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Inquiry Learning: Level, Discipline, Class Size, What Matters?

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Abstract
Inquiry learning is a pedagogical approach that focuses on the processes and skills required to conduct research. It is a pedagogical approach that has been demonstrated to have positive learning outcomes. McMaster University has been committed to this form of learning for more than ten years in three of the faculties on campus (i.e., Humanities, Science and Social Sciences). This commitment has been in the creation of stand-alone, small class size first year inquiry classes. The current research, involving document analysis of 545 course outlines from the Faculty of Social Sciences demonstrates that inquiry learning is concentrated in first and fourth year primarily with modest amounts in second and third year courses. Results reveal cross-discipline variation. Some disciplines exhibit higher levels of inquiry (i.e., Social Work, Labour Studies and Political Science) than others (i.e., Gerontology, Geography and Anthropology). Although inquiry was more likely to occur in small classes there were examples of inquiry learning in classes with more than 250 students.

Keywords
Inquiry learning, Methodology, Course outlines, Class size

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Abstract

Inquiry learning is a pedagogical approach that focuses on the processes and skills required to conduct research. It is a pedagogical approach that has been demonstrated to have positive learning outcomes. McMaster University has been committed to this form of learning for more than ten years in three of the faculties on campus (i.e., Humanities, Science and Social Sciences). This commitment has been in the creation of stand-alone, small class size first year inquiry classes. The current research, involving document analysis of 545 course outlines from the Faculty of Social Sciences demonstrates that inquiry learning is concentrated in first and fourth year primarily with modest amounts in second and third year courses. Results reveal cross-discipline variation. Some disciplines exhibit higher levels of inquiry (i.e., Social Work, Labour Studies and Political Science) than others (i.e., Gerontology, Geography and Anthropology). Although inquiry was more likely to occur in small classes there were examples of inquiry learning in classes with more than 250 students.

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Introduction

In this paper the concept of inquiry learning will be explored and a methodology to describe the breadth and depth of inquiry learning within individual courses, across departments, will be discussed. The questions that guided this research are:

1. What is the relationship between inquiry content and course level?
2. What is the relationship between inquiry content and different academic department?
3. What is the relationship between inquiry content and class size?
4. What is the relationship between the type of inquiry (structured, guided and open) and both class size and level?

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Using results from the case-study application of this method within the Faculty of Social Sciences at McMaster University, a series of recommendations to increase the overall amount of inquiry within the Faculty will be discussed.

What is Inquiry?

Inquiry is both a pedagogical process and a set of skills. The inquiry process is about exploring, discovering, and ultimately reaching a higher level of understanding. This process has a number of steps including actively identifying a topic or issue, generating a researchable question, investigating the problem by performing relevant research, critically thinking about the issue, answering the questions raised, drawing conclusions and reflecting on the inquiry process. Inquiry promotes student-directed learning and helps students to develop the skills necessary to acquire and reflect on new knowledge and understanding. Lee and her colleagues (2004) suggest that inquiry-guided learning:

> Refers to a range of strategies used to promote learning through students' active, and increasingly independent, investigation of questions, problems and issues, often for which there is no single answer. A range of teaching strategies is consistent with inquiry-guided learning including interactive lecture, discussion, problem-based learning, case studies, simulations, and independent study (Lee et al. 2004, p 5).

Inquiry learning has been associated with statistically significant, positive differences in the rate of students earning passing grades, achieving Honours standing, achieving and staying on the Dean's Honour list, and remaining in university (Justice et al. 2007b). Research has demonstrated that the positive learning outcomes of Inquiry skill development include critical thinking, the ability to undertake independent inquiry, and responsibility for their own learning, intellectual growth, and maturity (Kuhn et al. 2000; Kinkead, 2003; Kirschner et al. 2006). In Britain, similar work has been done in the context of specific types of learning approaches (deep and surface) (Entwistle & Tait, 1995). The skills learned in inquiry prepare students to become both researchers and lifelong learners (Justice et al. 2007b).

Throughout the inquiry process, the student is almost entirely independent, with minimal guidance from the instructors. For example, instructors may raise important questions, help students to plan their research process, and guide students in formulating and justifying conclusions about what they have learned about the topic (Hudspith & Jenkins, 2001). Research has demonstrated that the positive learning outcomes of inquiry skill development include critical thinking, the ability to undertake independent inquiry, and gaining responsibility for their own learning, intellectual growth, and maturity (Kuhn et al. 2000). These skills prepare students to learn how to become both researchers and lifelong learners (Justice et al. 2007b).

Previous research (Kuhn et al. 2000) and the belief that inquiry learning is a valued educational tool for university students, supports the research objectives. Therefore, the authors begin from the value position that all students studying in a post-secondary institution should have an opportunity to engage in inquiry learning, rather than simply through a process of knowledge transmission (Hudspith & Jenkins, 2001).

Staver and Bay (1987) distinguished three types of inquiry by their goals – structured, guided and open. In *Structured Inquiry (SI)* the teacher provides learners with a problem to investigate, as well as procedures and materials, but does not inform them of expected

outcomes. SI is intended to introduce concepts, vocabulary, processes, skills, and investigation methods, to guide students toward specific discoveries, to provide a common base of experiences, and to develop reflection as a skill to be applied in an academic setting. Often the first form of inquiry encountered by students, SI differs from *Guided Inquiry (GI)* in which the teacher provides the materials and the issues, which serve as investigative vehicles, but the learners devise their own procedure to solve the problem. GI is used to challenge students' conceptual understanding and skills, to develop creativity, to discover a deeper and broader understanding of the subject, and to acquire some research skills. *Open Inquiry* (OI) requires learners to both formulate their own problem, and develop the procedure(s) to investigate and solve the problem. The goals of OI are to generate questions, to develop creativity in answering questions independently, to draw conclusions based on evidence, to develop critical thinking skills, to discover deeper and broader understanding of the subject, and to reflect on learning (Staver & Bay, 1987)

Inquiry-based learning was first formally used at McMaster in the Arts and Science program in the early 1980s (Jenkins, 2007). During the 1998-99 academic year the Faculties of Social Sciences, Science and Humanities at McMaster University introduced an inquiry course for first year students. Students were divided into a number of small classes and instructors in each Faculty worked together to deliver the course. Each small class was taught by one faculty member. The broad process-based learning outcomes for these courses were to enhance ability and proclivity to **learn deeply, think critically,** take **active control** of learning, be **precise, accurate and clear** in communicating, learn in a **participatory** fashion and be open and enjoy the pursuit of understanding (Justice et al. 2002).

Current State of Inquiry in the Faculty of Social Sciences

The Faculty of Social Sciences at McMaster University is one of six faculties in a research intensive university. In 2007-08, the Faculty had an enrolment of 4047 full-time and 1158 part-time students who make up 22% of the total student population of the university. In order to understand the amount and depth of the inquiry learning experience for undergraduate students in the Faculty of Social Sciences at McMaster University we analyzed by level, department, and by class size all 545 courses offered in the Faculty during 2007-08. Each course was analyzed by reviewing the course outline for inquiry content and assigned an **Inquiry Score**. Course outlines at McMaster University follow a pattern prescribed in the Undergraduate Course Management Senate policy - typically publicly available either online or through Department offices. Course outlines tend to be multiple page documents (e.g., 5-7 pages) that include learning objectives for the course, a description of the course, details on how students will be evaluated and assessed, required course materials and typically a detailed schedule of class topics, activities, assessment and readings.

The **Inquiry Score** was determined from the responses to a series of 10 questions designed to identify the presence and the depth of inquiry learning in a course (Appendix I). Both explicit statements about the inclusion of inquiry on the course outlines and implicit inquiry statements including statements about skills, processes and goals that are inquiry in nature were scored. Question 1 asks if there is any evidence of inquiry in the course. By examining evaluation components of the course, evidence of inquiry was determined. Evaluation mechanisms that are typically inquiry in nature (e.g., essay writing) would score positively on this question, while the opposite was true of mechanisms that are typically not inquiry in nature (e.g., multiple choice test, final exam). In addition, the descriptive material contained within the course outline was examined in light of the goals and

processes involved in inquiry (discussed above) to determine if inquiry was occurring in the course. If evidence of inquiry learning was evident, the remaining questions were considered; conversely, if inquiry learning was not evident no further review of the outline would occur. Questions 2 through 10 allowed for the type of inquiry – structured, guided and open – to be determined. In addition, these questions allowed the researcher to consider the level of value being placed on inquiry learning. Value was determined by the percentage of the final grade in the course that was the result of an inquiry learning experience. For example, question 2 and 3 are concerned with question generation and access to resources throughout the inquiry process. If the student generates the questions and accesses the resources independently, the course gets 1 point for each question. If the instructor provides the question and the resources, the course gets 0 points for each question, respectively. Points are added together from questions 2 to 7, and this number is multiplied by the inquiry course weight (question 8). The result is the final inquiry score for the course. In question 9, the type of inquiry is determined by the level of inquiry evident in the course outline. Finally, question 10 allows for qualitative comments about the course that were not previously mentioned. The maximum score a course can get is 600. If the course has no evidence of inquiry, it gets a score of 0. Inquiry scores were then converted from a 600 point scale to a 100 point scale, with 0 indicating no inquiry and 100 being the highest possible inquiry score.

Outlines were scores by two research assistants on the project. Inter-rater reliability between the inquiry scores of the two research assistants exceeded 98%. Two of the researchers on the project scored course outlines to compare their results with the research assistants and the inter-rater reliability of these scores also exceeded 98%. Additionally, by phone, eight instructors, teaching a total of 36 courses, in different academic departments within the Faculty, were contacted by the research assistants to confirm their interpretations of the course outlines, and validate the inquiry score assigned by the rater with the actual practices that were occurring in the classroom. In all classes the inquiry score and the instructor's practices were aligned, resulting in no change to the inquiry score. The high level of inter-rater reliability and the high level of alignment to the course instructor practices likely occurred because of the high level of detail in the course outlines and the development by the raters of a guidebook on rating.

Results

Inquiry Content Course Level

The weighted average inquiry score for 545 courses in the Faculty of Social Sciences were calculated and analysed by course level (Figure 1). First year Inquiry 1SS3 courses, which have inquiry scores of 100 on the 100 point scale, were removed from the data. First year inquiry consists of 18 course sections of 28 students per section that are designed to provide inquiry learning opportunities and develop inquiry skills. First year courses (23) have a slightly, but significantly, higher average inquiry score than second year courses (16). Third year courses (30) have a higher average inquiry score than both first year and second year courses. Finally, the average inquiry score of fourth year courses increased dramatically to 72, which is a higher score than the combined score of first year to third year courses. The data show that a large emphasis is placed on providing some inquiry learning opportunities in first year courses and that the amount of inquiry increases from level two through four.

Figure 1. Inquiry Content Score by Level of Course

Inquiry by Department

Within the Faculty of Social Sciences students in Level 1 are enrolled in a common program. Beyond Level 1, students are enrolled in degree programs in one of the following departments: Anthropology, Economic, Health, Aging and Society, Indigenous Studies, Labour Studies, Political Science, Religious Studies, Sociology, Social Work, Some students are enrolled in degree programs in Psychology, Geography and Earth Sciences, or Kinesiology, all affiliated with the Faculty of Science. Three groups emerge in the data when the average inquiry scores are grouped by department or area (i.e., high, medium and low average inquiry scores). Inquiry (100) and Social Work (73) have high average inquiry scores (Figure 2). Three areas: Social Sciences (2); Economics (3.5); and Psychology (18), have low average inquiry scores. The remaining areas are in the medium inquiry score zone. These include: Labour Studies (48); Political Science (49); Gerontology (32); Health Studies (36); Religious Studies (36); Anthropology (24); and Geography (21). When the data within the departments and areas is sorted by level the same trend that is observed in Figure 1 exists within the individual departments.

Figure 2. Inquiry Score by Department or Area

Inquiry and Class Size

In the Faculty of Social Sciences, typical of the broader university, 1st year classes are primarily taught in large lecture format. Second and third year courses reflect a mixture of sizes (class sizes ranging from <30 to >251) and teaching formats. 4th year courses are much smaller (91% of all 4th year courses have between 1 and 60 students registered). The average class size (all years) in the Faculty of Social Sciences is 95. The relationship between class size and the inquiry score was analysed by dividing the data into four class size ranges (i.e., < 50 students; 51-100 students; 101-250 students; and > 250 students). There is an inverse relationship between class size and inquiry score (Figure 3). Classes with less than 50 students have the highest average inquiry score, at 53. Classes with 50 to 100 students have a much lower average inquiry score of 27, consistent with the next class size (101 to 250 students), with an inquiry score of 23. Finally, classes larger than 250 students have the lowest average inquiry score of 16. The trend shows that the majority of inquiry learning and teaching occurs in smaller class sizes, while only some inquiry learning and teaching occurs in the larger class sizes.

Figure 4. Weighted Inquiry Score by Class Size

The same data (inquiry score to class size) can be analyzed in a scatter-graph with a log trend line of $r^2 = 0.2762$ (Figure 5). The linear relationship does not explain the data as well ($r^2 = 0.1862$).

Figure 5. Inquiry Score and Class Size Scatter-graph

Types of Inquiry

In a scatter-graph, inquiry score is plotted against class size and differentiated by type of inquiry (Figure 6). Open Inquiry, represented by yellow points, is notably concentrated on the left and upper corner of the graph, indicating that open inquiry classes tend to have high inquiry scores (which they should, based on the scoring rubric) and smaller class sizes. Guided Inquiry courses, represented by blue diamonds, are spread over the middle of the graph, extending slightly outwards. This shows that guided inquiry courses have lower inquiry scores than open inquiry courses. Finally, Structured Inquiry, represented by green crosses, is concentrated on the lower half of the graph, stretching farther to the right side. Structured inquiry courses generally have the lowest inquiry scores (again, as expected from the application of the scoring rubric) and the largest class sizes. It is also interesting to note that both small, medium and large classes occur in which no inquiry learning and teaching appears to occur (i.e., pink).

Figure 6. Inquiry Score by Type of Inquiry

When the different types of inquiry are examined, by level, the results indicate that the amount of structured inquiry is greater in the lower levels and is inversely related to level (Figure 7).

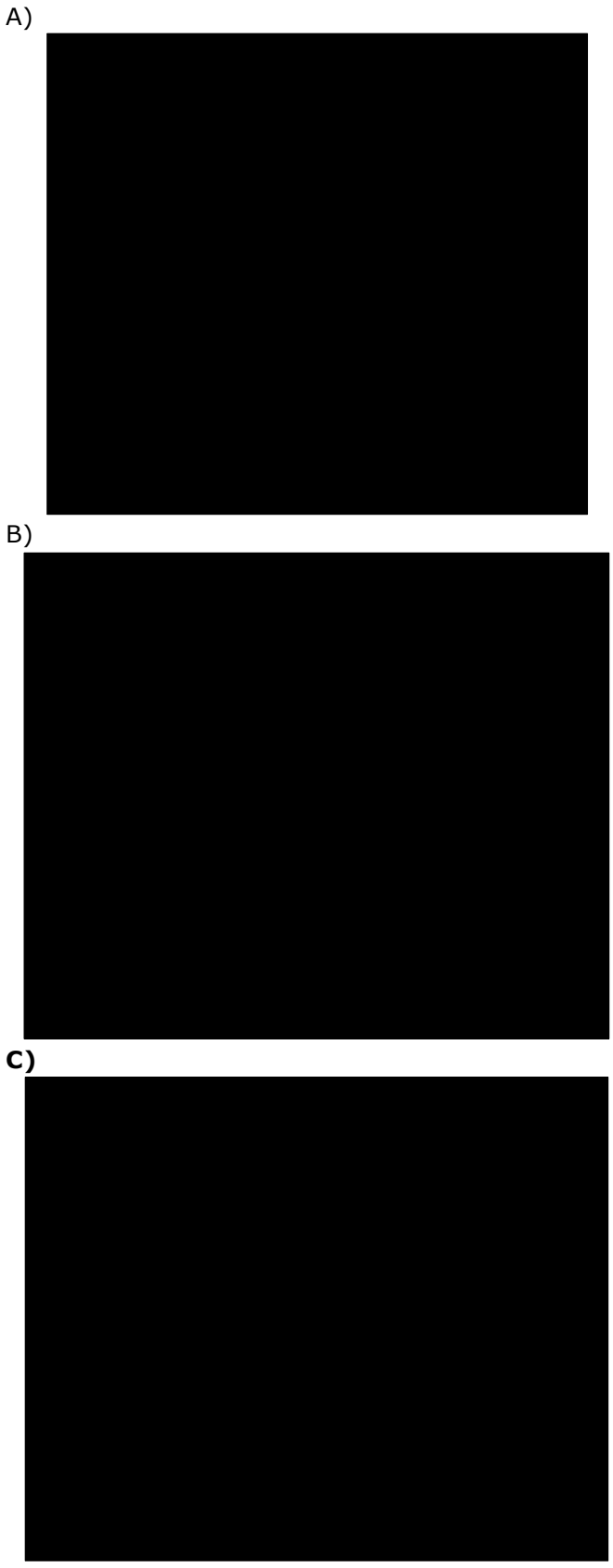

Figure 7. **A** – Structured Inquiry; **B –** Guided Inquiry; and **C –** Open Inquiry by class size and level

Discussion

Recall, that inquiry learning has been demonstrated to have a number of positive learning outcomes including: positive difference in the rate of students earning passing grades, achieving Honours standing, achieving and staying on the Dean's Honour list, and remaining in university (Justice et al. 2007b) and the ability to develop students' critical thinking skills, responsibility for their own learning, intellectual growth and maturity (Kuhn et al. 2000; Kinkead, 2003; Kirschner et al. 2006). The results of this case study which demonstrate that inquiry learning can and does occur in all disciplines and can occur in all class sizes can be used to inform a number of operational decisions about teaching and learning.

For example, focusing on incorporating inquiry learning pedagogy in larger sized classes using structured and guided inquiry approaches, will ensure more students have exposure to this pedagogical approach creating positive learning outcomes. Further study on understanding why some instructors use an inquiry approach while others do not, may reduce barriers related to the introduction of inquiry. Focusing efforts to incorporate inquiry learning in the disciplines without a large amount of inquiry learning throught increased targeted inquiry experiences would also contribute to positive student learning outcomes. This research has shown that second year courses in the Faculty of Social Science have under-utilized the inquiry approach to teaching and learning, when compared to other course levels. Focusing on increasing inquiry learning opportunities at year two would enhance student learning and permitting students to utilize skills developed in level one.

The inquiry learning experience within the first year Social Sciences is currently under review in order to better understand the benefits of the course and to ensure that those benefits are being translated across the Faculty.

Using this methodology in another Faculty at McMaster that has focused on inquiry learning (i.e., Science or Humanities), would add to the generalizability of the findings. In addition, applying this approach within one or more additional Faculties of Social Sciences, outside of McMaster University, would allow inferences to be drawn about the level of inquiry infiltration as a result of the first year inquiry experience at McMaster.

Conclusions

Evidence shows that the amount of inquiry taught in this case varies significantly by level, department, and class size. In general, inquiry increases by level. Higher inquiry scores are also evident in smaller class sizes. Therefore, the classes with the highest inquiry scores are most often small (<50 students), third and fourth year courses. Different departments have varying inquiry scores due to the diversity of subjects taught and the course instructors. Courses with more written assignments, such as research papers, had higher inquiry scores than courses with only tests.

In addition, there is a notable difference between the three types of inquiry -- open, guided, and structured. Structured inquiry courses are more likely to be first and second year courses, with large class sizes and low inquiry scores. Guided inquiry courses are found more often in third and fourth year courses, with lower class sizes and higher inquiry scores. Finally, Open inquiry classes are generally third and fourth year courses that have the highest inquiry scores and lowest class sizes. However, achieving Open inquiry in larger class sizes is possible, even in Level 1 courses of considerable size.

The methodological approach of applying an inquiry score and comparing the results across course level, discipline and class size was very illuminating. Applying this methodological approach at another institution in order to compare the results would be useful. Has the presence of first year inquiry at McMaster influenced the amount of inquiry in upper year classes? In addition, this approach could be used to provide evidence of baseline conditions prior to the implementation of a large scale curricular change. Course outlines are challenging documents to interpret because of the large amount of variability in the depth of content and in interpreting the intentions of the instructor.

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Appendix One:

Course Outline Criteria for Inquiry

Scale: Inquiry <----------->Not Inquiry

Course: **Section:** **Instructor:**

1. Evidence of Inquiry in the Course
Y----------N

2. Question Generation
Student----------Teacher

3. Access to Resources
Student----------Teacher

4. Critical Review (e.g. judge, compare, analyze)
Y----------N

5. Graded Communication – Multiple Forms
Y----------N

6. Reflection
On Learning----------As a Skill Development----------None

7. Student Responsibility
Y----------N

8. Course Weight
5% 10% 15% 20% 25% 30% 35% 40% 45% 50% 55%
60% 65% 70% 75% 80% 85% 90% 95% 100%

9. Type of Inquiry
None Structured Guided Open

10. **Comment**
Multiple the sum of the answers from Q2 – Q7 by the course weight to find the level of inquiry in the course**.**

Score: