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VIP Approach at the University of Strathclyde:

A Pilot Evaluation Report 2015-16

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Abstract: *The potential for enhanced knowledge creation through collaborative group effort has been reasonably well established within educational discourse. This stands in direct contrast to former traditional models, where knowledge was treated as a transmitted commodity from ‘expert’ to ‘student’. Such transmission models have long been viewed as broadly ineffectual, especially as regards the teaching of primary Science, Technologies, Engineering & Mathematics (STEM) subjects. The Vertically Integrated Project (VIP) approach may offer pedagogical advancement in terms of STEM teaching and learning in Higher Education (HE).*

Established within the University of Strathclyde some five years ago, an initial University-wide evaluation of the programme was piloted in Session 2015-16. Students’ perceptions of their participation in VIP generally very positively reported within the pilot evaluation. Key messages centred on students’ perceptions of the benefit of participation in the unique collaborative real-world study afforded by the VIP approach and their desire for the programme architecture to expand even further both laterally and vertically across the University.

Informed Change in STEM Pedagogy

The case supporting enhanced knowledge creation through authentic collaborative group effort in Science, Technology, Engineering and Mathematics (STEM) Education at a pre-tertiary institutional level has been reasonably well established within research discourse in the UK and Scotland in recent times (Harlen, et al, 1995, HMI, 1999; HMIE, 2005; HMIE, 2007; Scottish Government, 2008;

Harlen, 2008, Royal Society, 2012). This has been in direct contrast to former (traditional) models, where knowledge was treated as a transferable commodity transmitted didactically from 'expert' to 'student'. Such transmission approach may now be widely held as a weak and ineffectual pedagogical form which lies in direct contrast to approaches favouring learners' construction of relevant knowledge and skills through collaborative participation in solving real world problem – based contexts. Additionally, approaches known to facilitate transformational learning of this kind while simultaneously adopting a study dynamic which has sought to deliberately blur the traditional boundary between 'expert' and 'student' has also been suggested as a more efficacious pathway to generating deeper forms of STEM subject knowledge and skills acquisition in learners (SSEAG, 2012).

Whereas formalised policy encouragement towards the open co-construction of knowledge education has been readily adopted by key proponents of best practice in pre-tertiary STEM teaching and learning across the UK (Harlen, 2008; Scottish Government, 2009), it has been argued that challenges have remained in establishing a similarly optimal format for supporting equally socially collaborative and sustainable forms of STEM learning for some students in tertiary level Higher Education (HE) (Collins & Chambers, 2013). Of course, theoretically, it could be argued that such a structure may emerge as part of a naturally occurring professionally collaborative and

evolutionary process in HE STEM Education generally, as provision weaknesses are naturally identified and then addressed within and across University institutions (Hargreaves, 2000). Equally, it may be possible to envisage that pedagogical evolution in this way may even be of preference to

many already teaching within the HE environment, as it may be held to engender professional and curricular development free from what may be viewed by many as the general imposition of unwanted extraneous authoritative structures (Christie et al, 2007). Pedagogical development of this kind however, although likely to ultimately herald enhanced provision, may leave large questions regarding such a process' ability to match the expediency of change inferred as essential in current national strategic policy across the panoply of national STEM Education provision (SSEAG, 2012).

In addition to a potential lack of expediency, it has also been recognised that intra-professional collaboration that occurs solely within any bounded individual educational conclave carries the danger of generating only a limited and narrowed local introspective regarding the generation of new knowledge and pedagogical practice (Hargreaves, 2000; Sachs, 2003). On the other hand, impactful development at a national or global level have often borne requirement for establishing shared understanding capable of fostering accelerated change within both individual local learning environments and across a much wider collaboration of policy, teaching and research institutions (Wilson et al, 2007). It would seem at least intuitively correct then, to propose that an approach format capable of accelerating naturally evolving localised professional pedagogical improvements,

while simultaneously involving enhanced collaborative contribution more widely - both within and across - policy, teaching and research institutions, may perhaps be preferable for optimum knowledge generation. It is perhaps with such considerations in mind that advice informing current national policy in Scotland has suggested the relevance in STEM-focussed educational institutions to consider fostering innovative pedagogical infrastructures to help develop authentic learning

provision for learners which is capable of supporting deeper creative learning and ultimately international competitiveness in STEM-related fields (SSEAG, 2012).

A Model for Change in STEM Pedagogy

From an international perspective, report related to Vertically Integrated Projects (VIP) programme (Coyle, 2006; Abler et al, 2010), has offered detail of one such innovative pedagogical approach within STEM Education. Structured under the auspices of a single academic faculty lead, project team membership within the VIP programme were multidisciplinary in nature, and included unique membership constituencies drawn from across traditional domain and discipline HE campus communities. As with standard aims of facilitating authentic new knowledge generation and purposeful learning synergy between project team members, VIP pedagogy could be seen to have differed from more traditional forms of HE study in two main ways. Firstly the VIP programme garnered recruitment of team membership laterally from across traditional HE discipline boundaries, as the modular design sought inclusion of all domain cognate areas interested in meeting the real-world design challenge focus of the VIP context. Secondly, project team constituency within the VIP sought to reach vertically through all levels of knowledge and skills expertise within the available HE community. Additional capacity here was also offered through a shared approach via virtual online communication within its local institutional membership and between various partner campuses. In these ways the VIP may be seen to be unique as it sought to bring together a wide integrated community of HE participants, with varying academic levels of STEM expertise, towards solving a common problematic purpose and within a single recognisable real-world context.

Ultimately, proponents of VIP considered such pedagogical format as optimal inasmuch as its design was seen to have fostered perceptions of enhanced learning experience of its membership, sustained a pan-institutional STEM-focussed research environment and developed a unique institutional research climate with impactful product-orientated and research publication purpose. Additionally, VIP was also held by participants to have promoted an egalitarian structure between team members by deliberately blurring traditional learning boundaries and reforming authoritative hierarchies in teams through equality of effort, value of contribution and recognition of participation by its members (Abler et al, 2010; Coyle et al, 2006). Important secondary aims of the VIP programme also sought to develop students' wider interpersonal professional skills - in tandem with that of gaining an understanding of new subject knowledge or developing research capacity. In particular, participant communication and confidence were targeted as broader skills which could be developed simultaneously through involvement in the programme and those included related to learning and socialisation, collaboration, interaction and mentoring (Coyle et al 2006). Key considerations were identified as follows:

1. *Student Learning and Socialisation* – How has the student experience and of design processes changed as a result of VIP involvement? What other skills have been learned (technical, team working, communication, attitudes etc.) as a result of VIP involvement? If there are differences what can explain them and how can the VIP experience be improved?
2. *Student Mentoring Experience* – Expectations and experiences of mentoring at all levels in the VIP. What knowledge was gained from VIP faculty mentors and peers?

3. Developing Knowledge and Learning Exchange Networks in the VIP Environment – What was the development of patterns of communication within the VIP environment? (Including questions related to communications complexity, dynamics, gender, ethnicity and power).

4. Technology Impact on Student Learning and Team Building – What communication technologies are most important in developing ties across VIP team institutions? (Including questions related to acceptance, use and related outcome of product).

Advancing STEM Pedagogical Change: University of Strathclyde

These primary and secondary themes also resonated with many of the factors identified as important in the strategic development of enhanced practice in attaining education and research excellence at the University of Strathclyde around 2010. Importantly the ethos with which the VIP teams were formed also chimed further with key recommendations for sustainability and success of these initiatives, such as egalitarianism and familiarisation of relationships. It was envisaged then, that the VIP architecture could constitute a special form of the community of practice or enquiry within and across University faculty boundaries and also afford a formalised pathway to student collaboration and enhance faculty research output with external industry partners in real-world and product-orientated purpose.

Initial review of VIP activity across the University of Strathclyde in January 2015 has identified seven accredited VIP programmes and two programmes ostensibly proposing to use a VIP approach in their future delivery. At the time of the review it was unclear as to whether these proposed programmes would fulfil criteria for full VIP accreditation by the University. The total numbers of students, departments and degree programmes involved across these programmes is displayed in Table 1 below.

Table 1: VIP Status Update January 2015

Total Number of students	235
Total Number of Departments	22
Total Number of Degree Programmes	35

At the time of review it was identified that total student numbers for VIP in Session 2015-16 would be capped at around 400. Review also indicated a wide and varied range of context and student participants in programmes. Tables 2 & 3 below offer summaries of these key programme details covering student VIP participation across the University at the time of review. Of these programmes those entitled WASH, Mobileland, Textlab and Enterprise were deemed among the most

established, having been three of the first VIP developed at the time of the pedagogy's initial introduction to the University. Student recruitment numbers within these programmes also directly reflected their longevity and mirrored subsequent advice from originators of VIP pedagogy that success and sustainability of VIP programmes within departments correlated to those VIPs which had actively recruited students into projects and also deliberately limited student numbers in their early phases and grown steadily through regular review in a carefully phased and structured manner (Coyle, 2015).

Table 2: Details of VIP across University of Strathclyde: January 2015

Project Title	Departments	No of Students
Polarised Growth	Maths/Statistics, Biology, EEE	12
Textlab	HaSS, Computer Science, Maths/Statistics	25
Sustainable Energy	DMEM, CES/EME, EEE, Computer Science	16
WASH	SBS, CES, DMEM, EEE, Law, Mechanical	47
Competitive SME	SBS, Sciences, HaSS	18
Rover	DMEM, CES/EME, EEE, Sciences, Maths/Statistics, SBS	19
Enterprise	SBS	39
Mobileland	Architecture	52
Theatre Performance	EEE, HaSS	7*
Total		235

**Denotes receipt of proposed student involvement in VIP approach in programmes/proposals only as of January 2015*

Table 3: Details of Existing and Proposed VIP January 2015

Title	Programme Detail
SYSTEMS BIOLOGY OF POLARISED GROWTH	This VIP team aims to better understand polarized growth (vasculature, nervous system, plant roots, filamentous microorganisms) through genetic manipulation of a model system based on a filamentous antibiotic producing bacterium combined with advanced image processing methods and mathematical models.
SUSTAINABLE ENERGY FOR DEVELOPMENT	This project will deliver a tangible output in the form of a prototype product for individual consumer applications (e.g. domestic & educational use) and inform design parameters for an optimal charging station to support off grid, battery based electrical services.
WASH - Water and Sanitation Hygiene	This VIP explores how the knowledge and experience within all four Faculties in the University can be adapted and used to underpin International Development goals for Water and Sanitation for Malawi.
VIP in Developing Competitive SMEs	In this VIP the student group will work with SMEs to apply the capability diagnostic and the supporting improvement tools to help real companies to develop their competitive capabilities and performance.
ROVER: Robotic Vehicles for Education and Research	This VIP team aims to design, build and develop completely autonomous, robotic vehicles to improve sensing capabilities of our environment and the smart cities of the future.
ENTERPRISE	This VIP has three components: Enterprise 1: Building Strathclyde's Entrepreneurial Ecosystem, Enterprise 2: VIP Commercialisation Consultant, and Enterprise 3: Sustaining a Student Enterprise Society at Strathclyde.
MOBILELAND	The proposal for this VIP is a versatile D.I.Y. landscaping scheme, which has the potential to enhance public space and offer community groups, schools and those without gardens their very own portion of land to produce pieces of

	radical landscape architecture based on the theme of reduce, re-use and recycle 'on wheels'.
TEXTLAB	This VIP project selects, prepares, analyses and preserves digital texts using techniques and technologies drawn from Digital Humanities, Linguistics, Statistics, and Information Science.
*THEATRE PERFORMANCE	This VIP team aims to address the issue of public engagement with and understanding of Science, Technology and Maths subjects in modern society via innovative performance based teaching methods.

**Denotes receipt of proposed/operated VIP approach in programmes/proposals only as of January 2015*

Subsequent enhancement to the nature of VIP proposals and content at the University of Strathclyde in Session 2014-15 had also developed in a threefold manner. New VIP proposals from Session 2014-15 onwards were required to consider a clear STEM content focus, evidence capability to assist the University in addressing perceived gender imbalance within STEM subjects' study in courses nationally and were also tasked at meeting the need for widening public engagement regarding STEM, particularly in areas of disadvantage across Scotland. In this way the future of the institutional VIP programme as a whole would not only be aimed at helping to support research output and complement positive student learning experience, but also be extended to enhance the position the University as a key national entity in addressing wider public access to science literacy acquisition across a wider range of participant constituency involvement.

The newest addition to the VIP programme suite from within the School of Education: Faculty of HASS entitled 'STEM Education & Public Engagement' in Session 2015-16 perhaps best exemplifies

response to the new direction. In its ambition to form STEM Clinics in local hubs for the purpose of developing science literacy skills in local communities within areas of disadvantage in Glasgow, the project also successfully sought to actively recruit female students to the project in order to help facilitate community learning. Such was the success of the initiative that the project in meeting the new threefold requirement that it was asked to present findings at Education Scotland's annual national STEM event in Edinburgh in recognition of its contribution to pedagogical change in Scotland and won a University prize at the Inaugural VIP Consortium Conference at the University of Strathclyde in April 2015.

Optimum Climate for Evaluation of VIP: University of Strathclyde

Although regular evaluation report by individual VIP leads across departments since Spring 2011 had seemed to identify students' general satisfaction with participation in the initiative, by the conclusion of Session 2014-15 no evaluative overview had been made of the programme in its entirety across the University of Strathclyde. In effect, it is likely that key factors such as non-compulsory faculty implementation of the pedagogy, and low student recruitment numbers - together with the yearly increment of VIP contexts available - somewhat affected the necessity for such wide programme evaluation across the first few years of VIP operation. Considerations seemingly indicating significant delays and limitations to programme evaluation, however, could nonetheless be viewed through the lens of expectation regarding the University's adoption of the

initiative from the outset. In actual fact, the necessity of imposing just such limits, as well as facilitating patient development to support a strongly sustainable programme formation had formed key strategic recommendations from the outset by the pedagogy's originators in terms of the University's longer-term inclusion in the wider VIP International Consortium family (Coyle, 2015).

It is perhaps unsurprising then that the climate for University-wide programme evaluation at Strathclyde only became choice after the conclusion of the initiative's fifth year of operation, at a time where both precedence of placing a cap on student recruitment numbers to the VIP programme had been considered pertinent and the range of contexts had offered the widest scope of student choice since the programme's introduction at the University of Strathclyde. It was subsequently decided in the Spring of Session 2015-16 that the optimum time to commence a University-wide evaluative study of the programme had been reached and that a process of VIP programme evaluation at the University of Strathclyde should be initiated by a VIP investigative team drawn from central University services and existing VIP Leads. This team subsequently comprised of a representative from Educational Enhancement service and three Lecturers drawn from the faculties of Humanities & Social Sciences and Electronic and Electrical Engineering.

Method

Evaluation of the VIP programme sought to employ similar mixed method evaluation instruments and approaches used by the pedagogy's originators (Coyle et al, 2006; Abler et al, 2010). Early in the development phase of the evaluation process it was decided by the University's VIP investigative team that necessary adaptations to this toolkit in terms of aligning instruments' linguistic cultural norms and neutralisation of domain-specific cognate area questions would be made in order to accommodate the range of VIP contexts to be evaluated. In addition, it was decided that a dual-phase evaluation process consisting of an initial formative pilot phase followed by review and then a subsequent deeper evaluation second phase would also be implemented. As with the initial instruments, this dual-process approach also reflected the process of evaluation adopted by the pedagogy's originators. Mindful of these decisions and the strictures of the timescale involved, instruments already similarly developed regarding VIP pilot evaluations within the University's School of Education (Collins & Chambers, 2013), was adopted and adapted by the University's VIP investigative team for the purposes of the first phase of this evaluative pilot study (see Appendix A).

Crucially, it was decided that selection of the instruments used in Session 2015-16 should be considered only to supply a snapshot of University-wide VIP programme in advance of supporting formative process and instrument development for future enhanced evaluation in Session 2016-17. As such, investigation using the modified instruments was aimed at informing on flavours of students' perceptions of primary skills acquisition gained as part of their participation in the VIP process, to help identify student thoughts on attainment of secondary interpersonal professional skills and briefly comment on student communication networks development within and across the

VIP experience. Additionally, the pilot evaluation would also afford VIP Leads an opportunity to trial a process of shared evaluation across the VIP programme. In this way it was hoped that brief overview of students' perceptions and familiarisation with a central VIP evaluative process would be of benefit to individual VIP Leads in developing their projects in Session 2016-17.

Crucially, the pilot did not attempt to gather information beyond that which could normally be expected to be supplied in the course of VIP modular evaluations, rather it sought to unpack many of the regular themes common to evaluative fields, such as student perception of attainment and satisfaction. With this in mind, garnering qualitative information in the form of focus groups was considered, but was not pursued in the evaluation pilot. Rather, written qualitative comment was encouraged from participants as part of the evaluation survey. Quantitative information gained within the evaluation was presented in statistical descriptive form only as it was concluded that the sample numbers targeted were unlikely to support valid statistical inference. Similarly, unlike the progenitor VIP (Coyle et al, 2006; Abler et al, 2010), students' communication patterns were not subjected to complex network analysis. As with prior agreement with students at their registration onto the VIP programme, the normal levels of anonymity of participants' evaluative information for research purposes within the programme was upheld.

Results/Findings

As stated, findings derived from the pilot evaluation had a purely formative nature. As such, it sought to use evaluation tools and approaches adapted from original formative evaluation work on VIP (Abler et al, 2010; Collins & Chambers, 2013), primarily to create a brief overview of VIP from students' perspective to aid future evaluative direction. Initial steps involved subjecting these initial VIP evaluation formats to review regarding cultural fit for common use of linguistic forms and removing overtly domain-specific cognate questions. In addition, a tacit sift for useful parallels between the existing evaluation themes and those skills thought commonly attributable across VIP provision was conducted, with any parallels within existing VIP evaluative tool themes and formats being retained. It was also thought that by in so doing results of the pilot could be more readily discussed cross-departmentally with all VIP groups across the University of Strathclyde.

It should be reiterated that the tools selected sought only to supply data relevant to a snapshot evaluation overview and possibly as a stimulus informing next steps in the development of the VIP programme across the University in subsequent years. As already stated, the instruments followed very much those of initial studies (Abler et al, 2010; Collins & Chambers, 2013) and were dedicated to investigate flavours of student perceptions of VIP. Results and findings from the evaluation are summarised below, together with a brief commentary relevant to the pilot.

Skills Development: Perceptions & Meeting Motivation

The initial section of the evaluation asked students to comment retrospectively on the types of skills they had hoped to acquire through participation in the VIP programme. As with progenitor studies (Coyle et al, 2006; Abler et al, 2010) it was viewed that aspiration of attainment, as well as perceptions of related acquisition gains, could be related to students' motivation not only to join, but to sustain longer-term involvement in VIP.

Table 4 below displays the spread of student response using a standard Likert scale format. From an initial reading what seems clear was that students' seemed to hope that participation in VIP would help meet personal aspirations in learning how course skills and concepts could be used to solve practical or applied contexts in the real world. Additionally, aspects of collaboration and communication with other VIP group members seemed prime drivers for students joining VIP.

This idea of learning skills relevant to using course skills to solve practical problems through participation in a collaborative group dynamic can be seen to be further reinforced if Likert scores for 'very much' and 'quite a bit' are collapsed together. In effect, motivation to use course skills learned and participating in a collaborative group dynamic for this purpose were indicated as key

considerations by 19 out of a possible 20 participants and as such clearly constituted the main two underlying determinants of their motivation to join VIP.

Conversely, aspects of gaining conflict resolution skills or gaining mentorship experience (both acquiring only 7 points using the same approach) would seem to be out-with students' consideration when thinking about joining VIP.

On the whole though, with these two latter exceptions, it would seem that each theme from across the full gamete of skills mentioned within the evaluation survey and already identified by Coyle, (2006), Abler et al (2010) and Collins & Chambers (2013) were of significance to more than one half of the student body recruited to VIP at the onset of study in VIP.

Table 4: Students' VIP Retrospective Regarding Aspirational Skills Development

	Very much	Quite a bit	Some	Very little
Identifying and solving practical or applied problems	11	6	3	0
Planning long term projects	7	7	5	1
Understanding how ideas and skills from your course are used in an applied context	15	4	1	0
*Communicating complex and technical information to others	5	10	4	0
*Managing a project team	3	9	4	3
Collaborating on project team solutions	8	11	1	0
Designing processes, systems, components or materials to meet a practical or applied need	9	6	1	4
Working in a multi-disciplinary team	10	7	2	1
Using methods, techniques or tools necessary for professional practice	9	7	2	2
Working on a project team within your discipline	7	9	2	1
Making professional presentations	6	9	2	3
Writing professionally	3	8	7	2
Resolving team conflicts or disagreements	2	5	8	5
Conducting research in your field of study	9	7	3	1
Evaluating the outcomes and results of research	7	8	5	0
Understanding of relevant technologies (including hardware and software)	9	7	3	1

Managing your time and effort on practical projects	4	10	5	1
Working with co-workers outside your immediate field	5	10	4	1
Working with other project managers	2	10	6	2
Working with other people in your discipline	10	7	2	1
Getting a feeling for how professional teams work	9	8	2	1
Understanding how concepts in other classes apply to real-world tasks	13	4	3	0
Mentoring other people in your project team	3	4	7	6

As stated previously, acquisition of skills identified as key determinants for students' self-recruitment onto VIP may be held to be of prime importance in meeting students' satisfaction and their subsequent retention on VIP projects. When these aspirational scores are compared to scores related to students' perceptions of actual skills acquisition (Table 5) what seems generally true is that, most of the skills identified as desirable for acquisition by students in Table 4 were subject to subsequent perceptions of realised attainment by the majority of students' who had participated in the University's VIP programme in Session 2015-16

What is particularly clear across VIPs in the University of Strathclyde in Session 2015-16 was that the single key determinant of students' gaining understanding of how ideas and skills from courses can be used in an applied context may be considered to have been a general pedagogical component across the VIP programme. Here almost all (19) of the surveyed participants indicated that this aspirational target had been met to high level of satisfaction. Additionally, scores related to experiences of meeting acquisition in terms of aspirations regarding collaborative learning situations can also be seen to have shared similarly high or very high ratings by students.

Particular mention should perhaps also be made of a potential gap between that of initial aspirations by students as related to their perceptions of skills gains related to actual VIP experience, however.

It would seem from Table 5 that the aspect of skills acquisition perception regarding self-regulation of time management skills, as well as collaboration with team members from within students' own discipline, supersedes that of the scores related to meeting an aspiration of looking forward to multi-disciplinary collaborative learning in terms of students' actual experience on the VIP programme. In short, this mismatch between students' expectations and experiences may contain messages for VIP development related to maintaining student satisfaction or longer-term motivation. In effect it may be concluded that some consideration may need to be taken by future iterations of the University's VIP programme to further promote not only that project team constituency reaches vertically upwards in academic level, but also seeks to better reach laterally across subject disciplines.

As with skills aspirations, what is also clear is that both mentorship skills and conflict resolution remain very low on the list of students' VIP acquisition experiences. This may or may not indicate that current VIP projects give limited opportunity to acquire either of these skill sets. Crucially, in terms of student motivation and satisfaction dynamic, it would seem, however, that this non-emphasis would seem unlikely to affect student's willingness to enjoy or continue on VIP.

Table 5: Student Report Regarding Perceptions of Actual VIP Skills Acquisition

	Very much	Quite a bit	Some	Very little
Identifying and solving practical or applied problems	9	7	3	1
Planning long term projects	10	6	3	1
Understanding how ideas and skills from your course are used in an applied context	13	6	0	1
*Communicating complex and technical information to others	9	6	5	0
*Managing a project team	6	4	6	4
Collaborating on project team solutions	9	7	4	0
Designing processes, systems, components or materials to meet a practical or applied need	9	4	4	3
Working in a multi-disciplinary team	7	6	4	3

Using methods, techniques or tools necessary for professional practice	10	6	2	2
Working on a project team within your discipline	11	7	1	1
Making professional presentations	8	8	1	3
Writing professionally	4	11	3	2
Resolving team conflicts or disagreements	6	2	6	6
Conducting research in your field of study	11	6	2	1
Evaluating the outcomes and results of research	8	8	3	1
Understanding of relevant technologies (including hardware and software)	9	7	2	2
Managing your time and effort on practical projects	10	9	0	1
Working with co-workers outside your immediate field	7	5	5	3
Working with other project managers	4	6	7	3
Working with other people in your discipline	11	5	3	1
Getting a feeling for how professional teams work	9	8	1	2
Understanding how concepts in other classes apply to real-world tasks	10	4	4	2
Mentoring other people in your project team	5	2	2	11

The VIP investigative team were also keen to enhance or expand upon the themes identified in earlier evaluative studies as key aspirational or experiential skills met by students on VIP. However, from the sample of 20 students, only 3 additional replies to theme expansion were offered. These took the form of advice on listing aspects of self-confidence in self-validation and argumentation, as well as listing pedagogical understanding as additional skill themes. Unfortunately, the nature of responses did not – nor did the survey encourage- expansion on these themes, but it seems intuitively correct that future evaluative survey on VIP may well wish to consider unpacking these themes, perhaps with student focus groups, ahead of future evaluation.

In terms of prioritisation of importance of professional skills acquisition, students participating in VIP in Session 2014-15 were asked to prioritise the top three skills they felt they had met while participating in VIP. As can be seen clearly in Table 6 below the single key skill acquisition students valued again related to the use of course skills and ideas within an applied context. This is further reification perhaps of the single main attraction of VIP to University of Strathclyde students. This

consideration can be seen to be closely followed by aspects of the acquisition of communication skills, the use of methods/techniques/ tools for professional practice, learning how to evaluate research outcomes and, again, the identification and solution of applied practical problems.

Table 6: Students' Prioritisation of Most Important Skills Met on VIP Programme Regarding Professional Development

Identifying and solving practical or applied problems	6
Planning long term projects	1
Understanding how ideas and skills from your course are used in an applied context	9
Communicating complex and technical information to others	6
Managing a project team	4
Collaborating on project team solutions	2
Designing processes, systems, components or materials to meet a practical or applied need	2
Working in a multi-disciplinary team	4
Using methods, techniques or tools necessary for professional practice	5
Working on a project team within your discipline	1
Making professional presentations	2
Writing professionally	0
Resolving team conflicts or disagreements	1
Conducting research in your field of study	5
Evaluating the outcomes and results of research	1
Understanding of relevant technologies (including hardware and software)	4
Managing your time and effort on practical projects	0
Working with co-workers outside your immediate field	0
Working with other project managers	0
Working with other people in your discipline	2
Getting a feeling for how professional teams work	1
Understanding how concepts in other classes apply to real-world tasks	1
Mentoring other people in your project team	1

Skills acquisition of least concern to students through VIP participation would seem to be related to professional writing and working with other project managers. Surprisingly, students also seem to note that self-regulation of time management and working with others outside of their given field was of little or no consequence in terms of skills acquisition prioritisation. Again, although not

generalizable, it would seem intuitively prudent for further VIP programme iteration and evaluation study to investigate disparity between agreements of these themes as presented in Tables 4, 5 & 6.

Communication & Networking

In keeping with prior VIP studies (Coyle et al, 2006; Abler et al, 2010; Collins & Chambers, 2013) the current evaluation also sought to investigate student communication and networking within the VIP programme. However, in contrast to earlier studies the current study did not seek to investigate students' communication networking dynamic, rather, it sought to identify basic patterns of interaction between students. Another contrast was that particular focus in the current study focussed on the types of communication between VIP programme constituencies. Specifically communication aspects of students' seeking technical/practical, theoretical/conceptual and team management were investigated by the team.

As can be seen from Table 7 below, students' perception of their general interactions in VIP across Session 2015-16 indicated that they felt the majority of their communication was skewed towards students within the same University stage. This perhaps resonates with perceptions related to mismatch between Likert scores of aspiration and actual experience regarding interaction across year groups. There may also be seen to be at least some evidence of moderate interaction with other students from across degree programmes. So, as previously stated when looking at student motivational issues, it would seem prudent that aspect of vertical interaction in future iterations of

the University's VIP programme may be worthy of future study and development – although this may now be tempered with some assurance that cross-degree domain student interaction has indeed been accomplished by VIP in Session 2015-16.

It is perhaps intuitively unsurprising that students also seem to have perceived academics as the next major group within VIP constituency with whom they had large amounts of communication and interaction. Clearly the evaluation evidence did not indicate whether these academics were drawn from within or across traditional domain boundaries and so additionally, a message from the evaluation pilot may be perceived as a suggestion to better investigate the lateral academic component of VIP structure moving forward.

What seems clear from Table 7 is that it might be claimed that, with the exception of same stage peers and academics, only moderate- to- little interaction or communication between students in differing year groups seemed to have occurred within VIP teams in Session 2015-16. Of particular relevance is also what seemed to have been the seeming paucity of interaction with representatives from out-with the University setting. As a key pillar of VIP pedagogy has been purported as its capability to impact on real-world environment (Coyle, 2006; 2015), and given that use of course knowledge and skills may be seen to be a key component of student recruitment, motivation and retention, then it may be prudent for the VIP programme to investigate this anomaly in greater depth in future.

Table 7: Students' Perceptions of General Interactions

	Very often	Often	Sometimes	Never	N/A
Students from earlier years	5	0	3	4	8
Students from your year	13	6	0	1	0
Students from later years	1	4	5	4	6
Postgraduate students	1	5	7	3	4
Academics	6	8	5	0	1
Students (from any year) from other degree programmes	1	4	7	3	5
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)	0	1	2	11	6

Tables 8, 9 & 10 below evidence results of students' perceptions of interactions as they pertained to advice sought on technical/practical, theoretical/conceptual and team management issues respectively. Although it may be fair to say that there can be seen to have been some minor general shift towards a greater spread of interactions as regards these themes, what has seemed clear is that once again advice sought by students has a clear focus from peers within their own University stage and from academics. Again, whether these interactions with academics are drawn solely from within traditional subject domain boundaries is not clear from the evaluative evidence. However, although interactions reaching vertically upwards through University levels seem to have improved, and interactions with other-degree students would seem to have remained moderate, these overall changes or improvements can be seen to have remained limited. This may perhaps hold an inherent message for VIP programme to investigate more closely individual project architectures in their aim to facilitate both lateral and vertical interactions ahead of future programme iterations.

Table 8: Students' Perceptions of Interactions: Advice sought on technical or practical issues

	Very important	Quite important	Not important	N/A
Students from earlier years	3	2	4	10
Students from your year	7	11	0	1
Students from later years	2	4	4	9
Postgraduate students	5	3	3	7
Academics	14	3	1	1
Students (from any year) from other degree programmes	1	4	5	9
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)	1	1	4	13

Table 9: Students' Perceptions of Interactions: Advice sought on theoretical or conceptual issues

	Very important	Quite important	Not important	N/A
Students from earlier years	3	3	4	9
Students from your year	9	6	2	2
Students from later years	4	2	4	9
Postgraduate students	7	2	2	8
Academics	14	4	0	1
Students (from any year) from other degree programmes	2	2	4	11
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)	1	2	3	13

Table 10: Students' Perceptions of Interactions: Advice sought on issues about VIP team management?

	Very important	Quite important	Not important	N/A
Students from earlier years	1	3	4	11
Students from your year	4	9	2	4
Students from later years	3	3	4	9
Postgraduate students	1	4	5	9
Academics	12	6	0	1
Students (from any year) from other degree programmes	1	3	4	11
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)	1	2	3	13

Table 11 & 12 below present an overview of students' general perceptions in terms of their overall VIP experience in Session 2015-16. As can be seen from Table 10 in particular students' very favourable perceptions of the benefits of VIP participation regarding future employment and willingness to recommend the VIP experience to peers in future years is particularly strong. It may be relevant to purport that from this evidence students again perceived working in tandem with students from earlier year groups to have been of quite limited benefit. Strong-to-moderate perceptions of collaborative working with students from later years can also be seen in these findings, however. This anomaly would seem to directly contradict evidence relevant to other stage working from Tables 7-10, and again would seem to suggest a focal point for future VIP evaluation and programme development.

Table 11: General Perceptions of VIP Students

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
9. I would recommend taking part in a VIP to another student	17	2	0	0	0
10. I feel that participating in a VIP has prepared me for future employment	11	6	2	0	0
11. I feel that I have benefitted from working on a project with students from later years and postgraduates	12	1	6	0	0
12. I feel that I have benefitted from working on a project with students from earlier years	7	1	11	0	0

Table 12: VIP Students Positive & Negative Qualitative Comments

Positive (23 comments) :

- On VIP you can put what you learn into practice, making what you learn more interesting and helping you to see why it is important. It is also exciting as it gives you a taste of what working on a project and research is like early, which you wouldn't be able to experience for another few years otherwise.
- Conflict resolution
- Working with postgraduates was a great experience. Seeing theory being effectively implemented in a school and the difference it made to children's learning.
- Although everyone on the project was from different subjects and year groups everyone's ideas and contributions were equally important to the project's success. Learning from students from different disciplines was a very valuable experience and working with them gave me a better understanding of working in a professional environment. The VIP allowed each student to excel in and utilise their individual strengths while learning new skills.
- The community engagement aspect of our VIP project is something that I feel merits particular mention, as a valuable learning experience for me and as a worthwhile outreach programme.
- There were many issues that arose which would be just as likely to do so in any lab environment, learning work through these issues was particularly useful and gave me some significant insight into the lab environment.
- I learned a lot on technical level
- The work completed was always making a difference in society
- VIP is a different style of work that I have taken part in before
- I enjoyed working with people I would never normally be able to meet
- I now feel confident in researching academic papers and self-validating my own work
- Choosing own objectives. Good experience in self-managing
- Not a solid structure – more like the real world
- Working with other students from different areas of studies and degrees
- Provided an insight into what a career as a research scientist would be like
- Experience in research
- Delivering a presentation
- Writing report
- Meeting people from other disciplines
- Very good insight in Mathematical research
- Good and important experience to be part of a conference
- Good practice in writing a scientific report
- Being able to work on a project aspect that has never been done before has assisted in the

development of how I work in a team and how I approach project work in the future

Negative (11 comments) :

- It does take up a lot of your free time so can be difficult to fit VIP as well as studying, working, etc. But not completely a negative if you're willing to put in the effort and enjoy being part of VIP.
- Unequal work distribution
- I have no negative feedback
- I expected the VIP to be more collaborative between the different disciplines.
- Sometimes a clear goal would have been beneficial. However, I realise this would create a safety net of sorts and move away from the aims of the project.
- We needed to commit to an objective sooner

In terms of personal testimony offered by students it would seem that positive perceptions related to self-regulated learning, egalitarianism, gaining research experience and working on applied or real-world problems are prevalent (see Table 12). Negative impressions of VIP programme participation can be seen to have centred round aspects of disappointment in not working with a wider range of students from differing disciplines and also the increased time and effort needed for this type of study – although caveat that this effort produced benefits was offered. From the qualitative evidence offered by students, it seemed clear that positive (23) far outweighed negative comment overall (11). Indeed of these negative comments transcribed at least 3 alluded to having no negative feedback to offer and of the other 8 at least 2 offer mitigation supporting a positive aspect of VIP participation.

Conclusion & Implications

In conclusion then it would seem that at a very general level students' perception of participation in the VIP at the University of Strathclyde in Session 2015-16 was generally very positive. Key messages that might be taken forward from the evaluation pilot would seem to centre on several discrete issues. Firstly, it seems clear that students within the VIP evaluated were motivated to join and were engaged during the VIP experience by the opportunities the programme provided in using course knowledge and skills in an applied, real-world context. Following on from this, it would also seem that the concept of collaborative working with other students was also a strong draw to joining the VIP programme, and while students seemed to wish to have placed much value in enhanced exposure to meeting peers from other degree pathways and from later stages within the University, this was nonetheless not of serious enough concern to impact negatively on their overall experience or willingness to continue or recommend the VIP experience to other students.

Messages for future development of VIP within the University of Strathclyde were also present. In particular closer investigation of the lateral and vertical architecture of individual projects may be prudent. Together with this, further investigation at a more detailed level on the nature of project constituencies in terms of their placement across traditional domain boundaries may be of relevance. Such closer refinement to programme structure and future evaluation approach, when coupled with what would seem to be the very positive perception of students towards their study on the VIP programme, would, it is hope, further strengthen what has proven to be an already well received programme of study by students.

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Appendix A

Your experience of Vertically Integrated Projects

The purpose of this questionnaire is to find out about your experience of participating in a Vertically Integrated Project (VIP). The results will be used to evaluate the effectiveness of VIPs, and to help the academic leads to make improvements.

The questionnaire is anonymous. Data will be used for research and evaluation purposes, and will only be reported in aggregated form.

For each question, please select an option by putting a cross in the box which best reflects your experience of the VIP.

Section 1 - Skills development

These questions ask about your development of skills and abilities as a result of taking part in a VIP

Question 1: Thinking back to before you joined the VIP, how much did you hope to develop your skills in the following areas as a result of your participation in the VIP?

	Very much	Quite a bit	Some	Very little
Identifying and solving practical or applied problems				
Planning long term projects				
Understanding how ideas and skills from your course are used in an applied context				
Communicating complex and technical information to others				
Managing a project team				
Collaborating on project team solutions				
Designing processes, systems, components or materials to meet a practical or applied need				
Working in a multi-disciplinary team				
Using methods, techniques or tools necessary for professional practice				
Working on a project team within your discipline				
Making professional presentations				
Writing professionally				
Resolving team conflicts or disagreements				
Conducting research in your field of study				
Evaluating the outcomes and results of research				
Understanding of relevant technologies (including hardware and software)				
Managing your time and effort on practical projects				
Working with co-workers outside your immediate field				
Working with other project managers				
Working with other people in your discipline				
Getting a feeling for how professional teams work				
Understanding how concepts in other classes apply to real-world tasks				
Mentoring other people in your project team				

Question 2: How much have your skills in the following areas actually increased as a result of your participation in the VIP?

	Very much	Quite a bit	Some	Very little
Identifying and solving practical or applied problems				
Planning long term projects				
Understanding how ideas and skills from your course are used in an applied context				
Communicating complex and technical information to others				
Managing a project team				
Collaborating on project team solutions				
Designing processes, systems, components or materials to meet a practical or applied need				
Working in a multi-disciplinary team				
Using methods, techniques or tools necessary for professional practice				
Working on a project team within your discipline				
Making professional presentations				
Writing professionally				
Resolving team conflicts or disagreements				
Conducting research in your field of study				
Evaluating the outcomes and results of research				
Understanding of relevant technologies (including hardware and software)				
Managing your time and effort on practical projects				
Working with co-workers outside your immediate field				
Working with other project managers				
Working with other people in your discipline				
Getting a feeling for how professional teams work				
Understanding how concepts in other classes apply to real-world tasks				
Mentoring other people in your project team				

Are there any skills not listed above that you feel you have developed by participating in the VIP?

Question 3: From the following list of skills, please put a cross in the box next to the THREE skills that you think are most important for your professional development

Identifying and solving practical or applied problems	
Planning long term projects	
Understanding how ideas and skills from your course are used in an applied context	
Communicating complex and technical information to others	
Managing a project team	
Collaborating on project team solutions	
Designing processes, systems, components or materials to meet a practical or applied need	
Working in a multi-disciplinary team	
Using methods, techniques or tools necessary for professional practice	

Working on a project team within your discipline	
Making professional presentations	
Writing professionally	
Resolving team conflicts or disagreements	
Conducting research in your field of study	
Evaluating the outcomes and results of research	
Understanding of relevant technologies (including hardware and software)	
Managing your time and effort on practical projects	
Working with co-workers outside your immediate field	
Working with other project managers	
Working with other people in your discipline	
Getting a feeling for how professional teams work	
Understanding how concepts in other classes apply to real-world tasks	
Mentoring other people in your project team	

Section 2 - Networking

These questions ask about how you have interacted with other people through your participation in the VIP

Question 4: For each of the following groups of people in your VIP, how many did you know prior to starting the VIP?

	None of them	Some of them	Most of them	All of them	N/A
Students from earlier years					
Students from your year					
Students from later years					
Postgraduate students					
Academics					
Students (from any year) from other degree programmes					
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)					

Question 5: On average this year, how often have you interacted with the following groups of people on your VIP?

	Very often	Often	Sometimes	Never	N/A
Students from earlier years					
Students from your year					
Students from later years					
Postgraduate students					
Academics					
Students (from any year) from other degree					

programmes					
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)					

Question 6: How important were the following people in your VIP for advice on *technical or practical issues*?

	Very important	Quite important	Not important	N/A
Students from earlier years				
Students from your year				
Students from later years				
Postgraduate students				
Academics				
Students (from any year) from other degree programmes				
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)				

Question 7: How important were the following people in your VIP for advice on *theoretical or conceptual issues*?

	Very important	Quite important	Not important	N/A
Students from earlier years				
Students from your year				
Students from later years				
Postgraduate students				
Academics				
Students (from any year) from other degree programmes				
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)				

Question 8: How important were the following people in your VIP for advice on issues about *VIP team management*?

	Very important	Quite important	Not important	N/A
Students from earlier years				
Students from your year				
Students from later years				
Postgraduate students				
Academics				
Students (from any year) from other degree programmes				
VIP team members from outside Strathclyde University (e.g. from industry, commercial companies, education institutions or the local community)				

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
9. I would recommend taking part in a VIP to another student					
10. I feel that participating in a VIP has prepared me for future employment					
11. I feel that I have benefitted from working on a project with students from later years and postgraduates					
12. I feel that I have benefitted from working on a project with students from earlier years					

Section 3 - Overall

These questions ask about your overall perceptions of taking part in the VIP. Please show the extent of your agreement or disagreement by putting a cross in the box which best reflects your view.

13. Looking back on your experience in the VIP, are there any particularly positive or negative aspects you would like to highlight? (Please use the boxes below)

Positive:

Negative:

Section 4 – Information about you

14. Which VIP are you participating in?

15. What is your degree programme?

16. What is your year of study?

17. What is your gender? (please circle the correct option)

Male	Female	Prefer not to say
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