

RETHINKING ENGINEERING INTERNSHIPS IN TIMES OF DISRUPTIONS

Norazrina Muhammad Mustafa, Thijs Willems

Lee Kuan Yew Centre for Innovative Cities,
Singapore University of Technology & Design

Cheah Sin-Moh

School of Chemical & Life Sciences, Singapore Polytechnic

ABSTRACT

Internships represent an important opportunity for students. It is an opportunity to develop a feel of the engineering work and profession, to be engaged in learning that enables them to observe experts at work, apply and practice knowledge and skills gained in the classroom and for many, it subsequently informs their decisions on further education and/or career options. The internship therefore is a bridge between two different phases, namely, education and work. Aligned with the theme of the CDIO conference on thriving and surviving, the challenging situation brought about by the Covid-19 pandemic on a global scale affected the way work and learning were conducted. Students' internships were canceled, postponed, or reduced to virtually participating in a company, hampering their professional development through hands-on experience. This paper aims to make sense of this disruption by using the work of Bourdieu on habitus and field to examine the transition process and the ways in which the interns develop an understanding of their internship experience and adapt to the changes amidst the disruptions brought about by the pandemic. Bourdieu's work is significant here because it sees education and practice beyond the explicit transferal of knowledge by highlighting the importance of practical and embodied experience, something which was affected in internships during the pandemic. The research was conducted through digital focus group discussions with 22 students. Here, we present the story of 2 students that provide insights in how students experienced and managed disrupted internships. This is especially crucial as for most of these interns, the internship is an initial foray into the world of work, providing them with an insight into engineering in practice that guides their understanding and decisions relating to their future. Together, this paper contributes to advances in the theory and practice of CDIO by reinforcing the need for closer alignment between education and industry.

KEYWORDS

Disruptions, Digitalisation, Internship, CDIO Standards 1, 2, 3, 5, 6, 7, 11

INTRODUCTION

Internships, also known as industrial placements, work integrated learning among other synonyms represent an opportunity for tertiary students to gain authentic workplace experiences in the specific role and industry related to their field or discipline of study. In the context of this research, third year polytechnic students pursuing the Diploma in Chemical Engineering (DCHE) went on a 22-week internship to fulfill part of the requirements of their diploma programme. In terms of ‘vocational intent,’ (Brennan, 1985), DCHE, with its strong alignment with CDIO standards, aims to provide students with the knowledge and skills needed by the vocation and industry (Clark et al., 2011).

The DCHE curriculum prepares graduates to work in wide ranging areas of the energy and chemicals sector, e.g., petrochemicals, pharmaceuticals, biopharmaceuticals, specialty chemicals, advanced materials, engineering and services, and environmental safety and health (ESH) protection. Graduates work in a range of roles such as process technicians, technical executives, laboratory technicians, and ESH officers; and carry out key tasks in operating and supervising process plants, assisting engineers in process development, quality control, handling effluent treatment, and waste and energy management. More than 50 per cent of DCHE graduates continued or planned to continue their education by enrolling for advanced diploma or degree courses. Those who did not pursue further studies went directly into employment although not always in the job role that they are trained for such as in technical sales. This is often seen as presenting “leakage” issues in the eyes of the chemical industry, and challenges for the educational institutions. The internship experience for DCHE students is often seen as key to enabling a smooth transition from education to industry.

While the above represents the ideal progression from education to the workforce, reality might tell a different story. Given Singapore’s labour market challenges brought about by a rapidly ageing workforce and a shrinking talent pool (National Population and Talent Division, 2021; Platon, 2021), internships become an important platform in enabling the transitions of trained students to professional settings. Chin et al. (2020) stressed the importance of leveraging tertiary-level internships as a platform to support the development of professional identity in students who will continue to undertake further education and/or become part of the industry that they have been trained for and that it would support the retention of the students in their specific field or industry. Using Bourdieu’s work related to habitus and field, the former concerning an individual’s inherent disposition (i.e., as a student or intern) and the latter concerning structured social spaces with norms, rules, and accepted patterns of behaviour (i.e., the engineering field and profession), we will examine the ways in which interns navigate through their disrupted internships. Further, we argue that the internship experience is critical for the development of professional identity. Thus, one of the key purposes of the internship component is to help students to translate their skills learned in school to the workplace and thereby enhancing their employability (Jackson, 2016) and facilitating the integration of different types of knowledge and skills (Bowen, 2018). However, in an era marked by disruption and with companies increasingly having less resources for internships, effective transitions from polytechnic to university and/or industry has become more and more challenging.

Polytechnic education represents an interesting and critical phase in that while most research on transitions from education to graduate work tend to focus on universities, more needs to be done at the polytechnic level where there are two viable options following successful completion of the students' diploma programme. One option would be to pursue a university degree in the same or different field, or the second option would be to join the workforce in a related or unrelated field to their polytechnic diploma. Given Singapore's strong alignment between its educational policy and planning to the needs and demands of the economy and its workforce, the issue of leakages from the field that the students have been trained for must be addressed accordingly. This research adds to the literature in that we examine the transitions experienced by students and its impact on their future decisions pertaining to their further studies and career options. Specifically, we look at this from the context of the Covid-19 pandemic and how this has impacted the internship placements of students. Arguably, the development of professional expertise has been much more challenging during the pandemic. Consequently, this research aims to examine the ways in which students evaluate their internship experiences against their expectations and its subsequent impact on their future decisions.

THEORETICAL FRAMEWORK

To examine the above issues, we propose to draw on the work of the French sociologist Pierre Bourdieu, specifically his work which pertains to the role of modern education. In brief, educational systems, for Bourdieu, are systems of 'reproduction' where specific existing social and cultural structures are being taught, thereby reproducing these within students who come to embody these structures and so forth. In other words, education is at least as much about learning how to behave and to learn the implicit values and norms of a social group as that it is about developing knowledge and the right skills. As his view aligns with how we see the development of professional identity of students through internship programs, we decided to use Bourdieu's work - specifically his concepts of 'field' and 'habitus' - to analyse and interpret our data.

Bourdieu's work on habitus and field (Bourdieu, 1977, 1990) enables us to understand the ways in which students experience and evaluate their transitions from polytechnic education and their progression into practice via the internship component. In brief, habitus is defined as 'the system of durable and transposable dispositions through which we perceive, judge, and act in the world' (Wacquant (2008) in Clark et al., 2011, p. 137). Arguably, the individual habitus is informed by what the students have experienced throughout their lives, built, and shaped by what they have experienced, seen, heard, practiced, and reproduced' (Corrêa Junior et al., 2017, p. 155), 'structured by past and present circumstances' (Clark et al., 2011, p. 137) which subsequently affect their perceptions, practices, beliefs, and feelings. This can cause tensions when interns transit from one field to another. Based on an understanding of the concept of 'field' as 'a structured social space with autonomy to establish rules, patterns of normal behaviour and forms of authority' (Clark et al., 2011, p. 135) or as a game with players required

to adhere by specific rules governing their interactions and actions which can evolve and change (Clark et al., 2011; Corrêa Junior et al., 2017), this research outlines two possible changes in terms of 'field' that the students experience in their internship. Firstly, it refers to their transition from an educational institution to a professional setting, namely, the engineering field. These represent two separate yet interrelated fields, the former being a precursor and a preparatory stage for the latter. Secondly, such transitions especially in the current context of disruptions arising from the digitalisation, which was accelerated by the Covid-19 pandemic affects the engineering field where their experiences might not be aligned with what they have come to expect and as such, requires the students to be flexible and adaptable to change.

In using both of Bourdieu's thinking tools: habitus and field, we can better understand this transition process by examining the interactions between them (Bloomer & Hodkinson, 2000; Bourdieu, 1977, 1990; Clark et al., 2011; Xu et al., 2021; Yang, 2014). Despite criticisms about Bourdieu's work being deterministic (Bloomer & Hodkinson, 2000), Yang (2014) contends the potential of its application in the context of change. In particular, she discussed the possibility of a mismatch between habitus and field as well as the 'structural gap' that ensues when the two are 'out of sync' or when the field undergoes any change. As such, it allows us to understand the impact of disruptions arising from the Covid-19 pandemic and/or digitalisation on the students' internship experiences, their individual habitus in managing the transitions and their thoughts on further studies and career options following their graduation.

In this transition they move gradually from the educational field into the professional field, but this transition is a liminal one: interns are neither fully part of the education field anymore and neither full participants of a professional field yet. In terms of habitus, they need to align the 'rules of the game' of being a student with that of being a professional, thereby not only having to socialise within the new field but also unlearn some of the rules of the old field that may have become sedimented and embodied in a student's identity. The learning potential in such liminal transitions can be powerful (Irving et al., 2019), thus the internship experience is an important period in which students are able to develop their professional identity and become part of a professional community.

However, the Covid-19 pandemic has affected the internship for many students. For those students whose internship continued, they entered a workplace that itself was in transition; it arguably is challenging to learn the rules of a game while those rules are being reconstructed. For others, the internship was canceled altogether, making it difficult to develop a professional sense of identity and make the leap from the educational to the professional engineering field. For many, however, the internship continued but in a different format (e.g., virtually), thereby reducing the possibility for personal interactions. Given that habitus requires not just 'knowing' the rules of a field intellectually but by embodying them and becoming part of one's structure, virtual internships in this respect can be seen as a suboptimal substitute. In the findings, we explore different kinds of experiences via two vignettes of students, thereby highlighting what a disrupted internship may mean for students transitioning into a professional field.

METHODOLOGY

The data presented in this paper is part of a larger study on the digitalisation of the engineering profession in Singapore for which a report outlining the full methodology was published by SkillsFuture Singapore in 2021 (Poon et al., 2021).

During our engagement with engineering students embarking on their internship, the Covid-19 pandemic hit Singapore and we were forced to halt all physical interactions in our research. As a result, we decided to engage with the interns in a virtual way. In total, twenty-two students from the DCHE course at the Singapore Polytechnic participated in this part of the study. They were about 18-19 years of age. Out of the 22 students, 16 were male, and 6 were female students, which was somewhat representative of the student population enrolled in the DCHE programme.

We created two groups on the online messaging platform, WhatsApp, with 5-6 students and two researchers acting as moderators. Every week, we would share a question in the group where we asked students to elaborate on their internships or on specific aspects that pertained to the research. There were two runs of this, so this part of the research involved a total of four groups of students. They were final year students and were required to complete an internship for a duration of 22 weeks as part of their diploma course requirements. Participation was on a voluntary basis and written consent was obtained from each participant prior to the start of the DFG discussions. Further, students' identities and responses were also kept anonymous and confidential aligned with ethical requirements set by the research institute.

With each group of students in each WhatsApp group, we conducted a digital focus group (DFG) discussion via a digital platform at three junctures namely, at the start, mid-way and at the end of the internship. The DFG discussions which lasted between 60 to 80 minutes per session were conducted in 2020. These were recorded and subsequently transcribed verbatim. During the DFG discussions, the interns were asked to discuss their preparation and expectations of the internship experience, tasks, and projects that they worked on, work environment, preferences in ways of learning, knowledge of the organisation and industry, relationship with mentor and colleagues at work as well as their future plans and aspirations. Such discussions provided them with an avenue to reflect and become more aware of the development of their professional identities (Bowen, 2018). During some of the DFG sessions, they also participated in activities that required them to reflect on their experiences. For example, they discussed ways of learning during the internship and ranked these based on their preferences. Some of these were based on individual input while others required them to discuss as a group and provide responses that were based on their discussion and reaching a consensus. This provided an insightful way of gathering data based on individual experiences as well as data that were obtained through the DFG participants' discussions where they were able to share specific experiences, come to an agreement or disagreement in terms of their responses and to provide relevant justifications where necessary.

DATA ANALYSIS

Open coding was done based on the transcribed DFG discussions without any imposition of preconceptions on participants' responses to the questions that were asked in each session. In this way, the codes remained close and true to the meanings intended by the participants. Subsequently, axial coding was done to examine possible linkages between the codes, and these were then developed into themes. The process was undertaken by two researchers. Upon completion, the third researcher was able to examine the codes and themes and provide further suggestions where necessary.

From the analysis, it was evident that the internship experiences were very varied, providing some parallels and contrasts. For example, on one extreme, there was an internship experience that was prematurely terminated due to the pandemic, leaving the intern feeling 'lost' and 'demotivated' as compared to his peers that were able to continue in their internship albeit in varied ways such as via reduced workloads, remote working among others. On the other extreme, there were interns that were not affected by the pandemic while there were others that were able to continue with their internship but had to contend with other forms of disruptions such as digitalisation and having to undertake work that was considerably different from their academic training in the polytechnic. Through these varied examples, we selected two cases which were disrupted both in terms of the pandemic and the impact of digitalisation on work and learning, because they provided a contrast in terms of the ways in which they managed the disruptions to the internships. Other interns who had experienced disruptions and tend to exhibit similar tendencies in the way they managed and/or adapted to it.

FINDINGS

The two cases selected had one thing in common with their other peers that underwent the internship and who had participated in this research. They had similar expectations for their internship, which was to gain experience of working in the industry, and through that, learn, apply and more importantly, expand their knowledge of the industry pertaining to chemical engineering and inform their future decisions.

DIGITALISATION: NEW SKILLS AND NEW PATHWAYS

Digitalisation disrupts work and industry in that it introduces new ways of work, opening up new job roles requiring new skill sets. X, an intern in a multinational company in the petrochemical industry, was working remotely and assigned to develop a dashboard using Power BI, a data visualisation software application. It was an area of work that he recognised to be new and different, *“actually this intern work (that) I was given right, past SP interns never*

do (it) before. So, it's like kind of (I am) the first one." X shared about his reservations of being assigned to a role that was not quite what he expected, given that he would have liked to explore the more traditional engineering aspect of working in a plant which he opined would allow him to make a future decision based on his fit/compatibility with the industry, *"I guess I would rather have a more chemical engineering related work. So that I'm able to like, experience this industry better first. I guess, to like ask myself (if) I would like to continue in this industry."* In other words, X expected to enter a different kind of professional field which was more aligned to his academic training.

Despite X's reservations, and the complexity of the task at hand, *"actually, I wouldn't say (that) it's easy, but it requires all sorts of problem-solving skills,"* he was able to persevere by deploying various ways of learning which was self-directed and independent to complete the development of the dashboard, *"so, the learning wise, the supervisor won't tell you step-by-step, because he has his own work to do. So, it's all mostly he will say what he wants, like he wants to display this data like this. And must be able to, like, choose some options for it. And that's it, he will show a final product, but he won't show the steps on how to reach it. So that part, I have to learn it myself, through online. Sometimes, you have to ask for help online, like (in) community forums, to get like, those experts' help. Then, also, sometimes (I) have to ask other interns that are also new, also working on similar projects, using Power BI, for their help. At the same time, I also help them based on my experience."* While he acknowledges that the organisation provides training, his status as an 'intern' sets the limitations of the resources he can access when it comes to learning, *"but if you want to pick up that skill, we require, like a business reason. Because these skills require professional help and will cost money, you need to ask your supervisor to approve these kinds of skills, which I probably won't do."* Evaluating his internship experience after 22 weeks, X still felt that he should have had more opportunities to gain direct exposure and experience working on-site, to shadow an engineer working in the plant and experience *"a day in the life of an engineer."* Despite that, his internship experience opened up new areas of interests which he perceived to offer good prospects for his future, *"like make me lose interest a bit in chemical engineering, then make me more interested in the digital area,"* and led him into wanting to pursue a computer related degree at university in future.

INTERNSHIP DISRUPTED

Like most interns, Y shared that *"before the start of the internship, my goal was to learn as much as I can, because from what I know, from what my supervisor told me, this company is a good place for interns because it's what I really learnt in SP."* Eager to step foot into an actual plant, with *"those distillation columns and reactors, and all that,"* he was disappointed when Covid-19 affected the experience by first limiting him to working remotely with virtual learning sessions with his mentor which then slowly dwindled over time, *"basically I don't have communication with him that much, but then after – because I had to do stay home notice and all, then I couldn't see him"* and *"he also doesn't check in."*

Despite having a disrupted internship which confined him to working remotely and having limited tasks assigned to him, Y's academic training at the polytechnic combined with his interest for the industry shaped his understanding and expectations of the work and industry and this seemed to come across when he talked about different aspects of engineering work. Although he was disappointed with not being able to gain the internship experience that he envisaged for himself, he was *“assigned (with) things to do, (and a) project. Like just now, I already mentioned. Creating the procedure. And I did that. But I did it slowly. There's no time frame either.”* Reflecting on the ability to apply what he had learnt, *“I can say that I have learnt it before in poly (polytechnic). I mean, we have all learnt it before in poly (polytechnic). Just that I can finally apply what I learnt to the company because they also don't have the (process) that's what I observed from the SOPs (standard operating procedures).”*

Out of the 22 weeks of internship, Y was able to return to the plant for about 8 weeks of his internship and he enjoyed being able to *“see familiar faces”* but the limited time spent on site had impacted his outlook on the industry and he reiterated the importance of the internship in allowing students to gain an insight about the work and industry, *“because whatever we learnt in school is just the basics. When you start work, you go into the industry, that's where you find – that's where you are exposed to more things and real-life things that will happen. Because (for) the polytechnic, they have practical, but they don't really have advanced, you know, the things we have never seen before.”* In assessing the important aspects of internship, socialisation was critical, and this was probably due to his limited opportunities for professional socialisation where he reiterated that, *“I should communicate and network with the people there more because you never know when you need them in the future, when you are working in the industry. For example, my supervisor, maybe his testimonial will help you in the future, you would never know. So that's why networking is important.”* Overall, the disrupted internship has an impact on his future decision, *“I don't really see myself in this industry also. After what I have experienced. I didn't experience much but I can observe. So, it's not really... basically like personal experience, you have to try it for yourself.”*

DISCUSSION AND CONCLUSION

We highlighted two cases where students experienced disrupted internships but had different ways of managing it which led to different outcomes. While the initial expectations of the students were quite similar, how their internships actually happened and how these were experienced were rather different. This was, we have shown, in part due to the pandemic with companies radically changing their modus operandi. Arguably, internship experiences will always be different and dependent on a number of factors such as the quality of guidance received (from hosting companies and schools), the tasks and responsibilities given to the intern, and the alignment between expectations and realities. We zoomed in here on the pandemic, however, because this posed a particularly relevant breach in what students might have expected from their internship and how this was actually experienced.

This breach can be better understood via the work of Bourdieu as we laid out in our theoretical framework. An internship, we have argued, is a specific case of a transition between fields, from student to professional. In turn, during such a transition the habitus of students are challenged and expanded. A student's habitus, as the internalised habits and dispositions of a social field that in turn shapes how people behave thereby reproducing the structures of that field, is a source for developing professional identity. When the structures of a field themselves break down (e.g., companies changing their modus operandi or realigning visions and goals), this poses challenges to what extent students can try and test with their different identities and grow as a professional. Now, to be sure, this does not mean that developing professional identity is impossible in times of disruption, but it does imply that it brings certain challenges to the table. As such, in terms of specific improvements that can be considered for the internship that would allow students to deepen their understanding of the engineering field and develop their professional identity and habitus include some approaches adopted by Paul et al. (2016). The author highlighted benefits arising from the introduction of online lessons and personalised feedback focusing on students' professional development while they were on their internships. The aim was to develop students' self-awareness skills in order to encourage them to reflect on their learning experience during the internships thereby contributing to the development of their professional identity.

The interaction between field and habitus is significant in developing an understanding of transitions from one field to another (i.e.: education to professional practice). Further, in examining the impact of changes in the field especially as new rules of the game were being constructed due to the disruptions from both the pandemic (move from physical locations to remote working) and digitalisation. The latter meant that the new job roles and associated tasks were somewhat misaligned with what the interns had come to expect as a result of the polytechnic education. In this regard, it reinforced the importance of practical and embodied experience in professional identity development. There are two implications here. The first one relates to the important role of industry in the internships and its alignment with the educational institutions. For example, Rouvrais, et al. (2017) suggested to extend the CDIO framework by adding 'Industry Partnership' to systematically include work-based learning (WBL) as integrated activities in educational programmes to better match graduates' skills and competency development with industry requirements. Kamp & Verdegaal (2015) had earlier reported on the relevance of selected CDIO standards to internship for a Masters' programme at TU Delft, for a range of learning outcomes including better understanding of employment options after graduation and developing a good sense of ethical accountability and social responsibility. Calling it 'Industry Engagement', Cheah & Leong (2018) also argued for a new CDIO standard which they described as 'actions that educational institutions undertake to actively engage industry partners to improve its curriculum.' The authors highlighted an area that can benefit from such a standard is in enhancing student learning via the internship component.

Secondly, the disruptions arising from the Covid-19 pandemic where the interns' expectations of the internship may not be fully realised were mitigated and/or mediated by their habitus. For instance, the polytechnic had strongly emphasised on self-directed and independent learning

but for many, their student habitus meant that they were not able to fully relate nor see the need and relevance of self-directed and independent learning as much as it became pivotal in enabling them to adjust to the disrupted internships. This was particularly important given that access to mentors/supervisors, guidance from colleagues, organisational resources were less available as a result of working remotely, and they had to rely on other sources of knowledge and guidance to complete their assigned tasks and projects.

Aligned with existing literature, the data presented here suggests that the internship is an important and pivotal point in students' experiences. It is their first real glimpse into the professional field and a moment where their habitus as a student is challenged and they may find room to expand this in becoming a professional themselves. The experience of this transition is, especially during disruptive times, contingent on a number of factors that may shape the extent to which a student can feel empowered to develop a professional sense of being. This indicates, from the perspective of the educational institutions, that it is a process that must be carefully managed and where students' expectations are realistic from the start and, moreover, aligned with practical reality.

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BIOGRAPHICAL INFORMATION

Norazrina Muhammad Mustafa* is a Human Resource researcher and practitioner in the public sector, focusing on sectoral workforce development efforts. Her academic interests include the future of work and learning, ageing workforce, HR policy and practice in equality, diversity, and inclusion.

Thijs Willems is an organizational ethnographer and generally interested in the daily work of people in complex and technological organisations, as well as how they experience their work in the broader organisational context. In his work, he draws on rich, ethnographic empirical data analysed via practice and process theories. His latest research project, “Mastery in a Digital Age”, studies how professional expertise is changing amidst the digital disruption of workplaces.

Sin-Moh Cheah is the Lead Teaching and Learning Specialist in the School of Chemical and Life Sciences, Singapore Polytechnic, as well as the Head of the school’s Teaching & Learning Unit. He spearheaded the adoption of CDIO in the Diploma in Chemical Engineering curriculum. His academic interests include curriculum revamp, academic coaching, and mentoring, and using ICT in education.

***Corresponding author**

Norazrina Muhammad Mustafa
Singapore University of Technology & Design
Lee Kuan Yew Centre for Innovative Cities
phd13nb@mail.wbs.ac.uk



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