to why they had opted to take the first year module. The main drivers were two-fold. Firstly, they all thought that the opportunity to create a curriculum vitae (CV) and learn more about the chemical industry would be useful. Secondly, students were attracted to the module because it did not have a formal examination, whereas all of the other chemistry modules (except laboratories) did. When it came to the second year, again, the absence of a formal examination was attractive. However, the students also identified that ‘business skills’ would be useful for their career futures. Additionally, they had enjoyed the experience of working as a group in year one, so the module felt like less of an unknown entity. Moving onto year three, the motives were very similar to year two. The students were also keen to have the opportunity to develop their own ideas, although that brought some challenges too.

In terms of benefits, the participants self-identified the following skills and competency development through participation in the modules: Teamwork, organisational skills, presentation skills, time management, professionalism, communication, decision making, research skills, planning, confidence, lateral thinking, business acumen, networking, change in attitude, reflection, problem solving and leadership. This list went far beyond the initial intentions of the module, described as: Communication, information retrieval, teamwork, persuasive skills and commercial awareness. For many of the skills, students stated that these

modules were the only place throughout their degree where they had an opportunity to develop these skills.

The challenges that the students faced throughout the modules were largely due to working in a team. The modules are the only place during their degree where they formally work in a team, although there are examples of cooperation in tutorials and laboratories. Understanding team dynamics and how to work with others was a big challenge, with the most challenging time being during year two. Due to their busy timetable and other commitments such as part-time work, finding a time to meet was also a challenge. This needs to be considered if courses are designed that rely on unscheduled group meetings. Another challenge that all of the students faced was regarding decision-making. The majority of their studies have been tutor-directed, with a focus on traditional didactic lectures. These modules needed the students to make their own choices throughout and direct their own learning throughout, with the level of autonomy increasing through the years. Students found this challenging, however, it is a much more authentic experience and good preparation for the workplace.

Throughout the reflective essays, and then during the focus group, all students referred to their career decision-making. Generally, students started out with some career aspirations but they were often generic or vague. As the students progressed through their programme, and as seen through the modules, students had a clearer picture of what they did and, just as importantly, did not want to pursue career-wise. It is valuable to provide students with the opportunity to explore possible career futures through the curriculum. This addresses the issues with expecting students to take a proactive approach, such as visiting a careers service. Through curricular learning, students are automatically exposed to career possibilities. It is really important, especially for students that have decided they do not want to work in a lab environment, that there are other related career options available to them (Mellors-Bourne, Connor & Jackson 2011).

As the modules progressed, the students became increasingly reflective and reflexive; that is, not only were they reflecting on their experiences, they were also putting what they had learned into practice for future work. There was evidence that the students drew upon their previous experience and applied the learning to their current work. Reflective practice is a useful life skill and will help students to become lifelong learners, by giving them the skills to identify their own developmental needs in the future.

Students demonstrated through the narratives that they had experienced authentic learning and that they had collective ownership of their projects. Ownership and autonomy are known to support intrinsic motivation, rather than relying on external motivators such as the lure of high grades. Once students leave education and enter the workplace, intrinsic motivation will have longer-term benefits as it can lead to greater job satisfaction and, ultimately, success (Pink 2018).

Conclusions and implications for practice

There has been extensive evidence from the literature that context and problem based learning is a very valuable way for students to experience authentic learning and improve outcomes. This particular intervention adds to that body of evidence. Exposing students to different career profiles through their learning, particularly pathways such as marketing, finance and intellectual property, is invaluable in terms of ensuring that all students have the opportunity to consider their future career options, both within and beyond chemistry. There was evidence that the students found that the modules helped them to consider career options that they both did and did not want to pursue in the future.

A possible future development to address issues with team dynamics could be to include more discussion with the students about team dynamics and the different roles that members of a team may adopt. A useful framework is the Belbin Team Role Descriptors (Belbin Associates UK 2016). If students are able to self-identify their ways of working, and also share that with their team members, it may help to address some of the issues that the teams faced. This will also be a useful awareness to take forward throughout their careers.

An unexpected benefit of the modules was the wide range of skills that students self-identified. The most surprising to the author was that students identified that the modules were the main place in the curriculum where they developed their research skills. Whilst the modules clearly needed students to undertake research to find information, this was not a part of the modules by design. This research experience has lasting benefits for the remainder of the programme, and especially for the students' final year research capstone project.

This chapter has taken a qualitative approach, following the experiences of three students that studied all three modules. An interesting and comparative piece of future work would be to examine the impact on those students who opted to take only one of the modules. This work could be undertaken by examining their reflective essays. However, student consent would need to be granted beforehand, which has been a limiting factor in this particular study.

Whilst building a skills-rich curriculum is important, it is insufficient if students are not provided with the opportunities and support to reflect upon their experiences. This process of reflection is where students make sense of their experiences and derive the most benefit from them. Through this reflective process, students were able to articulate the wide range of skills and competences that they had developed during the modules. There was also evidence of the students taking forward their learning from one year to the next. In this particular case, the modules are an optional part of the programme, but given the wide range of benefits that have been identified, there is a compelling argument that such interventions should be part of the compulsory core curriculum. This would also align with the 'professional skills' element of the QAA benchmark statements (QAA 2014) and RSC accreditation framework, as articulated in the introduction to this chapter.

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