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A Framework for Student-Instructor Partnerships

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In recent years significant emphasis has been placed on staff and students as partners in higher education in order to address issues of engagement and transferable skills. However, the concept covers a wide range of meanings. On the one hand it can refer to module feedback questionnaires. At the other extreme it can include student input in curricular design, particularly constructing course materials. These very different experiences require different levels of academic preparation and student engagement. For the purpose of clarity in discussion it would seem useful to have a framework for the different levels of student-instructor partnerships, which emphasizes this range of experience rather than the activity content. This paper presents a framework based on the levels of student initiation of the partnership and of student involvement in the outcomes (referred to as ownership and autonomy respectively). The scheme was arrived at following study of the collaborative activities in two cognate programmes, the Natural Sciences degree programme at the University of Leicester and the Honours Integrated Science program at McMaster University. These programmes adopt pedagogical models which encourage the formation of strong, cohesive learning communities, thereby providing a rich variety of examples and an international perspective.

Introduction

The traditional form of education, especially in the sciences, has long been the transmissive mode, as if education is something done to the pupil, not with the pupil, even where students complete closed exercises or follow laboratory scripts. Much has been done to change this through active engagement in problem solving including guided instruction (for example, McDermott, 1996; Moog and Spencer, 2008), various forms of problem-based learning (Raine, 2019), peer learning (Boud et al. 2001), or peer instruction (Crouch & Mazur, 2001), among many others. Student-instructor partnerships provide Higher Education Institutions with a means to develop curricular, co-curricular, and extracurricular experiences in a way which fully integrates student representation in course and program design and review processes, discipline and pedagogical research projects, and the development of outreach and in-reach strategies (Healey, Flint & Harrington, 2014; Williamson, 2013). Such partnerships are well placed to encapsulate the difference between school and university and to re-focus the emphasis in science from content (knowing science) to process (becoming a scientist). Student-instructor partnerships span multiple roles for both students and instructors, from student representation on instructor-led curriculum committees to student-conducted research and outreach projects. In implementing student-instructor partnerships as a developmental process within the curriculum, there is a need to articulate the level and type of interaction involved. The aim of our research is to construct a framework for partnerships that can guide the development of process (how to cooperate) rather than content (what to cooperate on). We arrive at this framework by observation of partnerships in two science programmes.

We describe a new two-dimensional scale based on axes of increasing student ownership and increasing student autonomy to allow the classification of various activities or projects according to the degree of student and instructor involvement. We have developed this framework principally through analysis of two programmes (one in the United Kingdom and one in Canada) showing how students at two universities have contributed to student-instructor partnerships as joint owners and decision makers (Healey et al., 2014). The analysis was conducted over a two-day roundtable meeting of the authors. The two institutions feature interdisciplinary science programs and include instructors in a unique role: teaching fellows and teaching-dominant lecturers (University of Leicester, UK) and teaching professors (McMaster University, Canada).

A note on terminology: the expression "instructor-student" is the usual way of referring to these partnerships in North America. On the other side of the Atlantic, they would be more naturally termed "staff-student" partnerships. We have used the terms interchangeably and, similarly, with the spelling of "program" or "programme," in reference to the two institutions.

Classification of Student-Instructor Partnerships

Healey et al. (2014) have proposed a conceptual model of the staff-student partnership based around broad areas of interest: learning, teaching, and assessment; subject-based research and inquiry; the scholarship of teaching and learning; and curriculum design and pedagogic consultancy. The emphasis is therefore on the content of the activity – essentially what can be collaborated on. While usefully laying out the field of possibilities for partnership, such typologies are of less help in designing a progressively structured curriculum. We propose a complementary approach in which we consider where the focus of ownership lies and the depth of the collaboration: essentially the nature of the collaboration. The two-dimensional framework we propose for the classification of student-instructor partnerships centers around two factors: the level of student initiation in the creation of a partnership and the level of student involvement in carrying out a partnership activity (see Table 1).

Table 1
The Classification Framework for Partnerships According to the levels of Student Initiation and Student Involvement with the Examples Presented in the Text

	Student ownership →	
Student autonomy	A. Instructor-initiated	B. Student-initiated
1. Instructor-led	Module Evaluation	Lecture capture Research seminars
2. Co-conducted	Laboratory working group Enhancing PBL PBL resources Chemistry clips	Well-being initiative
3. Student-led	Research (capstone) project Student conferences Large scale outreach	High school workshop Research talks Careers Symposium

We have observed that student-instructor partnerships take a variety of different forms. They may involve a wide range of different levels of student input at the initiation stage, for example from an instructor-initiated partnership to carry out pedagogical research to a student-initiated project to develop a careers seminar. The level of student involvement in conducting the activity defined by the partnership also varies widely, ranging from students acting as advisors to academics to students taking co-ownership of a project and conducting much of the work themselves. The framework has been constructed to reflect the fact that these two descriptors are independent: for example, an instructor-initiated pedagogical research partnership may be largely conducted by a student partner. The nature of the partnership may also change over time.

In Table 1 the level of student initiation is divided into two columns that describe whether the partnership activity is primarily initiated by either the instructor or the student. The level of student involvement in the partnership activity is classified by the different rows of the framework. The framework was developed inductively by fitting examples of student-instructor collaborations into a matrix. A 3 × 3 matrix with a column for shared initiation has some merit (a project may be molded by instructor input into a student idea) but limited applicability. On the other hand, a 2 × 2 matrix, omitting the central row, proves too crude to distinguish the examples. We believe this is the first time a framework to describe student-instructor partnerships has been developed which describes both level of student initiation and level of student involvement in partnership activities.

The Natural Sciences Programme (Leicester) and the Honours Integrated Science Program (McMaster)

In order to set our examples in context, we start with a brief description of the degree programs from which the examples are mainly drawn.

The Natural Sciences Programme at the University of Leicester is a three-year (BSc) or four- year (MSci) degree course which is built around interdisciplinary (as opposed to multidisciplinary) modules (University of Leicester, 2019). The programme adopts a pedagogical model which incorporates elements of Problem-Based Learning (PBL) and Context-Based Learning (CBL) to create a series of group-based learning experiences. Students research novel problems based on research themes at the frontiers of biological science, chemistry and physics. Instruction is led by a teaching team assigned to the programme, together with specialist lectures from about forty academic researchers, and has an intake of 20 to 30 students a year.

The Honours Integrated Science (iSci) Program at McMaster University (McMaster University, 2019) is a four-year limited enrollment H.B.Sc. program which involves students in research from the earliest stages. A cohort of 60 high-achieving students is accepted annually. In the first year of study the program interweaves the disciplines of chemistry, earth science, life science, mathematics and physics along with science literacy. The learning of discipline content in all four years is driven through a series of interdisciplinary research projects. Students may choose to complete a "concentration" in a particular science discipline, which allows them to focus their non-iSci courses in that area. Students largely work in groups to complete the projects. However, in order to develop independent research skills, Level 2 students undertake an enrichment project, Level 3 students engage in a supervised independent (research) project of their choosing, and at Level 4 the capstone project is an independent thesis. The programme instruction is carried out by a group of instructors, which includes two full-time teaching professors (McMaster University, 2019) and other teaching-focused or traditional instructors from specific science departments.

Teaching in both programmes is delivered largely by instructors who are actively engaged in the scholarship of teaching and learning (Gretton et al., in-press), and there is a high level of inter-programme interaction (Hurkett et al., 2018). The examples of partnership will be supplemented by case studies from the Chemistry programmes at Leicester and McMaster, which are taught by more traditional pedagogical approaches.

Examples of the Framework

A1: Instructor-Initiated, Instructor-Led

The ubiquitous module evaluations fall into the simplest category of staff-student partnership. We include these for completeness, but also because our examples here have a small twist. At Leicester an annual planning meeting reviews student inputs to module evaluations and to the student-staff committee. The important twist is the closing of the loop – that is, feedback to students on the outcomes of their input. We publish to students' actions taken as a result of consultation and run through these changes at the induction sessions at the start of each year. This is also useful in damping the "yo-yo" effect since students get the picture of how previous student inputs have impacted on the programme.

Since the introduction in 2008 of a revamped Honours Chemistry program and a new Honours Chemical Biology program in the McMaster University Department of Chemistry and Chemical Biology, students have been invited to participate in annual program refinement sessions. These are conducted on behalf of the Department by staff from the McMaster Institute for Innovation and Excellence in Teaching and Learning (MIIETL). The value of third-party facilitation is that students' participation and responses are anonymous and less likely to be influenced by instructor-led sessions. The third-party facilitator consolidates the results and notes any recommendations.

A2: Instructor-Initiated, Co-Conducted

The original idea and basic structures for the following projects were defined by the staff partners, but the research work was planned, carried out, and the resulting data analyzed by the student partners. The first example here exemplifies the transition between A1 and A2. The final cases are more illustrative of student contributions.

Natural Sciences Laboratory Working Group

In 2015 a group of students on the University of Leicester's Natural Sciences programme wrote a letter to staff raising issues about the laboratory modules related mainly to scheduling, the format and marking of assessments, and the workload. In order to address student concerns, a laboratory working group was assembled. The aim of this working group was to evaluate the laboratory programme and to check the alignment between student and instructor expectations.

The working group took the form of a series of regular meetings between instructors of the course and two student representatives from each of the year groups. The outcome was a series of changes to the laboratory programme that were completely acceptable to staff and manifestly addressed the students' concerns. The group also helped to ensure alignment between student expectations across cohorts: year three and four representatives were very effective at emphasizing the rationale for the structure of the laboratory programme to year one and year two students.

A similar structure is used in the iSci Curriculum Committee at McMaster University. The members (student, staff, and faculty representatives) work together to create informal surveys gathering in-progress feedback to improve the program.

Enhancement of Problem-Based Learning Sessions

The University of Leicester has used Problem-Based Learning (PBL) in its chemistry degree programme since 2007 (Williams, Woodward, Symons, & Davies, 2010). Evaluation has shown that PBL does improve social cohesion (shown by enhanced student retention figures) and that students do appreciate the opportunity to learn how abstract chemical contexts are applied to real situations.

The integration of highly varied assessments in the PBL module has provided the opportunity for first-year students to be trained in a range of workplace and transferable skills. Students tend to appreciate these skills toward the end of their degrees when they may be thinking about applying for jobs or postgraduate study opportunities. But they tend not to appreciate the significance of these skills in earlier years of study and consequently sometimes struggle to relate what they do in years one and two to their professional skills development.

In order to address this issue, in 2014 we set up a student-staff partnership project to help year one students recognize the personal skills they develop during PBL modules. Student partners took responsibility for developing and deploying resources, including reflective questionnaires and video resources, which highlighted how the primary transferable skills developed would become useful towards the end of the degree programme.

In a second project in 2015 a team of student partners contributed to the development of a new PBL module based on the role of chemistry in food security. Student partners were briefed by members of the staff on the scope of the project and the expectations of the external funding body (the Royal Society of Chemistry) supporting the project. The students undertook an open-ended laboratory research project as the basis for the development of a learning activity. This gave these students the opportunity to appreciate the considerations necessary in the development of engaging learning resources. From the staff perspective, involving students provided an opportunity to integrate their suggestions as stakeholders in the new resource.

These two projects were supported by a teaching fellow as a staff partner. It is likely that the success of such projects is enhanced by a staff partner with a deep understanding of the theories of teaching and learning as well as the relevant subject material.

Chemistry Clips - Creation of a Blended Learning Environment

The Department of Chemistry and The Centre for Interdisciplinary Science at the University of Leicester started producing multimedia resources (video and audio clips) for use as part of a blended approach to teaching chemistry in 2011 (Williams, Bird & Davies, 2013). The project was conducted as a student-staff partnership as it was felt that students could identify topics where these resources would be of most benefit and would also be able to help design, produce, and evaluate resources which met student expectations.

Since it was essential that the student partners had a good overview of the content taught in years one and two modules, final year BSc students were recruited as partners. At the start of the academic year these students were briefed on the goals of the project by the blended learning coordinator. They were reminded that student and staff partners would make equal contributions and that they would be expected to contribute to the decision making and evaluation stages of the project, as well as to resource planning and development. Regular meetings of the student and staff partners were held throughout the term.

Students created drafts of the multimedia resources which they shared with staff partners for feedback. Staff partners provided guidance on relevant points of educational theory. Following some modification, the drafts were recorded as screen-capture presentations and distributed to year one and two students via the Virtual Learning Environment (VLE). The resources were evaluated by monitoring student usage (using “Statistics Tracking”) and by questionnaires and focus groups managed by students. Responses indicate that year one and two students value these resources.

From the perspective of the student partners, creating the resources is a useful experience in allowing them to consider familiar course material in a different way. Student partners gain a useful insight in how to present their understanding of scientific concepts in a way that results in productive learning experiences for a diverse cohort of undergraduate students. From the perspective of staff partners, this resulted in a useful set of learning resources and the publication of valuable research outputs (Williams et al., 2013; Williams, Balonwu, Banwaitt & Davies, 2013).

A3: Instructor-initiated, Student-led

The first example is probably the most familiar illustration of student autonomy: the capstone research project. The audience for these is usually internal, although the group research projects in many UK Physics Departments involve interactions with industry (King, 2013), and external partners are common in more applied sciences such as engineering.

As research partners, students can make important contributions to pedagogical research projects. Student partners can provide a user’s insight that instructors may lack. Student partner contributions range from the development of research questions to managing and evaluating a project.

Independent Projects in iSci and Other McMaster Programs

While traditionally structured programmes have long offered capstone thesis projects in the fourth year of undergraduate study, newer examples offer a shorter-term introduction to independent project work at earlier levels of study (Levels 2, 3). Three of the authors have experience with these projects, as well as thesis projects, both within the iSci program and beyond. Projects for credit have ranged from the equivalent of a single course (module) to 4 course equivalents. Since many of these projects involve pedagogical research into the curriculum of a course or program (see for example, Cunningham, Lock, Knorr & Vajoczki 2012; DiPucchio & Lock 2014; Pantaleo & Lock, 2012), they may also appear in the framework as curriculum enhancement activities.

Student Conferences

Synthesis, which began in 2012 and has continued annually at McMaster, is an end-of-year research conference across all years organized by students. It has three purposes. First, it is a model academic science conference. Students plan the sessions, invite speakers, and submit papers which they peer review. Second, it offers students the opportunity to communicate their research in a variety of formats. This includes original research from projects, as well as work outside the curriculum, for example as summer research assistants. Third, the event serves to promote coherence across the cohorts, providing continuity between years such that methods, expectations, and culture are passed down. As a staff-student partnership, students act as junior colleagues in taking responsibilities and receive mentorship in aspects of professionalism that may not be part of the curriculum. The one-day event provides staff with an archive of student data to showcase the program both internally and externally.

A Large-Scale Outreach Event

Each year since 2012, a group of around 25 final-year chemistry BSc students at Leicester conduct some laboratory-based research from which they develop an outreach activity that allows them to disseminate the highlights of their research in a week-long exhibition. The staff partners in these projects provide students with an initial outline of research themes. Weekly progress meetings allow cross-fertilization of ideas between students working in different themes. The outreach exhibition takes place in a local museum at the end of the project. Staff partners take responsibility for booking the venue and notifying local schools, but all other organizational matters are dealt with by the students, including the greeting of visitors and the planning of evaluation questionnaires. The project gives students an opportunity to develop laboratory research skills as well as professional skills, including communicating scientific research to a range of audiences, running a large-scale event, and collecting and analysing evaluation data.

B1: Student-Initiated, Instructor-Led

The collaborations in this category are responses to "Why don't staff do something?" beyond changes to curricula and syllabi. Examples include the provision of lecture recordings. The case below resulted from a wish from undergraduate students to get some insight into current interdisciplinary research in a way that, authentically as possible, mirrors the post-graduate experience.

Undergraduate Research Seminar

Most of our instructors have a research background in a single discipline, and while we may collaborate across disciplines and can talk about interdisciplinary research, our students at Leicester suggested it would be confidence-building to hear from some interdisciplinary researchers from outside the institution. The idea is quite straightforward: several times a year we invite speakers to give a seminar on their research in a form that is accessible to an undergraduate audience. Students from all years attend and meet the speaker afterwards. There is a small associated assignment of a short article or blog post which serves to provide practice in science communication. More recently, we have handed over the organization of some of the talks to year four students, a task which they accepted enthusiastically and from which they have learned a great deal about the practicalities of event management!

B2: Student-Initiated, Co-Conducted

Well-being Initiative

In 2014 a student-initiated mental health in-reach event took place for the first time at McMaster. Students were motivated from their own experiences with stress and mental health issues to create a forum where they could share their experiences with younger cohorts in the same programs. A collaborative team of students and faculty members worked together to create a vision for the event, which centered around three goals: (1) [I]t's okay to talk about mental health; (2) [I]f you are experiencing stress or mental health issues you are not alone; and (3), [L]et's get students connected to resources. Because of the sensitivity of mental health issues and the perception by students of the attached stigma, clear communication among the team members was critical, as was careful facilitation of the group dynamics. Staff from Student Wellness gave critical support to the planning and delivery of the event. The event was hosted by students and with small discussion groups led by senior students. Faculty members were invited to be present at the event to sit apart during the small group discussions and then to join in a large group discussion. Students identified that the presence of faculty at the event was very meaningful to them and was seen as supportive. Students were surprised to learn that faculty had lived with some of the same concerns in their time as students (and in their current jobs). Students and faculty learned to listen to each other's concerns and viewpoints. Faculty members were able to hear about specific concerns related to academics and curricula that were stressful, and they took this information away to consider how to make changes. Student partners also created an evaluation form for event participants and event organizers to collect feedback on the event and the planning process. In 2015 the event was put together largely by students, based on the experience in 2014.

B3: Student-Initiated, Student-Led

The activities in this group are classified as student-initiated and student conducted partnerships as they are largely student conceived and student-led throughout. They demonstrate what a highly motivated and organized student cohort is capable of with a minimum level of support from instructors.

High School Workshop

Originally part of *Synthesis* (see A3 above), the workshop was conceived by students as a way of introducing the iSci program to prospective students based on their own difficulty in understanding the nature of the program. Initially they proposed taking some of the degree coursework and adapting it to a workshop. The staff pointed out the issues with this, and instead students created specific materials for the workshop designed specifically for high school pupils. Instructors play a minor role with regard to laboratory safety and communication.

The project involves around fifteen students a year. Optionally, they can write a reflective essay for credit. The students see this as largely altruistic; the benefit to staff with respect to recruitment is perhaps obvious.

Research Talks

In 2012 the Natural Sciences student society at Leicester decided to respond to a perceived lack of support provided for students wishing to pursue careers in academia. One of the primary aims of this intervention was to create a series of experiences which would demystify the nature of academic roles from the student perspective. The intervention took the form of a regular programme of research seminars delivered by postgraduate and postdoctoral researchers. Researchers at this career stage are only one or two steps ahead of the undergraduate students themselves. The project involved a minimal level of guidance and support from staff. The seminars also benefitted the postgraduate and postdoctoral speakers as it allowed them to gain valuable experience of presenting to a supportive audience. The individual seminars were well attended, and the programme ran for four years as successive student society members took on responsibility for managing the series.

Student Organized Careers Symposium

Following the success of the student seminar series and motivated by the student concerns that most careers events were not sufficiently focused towards Natural Sciences graduates, the Natural Sciences student society decided to create an event that would provide careers information for students who did not have a career in academia in mind. The event took the form of a one-day employability symposium. This involved collaboration with instructors from the course, staff from the University's career development service, course alumni (contacted by student partners via social media), and employers. The organization of the event was student-led with the staff role limited to guidance on some aspects of organization, such as liaising with the catering services and the provision of a small amount of departmental funding.

The event also served to bring back some of the programme's alumni, helping to create an effective student-alumni-staff community.

Developing a Learning Community

Students' active engagement in their learning has long been recognized as a desirable feature of higher education and has been implemented in various ways from project work to Problem-Based Learning. The notion of a student-staff partnership takes this beyond active engagement towards a sense of community (Wenger-Trayner & Wenger-Trayner, 2015). Healey et al. (2014) have emphasized the role of student-staff partnerships in terms of the development of learning communities. There are, however, inevitable "power relations" within that community and different responses to the ceding of control that the notion of partnership is felt to imply. Our framework is designed to recognize how the different facets of that relationship are reflected in the types of collaboration. The framework is intended to provide a structure around which staff-student partnership can be embedded in programmes. If students know that they are making a valued contribution to the development and management of their learning experience, they are more likely to be engaged in the learning process. By embedding student-staff partnerships, staff can begin to recognise the fact that they are co-learners and co-creators of the educational experience (Cook-Sather & Alter, 2011).

The impact of a developmental framework for student-instructor partnerships can be judged by the extent to which it becomes self-sustaining; the extent, that is, to which it changes the culture from, "Why don't you?," to, "Why don't we?" One example has been the revisions to laboratory practice initiated by students discussed in section A2. A more recent example is provided by the approach of McMaster students to one of the consequences of lockdown during the COVID-19 pandemic. The lockdown resulted in the cancellation of the Synthesis conference (section A3). The response from students was to ask to work with instructors to replace this with an on-line version including students from Western University, even though this would no longer count towards assessment.

We hope that the framework may prove of some use as a curriculum development tool in enabling the conceptualization of partnerships as a developmental process. The Leicester team has found it useful in planning the transition to a newer version of the program, somewhat closer in form to the McMaster iSci program, which launched in 2019. For example, module evaluation appears in A1 as essentially the first example of partnership. As much as the goal of obtaining student input into course delivery is a worthy one, the completion of module evaluation forms is scarcely the most collegiate introduction to the concept of partnership. We have therefore introduced a more informal setting for low stakes (or no stakes) student-staff interactions in the form of monthly staff-student lunches. We have also introduced (in A3) a larger element of peer-marking for formative assessment at the start.

Summary

The framework is an ethnographic description of student-instructor partnerships that evolved by examining practice in two example programmes. We judge the result as successful in enabling us to group the wide range of activities in these programmes. In practice, there will be a continuum of autonomy and ownership that may evolve in the course of a partnership, but for the purpose of curriculum design and planning, a discrete description is more helpful. The grouping adopted is fine enough to distinguish different activities and compact enough to be of use.

A given activity may be found in more than one position in the grid. For example, a "research project" may be tightly defined with clear instructions (what might be called a "do this" project) or may be entirely open-ended (a "do something" project). Specifying its position in the grid enables the formation of a view as to the type and extent of the partnership involved. In this respect we feel that the framework will be useful in the description and evaluation of programmes.

The breadth of experiences from two interdisciplinary student-centered programmes at two international institutions illustrates the potential transferability of the framework. It may be argued that such student-centered active learning environments are special cases since students already experience a higher degree of control than in traditional settings. However, with one exception, none of the examples make reference to Project- or Problem-Based Learning. The one exception is a PBL module in an otherwise traditional framework. One might also argue – correctly – that the framework has been reverse engineered: that the activities came first and the framework only afterwards and has therefore been adapted to the particular circumstances of the programmes. It is, of course, true that we developed most of the activities at both institutions prior to constructing the framework. However, it has not been fitted post-hoc to the examples. Rather, the non-uniformity of the representation of examples in each element of the grid (Table 1) enables us now to reflect on the range of our activities and to use such reflections in developing the framework and future planning. We therefore believe that the framework is transferable to other higher education programs.

References

Boud, D., Cohen, R., & Sampson, J. (2001). *Peer learning in higher education: Learning from and with each other*. Sterling, VA: Stylus Publishing.

Cook-Sather, A., & Alter, Z. (2011). What is and what can be: How a liminal position can change learning and teaching in higher education. *Anthropology and Education Quarterly*, *42*(1) 37–53. doi:10.1111/j.1548-1492.2010.01109.x

Crouch, C. H., & Mazur, E. (2001). Peer Instruction: Ten years of experience and results. *American Journal of Physics*, *69*(9), 970–977. doi:10.1119/1.1374249

Cunningham, N., Knorr, K. J., Lock, P. E., & Vajoczki, S. L. (2013). Breaking down the boundary between high school and university chemistry. *Collected Essays on Learning and Teaching*, *6*, 65–70. doi10.22329/celt.v6i0.3784

DiPucchio, R., & Lock, P. E. (2014). *Transforming the development of inquiry skills: To what extent does participation in an inquiry course enhance the development of inquiry skills as opposed to other inquiry-based opportunities?* Paper presented at the 34th Conference of the Society for Teaching and Learning in Higher Education, Kingston, ON.

Gretton, S. N., Harvey, C. T., Williams, D. P., Hurkett, C. P., Symons, S. L., & Raine, D. J. (In-press). *Revisiting the Research-Teaching Nexus Framework: Two case studies introducing research into programme level, undergraduate teaching*.

Healey, M., Flint, A., & Harrington, K. (2014). *Engagement through partnership: Students as partners in learning and teaching in higher education.* York, UK: Higher Education Academy. Retrieved from https://www.heacademy.ac.uk/engagement-through-partnership-students-partners-learning-and-teaching-higher-education

Hurkett, C. P., Symons, S. L., Gretton, S. N., Harvey, C. T., Lock, P. E., Williams, D. P., & Raine, D. J. (2018). The benefits of sustained undergraduate inter-programme collaborations between international partners. *Journal of Learning and Teaching in Higher Education*, *1*(1), 31–42. doi:10.29311/jlthe.v1i1.823

King, J. (2013). *Group industrial projects*. Institute of Physics. Retrieved from

https://www.birmingham.ac.uk/Documents/college-eps/college/stem/group-industrial-projects.pdf
McDermott. L. (1996). *Physics by inquiry: An introduction to physics and the physical sciences*. Hoboken, NJ: John Wiley & Sons.
McMaster University. (2019). *Honours Integrated Science Program*. Retrieved from https://www.science.mcmaster.ca/isci/
Moog, R. S., & Spencer, J. N. (Eds.) (2008) Process Oriented Guided Inquiry Learning (POGIL). Washington, DC: ACS Publications. doi:10.1021/bk-2008-0994
Pantaleo, A. N., & Lock, P. E. (2012). *Integrated, inquiry-based laboratories in chemistry and integrated science (iSci): Do the benefits of crossing the boundaries outweigh the costs?* Paper presented at the 32nd Conference of the Society for Teaching and Learning in Higher Education, Montreal, QC.
Raine, D. J. (2019). *Problem-based approaches to physics*. Bristol, UK: IOP Publishing. doi:10.1088/2053-2563/ab3803
University of Leicester. (2019). *Natural sciences at Leicester*. Retrieved from https://le.ac.uk/natural-sciences
Wenger-Trayner, E., & Wenger-Trayner, B. (2015). Introduction to communities of practice. Retrieved from https://wenger-trayner.com/introduction-to-communities-of-practice/
Williams, D. P., Balonwu, M., Banwaitt, M., & Davies, D. L. (2013). Using multimedia resources to facilitate peer-teaching. *Proceedings of Eurovariety 2013*, 61.
Williams, D. P., Bird, T., & Davies, D. L. (2013). Multimedia resources for teaching chemistry. *New Directions in the Teaching of Physical Sciences*, *9*, 18–23. doi:10.29311/ndtps.v0i9.482
Williams, D. P., Woodward, J. R., Symons, S. L., & Davies, D. L. (2010). A tiny adventure: The introduction of problem based learning in an undergraduate chemistry course. *Chemistry Education Research and Practice*, *11*(1), 33–42. doi:10.1039/C001045F
Williamson, M. (2013). *Guidance on the development and implementation of a Student Partnership Agreement in universities.* Edinburgh: Sparqs Retrieved from https://www.sparqs.ac.uk/ch/Student%20Partnership%20Agreement%20Guidance%20-%20final%20version.pdf

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