ENHANCING WORKPLACE LEARNING THROUGH STRUCTURED INTERNSHIP

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ABSTRACT

Internship has been an integral part of engineering education globally to develop proficiency in professional knowledge and skills, as well as personal and interpersonal skills. The integrated learning experiences provided by internship helps to foster learner's disciplinary knowledge, critical thinking, problem solving, teamwork and communication skills. Internship provides opportunity for learners to work on conceiving, designing, implementing, and operating (CDIO) engineering systems in a real-world context. In Nanyang Polytechnic (NYP), internship is offered to all year-3 learners at the School of Engineering (SEG). There are two types of internship programmes, one with a duration of 12 weeks and the other with a duration of 24 weeks, and learners can carry out their internship in local or overseas companies or institutions. The Internship Framework at NYP undergone a major revamp to introduce Structured Internship in 2015. With this revision, a new set of clear and relevant learning outcomes were defined for the structured internship programmes. More 24-week internships were allocated for industry sectors requiring deeper technical expertise to be developed, and interns could benefit from structures workplace learning and project assignments. A study was conducted in year 2020 to evaluate the effectiveness of the revised internship framework, as well as to identify key internship design characteristics that enhance workplace learning. The results of the findings depict that the workplace learning experience has improved significantly since the revision, and that longer internship duration does enhance the intrinsic motivation of our learners. Graduate employment surveys conducted have also shown that workplace experience gained during structured internship has been useful for work and life after graduation. The study also identified top four factors impacting the success of structured internship, and they are "Able to learn and apply technical and soft skills," "People they worked with," "Task assigned is achievable" and "Industry Internship Mentor" respectively.

KEYWORDS

CDIO, Internship Design, Integrated Learning, Workplace Learning Experience, Intrinsic Motivation.

INTRODUCTION

Internship has been an integral part of the engineering courses offered by the School of Engineering (SEG), at Nanyang Polytechnic (NYP) since its establishment in 1992. In SEG, all learners go through a 12-week full-time internship programme during the third year of their

studies, aimed at providing opportunities for learners to gain workplace experience and to prepare them for employment. In 2014, an Applied Study in Polytechnic and ITE (ASPIRE) was conducted by the Ministry of Education Singapore. It led to the establishment of SkillsFuture Singapore with the mission to build a future based on skills and mastery. Following on the recommendations made by ASPIRE, a few major changes were proposed to the curriculum of the diplomas offered by the polytechnics. Two of these changes were the structured internship and the education & career guidance. The structured internship is the focus of this paper.

With the introduction of the structured internship, major revisions were made to the existing internship programme so that new elements could be introduced. The key elements that are introduced include more detailed learning outcomes covering key objectives of the structured internship, internship scopes that are coherent with the intended learning outcomes, use of assessment rubrics that are aligned with the learning outcomes, pre-internship briefing and post-internship review, and well-defined guides for School Internship Mentors (SIM) and Industry Internship Mentors (IIM). Along with these proposed elements, there was also recommendation to lengthen the duration of the internship. The following sections cover the design, development, implementation, and review of the Enhanced Internship Framework that NYP has introduced in 2015 to meet the structured internship requirements.

Enhanced Internship Framework (EIF)

Two base models were proposed in EIF to provide basic guidelines in internship design. Base model 1 is a combination of a 12-week Internship (ITP-12) and a 12-week Final Year Project (FYP) Work. Base model 2 is a 24-week Internship (ITP-24) with substantial amount of project-based learning. Both ITP-12 and ITP-24 provide an avenue and opportunity for learners to work with the industry on projects mutually agreed upon by the company and SEG. Learners will carry out their projects at the company. In addition to enhancing technical knowhow and skills in project development, learners will have the opportunity to develop other important workplace skills such as positive working attitude, personal and interpersonal skills, and communication skills. Learners will also be able to gain industry experience and appreciate the challenges of working on projects with real-life constraints. The introduction of a longer internship (ITP-24) was meant for industry requiring deep technical expertise that could better be developed through meaningful workplace training, assignments, and experience.

Learning Outcomes

The objectives of the structured internship are to provide a real-life work environment to facilitate a structured and integrated learning experience for the learners. This will enhance their learning by applying the knowledge and skills gained during the course work to work practice. By working on real-life scenario, the learners will be able to deepen relevant skills as well as gain broader perspective and knowledge of the industry, companies and professions, work value and culture, so that they are better prepared to pursue a career in their field of studies. With these objectives in mind and using CDIO Syllabus as a guidance, SEG has developed a set of learning outcomes (LO) to be achieved at the end of the internship programme. Table 1 lists the LOs for the structured internship, with mapping to the updated CDIO 2.0 syllabus (Crawley, Malmqvist, Lucas and Brodeur, 2011.)

Table 1. Mapping of LOs to CDIO 2.0 Syllabus

S/N	Learning Outcomes	CDIO Syllabus
1	Demonstrate the application of knowledge and skill sets acquired from the studied course and workplace in the assigned job function(s)	2.1.1 Problem Identification and Formulation 2.1.4 Analysis with Uncertainty 2.1.5 Solution and Recommendation 4.3.4 Development Project Management 4.4.1 The Design Process 4.4.3 Utilization of Knowledge in Design 4.5.1 Designing a Sustainable Implementation Process 4.5.2 Hardware Manufacturing Process 4.5.3 Software Implementing Process 4.5.4 Hardware Software Integration 4.5.5 Test, Verification, Validation, and Certification 4.5.6 Implementation Management 4.6.1 Designing and Optimizing Sustainable and Safe Operations 4.6.2 Training and Operations 4.6.3 Supporting the System Life Cycle 4.6.4 System Improvement and Evolution
2	Solve real life challenges in workplaces by analysing the work environment and conditions, and selecting appropriate skill sets acquired from course of study	
3	Articulate career options by considering opportunities in the company, sector, and industry for professional and educational advancement	2.5.3 Proactively Vision and Intention in Life 2.5.4 Staying Current on World of Engineering
4	Communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	3.2.1 Communications Strategy 3.2.2 Communications Structure 3.2.3 Written Communication 3.2.4 Electronic / Multimedia Communication 3.2.5 Graphical Communication 3.2.6 Oral Presentation 3.2.7 Inquiry, Listening and Dialog
5	Exhibit critical thinking and problem-solving skills by analysing underlying issue(s) to challenges	2.4.1 Initiative and Willingness to Make Decisions in the Face of Uncertainty 2.4.2 Perseverance, Urgency and Will to Deliver, Resourcefulness and Flexibility 2.4.3 Creative Thinking 2.4.4 Critical Thinking 2.4.5 Self-awareness, Metacognition and Knowledge Integration 2.4.6 Lifelong Learning and Educating 2.4.7 Time and Resource Management
6	Demonstrate the ability to harness resources by analysing challenges and considering opportunities	
7	Recommend ideas to improve work effectiveness and efficiency by analysing challenges and considering viable options	
8	Demonstrate appreciation and respect for diverse groups of professionals by engaging harmoniously with different company stakeholders (e.g., colleagues, supervisors, suppliers etc.)	2.5.1 Change to Ethics, Integrity, and Social Responsibility 2.5.2 Professional Behaviour 2.5.5 Equity and Diversity
9	Exhibit professional ethics at work	

Assessment

An important consideration when designing the structured internship programme is to ensure assessments and instructional strategies are aligned with the LOs (Biggs & Tang, 2011; Maki, 2010). During the internship, learners are assessed by both the IIM and the SIM based on their workplace learning and tasks performance, their documentation of work log, as well as their reflection of the tasks completed. In assessing learners' workplace performance, the criteria used in the rubric include work ethics and professionalism, professional proficiency, quality of works and work outcomes, communication and teamwork, and independent learning skills. At the end of the internship, learners will have to make a presentation on the outcomes of their internship to an assessment panel, and to submit a written report on the work or tasks completed during their internship. The criteria used in the rubric to assess learner's internship report are organization, content, quality of writing and reflection on the internship, while the criteria used for assessing presentation are organisation & content, presentation skills and ability to answer questions.

Implementation

A series of communication channels and platforms were instituted to ensure the objectives of the enhanced internship programme were communicated clearly to the stakeholders. For instance, an IIM guide was developed to explain the objectives of the structured internship, the need to provide a structured training to interns, the assessment framework which include the assessment plan, criteria and rubrics, and the feedback mechanisms. A similar guide was also developed for the SIM for them to work closely with IIM. Briefing is conducted for learners one week before they start the internship. The briefing aims to provide opportunity for the learners to clarify any concerns regarding internship, and to motivate them to make the best use of workplace learning opportunity provided by the hosting companies.

Evaluation

At the end of the internship, interns are encouraged to provide feedback in the form of survey for programme evaluation. The survey gathers feedback on the LOs, workload, assessment, equipment or facilities, SIM, IIM, as well as overall workplace learning experience. IIMs are also encouraged to provide feedback through the internship evaluation form. Feedback from IIMs are sought in the areas of internship duration, scope of learning outcomes, operational effectiveness and efficiency, and areas for improvement.

BACKGROUND

Literature review

A study conducted by James (2018) on benefits of mandatory internship has shown that internship better prepare learners in career skills, such as problem solving, networking, oral presentation, interpersonal communication, among others. The top 4 substantial benefits interns gained were Experience (gain hands-on/real world/relevant experience), Career (clarity, exposure, security, and success), Networking (made connections, gained references, built network in industry), and Increased industry awareness. Rouvrais and co-workers (2018) shared that having workplace learning during internship permits learners to apply their knowledge and skills in real contexts, in non-simulated environments, and thus develop real professional competencies. They have also suggested an extension to the CDIO framework to systematically include work-based learning as integrated activities to better match industry's requirements as well as learner's competency when they work as engineer upon graduation.

Johari & Bradshaw (2006) shared in their study on employing Project-based Learning in internship, concluded that tasks assigned should be collaborative and doable but challenging, not too complex, and offer choices. In addition, the roles of mentor were equally important; other than providing encouraging feedback, the role of mentor largely involves facilitation, monitoring learning processes, and gradually releasing learning responsibilities to the interns. Kamp & Verdegaal (2015) on a separate study found that the main motivational factors in internship, based on learner's perspective, were gaining personal and interpersonal skills and engineering capabilities, such as employability, preparing for job interviews and writing application letters, giving tools how to approach and apply, among others.

Preliminary Observation on Structured Internship

Knowing the importance of workplace learning as well as key factors impacting workplace learning experience from the literature review, the aims of this study were to establish evidence that the introduction of structured internship does produce outcomes that are aligned to these review findings. In fact, with the introduction of EIF since 2015, two positive trends were already observed. First observation was that learner's performance in internship modules was generally better than most of the other academic modules. Second observation was that more learners were opting for 24-week internship instead of the hybrid model of Internship (12-week) and Final Year Project work(12-week). This second trend is shown in Figure 1 where the percentage of learners opting for ITP-24 has increased from 25.7% in 2016 to about 41% in 2019.

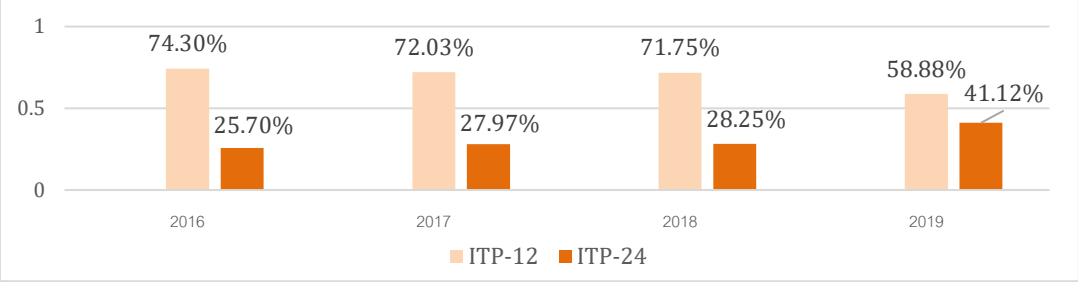

Figure 1. Distribution of 12-week Internship and 24-week Internship

In discussion with the course management teams, they opined that learners are motivated to perform well due to grading of internship modules. Learners strife to perform better to obtain good grades so that they have higher chances to be enrolled into reputable universities or to qualify for distinguished scholarship or awards. A follow-up focus group discussion with some learners was conducted, they fed back interest in engineering careers was higher after their internships. This finding suggests that learners could have opted for the ITP-24 due to module grading, but interest in engineering field was gradually built up during their internships.

Research Questions

This study sets to, firstly to establish evidence that learners are gaining better workplace learning experience through the introduction of structured internship. Secondly, the study aims to establish evidence that longer internship duration (ITP-24) does nurture higher interest in engineering fields to learners as compared to ITP-12. This finding is important as learners with intrinsic motivation toward a certain engineering field would have more sustainable interest and hence be able to learn at an optimal level and acquire important workplace knowledge

and skills during their internship. Thirdly, the study aims to establish important internship design characteristics that lead to successful workplace learning for our learners.

METHODS

The effectiveness of the structured internship programme is evaluated using the data gathered from two survey mechanisms put in place. One of them is the module feedback survey that is administered to all learners at the end of the internship each semester. The learners' responses on "Overall experience gained is useful and relevant" are used as the indicator on workplace learning experience. The survey uses a Likert Scale of 1 to 4, 1 being "Strongly Disagree" and 4 being "Strongly Agree". A second mechanism is based on graduate employment survey, which is conducted six months after learners graduated from the Polytechnic. Graduates can feedback if they have gained useful work experience from the internship by indicating one of the following responses: "Strongly Agree", "Agree", "Disagree" or "Strongly Disagree".

In addition, the Intrinsic Motivational Inventory (IMI) Questionnaire is adopted in this study to evaluate the impact of internship duration on learner's intrinsic motivation. This survey consists of 20 questions covering 5 subscales defined in the original IMI questionnaire, namely "Interest" (4 questions), "Perceived Competence" (4 questions), "Usefulness" (5 questions), "Relatedness" (4 questions), and "Effort" (3 questions), using a Likert Scale of 1 to 7. The "Interest" subscale is a self-report measure of a person's liking towards the tasks given; the "Perceived Competence" subscale refers to a person's perceived ability to carry out the tasks given; the "Effort" subscale refers to the how much effort a person is willing to put in to carry out the tasks; the "Usefulness" subscale refers to how a person find the tasks and experience useful or valuable; and the "Relatedness" subscale is used in studies having to do with interpersonal interactions, friendship formation, etc. Within this survey, an additional question is added for learners to provide input on the top three factors that have positive impact on their internship. There were 9 options provided, and an open-ended space for learners to provide any other factor that they deemed important to the success of their internships. This survey was administered to 120 learners from 4 randomly chosen diplomas in SEG in year 2020 using a Google survey form at the point when this study was conducted. As a follow up from the survey, 10 learners from the 4 diplomas were invited to participate in an interview. Semi-structured questions that focus on internship design elements that impact their workplace learning experience were used to gather additional views and opinions from the learners. Learners were interviewed individually after their internship. Their feedbacks were analysed manually, to find the underlying reasons, views, and factors affecting internship experience.

RESULTS

Internship Module Feedback

Table 2 shows that the overall internship experience extracted from 2015 to 2018 feedback data. Learners reported an average score 3.49 with a standard deviation of 0.22 on a Likert Scale of 1 to 4 in 2018, as compared to an average score of 3.25 with standard deviation of 0.18 in 2015. The data shows that their experience has improved over the last 4 years, since the introduction of the structured internship.

Table 2. Workplace Experience Feedback Score

	2015	2016	2017	2018

Mean	3.25	3.41	3.48	3.49
Median	3.29	3.38	3.41	3.43
Standard Deviation	0.18	0.25	0.21	0.22
No. of learners	1109	1140	1230	1154

Graduate Survey on Internship

Result from an analysis on the graduate employment survey data between 2018 and 2020 for all engineering graduates is shown in the Figure 2. The percentage of graduates who acknowledged that they had gained useful work experience during internship, i.e., those who had responded as "Strongly Agree" and "Agree"), has improved over the last three years, from 82.11% in 2018, to slightly above 88% in 2020.

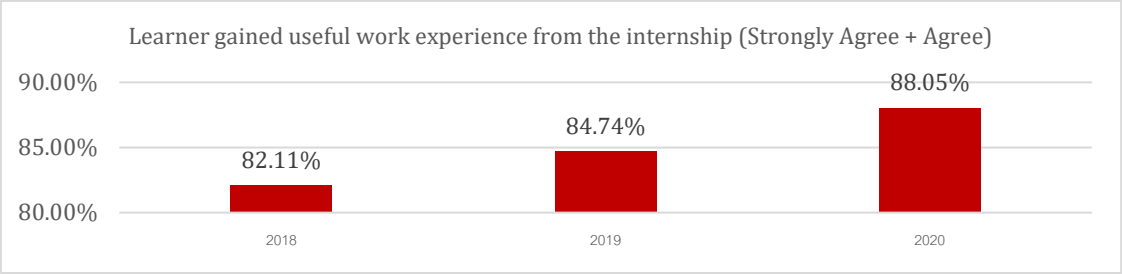

Figure 2. Graduates' response on gaining useful work experience during internship

Intrinsic Motivation Inventory Survey

For the IMI survey adopted and posted, a total of 108 responses were received from learners coming from Biomedical Engineering, Nanotechnology and Materials, Electronics System and Electrical Engineering with Eco-Design. Of these learners, 63 and 45 completed their ITP-12 and ITP-24 respectively. Table 3 shows the results of the IMI Survey. A t-test was conducted to compare learner's intrinsic motivation in 5 subscales, the result shows that except for "Relatedness", ITP-24 is statistically significant ($p < 0.05$) on all the 4 subscales, "Interest", "Competence", "Usefulness" and "Effort", as compared to ITP-12. The effect size (Cohen's D) for the following 4 subscales is high: Interest: 0.3782, Competence: 0.3697, Usefulness: 0.3436, Effort: 0.2911), indicating nontrivial effect. However, the effect size for "Relatedness" is 0.18, indicating a trivial effect. The "Relatedness" subscale is used in studies on interpersonal interactions, friendship formation, etc. In our context, it refers to the relationship between the interns and their mentors, supervisors, or co-workers from the hosting companies. This result depicts that longer internship duration does increase learner's intrinsic motivation.

Table 3. Results of t-test on Intrinsic Motivation Survey

	Interest		**Competence**		**Usefulness**		**Relatedness**		**Effort**	
Internship	ITP-12	ITP-24	ITP-12	ITP-24	ITP-12	ITP-24	ITP-12	ITP-24	ITP-12	ITP-24
Mean	5.30	5.87	5.20	5.68	6.07	6.45	5.76	6.01	5.94	6.27
Variance	2.42	2.00	1.86	1.44	1.28	1.11	1.97	2.25	1.56	0.79
P(T<=t)	0.0001		0.0002		0.0001		0.0761		0.0110	
Cohen's D	0.3782		0.3697		0.3436		0.1753		0.2911	

The results of the additional survey question on factors impacting the success of internship are shown in Figure 3. It is observed that higher percentage of learners completed ITP-24 cited that the two factors: "Industry Internship Mentor (IIM)" and "able to learn and apply technical and soft skills" played an important part for the success of their 24-week internship, as

compared to those learners who completed ITP-12 (> 5%). On the other hand, learners completed ITP-12 felt that "Stipend" was important to them as compared to those learners who completed ITP-24 (> 4%). For the rest of the factors, it is observed that there is no significant difference between percentages in ITP-12 and ITP-24.

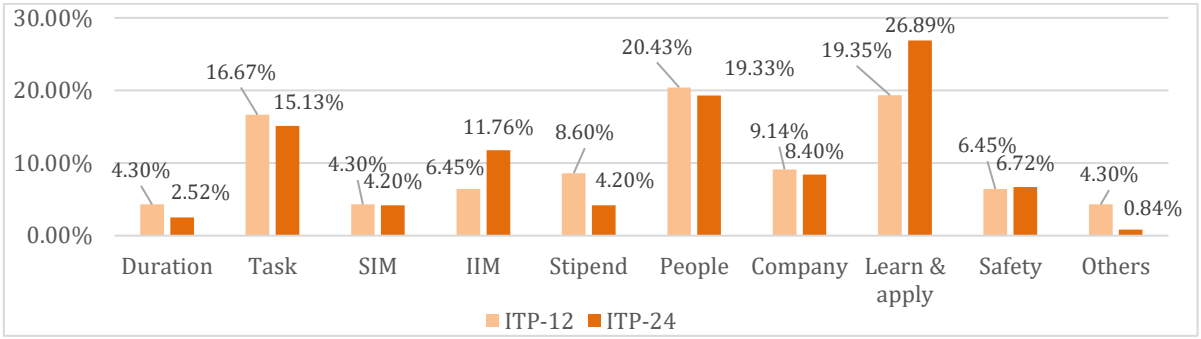

Figure 3. Factors Impacting Workplace Learning in ITP-12 and ITP-24

Individual Interview

The purpose of the individual interview is to explain and refine the survey results obtained from quantitative data analysis. A total of 10 learners who participated in the IMI survey, agree to, and attended the interview. Out of these interns, 7 have completed ITP-24 and the remaining 3 completed ITP-12. In this interview, the aim is to find out the reasons for the top 4 factors being selected as key to the success of their internships, namely "Able to learn and apply technical and soft skills," "People they worked with," "Task assigned is achievable" and "Industry Internship Mentor" respectively. Content analysis is usually used to analyse responses from interviewees. Content analysis is a research tool used to determine the presence of certain words, themes, or concepts within the given qualitative data (i.e., text). Using content analysis, researchers can quantify and analyse the presence, meanings and relationships of such words, themes, or concepts. Content analysis was used to analyse responses from the 10 interns.

After completing the coding, the results showed that most of the learners felt that the ability to learn new knowledge and apply them successfully would determine how well they performed in the company, and hence impacted the outcomes of their internships. They also felt that their success depended significantly on the availability of the supervisors or mentors in guiding them, in encouraging them, and in training them on the tasks assigned during the internships, which would directly impact the successful completion of their internships too. The results further showed that the tasks assigned should be achievable, and not something which were too routine and mundane, or something beyond what they were capable of doing. These observations reiterate the important design attributes of a successful internship.

CONCLUSION

The structured internship introduced in 2015 with the objective to enhance workplace learning experience, has been validated in this study. With the introduction of EIF, where several changes have been put in place, including grading and assessment methods, longer internship duration with establishment of SIM and IIM to guide and mentor the learners, the workplace learning experience has improved significantly. The study has also established that longer internship programme, in this case 24-week internship as compared to the 12-week internship,

has nurtured more intrinsically motivated learners as reflected by the 108 learners surveyed. From the graduate employment survey, graduates have also acknowledged that they had gained useful work experience during their internship. The study has also validated that learners who have completed 24-week internship have exhibited substantially improved intrinsic motivation in 4 IMI subscales, namely Interest, Competence, Usefulness and Effort. Learners who have completed both ITP-12 and ITP-24 have further fed back on important factors that had impacted the success of their internship, namely "Able to learn and apply technical and soft skills," "People they worked with," "Task assigned is achievable" and "Industry Internship Mentor" respectively. All these findings are aligned with the findings from the literature review.

With these findings, the School will be able to work closely with internship companies on key elements thus identified, in providing meaningful and successful internship to our learners. These include the design of the internship tasks, guidance provided by industry mentor and supervisor, and provision of relevant learning activities such that interns can develop professional, personal, and interpersonal skills during their internship.

While the study has validated the effectiveness of structured internship in enhancing workplace learning, there are some limitations in this study. There were several variabilities among the internship placement offered by the hosting companies, including internship tasks and scopes, working environment, guidance and mentorship provided. The different skills in term of mentoring, advising, assessment, communication, etc., would also indirectly impact the internship experience. In addition, company's varying welfare policies for interns could be another confounding variable affecting workplace learning experience.

As part of future work, we can study the relationship between the learners' primary reason in choosing internship, their perception of internship before placement, and how well they perform during the internship. The future study could also investigate the relationship between workplace learning and graduate's employment outcomes. The findings from these studies would further provide clarify on how the Polytechnic would better prepare our graduates for employment and introduce new and meaningful measures to further empower the learners and enhance their workplace learning experience.

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