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Developing teamwork in a multidisciplinary, multicohort curricular context: A case study of vertically integrated projects

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Developing teamwork in a multidisciplinary, multicohort curricular context: A case study of vertically integrated projects

Abstract

The ability to work effectively in a diverse team is a valuable skill which is transferable to many contexts. As such, it is important to build this skill through deliberate, targeted, and meaningful learning activities in higher education. The Vertically Integrated Projects (VIP) model enhances team diversity by combining students from different disciplines and years of study to work together on a research project within the curriculum. Additionally, VIP provides the option to remain on the project for an extended period over several semesters and gain team leadership experience. Our research investigates the recent implementation of VIP at the University of St Andrews. Using a survey of student perceptions and analysis of student reflective writing, this case study reports evidence that the VIP model adds value to the development of teamwork skills.

Practitioner Notes

1. Collaborative research in diverse teams is perceived by students to generate value added relative to more traditional team assignments.
2. Students find it useful to collaborate across different years of study and different disciplines.
3. Teamwork skills take time to develop, therefore facilitating team projects over longer periods is likely to be beneficial.
4. Team based activities designed to deliver research outputs are perceived by students as more desirable than team assignments designed primarily for assessment purposes.
5. Research based learning in teams provides students with opportunities to be creative, exercise agency and develop their interpersonal skills.

Keywords

teamwork, teamwork skills, transferable skills, interdisciplinary

Introduction

There is a well-documented, significant shift towards the collective production of research across academic disciplines over more than five decades. Evidence presented by Wuchty et al. (2007) demonstrates that the model of the solitary scholar advancing knowledge is becoming increasingly rare, especially in science, engineering and the social sciences. Not only is there a trend for more papers to be written in teams across nearly all subfields, but the average team size has also grown with corresponding benefits for research impact. In the arts and humanities, Wuchty et al. (2007) found that while the single author model dominated, there is still a positive trend towards teamwork, albeit growing more slowly than elsewhere in the academy. In learning and teaching, the Vertically Integrated Project (VIP) initiative is designed with the explicit intention of involving university students, at all levels of study, in this rising propensity towards team-based research and collaborative knowledge creation.

The VIP model was pioneered by Ed Coyle, an engineer at Georgia Tech (Marshall et al., 2014). It facilitates students working together on credit-bearing research projects. The VIP teamwork model differs from standard undergraduate team assignments in several important respects. First, the focus of collaboration is primarily that of open-ended research activity in an ongoing project which may continue for many years. Although students are assessed on their outputs, teamwork is not limited to the joint production of assessed work such as an essay or presentation for which the collaborative experience is typically of relatively short duration. Rather, the model is that of a research team working together throughout the semester with opportunities for students to remain on the project for subsequent semesters if that is feasible within curricula constraints. Typically, the VIP research team will meet with the supervisors for one to two hours each week to discuss the challenges of the project and prepare the next steps. Students will also meet regularly to progress their tasks outside of timetabled classes. Second, the composition of student teams is diverse and highly unusual in that it permits students to participate from different levels of study (the vertical dimension) and different degree programmes. This enables students to engage in research at an early stage of their university career, to interact with peers from a mix of disciplinary perspectives and academic cohorts, and to benefit from a range of expertise and skills spread across team members.

VIP is expected to provide a more authentic experience of not only academic research teams but also the collaborative social environments which arise in nearly all professional workplaces and the teamwork skills which graduate employers frequently screen for in their selection processes (Betta, 2016). While the intentional development of teamwork capabilities is now common across higher education, for some undergraduate students much of their experience of collaboration is still derived from extracurricular activities rather than through the curriculum itself. Where team assignments are provided, they tend to bring together students on the same programmes at the same level of study.

VIP was first introduced into the British higher education system in 2012 by Stephen Marshall at the University of Strathclyde (Strachan et al., 2019) who also provided advice and guidance for the subsequent start-up in the curriculum at the University of St Andrews in 2020. While there are only two VIP sites in the United Kingdom, the VIP model had been adopted by 43 universities across 12 countries by 2021 with most located in the United States (VIP Consortium, 2022).

Existing research on VIPs

There exists a small literature on team dynamics in VIP. Within the constraints of the article length, there is no space to survey the vast teamwork literature nor to address the unresolved debates on the value of team assignments in higher education (see Thom, 2020). We restrict ourselves to citing research on VIP and a few selected papers closely related to our discussion.

Research from Georgia Tech on teamwork in VIP illuminates some aspects of collaboration in this context using the method of social network analysis. Melkers et al. (2012) employed a repeated student survey and network analysis of the data to investigate the extent of knowledge flows within and between VIP teams in a longitudinal study in the spring semesters of 2010 and 2011 at Georgia Tech and Purdue University. Social learning can arise not only from observing what peers are doing but also from directly consulting them in the form of requests for advice or information. The authors found that the average student VIP participant consulted between two and three other students for advice. Student interactions not only concerned technical issues but also addressed the research process and team management and occurred between students at different levels of study but more strongly between students at the same level. Using regression analysis of various skill measures, the results showed that the more advice that was sought, the greater the learning in terms of self-evaluated skill acquisition for technical capabilities, project planning, collaboration across disciplines and resolving disagreements. Longer participation on the project was also found to be skill enhancing.

Sonnenberg-Klein et al. (2017) report a Georgia Tech exit survey showing that participants in VIP were more able to work in a multidisciplinary team and more able to work with individuals from diverse backgrounds compared to non-participants. Using social network analysis based on data from a peer evaluation tool, they investigated these teamwork and diversity benefits across 24 VIP teams. The key findings were that students interacted on average more with students from other degree programmes than from their own programme. There was a significant correlation between a shared degree programme and close student interactions for only one quarter of the teams. With respect to diversity, students had more interactions with peers of other ethnicities than their own though this was not the case for gender or domestic/international student status. In a related study, Sonnenberg-Klein et al. (2018) looked at help seeking and help giving patterns for 34 multidisciplinary VIP teams at Georgia Tech. Firstly, they found meaningful collaboration across disciplines in that, on average, students looked for assistance slightly more often (and substantially more often in 37% of cases) from students in other degree programmes than from students in the same degree programme as their own. Secondly, higher level students and those with more experience on the VIP gave more help as they typically had more to give. Thirdly, students with longer experience on the project provided more leadership in terms of being engaged with team progress and tackling team problems.

Research aims and data

The aim of this paper is to study student feedback on, and perceptions of, their experiences of collaboration and the development of teamwork skills within the context of VIP at St Andrews. The research question of interest is the extent to which the novel multi-level and multi-disciplinary composition of student teams, and the opportunity for multi-semester participation, adds value to the development of teamwork skills. It should be noted that the authors are all directly involved in the VIP programme as project supervisors and in directing and administering its delivery. We begin by describing briefly the implementation of the VIP model at St Andrews and documenting the

participation of students and staff. We then investigate three sources of evidence on teamwork. The first is the feedback received from students on their perceived professional skills development as reported in their end-of-semester module evaluations. Second, we analyse the results of an online survey instrument which was distributed to all currently enrolled VIP students and designed to collect more detailed data on their perceptions of their collaborative activities. Third, we complement these quantitative data sources with a brief review of qualitative information on teamwork experiences distilled from weekly reflective logs and final reflective reports composed by students in one of our VIPs. To the best of our knowledge, this is the first mixed methods study of the VIP model.

VIP Implementation at St Andrews

In its pilot year, the St Andrews' VIP programme started small with five projects and 27 students in Semester 1 of 2020-2021, growing to eight projects and 69 students the following semester and 10 projects with 56 students in Semester 1 of 2021-2022 and 13 projects and 112 students in Semester 2. To aid staff and students with planning, projects are advertised to all students in the middle of the preceding semester with the aim of completing recruitment by the end of the semester. This timing precludes first-year students from participating in VIP in their first semester of study. It is typical for projects initially to have a team size of 6-12 students with scope to grow larger as they mature. This scale permits supervisors and students to acclimate to the VIP model and fosters student experience of collaborative academic research, whilst also keeping team sizes manageable for supervisors. The minimum recommended team size also makes it more likely that some students will remain on the project beyond one semester and can mentor new team members. Students are required to apply for individual projects, explaining their motivation and interest in the project and potential contribution to the team. Applications are screened by the project supervisors who have discretion to choose their team members based on the needs of the VIP and the passion and quality of the applicants.

Table 1: Host Schools/Units and number of supervisors participating in VIP

School/Unit	**Number of VIPs hosted by a School/Unit**	**Number of Supervisors provided by a School/Unit**
Economics & Finance	1	2
Biology	2	4
International Relations	2	2
Film Studies	1	1
English	1	2
History	2	5
Mathematics	1	2

Geography	1	1
Classics	1	1
Social Anthropology		2
Computer Science		2
Centre for Educational Enhancement & Development	1	2
Careers Centre		1

Note: the supervisor numbers combine academic years 2020-2021 and 2021-2022.

In practice, at the University of St Andrews, team sizes have varied between two and 13 students with an overall average of eight students per project. The distribution of the projects across nine hosting Schools and one Unit, and the 13 Schools/Units supplying supervisory input is tabulated in Table 1 and combines both academic years. Despite the slower pace at which academic disciplines in arts and humanities have generally embraced collaborative research, it is notable that more than half of the VIPs (8) and supervisors (15) are hosted within these academic fields. This is an unusual distribution compared to VIP programmes elsewhere which are typically dominated by STEM research areas. While most supervisors contribute to a project hosted within their School, there are supervisors who lend their disciplinary expertise outside of their home School/Unit to form a multidisciplinary supervisory team. For example, one of the supervisors from Mathematics worked on the VIP developed in History and a supervisor from Computer Science contributed to two VIP teams hosted elsewhere.

Table 2: Distribution of the shares of VIP enrolments by academic level (four semesters)

Level	**1**	**2**	**3**	**4**	**5**
Student enrolment share (%)	6.8	35.6	26.1	29.2	2.3

With respect to student participation by academic level of study, the shares of 264 student enrolments across four semesters of VIP at St Andrews are shown in Table 2. The share is smallest at 2.3% for postgraduate taught students (level 5) as their programmes typically do not have credit space to accommodate VIP. First year student enrolments are also relatively low (6.8%) as they only have access to VIP in the second semester and have missed out on the main VIP recruiting round which occurs towards the end of the previous academic year. The largest share (35.6%) is for students in the second year of their degree programme who may not otherwise have access to research-based learning. All projects have students from at least two different levels of study and a mix of degree programmes.

Module Evaluation Questionnaires (MEQ)

To assess the impact of VIP on professional capabilities, we augmented the standard university end of semester MEQ with a set of 11 items designed to elicit the extent to which students considered they had developed their transferable skills through VIP. The prompt given read, "I was able to develop the following enterprise capabilities on the VIP module". The reference to enterprise reflects the introduction of VIP under the auspices of an enterprise education initiative introduced in response to the enterprise component of the university's five-year strategy (2018-2023). Students were invited to respond on a five-point Likert scale where 1 indicated strongly agree and 5 strongly disagree. Aggregating the results across the three completed semesters of VIP, we have a sample of 77 responses (a response rate of 51%). The average (mean) scores for each skill category, weighted by the number of responses each semester, are presented in Table 3.

Table 3: MEQ responses for the development of capabilities in VIP modules

I was able to develop the following enterprise capabilities on the VIP module	**Weighted average response** **1= strongly agree...5 = strongly disagree**
Communication	1.4
Teamwork and collaboration	1.4
Ability to reflect	1.6
Time management	1.6
Recognition of opportunities to contribute to the project	1.7
Project management	1.7
Task planning	1.7
Critical thinking	1.7
Interpersonal skills	1.7
Creativity and innovation	1.8
Leadership	2.0

Note: The results were derived from MEQs completed across three semesters (both semesters of academic year 2020-2021 and Semester 1 of 2021-2022).

As these are self-reports rather than measures of learning outcomes, they provide an indicator of student perceptions of skill development and their overall rankings. The capabilities are ordered in the table according to the extent to which respondents considered they were enhanced by their

experience on the project. A smaller number indicates greater enhancement. On average, students agree that all 11 skills benefited from significant development given that a response of 2.0 corresponds to the category "agree" on the Likert scale. Students identified the closely related skills of communication and teamwork and collaboration as the capabilities which witnessed greatest benefit and the categories of leadership, creativity and innovation slightly less but by no means unenhanced.

Overall, our MEQ student feedback suggests that the VIP cohorts perceive their training to have developed their teamwork and research abilities more than the other listed professional skills. Perhaps this outcome is no surprise in an active learning, project environment designed around sustained social interaction and peer cooperation in a team context. The results, however, are not informative on the student experience of teamwork and its components or how it compares to teamwork in a traditional curricular context.

Graduate Attributes

In 2020, the University of St Andrews introduced a new set of 20 Graduate Attributes (see https://www.st-andrews.ac.uk/careers/improve-your-skills/graduate-attributes/). To provide data at module level on the extent to which students considered they had developed these attributes within the curriculum, a new item was introduced in the MEQ round for Semester 1 of academic year 2021-2022. This asked each student respondent to select the five attributes from the list of 20 which they perceived to have enhanced the most within the module. The combined results for VIP modules are described in Table 4. The two attributes which students considered they had developed the most are "Effective team contribution" and "Research skills and problem solving", each selected by just over three out of four students as among their five attributes. Even though the sample size was only 22 students (39% of the cohort), it seems clear that collaborative skills, alongside research skills more generally, are perceived by the students themselves to be the two attributes most strongly cultivated by VIP. It is important to interpret the results with caution. For example, the 0% scores for the categories of Numeracy and Diversity Awareness do not necessarily mean that these attributes were not at all enhanced by participation in VIP. Rather, it is that these skills do not appear in the five skills most developed by any of our respondents because other attributes were considered relatively more important. For example, we have other evidence from student reflective writing which shows that, as a result of their VIP experience, students learned to recognize the value of diversity and to appreciate the benefits of different perspectives for improving project outputs.

Table 4: Student selected Graduate Attributes (% of students selecting each attribute), Semester 1, 2021-2022

Graduate Attribute	**%**
Effective team contribution	77.3%
Research skills and problem solving	77.3%
Technical and specialist academic skills and disciplinary knowledge	59.1%
Confidence and adaptability	50%

Self-awareness and reflection	40.9%
Interpersonal skills	36.4%
Oral communication	22.7%
Socially responsible	22.7%
Creativity	22.7%
Leading others	18.2%
Resilience	13.6%
Organisation	9.1%
Digital literacy	9.1%
Influencing and negotiation	9.1%
Networking	4.5%
Recognition of opportunities	4.5%
Commercial and business awareness	4.5%
Written communication	4.5%
Diversity awareness	0%
Numeracy	0%

Teamwork Questionnaire

To augment the findings from the MEQs and to address our research questions directly, we invited responses to an online questionnaire which was made available to students enrolled in VIP modules towards the end of Semester 1 of the 2021-2022 academic year. The survey ran for three weeks and elicited 22 responses from the 56 enrolled students (response rate of 39%). The survey was anonymous and did not identify the specific VIP project to which the respondent belonged. Since students self-selected to complete the questionnaire there inevitably remains a degree of uncertainty over whether the respondents are representative of the entire VIP cohort.

Table 5: Number of student collaborators in teamwork

Number of students with whom respondent engaged in teamwork in the VIP	Number of responses
0	0
1	1
2	4
3	4
4	5
5	1
More than 5	7
Prefer not to say	0

The first section of the questionnaire collected contextual data on the respondents and their teamwork experience. The responses indicate that half of the sample had already participated in VIP in the previous academic year. Only five students (23%) had not previously been exposed to teamwork elsewhere in the curriculum. Table 5 reports, for each student, the number of peers with whom they had engaged in teamwork in their VIP. There is a range of responses from one collaborator to more than five with half the students engaging with at least four other team members.

In the second section of the questionnaire, the students were invited to identify their degree of agreement with a sequence of 16 statements relating to teamwork on an ordered scale with four options from Strongly Agree to Strongly Disagree and a non-applicable category. In the discussion which follows, we report percentages for the combined Agree and Strongly Agree response categories for ease of interpretation. The responses are summarized in Table 6.

The teamwork results confirm the MEQ findings that most respondents (91%) report that participation in VIP has benefited their teamwork skills. This included the ability to help other team members (87%). Indeed, the opportunity to engage in teamwork and strengthen capabilities is identified by 72% of students as an attractor to participating in VIP modules and 96% affirm that their experience of teamwork in VIP has been beneficial for their learning. The importance of communication (100%), coordination (91%) and collaboration (77%) as well as meeting other team members outside of class (91%) strongly confirms the centrality of meaningful collaboration in the VIP experience. Opportunities for leadership roles are more mixed with 63% agreeing that they have developed their leadership skills, consistent with the lowest ranking of leadership among the list of capabilities in the MEQ results reported in Table 3.

There are three dimensions of VIP which distinguish it from standard teamwork, namely its interdisciplinary, multi-generational and multi-semester structure. In a vertically differentiated context, the expectation is that more experienced students can guide others and gain leadership, mentoring and project management skills. In an interdisciplinary team, students can contribute a wider range of complementary specialised skills to the benefit of the team and the project. In a multi-semester project, students have opportunity to acquire greater proficiency in their research skills including collaboration.

We asked students whether they agreed it was useful to collaborate with students in different years of study and from different disciplines and received positive responses in 77% and 73% of cases respectively. There was slightly stronger intensity of agreement regarding the utility of interdisciplinary teamwork (41% strongly agree) compared to the vertical dimension (32%). With respect to the opportunities to remain on the project for more than a single semester, 90% agreed that longer durations were beneficial for the development of their teamwork skills. One multi-semester respondent, who strongly concurred, submitted the following free-text comment comparing their teamwork experience in VIP to other modules:

> VIP allows you to develop teamwork skills within a long-term environment. I think teamwork is valuable in other modules. However, you never really get the opportunity to develop your teamworking skills. Working over a longer time period exposes you to more teamworking challenges that need to be overcome and therefore allows you to develop skills to a much greater degree.

Table 6: Distribution of responses to the teamwork questionnaire statements

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Applicable
"I have some specialist skills which are useful for my VIP team"	8 (36%)	13 (59%)	1 (5%)	0	0
"I think participation in VIP has been beneficial for my teamwork skills"	11 (50%)	29 (41%)	2 (9%)	0	0
"Participating in VIP allowed me to develop my skills in helping other team members"	5 (23%)	14 (64%)	2 (9%)	0	1 (5%)
"I've had opportunities to develop leadership skills in my VIP experience"	6 (27%)	8 (36%)	6 (27%)	0	2 (9%)

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"I was partly attracted to VIP by the opportunity to engage in teamwork"	8 (36%)	8 (36%)	4 (18%)	2 (9%)	0
"I think my experience of teamwork in my VIP has been beneficial for my learning"	9 (41%)	12 (55%)	1 (5%)	0	0
"Coordinating my work with that of other students in my VIP is important"	11 (50%)	9 (41%)	1 (5%)	0	1 (5%)
"Communication with other team members is important in my VIP"	16 (73%)	6 (27%)	0	0	0
"Meeting other team members to discuss VIP work outside of class is important in my VIP"	12 (55%)	8 (36%)	2 (9%)	0	0
"I have experienced a lot of collaboration with other team members in my VIP"	10 (45%)	7 (32%)	4 (18%)	1 (5%)	0
"Collaborating with students in different years of study has been useful for me in my VIP"	7 (32%)	10 (45%)	5 (23%)	0	0
"Collaborating with students in different disciplines or degree programmes has been useful in my VIP"	9 (41%)	7 (32%)	2 (9%)	4 (18%)	0
"My teamwork experience in VIP will be beneficial for my employability"	10 (45%)	8 (36%)	2 (9%)	0	2 (9%)
"The opportunity to participate in VIP for more than one semester helps me to develop my teamwork skills"	10 (45%)	10 (45%)	0	0	2 (9%)
"Reflective writing in VIP has helped me to understand my role in the team better"	2 (9%)	9 (41%)	5 (23%)	2 (9%)	4 (18%)

"Reflective writing in VIP has helped me to work more effectively as part of a team"	4 (18%)	6 (27%)	6 (27%)	3 (14%)	3 (14%)

Note: Calculated percentages may not sum exactly to 100% due to rounding.

To elicit more qualitative feedback, the survey design invited students to submit free-text responses which directly compared their experience of teamwork in VIP with that in other modules. Several responses commented that the small team sizes in VIP relative to larger teams in conventional modules and the tight-knit nature of VIP teams allowed more readily for collaborative opportunities. It is worth noting that larger VIP project teams are often, formally or informally, divided into smaller sub-teams for specific tasks. For example, a project team of six students may split into sub-teams of 2-3 students which may create a more intensive teamwork experience.

The student free text responses identify several other sources of VIP value added for their teamwork experiences in addition to the multiple semester benefits. First, participating in a team research project gives students the agency to plan and be creative in executing research tasks together. One respondent noted:

> In those [non-VIP] modules we were placed in groups and expected to carry out tasks, in the VIP we choose who to work with and plan our own work.

Another commented: ‘It is more free-flowing and invites creativity’.

Second, the consistency and intensity of team activity throughout the semester maximizes the opportunity to develop collaborative skills, especially as the team activity and project tasks are not always directly tied to summative assessments. The contrast with other teamwork experiences is noticed by students:

> Furthermore, teamwork in other modules is somewhat basic because realistically you work in a team for 2 weeks and then submit your assignment, never to see those people again.

> Teamwork in other modules is often brief, for something like putting together and giving a presentation. It's generally something we've done many times before and know exactly what to expect.

It should be noted though that degree programme credit requirements and other student curricular interests mean that some students only spend a single semester on VIP and this constrains the benefits of continuity in terms of peer mentoring and the development of leadership skills.

Third, students are exposed to team members from different disciplines and years of study, providing resources from which to learn and raise both productivity and enjoyment from collective working. To quote a couple of free text comments:

> In VIPs, we collaborate with people with very different skill sets (different years, different subjects), and our projects are multifaceted, unfamiliar, and throw curveballs we have to learn how to deal with, which other modules don't tend to have.

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> Most of my other modules at university has had some element of teamwork, but I think what differentiates the teamwork experience in the VIP is working with team members from different disciplines. Being exposed to different perspectives and ways of thinking about an issue has enhanced my understanding of the subject area.

Fourth, teamwork often faces practical problems of coordination of schedules and tasks and incentives to free ride rather than deliver for the team and VIP is no exception. Screening of students through an application process and student self-selection based on passion for the project and a prior understanding that the project is team-based may help to mitigate individual free riding incentive problems to some extent but not entirely. Comments consistent with this observation include:

> In other modules people are not as passionate about the topics, so in VIP I have more trust that other people will do their part, because they are equally engaged in the project. Therefore, it is less stressful and more focused on creativity in approaching the topic.

> Teamwork in other modules has been forced - there were people who did not want to engage with the project and were only in the team because it is a mandatory component of the assessment. In contrast, everyone on the VIP applied to join the project so there is much better collaboration and a general willingness to contribute.

Weekly Reflective Logs

Our final qualitative data source is that of student reflective weekly logs and final reflective reports. These provide further insights into the dynamics of acquiring teamwork skills and how these may progress according to the stage of the project and the size of the team. The results in the final two rows of Table 6 suggest that respondents to the teamwork questionnaire held rather mixed views on whether the reflective writing process itself helped them to develop their collaborative skills. Still, the student reflections provide the researcher with access to information on student perceptions of the team building process.

Analysing student reflective writing is a method occasionally used in the literature to study teamwork and collaboration. A recent example is the research by Bashan and Holsblat (2017) who investigated the reflective journals of Israeli student teachers as a source of qualitative data. In their phenomenological study conducted over three years, the researchers read the journals of 36 student teachers (12 each year) and identified common themes related to teamwork. They found that teamwork develops in seven stages which correspond to a model of team performance in the business context constructed by Drexler et al. (2009) which we also find useful.

We analysed 23 reflective journals and 23 reflective reports produced by student members of a single Vertically Integrated Project (HMO Caps in St Andrews). Hosted within the School of Economics and Finance, the participants comprised students on degree programmes in (Financial) Economics and joint degrees in Economics and either Management, Geography, Mathematics or Statistics. The logs and reports cover three semesters in which the enrolments were six, 13 and four students respectively and no student remained on the project for more than two semesters. Every week students were asked to reflect in their log for about 300 words on their contributions to the project, what worked well as well as the challenges and lessons they have learned over the past week. The logs are seen only by the supervisors. The VIP gave students significant autonomy to divide the workload, allocate roles and decide the direction of the project. As student enrolments and the composition of the team varied across semesters, this permitted the supervisors to observe how team

dynamics and students' learning experiences varied with team size and over time. We will provide a brief summary of the key findings rather than extensive quotations.

Evidence from the reflective logs shows that at the beginning of each semester, whether the project had only new team members or was composed of a mix of new and continuing students, there was uncertainty about the direction of the project and individual roles within the team. Students found themselves out of their comfort zones, and some were anxious and unsure. At the same time there was general excitement about the project and initial concerns were soon eased. Even in the larger team, the students rapidly gained familiarity with other team members and acquired greater clarity about their individual roles. At this point, sub-teams were formed to address specific aspects of the research project. Consistent with the findings of Bashan and Holsblat (2017), student reflections aligned well with the first three stages of the Team Performance Model of Drexler et al. (2009), namely: Orientation (Why am I here?), Trust Building (Who are you?) and Goal/Role Clarification (What are we doing?). These stages culminated in the Commitment (How?) stage which then led to the Implementation (Who does what, when, where?) stage. Although challenges with communication and collaboration arose throughout the semester, it was towards the end of the semester, as the complexity of the project increased, that these concerns became more pronounced. Unresolved communication issues clearly led to frustration and pressure on team members though they were able to reflect on the obstacles and take actions to resolve them and improve the efficiency of their communication and coordination. Stage six – High Performance (WOW!) typically occurred towards the conclusion of the semester as students worked on deliverables and were highly motivated to bring the project goals to fruition. At this point, efficient communication and an active student leader to coordinate joint work became especially decisive. At the end of the cycle, the teams took stock of what had been achieved and reflected on the process. Their focus switched to preparing for the next semester and the future of the project. This is consistent with the Renewal (Why continue?) stage of the model.

We have five further observations on teamwork in VIP from our reading of the student reflections. First, coordination of a larger team is more complex and presents more communication challenges but equally the problem solving required to overcome these provides more opportunities for learning about effective collaboration and leadership. Second, the multigenerational construction of teams raises novel concerns for students. Although all students may feel insecure at the beginning of the project, their anxieties are tailored to their level of study. Junior students expressed doubts about their ability to contribute to a project in a team including more senior students. By contrast, some of the more senior students felt internal pressure to perform at a higher level. Third, the multi-semester set-up with student turnover between semesters entailed students remaining on the project were concerned about their responsibility to induct new team members while new recruits worried about catching-up and having something to offer at an early stage. These early anxieties dissipated over time as the roles and project direction became clearer and students became more confident and positive about being able to contribute to the project. Fourth, in all three semesters, there was clear evidence of peer learning, both among existing members and new arrivals benefiting from the support of more experienced team members. Fifth, the autonomy given to students inevitably generated negotiation over preferred research strategies and direction. Students whose suggestions prevailed expressed contentment; those who were less successful faced learning to cope with frustration and disappointment.

Conclusion

The VIP model is designed to bring students together from different levels of study and disciplines to participate in an ongoing research project over a sustained period. Our quantitative and qualitative data analysis suggests several core messages.

First, cooperative research in diverse teams is perceived by students to generate value added, relative to standard team assignments, in terms of the acquisition of teamwork skills which transfer to other collaborative contexts beyond the classroom. Second, an important source of this value added is mixing students from different academic disciplines and years of study. The diversity brings students together with differentiated skill sets and perspectives which enrich and strengthen project activities. Third, students who remain on the project for more than a single semester have more to offer and to gain not only in terms of mentoring and leadership experience but also the research skills which benefit from longer duration on a project. Fourth, working together in a longer-term research collaboration is preferred by students to the traditional approach to teamwork which asks students to write a short assessed assignment in a small team. Fifth, research-based learning provides students with the space to be creative, to build confidence and develop their communication and teamwork skills in a supportive environment. Given that the research process inevitably involves learning in an open-ended, uncertain context, students experience the need to exercise agency, to learn from their mistakes, to cope with difficult problems and to explore solutions without this process being costly for their academic grades.

The VIP implementation at St Andrews has only completed three semesters at the time of writing and the results are necessarily tentative but promising. There are some limitations of the study. As Thom (2020) points out in his critical survey of research on collaborative learning in higher education, the use of small samples of student self-reports as outcome measures is not as persuasive as peer or supervisor evaluations or more objective skill development indicators. Moreover, in the absence of treatment and control groups for evaluating the impact of a teamwork intervention such as VIP, it is not possible to identify causal effects. There is clearly plenty of scope for further research.

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