【論文】

Conceptual and Pedagogical Issues for Undergraduate Thesis Preparation

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〔Abstract〕

In this article, I consider some conceptual issues with regard to public research and how it progresses incrementally as a collective endeavor. The extent to which students need to be informed about these issues as part of preparation for the writing of their undergraduate thesis is argued for. Engagement by students with the philosophy of science is also advocated as pedagogically useful in alerting students to the distinctive nature of rigorous academic research and how this may differ from their inherited notions of knowledge inquiry. Also, some core understandings and skills related to rigorous empirical inquiry are discussed as important for students in being well prepared for writing an undergraduate thesis. These include issues such as the priority of theory, the critical importance of measurement, and the nature of statistical inference as probabilistic reasoning.

Introduction

The writing of an undergraduate thesis represents, in the minds of many university students, the single most important endeavor in their four years of undergraduate study. For many students, the completion and submission of the thesis is an emotional point of closure in their university experience surpassed only by the graduation ceremony. From the institution's point of view, the thesis represents the culmination of effort made by the teaching staff to develop capacities for a variety of integrated skills including critical and creative thought, literary discipline and perspective, and often, but not always, inferences derived on the basis of data. The institution places value on the exercise of these skills in a personally disciplined way over a significant period of time, and also places value in their expression in a text which exceeds the length students commonly cope with in the many term papers completed over the four-year period of their tertiary education. Thus, preparation for the undertaking of a thesis is a critical pedagogical goal and this preparation needs to be seen as a cumulative process of skill building and conceptual development on the part of students, guided by teachers, leading up to the undertaking of the final thesis. Preparation cannot be undertaken satisfactorily through a "how-to manual" shortly before such undertaking. This is not to dispense with the usefulness of such tutorial manuals, but only to point out that they cannot be sufficient.

The purpose of this paper is to address some of the conceptual understandings we should seek to develop in students as they progress toward the project of undertaking their graduation thesis. This paper does not represent an attempt at curriculum outline, but rather a signposting of important conceptual understandings which need to be developed in students in any curriculum if they are to embark on their thesis with an appropriate understanding of what they are about to do. I begin with a discussion of the nature of private and

public inquiry as alternative forms of knowledge inquiry. I argue that the form of inquiry that new students recognize and understand as inquiry is typically more closely allied to private inquiry or the goal of "finding out for oneself." This is as opposed to the notion of public inquiry which is the hallmark of academia and relates to inquiry based on collective participation in a process which is larger than oneself, and to which one owes a greater debt of explanation as to the means by which one has reached inferences which one wants to contribute to the collective endeavor. I suggest grounding in basic notions of the philosophy of science, and particularly those offered by Karl Popper (2002)[i] and Thomas Kuhn (1962)[ii], as a high-leverage pedagogical tool to enhancing students' understanding of the demarcation between public and private inquiry and the importance of the collectivity of public inquiry. In this argument, I am roughly using science as a proxy for public inquiry which is something of an overstatement as some scholarly inquiry does not fall squarely within the scientific, but I argue that for pedagogical purposes there is still value in this approximation despite the imprecision. Finally, I turn to important conceptual issues related to public knowledge contributions, and specifically in the area of empirical research, which include the priority of theory over data, the importance of measurement and the nature of statistical inference. I argue that students need a conceptual understanding of these issues at the very least, and an executional understanding at the ideal, and that conceptual understanding best precedes the gaining of executional knowledge in these areas.

Private Versus Public Inquiry

Much of a university education, in whatever field, addresses the task of mentoring students from commonsense understandings of knowledge and the nature of inquiry to expert understandings of the same. This transition is closely associated with helping students to negotiate a complete understanding of private versus public inquiry and, more importantly, helping students to gain some separation from the notion of inquiry as private and personal, which is a notion more familiar to them, and to move over to a notion of inquiry as public and contributive. Students arrive at university with a notion of inquiry which is dominated by a sense that it is associated with personal endeavor for personal transformation which indeed it partly is; but this does not cohere with the distinctive and public nature of inquiry within academia which is what universities want to prepare students to participate in.

It is not surprising that students do arrive at university under the influence of a notion of inquiry as private for two main reasons. The first is that the typical student arrives at university having just negotiated the process of growing up—a process otherwise, and more academically, known within psychology as child and adolescent development. This process was the central theoretical concern of early luminaries such as Piaget (2001a, 2001b)[iii] and Vygotsky (1978, 1986)[iv] and remains of great theoretical concern today. Theory in this area attempts to explain the process of the child or adolescent inquiring for him/herself as he/she adapts to the external world in both the social and physical domain. This is not to suggest that the child develops *by* him/herself. On the contrary, Vygotsky in particular would emphasize child learning via social mediation and through the personage of significant others such as parents, teachers and older children. However, it is to suggest that the child learns primarily *for* him/herself in the process of maturation. This feature of child or

adolescent development does not represent a deficiency, but simply an inevitability of maturation as part of the process of adaptation. The second reason why students will arrive at university with a notion of inquiry which is dominated by the private version of such is that pre-tertiary education is significantly focused on the person. The goal in pre-tertiary education is generally, but not exclusively, to develop the mental capacities of the student and to ensure that the student masters a range of cognitive skills (mathematics and literacy, for example) and retains important information—all of which is regarded as important for a person to function adaptively in modern and literate societies. Testing is a critical feature of the objective evaluation of how well the child or adolescent is progressing in this endeavor. Overall, therefore, the young adult comes off a long passage of experience where what is of importance is what he/she knows and how well he/she is able to demonstrate his/her consumption of, and facility with, this knowledge.

Arrival at university represents a significant departure from the hitherto experience of the young adult's education; and here I am making the assumption that the new student will be a young adult which is a reasonable assumption in Japan. Much of what is intended in university education is to school students in more than the mere consumption of knowledge. In the end, knowledge which is to be consumed must be produced and made public, and it falls to the highest educational institutions in a society to prepare students for this social contribution which is distinctive of academia—that is the production of knowledge, as contribution, for public availability and then consumption. Although post-graduate schools pick up the major share of the responsibility for knowledge production and publication of such, undergraduate education is an important preparatory and instructional foundation for what gains full expression in post-graduate activity; and the undergraduate thesis is of critical importance in this regard. The undergraduate thesis requires students to locate their work within the existing literature, which is by nature public, and to follow publicly accepted norms for critical inferences (both analytical and empirical) in order to lend credibility to their contribution to this existing literature. Although it is the rare occasion that an undergraduate student's thesis, or part thereof, is actually published as a real contribution to public knowledge, the intellectual conduct associated with the work they do in completing the thesis is designed to at least simulate such real contribution as part of a pedagogical exercise, or first step, in preparing the student for actually doing so in the future. This is all a significant and challenging endeavor for any student, and thus it is that educators bear the responsibility of adequately preparing the student to undertake the thesis via training which should start from the day the student enters university.

Much of this training comprises the alteration of students' understanding of their relationship to knowledge. Students have to become more familiar with inquiry which is part of a public and collective process rather than a process which is personal and private. Their commonsense notion, inherited from pre-tertiary education, of inquiry being for oneself, has to be turned over to a stronger sense of inquiry as public contribution with this inquiry subject to more rigorous standards of inference under the process of public scrutiny. Much of this training undertaken by teachers involves not so much the teaching of a new way to students, but rather helping students to let go of the old way when they are engaged in activity which would count as academic inquiry.

This qualification as to when students need let go of the old way, or the commonsense way, is important because we do not want to supplant or delegitimize common sense; rather we want only to demarcate it as such and encourage students to suspend it while engaged in the different set of rules for academic inquiry. In the

world of day-to-day life, common sense and intuitive knowledge are not to be belittled, and are, in fact, critical to functional and adaptive behavior in competitive social life. Indeed, much of the criticism of academia is often directed at the apparent forfeiture of common sense, and while this may often bear truth, we should not be overzealous in our concession to the criticism. Inquiry within academia is distinctive from commonsense inquiry, and this is because commonsense inquiry is just as vulnerable to failure—though the characteristics of this failure may be different from those of over-exercised academic inquiry. However, given these careful qualifications, it is important to recognize that much of what we do as educators is to lead students into new and more stringent ways of making critical inferences in a process of inquiry which gradually becomes more for the production and publication of knowledge rather than the acquisition and consumption of knowledge.

The Philosophy of Science as a Pedagogical Tool

There are two distinctive features of the non-commonsense version of inquiry which the student has to comprehend and with which the student has to achieve a significant level of intellectual integration. The first is that inquiry conducted by the individual within academia is part of the social activity of the production of knowledge. The individual is making a contribution, so to speak, to a trajectory of knowledge which is socially constructed by many individuals, sometimes across the world, and the contribution is often-times, but not always, incremental. The second is that much of this inquiry is empirical, and if it is not, for example if it is theoretical, then empirical inquiry will have to be engaged with at some later point. Also, participation in empirical inquiry is governed by rigorous rules which constrain inferences to only those which are secure, and which will stand up to social scrutiny. By social scrutiny here, I mean the scrutiny of peers involved in the same knowledge trajectory and operating under a similar set of assumptions; and with this scrutiny usually involving peer review, critique, and replication and so on. The rigorous and empirical nature of non-commonsense inquiry is virtually emblematic of academic inquiry. Schooling students in these two distinctive features of non-commonsense inquiry is very much a foundational goal in preparing students for the undertaking of an undergraduate thesis. The teacher is essentially seeking each individual student's intellectual adaptation to a mode of inquiry where he/she is a participant in a social process of knowledge creation, rather than an individual finding out for him/herself, and where he/she is a participant to stringent norms of empirical research practice in this same process.

Given the challenge for the teacher, the question which begs answering is how best to proceed with this schooling. There is no monopoly on approaches for the task, but one I would particularly like to draw attention to concerns engagement by the student with the philosophy of science—and two important contributors to the philosophy of science in particular, namely Karl Popper (2002) and Thomas Kuhn (1962). The philosophy of science is essentially a metatheoretical discipline, and this metatheory can serve as a pedagogical tool for the student gaining perspective on how science is conducted. At this point it is important to note that I am not advancing science as coextensive with the kind of knowledge pursuits conducted in faculties of letters, humanities, education and so on, but the fact remains that much of the research conducted in such faculties remains deeply informed by the principles of scientific inquiry. In fact, in the case of Popper, seen somewhat

as the progenitor and architect of the philosophy of science, his undergraduate education was in elementary school education and his post-graduate education was in psychology, and not physics or one of the other "hard-science" fields typically seen as the object of the metatheory in the philosophy of science. I am also not advancing philosophy as a required field for its own sake (though some would still want to make that case given its status as one of the pillars of a classical liberal arts education), but rather pointing out the pedagogical leverage that the philosophy of science can bring to bear in the student gaining perspective on how much of public and academic knowledge distinguishes itself. In much the same way as metacognition has come to be seen as critical to an individual making adaptive responses to cognitive challenges (Flavell, 1979; Pressley, Borkowski, & Schneider, 1987), metatheoretical training in science provides the self-regulatory perspective a student needs to subordinate his/her intellectual conduct to the process of scientific endeavor; or at least academic endeavors deeply informed by scientific principles of observation and rigor. In this sense, metatheoretical training in science offers a critical pedagogical tool to expediting students' understanding of the framework and rules within which they will be expected to integrate as part of the process of completing an undergraduate thesis. Finally, and in one more disclaimer to the scope of arguments presented in this paper, I am not seeking to elevate Popper and Kuhn above other philosophers of science or willfully neglect criticism of their work. In the case of Popper for example, Feyerabend (1975) presents a radical critique of the plausibility of the philosophical demarcation of science and non-science in his treatise against method. I do not want to arbitrate this kind of engagement for want of not sacrificing the purpose of this paper which relates to the pedagogical usefulness of these ideas rather than to their ultimate philosophical tenability. However, I do owe it to the reader to make clear my assumptions which are that academic inquiry and scientific inquiry do follow rules though these are not absolute and are occasionally discarded in creative acts of knowledge production, and importantly, that this occasional discarding of the rules is best done by those who have learned them and discard them despite this, rather than by those who are ignorant of them. To not exercise rules as an act of ignorance is to discard nothing; this is merely neglect.

In the case of Popper, there are two aspects to his philosophical contribution which resonate with the pedagogical issues outlined in this paper, and which are particularly useful. The first is the demarcation of science versus non-science and the second is the nature of scientific knowledge claims and inferences. These two aspects are connected in that Popper's demarcation project is founded on arguments with respect to how knowledge claims within science gain their status as specifically scientific knowledge claims rather than any other kind of knowledge claim. With respect to the demarcation of science, the notion of falsifiability was the central criterion put forward by Popper. For Popper, only theories which offered the prospect of falsification fell within the order of science. His case was founded on the logical conclusiveness of a negative outcome in experimental testing of a theory versus the inconclusiveness of any number of positive outcomes in similar experimental testing (i.e. in a process of ongoing verification). In short, to be scientific a theory has to be testable by specifying observational events which would count as falsification of the theory. However, in terms of the remit of this paper, the important point is not to give an exhaustive account of Popper's position, and indeed there is much to be lost in this cursory account. What is of importance for the purpose of this paper is Popper's construction of the problematic for the philosophy of science as one of demarcation. Subsequent

philosophers of science may have challenged Popper's criterion for demarcation and may have provided rebuttal on the basis of the real execution of science versus the stipulative agenda of Popper, but the problematic itself was set as one of demarcation. Schooling students in the philosophy of science in so far as it is concerned with this problematic sensitizes them to the issue of demarcation and provides conceptual vantage points through which they can distinguish the version of inquiry they have inherited versus the version of inquiry they are expected to acquire. It sensitizes students to the distinctiveness of science and rigorous inquiry from looser forms of inquiry and commonsense inquiry, and also sensitizes them to how this distinctiveness is connected with the nature of inference and the reversion to empirical confirmation associated with science and the more rigorous versions of inquiry.

Schooling students in the philosophy of science will not leave them with a sense of certainty as to how science is demarcated because there is no certainty. Demarcation is the problematic, but the problematic is by no means resolved. This uncertainty may be of serious concern to philosophers of science, but it should not discourage the teacher wanting to exercise this problematic for pedagogical purposes in the preparation of students for the undertaking of their undergraduate thesis. The problematic is pedagogically useful in so far as it alerts students to the educational requirement that they are to integrate themselves into an intellectual practice which is distinctive; even if the nature of this distinctiveness is not metatheoretically conclusive in the more recondite region of the philosophy of science. The other contributor to the philosophy of science, Thomas Kuhn, who I seek to draw attention to in this paper, will no doubt exacerbate healthy uncertainty with respect to ideas on the demarcation of science, but equal to Popper and for slightly different reasons, Kuhn also offers ideas with important pedagogical leverage for teachers preparing students for thesis production.

Kuhn's (1962) central thesis was that science does not progress in a linear fashion but rather through a series of paradigms where the shift from one paradigm to the next could be characterized as a period of rupture or revolution, and hence the title of one of his most important works "The Structure of Scientific Revolutions." Exposition of this thesis involves the distinguishing of normal science from revolutionary science. Normal science occurs as a paradigm is exploited in the process of what is now sometimes characterized as routine and incremental work within the deep conceptual framework which the paradigm affords. In this routine work problems are solved and the paradigm is extended. Contrary to Popper, Kuhn did not see the decisiveness of the single case of falsification in the progression of science. Rather, he observed a process whereby falsification leads to accommodations until the accumulation of accommodations threatens simplicity and confidence. At this point, a new paradigm emerges with greater prospects for fielding explanation without such parsimony-threatening accommodations of the anomalies observed via the previous paradigm. An aspect of this notion of the paradigm is that it informs the way scientists see reality and that propositions or knowledge claims emerge from a paradigm and can be adjudicated from within the paradigm in which they emerge but not from within other paradigms. This feature of paradigms, which Kuhn referred to as the incommensurability of paradigms, is one which generates controversy because there is an implication of indeterminacy or relativism across paradigms, something which Popper would not be in favor of given the labor to objectivity characterizing his more stipulative project. Popper set out to distil what should demarcate science rather than to observe how science works in practice. Kuhn's approach on the contrary is more historical and attempts to provide an

account of how science does in fact progress.

Turning again to the pedagogical and the objectives for this paper, Kuhn's work offers much to teachers preparing students for the writing of an undergraduate thesis. The pedagogical leverage available in his work concerns the perspective it provides with regard to the sociality of knowledge production. Given the arguments previously stated that students typically present at university with an inherited notion of inquiry which is one of "inquiry for oneself," a form of egocentricism inevitable to maturation and the goals of pre-tertiary education, it is important to turn them over to an understanding of inquiry as involving the social production and public sharing of knowledge as a form of contribution. Kuhn's work, implicitly but unavoidably, amplifies this feature of scientific inquiry. The notion of normal science encapsulates the collectivity typical of knowledge production as large groups of scientists continue the extension of the paradigm under a common set of assumptions and in a manner which is integrated and cumulative; and it emphasizes the incremental nature of each specific contribution in this process. For students whose personification of the scientist rests in high-profile figures such as Newton and Einstein, some new perspective will be acquired from this distinction between normal and revolutionary science. These luminaries, of who Newton and Einstein serve as two of the most exemplifying and popular cases, characteristically make profound individual contributions to a field by altering the conceptual framework within which less well-known figures continue the more mundane work of normal science in a more incremental manner. Distinguishing these two types of contributions, the revolutionary and the incremental, helps students to locate and integrate themselves into an appropriate set of expectations for what they are attempting to achieve in terms of knowledge contribution within their thesis. While we never want to neglect the possibility that we may have a nascent revolutionary thinker in the midst of our student body, after all, the luminaries we know were once students and many luminaries have made their greatest contributions at a young age, it remains the case that the vast majority of students require mentoring for participation in the more incremental contributions of routine knowledge production. This kind of contribution is not the decisive and profound impact of the single intellect associated with a revolutionary scientist, but rather a participatory contribution to a socially constructed body of knowledge.

In practical terms, effective participation in this incremental and social production of knowledge boils down to satisfaction of a number of requirements. For example, a literature review which adequately represents previous contributions and deficiencies and which locates the contribution the student wants to make with respect to this previous research record is critical to participation in socially produced knowledge. This aspect of the thesis is what binds the student's contribution to the public body of knowledge for which the student should intend the integration of his/her thesis. This is the executional or practical skill which the university requires of the student and which will be part of the assessment for the student's thesis. However, the student is well served by having a deeper conceptual understanding of why he/she needs to develop this executional skill. Having the perspective offered by Kuhn of how normal science proceeds assists considerably with this pedagogical endeavor. To take another example, the student's thesis will be judged on how secure the critical inferences are, and in the case that these inferences are empirical, rather than say theoretical or analytical, much of this assessment will hinge on the use of appropriate research design, appropriate measurement/observation and appropriate statistical methods of analysis. It is appropriateness in these areas which indicates that the

student has been reasonably successful in integrating him/herself into the rule-governed intellectual behavior of those participating in the social production of empirically secure knowledge; invariably as part of normal science.

At this early stage of the student's education, he/she will have little say in the negotiation of these rules. However, while the rules may be handed to the student for his/her assimilation and strict observation, they are not arbitrary and ultimately have been negotiated by expert participants, and these expert participants negotiate under a remit for ensuring that only the most secure inferences are drawn. It is these rules, whose strict observance allows for secure inference, which demarcate the work produced under such observance. And in the case of empirical work, and while not to the letter, much of the heritage of the rationale by which these rules are constructed is in the preoccupations which concerned the likes of Popper within the philosophy of science. While the remit of this paper may require disengagement from actually adjudicating the merits and demerits of different aspects of the debate around the demarcation of science, there is no doubt that the demarcation of science is connected to the criterion of empirical testing generally; and the rules by which this testing occurs are central to communities of researchers who pursue research as a collective endeavor. Exposing students to the metatheory of the philosophy of science offers them conceptual perspective on the empirical and scientific rules which they are expected to integrate with and observe—if they are conducting empirical inquiry as part of normal science.

Critical Conceptual Understanding for Empirical Inquiry

I have made the case that the philosophy of science offers the potential for metatheoretical understanding of how rigorous empirical inquiry is demarcated. More specifically, I have cited Kuhn's work as useful for leveraging students' understanding of how scientific knowledge is produced—with the notion of normal science being particularly useful in amplifying the sociality and rule-governed nature of how this routine scientific knowledge is accumulated. Also, I have cited Popper as the architect of the project of demarcating science as a distinct form of inquiry and pointed to his emphasis on the nature of scientific claims and inference as the site for resolution of this problematic. It is with respect to the nature of scientific inference that I want to pursue this paper into outlining critical methodological understandings which students should have in hand before embarking on an undergraduate thesis.

As previously mentioned, Kuhn questioned falsifiability as the principal criterion for the demarcation of science as had been advocated by Popper; although, and as also previously noted, Kuhn's project was more historical and Popper's project was more stipulative. Despite this disagreement at the metatheoretical level, it would suffice to claim that there is consensus in scientific practice that knowledge claims require reversion to data and that the empirical arm of scientific practice is an imperative. In this regard, I want to highlight three areas of conceptual understanding which underpin the conduct of empirical research practice, and which need to be grasped by students in advance of undertaking an undergraduate thesis which is of this type.

The first issue is contentious and is not an issue for making absolute statements, but is in an issue worthy of making some generalizations, and it is at the very least something which a student should be acutely aware of.

This issue concerns the general rule of the priority of theory over data. By commenting on the priority of theory, I put myself at great pains to point out that this does not imply the dispensability of data. Claiming the priority of theory over data is only to point out that theory is explanatory and data is confirmatory, and we generally seek to explain first and then confirm explanations through observation; i.e. in data. There may be cases where data occasionally leads theory, or at least provokes new theoretical thinking, but it is typically the case that theorizing occurs in advance of confirmation in data. There are also cases where research is essentially descriptive in nature, rather than explanatory, and such description might invite new theoretical thinking, but this new theoretical thinking would then be tested in new data (an a priori test) rather than in the data which invited the new theoretical thinking. This issue is of heightened significance because recent sophisticated data modeling techniques (which it should be said, undergraduate students are less likely to use), enabled by the increase in processing capacity of computing over the past two or three decades, such as Structural Equation Modeling (Byrne, 2001; Kline, 2005), facilitate data-led inferences on a scale which was not possible before, and this carries with it the danger of data-driven rather than theory-driven research trajectories. For the student at least, and as a pedagogical issue for the teacher as well, the imperative is that the student thinks through the research issue first, and then collects data to address the issue, rather than collecting data in a relatively ad hoc manner and constructing the research issue around the data post hoc.

Another issue of critical importance is measurement. Observation inevitably involves measuring. This issue generally receives minute attention in the hard sciences and is seen as axiomatic to reaching secure conclusions. Unfortunately, the attention it receives is often insufficient within the humanities. Survey instruments have become pervasive and there is a danger that students are led by this pervasiveness into believing that these instruments are sufficient, and furthermore, that their construction is a fairly mundane question of simply writing questions to get answers or writing items to get responses. There are cases where they may function in a fairly mundane way, to gather reactions to a class for example, but there are three areas for caution. The first is that they are by nature self-report measures, and this creates the possibility of willful misrepresentation by the respondent for any number of reasons. The second is that they have become so pervasive in modern society, not only because they quickly and easily gather data but also because they perform a display function in legitimizing the activity with which they are associated, that there are serious issues with regard to respondent fatigue and therefore response sincerity. The third issue is that many survey instruments are more than they appear to be, and should be so, when they are deployed to measure psychological constructs, of which there are a whole host—anxiety, motivation, personality and so on. In such cases, the responses are being used to make measurements of the respondent's mind, and they then become a form of mental measurement. Validating the data generated by the instrument in these cases is a very serious issue, and there should be no less demand on this validation than there is for more familiar forms of mental measurement such as IQ and language proficiency testing. Simply because the instrument has the same superficial appearance as a routine survey that one would pass around to gather opinion on the reactions to a recent club-activity entertainment event, because it comprises a list of self-report items, does not mean that the instrument should be treated at the same face value as such routine deployments of surveys. A self-report instrument claiming measurement of psychological variables usually has a latent structure with multiple self-report items directed

at measuring the same underlying construct (see Crocker & Algina, 1986; Nunnally & Bernstein, 1994). Such latent structures in an instrument need to be examined for plausibility in the data generated, and ideally in every case in which it is used. If students are not ready to undertake such examination due to the technical demands of conducting such analyses, they should at least be critically aware of what they are using, understand the structure of the instrument, and search for evidence, at least, in datasets generated by the instrument in previous uses. Overall, however, and apart from the self-report aspect of measurement which has become so widespread, students should be aware that any inferences they make on the basis of their data are only as secure as the measurement on which such inferences are premised.

The final issue I would like to make concerning critical understandings which students need in order to be prepared for the writing of an undergraduate thesis concerns the nature of statistical reasoning. Gaining a fluent command of the methods used to make statistical inferences, and thus secure inferences, is a considerable task, and indeed it should be said that there are post-graduate students and even recognized researchers who proceed with insufficient knowledge in this area. Therefore, our expectations for executional command of statistical inference on the part of students should be realistic. Nonetheless, it is of critical importance that the desired, but perhaps overly-ambitions, goal of full executional command is at least preceded by a conceptual understanding of why these analytical methods are executed and what their important contribution to research impact is. Having a conceptual understanding of these methods displays to the student the intellectual and inferential empowerment which comes with them and will motivate at least some of them to engage with the demanding task of learning to use them properly.

There are a number of reference points for helping students gain a conceptual understanding of why these methods exist but I will mention two of the important points which should serve as starting positions. The first is that any research where the findings are bound to the sample is necessarily restricted in generalizability and therefore impact. Without the use of inferential statistics the findings will be bound to the sample, and this fact is independent of how good and representative the sample is. Much of the question of research impact goes to this issue. Powerful research is concerned with estimating the parameters of the population, and here I mean population in the statistical sense which means that it does not have to only reference people but can reference any target for generalizability. Powerful research is powerful precisely because it goes beyond the sample, and because it uses the sample only as a basis to make inferences about the population from which it was drawn. This is what makes research consumable in the public domain. Inferences which do not have the statistical support to be securely extended to the population and which apply only to the sample are parochial and of limited interest. Inferences which extend to the population have greater reach and influence. It should be said here that most students are unlikely to have the kind of representation in their sample to properly facilitate such statistical inferences to the population anyway, but this is often the case even with published research because having fully-representative samples is one of those issues which perpetually tests the feasibility of real research—and in practice this problem is often accommodated in the process of normal science as findings based on compromised representation of the population are accumulated and then, ideally, submitted to meta-analyses with the aim of achieving more secure inferences and greater conclusiveness (for example, Norris & Ortega, 2001). And anyway, much of the purpose of the undergraduate thesis is pedagogical, or as I said before,

a first step in mentoring the student into what will later gain better or full expression in post-graduate and other later work.

Connected to the issue of generalizing from the sample to the population is the associated issue of the probabilistic nature of statistical reasoning. No inferential claims about the parameters of the population with regard to a particular research issue are ever absolutist in nature (unless of course in the very unlikely situation where the whole population is observed); they are always probabilistic. A conceptual understanding of how this probabilistic reasoning works is essential to helping the student to demystify terms such as Type I and Type II error, alpha, power analyses, effect sizes and so forth. An executional command cannot follow from an incomplete grasp of the conceptual nature of statistical reasoning as essentially probabilistic reasoning. Even if the goal of producing the undergraduate thesis is pedagogical rather than to actually publish impactful and recognized research for consumption in the public domain, the object of the pedagogy is in fact for the student to be ultimately able to do so. For empirical research, statistical reasoning is a necessary (though not sufficient) requirement for this ultimate goal, and early engagement with it is essential; and this engagement should begin as conceptual with executional understanding to follow.

Conclusion

In closing, it is worth reflecting on the priority some of the issues I have signposted in this paper receive at different stages in students' progress through an undergraduate program. From my own point of view, there is a strong case that alerting students to the issue of the demarcation of public and academic inquiry is an early priority. If students gain an early understanding that their inherited notion of inquiry is insufficient and that they are about to embark on integrating themselves into a new way of inquiring, then much of what they encounter as this new way is revealed to them will be more easily identified as such and therefore more easily assimilated. Notions related to specifically empirical inquiry involving statistical, and therefore probabilistic, reasoning will not seem so arcane when the student is able to locate them within their own personal project of adapting to a demarcated, non-commonsense form of inquiry which they are aware of as such. While science as a form of inquiry, as I have said before, is not coextensive with inquiry conducted within faculties related to the humanities, where work can be scholarly without being quintessentially scientific, it nonetheless informs much of the work which does come out of these faculties. Engagement with the philosophy of science prepares students to understand and produce knowledge which is so informed, raises their attention to the issue of demarcation in general, and very importantly starts them thinking metatheoretically which is critical to intellectual empowerment.

Endnotes

i This text was originally published in 1934 in German. It was republished in English in 1959.

ii This text was first published in 1962.

iii These two works were first published in French in 1923 and 1947, respectively.

iv Mind in Society was first published in English in 1978 and is essentially a collection of essays written in Russian by Vygotsky in the early 1930s. Included are both published and unpublished original works. Thought and Language was originally published in English by MIT Press in 1962. The 1986 print cited here is a revised edition.

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