



# Course-Based Versus Field Undergraduate Research Experiences

## ABSTRACT

This paper compares undergraduate course-based research experiences to field-based research experiences to understand the relationship between these different forms of experiential learning. I study undergraduate research experiences across an economics department at a large Canadian research university. Statistical analysis indicates there are not large differences between field- and course-based experiences. The main differences favour course-based instruction, with course-based experiences associated with more independent thinking and relevant task engagement. Overall, I conclude curriculum designers should focus attention on proper course-based curriculum design rather than simply trying to adapt “research-like” experiences into the classroom.

## KEYWORDS

undergraduate research, course-based undergraduate research experiences, experiential learning, curriculum development

## INTRODUCTION

Research is important! It is widely viewed as one of the most valuable formative experiences in undergraduate education and has been directly identified as a “high-impact practice” by the Association of American Colleges and Universities (Kilgo et al. 2015). It provides a way to summarize and highlight what a student has learned while exposing them to the ideas and techniques used at the frontier of a field. It is a natural environment for experiential learning and incorporates many higher-order intellectual skills (Beckman and Hensel 2009). In other words, it demonstrates nearly all of the things we want our students to be able to do by the end of their studies (Hansen 1986). However, providing undergraduates with research experience is difficult. To understand why, we first need to understand the ways most undergraduate students engage in research.

In the scholarship of teaching & learning (SoTL), there are two basic models of undergraduate research: field-based experiences and course-based experiences (see the distinction drawn in Auchincloss et al. 2014). Field-based undergraduate research experiences (which I call FUREs) are very similar to the traditional “mentorship” model of academic training where a supervisor takes a student under their wing, gives them experience as an assistant on a project, then aids them in gradually developing their own research agenda. Unfortunately, in the modern university, these kinds of experiences are feasible only for a small fraction of the undergraduate population. Busy researchers,

under pressure to publish impactful work, often do not have time to train undergraduate students to the level where they can become independent members of a research team. Additionally, FUREs generally cannot be delivered to large cohorts of students due to the demands they place on the supervising faculty members.

Course-based undergraduate research experiences (CUREs, in the literature) are an appealing alternative. They can take on a variety of forms (such as a thesis, term project, or independent study) but all involve research that is conducted as part of a course of study, such as a university course, small-group seminar, or a directed investigation that takes place as part of a student's degree program. These usually involve group supervision and a lower level of academic or technical novelty, but in exchange they are accessible to students with a broader range of backgrounds and skills. Critically (from an administrative point of view), they can also be delivered at a large scale with only modest faculty investment. In the physical sciences (most notably biology), CUREs have become quite popular with a number of studies (see summaries in Bangera and Brownell 2014; Brownell and Kloser 2015) showing strong evidence that CUREs improve student achievement, particularly in the core scientific and technical disciplines relevant to the research process.

Despite this promising alternative, there is a gap in our understanding of undergraduate research. Most of the research on CUREs (and their effectiveness) has been conducted in the physical sciences—research situations characterized by laboratories and large teams of researchers. This type of research tends to be conceptually more straightforward to adapt into a CURE. On the other hand, consider fields such as the humanities or the social sciences, which are often characterized by non-laboratory research and very small (often individual) research teams. This model of research may be nearly impossible to adapt in a straightforward way. To put this in another perspective, in some fields CUREs are similar to FUREs, while in other fields they can be quite different.<sup>1</sup> In the literature's quest to answer the question "Do CUREs work?" we have omitted the more fundamental question of "What is the relationship of CUREs to other models of research?"

In this paper, I address this gap in the literature—specifically by looking at the situation in economics. Why should we care about economics? Economics is a good example of a field that sits neatly between the physical sciences and the humanities; while it does not (generally) use laboratories or large research teams, it still uses many of the same scientific methods and techniques. CUREs are challenging to develop in economics, but often exist alongside FUREs, teaching similar skills to similar students. In other words, it is an excellent situation to study the relationship between CUREs and FUREs. Insights and comparisons from economics can be applied to many other fields in the social and physical sciences, as well as some of the humanities.

Specifically, I look at the experiences of economics students at a large Canadian research university (the University of British Columbia's [UBC] Vancouver School of Economics [VSE]) and ask "Are course-based undergraduate research experiences similar to field-based undergraduate research experiences? Using a survey of current students and graduates, I ask students about their experiences in both CUREs and FUREs—including (a) what kinds of skills or tools they used, (b) what kinds of tasks they performed, and (c) their assessment of the experiences. I compare these responses using a variety of statistical methods and investigate whether the experiences of women or visible minorities are different

from others—a question prompted by past work on more general faculty-student relationships (see Mook 2002; Pascarella 1984 for examples) that shows relatively negative experiences for these groups.

My conclusions from these comparisons add to the SoTL literature in two ways. First, I show that course-based research experiences are good substitutes for field-based experiences in economics. The data demonstrate FUREs and CUREs are broadly similar, with the main difference favouring course-based instruction: CUREs engage students more frequently in valuable skills and tasks, such as statistical analysis, in comparison to FUREs. They also allow students more independence and are slightly more well-regarded by students in terms of their enjoyment and expectations. Heterogeneity analysis of this result does not find systematic variation in experiences across demographic groups, such as gender or visible minority status. In other words, I can affirmatively state that in economics FUREs and CUREs are similar. Generalizing this result outside of economics implies that CUREs and FUREs in related fields are also likely to be similar, with similar impacts on students.

The second contribution is more fundamental and deals with the question of authenticity in experiential learning. One of the key questions in this area is how do we, as educators, balance authenticity in our teaching with the realities of the modern higher education classroom? As Kreber (2013) discusses, this includes bringing students into the knowledge-creation process in which the teacher is also engaged. In instruction, “authenticity” is often connected to verisimilitude: i.e., how similar is this experience to a “real-life” experience (see the discussion in Stein, Isaacs, and Andrews 2004), as moderated by pedagogical context and the learner. This paper shows the field versus course distinction is not that important, at least in terms of what students do and what they learn. In other words, we should not be worried that CUREs are “less authentic” simply because they do not “look” like FUREs—they end up engaging the same skills and create the same learning experiences.

The remainder of this paper is organized as follows: first, in the “background” section, I give an overview of what we (in SoTL) know about CUREs, FUREs, and their relationship. I also expand on the rationale for economics as a useful area of focus. Next, I get specific in the “context and methods” section by introducing the setting for the research and the population being studied. I introduce the survey instrument used and provide an overview of the data collected. I also discuss and motivate the statistical techniques used. In the “results” section, I present the results of the statistical analysis, including heterogeneity analysis focusing on specific demographic groups. In the “discussion” section, I connect these results back to original questions and provide comments. Finally, I reiterate the core finding and outline future research in the “conclusions” section. Additional documentation is provided in the appendix.

## BACKGROUND

### **What is undergraduate research?**

So far, I have left the definition of “research” (especially at an undergraduate level) implicit, but it turns out that this demands more discussion. Hoyt and McGoldrick (2017)<sup>2</sup> define undergraduate research (in economics specifically, but their definition generalizes) as “the ability to create knowledge at the undergraduate level.” There is nothing specified about where or how this knowledge is created—it

could be in the classroom or in the field. However, it always requires the creation of new knowledge—that is, knowledge that is not currently known by the supervisor or the student.

In the modern economics curriculum, research has features of both the physical sciences and the humanities. Research experiences generally fall into three categories (see Cooley, Garcia, and Hughes 2008; DeLoach, Perry-Sizemore, and Borg 2012 for alternative ways of organizing):

1. *Theses or major projects*: Students carry out a research project under the supervision of an instructor, usually as part of a course. Some universities make explicit distinctions between projects and theses (Feyrer 2017); generally a project is shorter and more limited in scope than a thesis. A thesis also usually involves more independence in project choice and a more extensive supervisory role by faculty. Many projects are carried out in seminar courses, but this is not universal (Butcher and Weerapana 2017). Seminars, in this context, refer to the North American educational setting of a small number of advanced students working with a professor on a specific topic of study, usually involving discussion and debate.
2. *Independent study projects*: Students carry out a self-directed research project, usually for credit, but not as part of a course, under the supervision of a faculty member. The key difference from a thesis or project is motivation: independent studies come from a student's own questioning and motivation rather than an academic requirement.
3. *Research assistantships (RAs)*: Research assistantships (or internships, when unpaid), are formal positions where a student assists a senior scholar (sometimes a graduate student, but usually a faculty member) with a research project of the supervisor's design. This involves performing tasks at the supervisor's direction with varying degrees of independence. Undergraduate RAs usually form part of the "pool" of total RAs in the VSE with active graduate programs, which can lead to competition between graduate and undergraduate students.

In general, curriculum-based experiences such as (1) and (2) are more focused on learning outcomes and educational goals than RAs, which primarily serve a practical goal (assisting faculty in their research). This highlights an important distinction between undergraduate and academic research. Pedagogically, undergraduate research is often placed at the top of a ladder of learning experiences, starting from elementary orientation and culminating in self-directed inquiry (Beckman and Hensel 2009). It is also a frequent goal of scaffolded curriculum design. However, academic research means creating a product with (a) the goal of publication or presentation and (b) an element of novelty. At the undergraduate level in many fields this is difficult to accomplish, which leads to a debate over whether undergraduate research is "really" research.

Beckman and Hensel (2009) identify this as a disagreement between defining research as product-centered versus being student-learning-centered. They also discuss related debates over audience (professional versus academic), originality (to the student versus to the supervisor), and initiation (student versus supervisor). This discussion, in general, relates to the changing roles students play in an academic setting—particularly towards the end of their degree. The student is making the transition from learner to teacher; they are taking ownership of their own learning and beginning to act

as a colleague to their instructor. Research is simply one of the clearest dimensions in which this transition occurs.

This also highlights the position RAs fill, particularly at the undergraduate level: RAs are the archetypical FURE. In such an experience, students are acting as junior colleagues for faculty members on a research topic. This often follows an “apprenticeship model” (DeLoach, Perry-Sizemore, and Borg 2012) in which students take on more responsibilities as they demonstrate and develop appropriate skills. The consequence of this model means FUREs vary in terms of the tasks students do and the extent to which students engage in experience-based learning. At one extreme, an RA can act as a co-investigator, learning valuable skills and engaging in independent and collaborative inquiry. At the other extreme, an RA can be tasked with only highly routine and often non-skilled work, which does not improve their overall learning.<sup>3</sup>

Faculty often report (Cooley, Garcia, and Hughes 2008) positive experiences working with undergraduate RAs, but frequently face challenges balancing supervision and education (Kloser et al. 2011), especially at research-focused institutions. Undergraduate students nearly uniformly report positive experiences with undergraduate research, regardless of the implementation or experience (Cooley, Garcia, and Hughes 2008; Gibson, Kahn, and Mathie 1996; Lopatto 2004; Wei and Woodin 2011, etc.), which has led to a great deal of focus on identifying effective ways of delivering the undergraduate research experience to students in a way that maximizes the benefits to faculty and students. The clear value of FUREs and the challenges associated with them has been a major motivation behind the development of CUREs.

### **What can economics teach us about undergraduate research?**

So, if FUREs are valuable experiences for students but challenging for faculty, and CUREs are a promising alternative, how do we create impactful CUREs? The simple answer (given their demonstrated effectiveness in the physical science per Bangera and Brownell 2014) would be to mimic what was done in these successful CURE designs. However, in disciplines where the parallel between field- and course-based research is less clear, this becomes a significant challenge. For instance, how does a professor in philosophy or mathematical theory copy a large biology lab course’s design? Economics faces this problem: although it uses statistics and other tools from the physical sciences, it does not have laboratories, most research teams are small, and making meaningful contributions often requires a significant mathematical and theoretical background not typical of undergraduates.

In this study, by articulating and differentiating what goes into CUREs and FUREs in economics, I can provide guidance for other disciplines as to how they might apply the findings of this paper to their research context. Economics is a good field in which to study these differences: the tasks, tools, and skills used straddle a wide variety of disciplines. In fact, the tools and approaches used by economics have reached broadly across many of the social sciences and humanities (see the discussions in Lazear 2000; Mäki 2009 for an overview of this phenomenon). This makes the results easier to compare other fields, especially where they do not fit the traditional model from the physical sciences. The evangelistic nature of modern economic theory actually becomes beneficial here in that it

creates a situation where findings from studies on economics can often be immediately applied to other fields.

## EDUCATIONAL CONTEXT AND METHODS

### **Educational context**

The institutional setting for this research is the University of British Columbia's (UBC) Vancouver School of Economics (VSE) undergraduate program. UBC is a large research university, and the VSE is one of the top economics research departments in North America. The VSE offers two undergraduate degree programs: a bachelor of arts (BA) and a bachelor of international economics (BIE), both with a competitive admissions process. The BA is a liberal arts degree, admitting in the third year, while the BIE is a direct-admission cohort program<sup>4</sup> that incorporates elements of commerce into the curriculum. There are also a variety of combined and double major programs,<sup>5</sup> as well as a highly selective honours program. Total undergraduate enrollment is approximately 1,000 majors across both undergraduate programs, in addition to a graduate program with about 110 students in masters and doctoral programs (UBC Annual Report 2020).

Course-based undergraduate research experiences at the VSE occur in several ways, but a signature of the VSE is that all undergraduate programs include a fourth-year research seminar course in which students write a paper in the area of applied or international economics. Students take a one-semester (two-semester for honours students) research seminar where they write a paper (usually using data and statistics) on a topic in a faculty-selected area. Honours students are supervised by research faculty, while BIE and BA students are supervised by a mixture of research, teaching, and educational leadership faculty.<sup>6</sup> Other course-based research experiences include writing research papers as part of electives (in the third or fourth year), which vary depending on the instructor and the courses being offered. Typical learning objectives for these courses vary by section but agree with most economics programs (Allgood and Bayer 2017) and include:

- understanding the research process in the context of economics
- critically evaluating research and incorporating knowledge from past studies
- developing appropriate and interesting research questions
- identifying or constructing data useful in answering a research question
- understanding and using suitable statistical tools and specifications
- evaluating, interpreting, and critiquing statistical results
- comparing and integrating different approaches or methods to answer a question
- using feedback and responses to improve or expand on a result
- interacting with others and communicating the results of their research

FUREs at the VSE are less systematically organized, usually consisting of paid RAs or "research internships" (volunteering). Historically, these are ad hoc relationships formed in a variety of ways including job applications, solicitations, and student-direction. The BIE (over the period studied in this paper) intermittently had a formal system to offer top students in their second or third years to faculty

members for internships. One of the major challenges is the VSE high ratio of graduate students to faculty (2:1). For practical, pedagogical, and financial reasons, graduate students are preferred to undergraduate students for most research-related tasks. This fact, coupled with the very large number of undergraduate students enrolled in programs at the VSE, has made offering FUREs “at scale” very challenging.

### **Data and the survey instrument**

#### *Survey development and responses*

The question of how to replicate the FURE experience in courses was the motivation for this research. In this survey, I investigated this question by identifying how FUREs and CUREs differ (in terms of the tools, tasks, qualitative experiences, etc.) so that I could integrate the key unique feature of FUREs into CUREs. I was also interested in the interaction of course- and field-based experiences with the demographic characteristics of students. Research on student-faculty interaction (Dika 2012; Mook 2002; Pascarella 1984) highlights that research (supervisor-mentor) relationships can systematically disadvantage groups such as women or minorities.

The data for this project were collected using an online survey platform (Qualtrics) via email. I carried out two waves of data collection. In the first wave, the target population was all third year and higher undergraduate students enrolled at the VSE in an economics major program (approximately 400 students); data was collected between April and June of 2019. In the second wave of data collection, the target population was all alumni who majored in economics since 2011 and indicated they wished to be contacted post-graduation (approximately 2,500 individuals, however the extent to which these individuals actually monitored their email is unknown). Subjects were incentivized to participate using two \$100 gift card draws if they qualified for the survey. Response rates were approximately 6.25 percent for wave one, and 0.6 percent for wave two.<sup>7</sup>

The text of the survey can be found in the appendix to this paper. Following screening and consent, it asked students about their research experiences. For each experience, they were asked to characterize the experience, including a description and time commitment, then rate the frequency or importance of different tasks, tools, and skills they performed. For each experience, respondents were asked a detailed set of questions concerning the type of experience, when it occurred, and what it entailed. I formulated these questions based on job tasks and descriptions for economics-related careers developed by the US Department of Labor and available via their O\*Net online portal (O\*NET OnLine 2020), which includes tasks, tools, and knowledge. Finally, I also asked students reflective questions concerning how they felt about their research experience, including whether it was valuable in terms of developing skills, and whether it lived up to their expectations. Alumni were also asked some additional reflective questions about what skills they felt were the most valuable in their subsequent careers, which were based on reflective studies of experiential learning currently being developed at UBC. Finally, students were asked about their demographic and academic background, such as their gender, year of studies, and visible minority status.

### *Description of the data*

In total, 40 individuals completed the survey and consented to the data collection: 15 from wave two and 25 from wave one, resulting in 48 experiences. These individuals were asked about each of these research experiences during their undergraduate program, as well as some demographic questions. A majority (53 percent) of the sample identified as male, while 45 percent identified as female; the remainder preferred not to identify. Students came from diverse backgrounds, with 35 percent being non-Canadians (compared to 60 percent domestic, Canadian students) and 40 percent speaking English as a second language. Among the students who chose to identify, 38 percent were visible minorities, and 5 percent had a mental or physical disability. While this question was only asked of the alumni (in wave two), most respondents (60 percent) took part in a regular BA; the remainder took either honours or a combined program. No students identified as Aboriginal in the sample (see footnote 7), but this is expected. Based on internal studies of the UBC undergraduate program, a very small fraction of enrolled students (less than one in 250) identify as Aboriginal or Indigenous. The sample was representatively balanced, with 53 percent of students identifying as male, while 45 percent identified as female.

Of these individuals, they reported an average of 1.2 research experiences during their undergraduate program, with the most experiences for any individual being three. The most recent of these experiences tended to take place in the fourth or fifth year (78 percent) of a student's program, which agrees with the general timing of skill development and the curriculum of the economics programs at the VSE. This also indicates most students did not have multiple research experiences in their program.

### **Statistical methods**

I conducted a two-stage statistical analysis using the statistical software STATA. In the first stage, I compared student experiences in CUREs ( $n = 34$ ) to experiences in FUREs ( $n = 14$ ), then broke out these results by demographic characteristics. My main measures of comparison were affective in terms of either student experience (how did they feel) or student activity (what did they do). I used the results of this exploratory analysis to motivate the second stage. In the results below, I report two-sided comparison-of-means  $t$ -tests (with unequal variances) for whether students responded affirmatively to the associated question.<sup>9</sup>

One challenge for this study is the relatively small sample size; the small pool of students, issues with alumni response rates, and length of the survey combined to produce relatively limited response numbers. To assess the impact this had on the statistical results, I conducted a power analysis using the statistical software R; this technique allowed me to assess (for a given sample size and significance level) the likelihood of detecting effects of different sizes. The results indicate that for the  $t$ -tests used in the main analysis, at the significance level of 10 percent, this study should still be able to detect relatively large effects ( $\beta = 0.783$ ) (Cohen 2013) and has about a 50-50 chance to detect medium-sized effects ( $\beta = 0.450$ ). In other words, my results can be interpreted as saying that there are no *large* differences between CUREs and FUREs; any differences that exist must be modest or small in size.

In the second stage I used multiple regression analyses to compare the outcome variables against several explanatory variables, including type of experience. This technique allowed me to compare



multiple explanatory dimensions at once within a single framework, combining the direct and heterogeneity analysis into a single analysis. This provided a multidimensional analysis: the  $t$ -tests used in the first stage can only compare a single dimension at a time, which can hide important relationships, especially where demographic characteristics are concerned.

In all the models I adopted a linear probability specification in which I regressed an outcome variable ( $Y_i$ ) on a set of explanatory variables ( $X_i$ ):

$$Y_i = \beta_0 + X_i\beta + e_i \quad (1)$$

I chose a linear probability specification because in all cases the dependent variable was binary and I did not want to impose distributional assumptions on the residual term ( $e_i$ ). I also used heteroscedasticity-robust standard errors, which relax the assumption of a constant variance for this residual term and is necessary for this type of model.

The first set of regressions examined whether students responded affirmatively (agree or strongly agree) to measures of their experiences: (1) did they have independence, (2) did they enjoy their experience, and (3) did their experience live up to their expectations. The explanatory variables included their year of experience, domestic status, gender, minority status, and type of experience. The second set of regressions examined the types of skills and tools students used. The dependent variables were affirmative responses to whether they found their experience (1) useful, (2) practical, (3) enjoyable, and (4) whether it lived up to their expectations. The explanatory variables included the type of experience and the types of tools or skills they reported using during their experiences.

## RESULTS

### **Main results: FUREs versus CUREs**

The main results of my analysis are presented in tables 1 through 4. These tables present the difference in proportion between experiences in which a student responded affirmatively to a question about a FURE experience versus a CURE experience (column 3). The third column is the difference in proportions, while columns 1 and 2 are the proportions for FUREs and CUREs, respectively. Significance is reported relative to a null hypothesis (i.e., comparison) of “no difference” between the two types of experiences.

In terms of what students do (table 1), I find there are few statistically significant differences. As we can see, there is generally a less than 15 percent difference in the proportion experiences using a task in a FURE versus a CURE. I see similar rates of performing the kinds of tasks associated with supporting empirical research in economics, such as managing data, and verifying data accuracy. I do see differences between CUREs and FUREs in terms of activities that pertain to the design of a research project: students in CUREs are much more likely to undertake literature reviews (66 percent more likely), media and environment surveys (48 percent more likely), and conduct secondary research on the topic of study (42 percent more likely). I also see a significant difference in actually conducting statistical surveys. Although both FUREs and CUREs involve this, nearly all students (97 percent; 59 percent more likely) in CUREs reported carrying out such tasks. This likely connects to the increased likelihood for students in CUREs to also report creating reports or visualizations (66 percent more likely).

In terms of the tools used (table 2), I find only a few statistically significant differences: nearly all CUREs (97 percent) involve the use of statistical tools compared with only a majority of FUREs (62 percent). Students undertaking FUREs show broader utilization of technical tools, such as programming and database software (21 percent more likely), while students in CUREs show more emphasis on tools related to research communication and presentation, such as publishing, processing, and video creation (41 percent more likely). This is likely due to the emphasis most CUREs at the VSE place on conducting a research presentation (of some form) relative to basic data management skills. As we can see from table 3, CUREs generally draw more heavily (all of the differences, save for communication, are 15–25 percent more common in CUREs) on all knowledge-domains aside from communication skills, but these differences are not statistically significant; indicating only modest differences.

Finally, in terms of the student experience, table 4 shows CUREs are as similar or better than FUREs across most domains, agreeing with previous research from the physical sciences (Dolan 2016). All of the differences (save for independence) are less than 19 percent and not statistically significant. The only exception (i.e., large) difference concerns independence with CUREs demonstrating substantially more independent work from students. This is expected, given the “apprenticeship” model for FUREs in this context. This finding is notable, given the stated preference by many students for FUREs, demonstrating this is likely an *ex ante* belief, which changes following actual involvement in a CURE or FURE.

**Table 1. Tasks performed in research experiences**

	FUREs	CUREs	Diff
Manage databases	0.69 (0.48)	0.97 (0.17)	-0.28 (0.14)
Statistical analysis	0.38 (0.51)	0.97 (0.17)	-0.59** (0.14)
Verify data accuracy	0.62 (0.51)	0.74 (0.44)	-0.13 (0.16)
Perform data entry	0.46 (0.52)	0.57 (0.50)	-0.11 (0.17)
Computer programming	0.54 (0.52)	0.66 (0.48)	-0.12 (0.17)
Conduct media surveys	0.23 (0.44)	0.71 (0.46)	-0.48** (0.14)
Prepare lit reviews	0.38 (0.51)	0.77 (0.43)	-0.39* (0.16)
Create reports or visualizations	0.31 (0.48)	0.97 (0.17)	-0.66*** (0.14)
Conduct library/internet research	0.46 (0.52)	0.89 (0.32)	-0.42* (0.15)
Edit or review reports	0.38 (0.51)	0.49 (0.51)	-0.10 (0.16)
Clerical work	0.15 (0.38)	0.09 (0.28)	0.07 (0.11)
Manage expenses	0.15 (0.38)	0.09 (0.28)	0.07 (0.11)
Provide lab support	0.31 (0.48)	0.06 (0.24)	0.25 (0.14)
Administer surveys or tests	0.31 (0.48)	0.06 (0.24)	0.25 (0.14)
Perform consultations	0.08 (0.28)	0.06 (0.24)	0.02 (0.09)

*Note:* Results of *t*-test for difference in means for explanatory variables. Standard errors in parentheses. \* for  $p < .05$ , \*\* for  $p < .01$ , and \*\*\* for  $p < .001$

**Table 2. Tools used in research experiences**

	FUREs	CUREs	Diff
Statistical or analytical software	0.62 (0.51)	0.97 (0.17)	-0.36* (0.14)
Database software	0.38 (0.51)	0.17 (0.38)	0.21 (0.15)
Programming languages	0.38 (0.51)	0.20 (0.41)	0.18 (0.16)
Desktop publishing (e.g., LaTeX)	0.23 (0.44)	0.26 (0.44)	-0.03 (0.14)
Presentation software	0.31 (0.48)	0.71 (0.46)	-0.41* (0.15)
Spreadsheet software	0.69 (0.48)	0.83 (0.38)	-0.14 (0.15)
Word processing	0.62 (0.51)	0.83 (0.38)	-0.21 (0.15)
Graphics	0.15 (0.38)	0.11 (0.32)	0.04 (0.12)
Video creation	0.00 (0.00)	0.11 (0.32)	-0.11* (0.05)
Information retrieval	0.00 (0.00)	0.06 (0.24)	-0.06 (0.04)
Version control	0.08 (0.28)	0.11 (0.32)	-0.04 (0.09)

*Note:* Results of *t*-test for difference in means for explanatory variables. Standard errors in parentheses. \* for  $p < .05$ , \*\* for  $p < .01$ , and \*\*\* for  $p < .001$

**Table 3. Knowledge used in research experiences**

	FUREs	CUREs	Diff
English	0.77 (0.44)	1.00 (0.00)	-0.23 (0.12)
Clerical	0.77 (0.44)	0.77 (0.43)	-0.00 (0.14)
Computers	0.77 (0.44)	0.91 (0.28)	-0.15 (0.13)
Mathematics	0.69 (0.48)	0.91 (0.28)	-0.22 (0.14)
Economics	0.62 (0.51)	0.91 (0.28)	-0.30 (0.15)
Communication	0.62 (0.51)	0.54 (0.51)	0.07 (0.16)
Organization	0.46 (0.52)	0.66 (0.48)	-0.20 (0.17)

*Note:* Results of *t*-test for difference in means for explanatory variables. Standard errors in parentheses. \* for  $p < .05$ , \*\* for  $p < .01$ , and \*\*\* for  $p < .001$

**Table 4. Results of research experiences**

	FUREs	CUREs	Diff
Was experience independent?	0.46 (0.52)	0.86 (0.36)	-0.40* (0.16)
Was experience practical?	0.69 (0.48)	0.86 (0.36)	-0.16 (0.15)
Was experience useful?	1.00 (0.00)	0.94 (0.24)	0.06 (0.04)
Enjoyed experience?	0.77 (0.44)	0.89 (0.32)	-0.12 (0.13)
Met expectations?	0.62 (0.51)	0.80 (0.41)	-0.18 (0.16)

*Note:* Results of *t*-test for difference in means for explanatory variables. Standard errors in parentheses. \* for  $p < .05$ , \*\* for  $p < .01$ , and \*\*\* for  $p < .001$

**Table 5. Regression results for demographic specifications**

	(1) Independent?	(2) Practical?	(3) Enjoyed?	(4) As expected?	(5) Independent?	(6) Practical?
CURE	0.424*** (0.14) [0.00]	0.215+ (0.14) [0.12]	0.132 (0.13) [0.32]	0.191 (0.17) [0.26]	0.764*** (0.21) [0.00]	0.084 (0.26) [0.75]
Male	-0.004 (0.11) [0.97]	0.116 (0.11) [0.31]	0.060 (0.11) [0.58]	0.038 (0.13) [0.77]	-0.072 (0.10) [0.48]	-0.001 (0.27) [1.00]
Visible minority	0.167+ (0.12) [0.16]	0.084 (0.11) [0.44]	-0.130 (0.12) [0.27]	-0.057 (0.14) [0.67]	0.789*** (0.17) [0.00]	0.094 (0.12) [0.43]
Domestic student	-0.194* (0.10) [0.07]	-0.260** (0.10) [0.01]	-0.015 (0.11) [0.89]	-0.004 (0.15) [0.98]	-0.037 (0.23) [0.87]	-0.333 (0.27) [0.22]
CURE × domestic					-0.155 (0.26) [0.55]	0.091 (0.29) [0.75]
CURE × minority					-0.816*** (0.20) [0.00]	
Male × CURE						0.155 (0.31) [0.62]
Constant	0.502*** (0.16) [0.00]	0.724*** (0.15) [0.00]	0.784*** (0.16) [0.00]	0.614*** (0.17) [0.00]	0.275 (0.22) [0.21]	0.817*** (0.26) [0.00]
R-squared	0.26	0.16	0.06	0.04	0.39	0.17
observations	48	48	48	48	48	48

Note: Robust standard errors in parentheses, two-sided p-values associated a t-test for difference from zero in square brackets. †p < 0.2, \*p < 0.1, \*\* p < 0.05, \*\*\*p < 0.0

### Regression and heterogeneity analysis

I also conducted a heterogeneity analysis of the main results considering gender, visible minority status, and immigration results. I did see some evidence that domestic students find their experiences more practical than women or international students. However, the statistical approach used eliminates the possibility for intersectionality in these categories; accordingly, I considered my second stage, which used a multivariate regression approach instead.

The main results for the regressions are presented in table 5. In general, the results are similar to the main analysis. The only major difference between CUREs and FUREs concerns independence (after controlling for demographic characteristics); students in CUREs are roughly 42 percent more likely to agree their experience was independent than those in FUREs. There is also some evidence students find

CUREs more practical than FUREs, but this is weaker. Controlling for type of experience, I find visible minorities and non-domestic students are slightly more likely to report an independent experience, indicating the demographic results in the previous section are due to selection effects and not overall bias. There is no apparent gender effect present in the data.

To examine this more closely, columns 5 and 6 consider the interaction of the type of experience and these demographic properties. While I do not find any interaction effect for domestic students, I see a negative effect for CUREs and visible minorities, indicating they are relatively less independent in their course experiences than in field experiences. This could be a function of the selection of students into different programs and opportunities, but I cannot directly assess this explanation in this paper.

Finally, I assessed the impact of different kinds of tasks, conditional on experience type; the results are presented in table 6. In general, I find it is the content of the experience that matters, not whether it is a FURE or CURE. The only clear impact on practicality is statistical analysis. In terms of enjoyment, model three demonstrates students generally do not like experiences that include more data manipulation, but do enjoy programming. This is likely because data manipulation in this context is largely technical data clean-up, which students are ill-prepared for in prior coursework (and it is not usually enjoyable). Model four is similar; the use of databases and data entry negatively impacts experiences meeting expectations. The use of statistics and the software STATA positively impacts their expectation of the experience, likely because these are tools students have been prepared to use in their coursework.

**Table 6. Regression results for task specifications**

	(1)	(2)	(3)	(4)
	Useful	Practical	Enjoyed	As expected
CURE	-0.045 (0.04) [0.23]	0.007 (0.19) [0.97]	0.197 (0.23) [0.39]	-0.130 (0.17) [0.44]
Use databases	0.044 (0.05) [0.40]	-0.160 (0.23) [0.49]	-0.348* (0.19) [0.08]	-0.465* (0.25) [0.07]
Statistical analysis	-0.018 (0.02) [0.43]	0.350† (0.23) [0.14]	-0.007 (0.20) [0.97]	0.469** (0.18) [0.01]
Use STATA	-0.025 (0.03) [0.41]	-0.011 (0.17) [0.95]	-0.023 (0.16) [0.88]	0.340* (0.19) [0.08]
Verify accuracy	-0.100 (0.09) [0.28]	0.125 (0.18) [0.50]	0.043 (0.21) [0.83]	0.180 (0.20) [0.37]
Data entry	0.048 (0.09) [0.59]	-0.142 (0.14) [0.33]	-0.002 (0.14) [0.99]	-0.217† (0.13) [0.12]
Programming	0.040	0.011	0.215†	0.137

	(0.07)	(0.13)	(0.14)	(0.13)
	[0.59]	[0.93]	[0.14]	[0.31]
Constant	1.005***	0.656***	0.882***	0.515**
	(0.03)	(0.23)	(0.11)	(0.22)
	[0.00]	[0.01]	[0.00]	[0.02]
R-squared	0.05	0.14	0.17	0.26
Observations	48	48	48	48

Note: Robust standard errors in parentheses, two-sided  $p$ -values associated with a t-test for difference from zero in square brackets.

† $p < 0.2$ , \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

## DISCUSSION

### Interpretation of the results

This paper compared CUREs and FUREs to understand how these fit into the discussion around authentic, effective pedagogies in higher education. As I have shown, there are generally no large differences between CUREs and FUREs in terms of tasks, tools, and affective experiences. In fact, in terms of the authenticity that Kreber (2013) discusses, CUREs outperform FUREs in several ways. Although a field experience may emulate the experience of a junior researcher, it frequently involves tasks that do not contribute to “promoting the ‘authenticity’ of [students]” in the sense of developing new knowledge and becoming part of the knowledge-creation process. This broadly agrees with the difficulty faculty in economics have finding suitable FUREs for students; the field is simply very difficult for a typical undergraduate to accomplish impactful work as part of their FURE. On the other hand, CUREs can achieve many of the same pedagogical goals with much higher impact.

This study did not see any meaningful demographic variation in experiences, indicating both CUREs and FUREs in this context appear to impact students of different backgrounds in the same way. This is reassuring, especially given the literature on student-faculty interaction that indicates certain (typically vulnerable) student groups are relatively disadvantaged by increasing interaction (Mook 2002). However, this could be contextual: the institution under study is highly diverse, which might mitigate leading to exclusion due to the large pool of international and visible minority students (i.e., if faculty are biased, a larger pool of students will reduce exclusion because there will be more opportunities for student skill or quality to overcome the bias). Additionally, there is a selection bias at play: it is possible that there is positive a relationship between choosing to supervise undergraduates and holding positive opinions of them, regardless of their gender or ethnicity. Thus, these results may not generalize and should be studied further.

This study has several limitations that affect the interpretations of these findings. The first is that the statistical results, while significant, are based on a relatively small sample. As the power analysis conducted earlier, the main implication is that “null” (or no difference) results should be conservatively interpreted as no *large* or *major* differences; it is possible there are small or modest differences that the study lacks the power to detect. In addition, while I did sample from the entire population available, the responses were self-selected; this is an observational, not experimental study. Although the respondents appear representative of the overall study population, unobserved factors may impact the external



validity of the results reported here. We should hesitate to draw causal relationships, instead viewing the results as descriptive relationships.

In addition, I must also acknowledge this study is only able to assess the tasks, cognitive, and affective domain skills students report. I am not able to connect these more specifically to learning objectives at either the course or the program level; this is largely due to the heterogeneity of these outcomes across courses and the lack of specific objectives at the institution level. I am also unable to draw many inferences regarding the ongoing value of these experiences; most alumni reported finding the research skills the most valuable in their later career, but there is insufficient variation to differentiate this by research experience type or by temporal wave. There is also the question of whether graduates are markedly different from the rest of the study population; unfortunately, this is difficult to assess, and is worth further study to understand how impressions of experiences change after graduation.

### **Lessons for non-economics courses**

So, what can we learn about CUREs and FUREs even if we are not directly studying economics or a related field? Despite the disciplinary focus on this particular study, it still makes a clear point about CUREs and FUREs in general. In the literature on CURE effectiveness (as exemplified in (Brownell and Kloser 2015)), CUREs are portrayed as existing on a continuum from a highly standardized “cookbook” curriculum to “authentic” (in the sense of “like a real research project”) research experience—with more effective CUREs laying closer to the latter.

By this logic, FUREs (which are at the “research” extreme of the CURE continuum) should be the most effective learning experience. This study demonstrates that it is not that simple. When we move along this continuum, there is a risk of losing sight of the other elements of authenticity beyond verisimilitude. FUREs that are not designed with learning objectives in mind (as in this study) can be less effective than well-designed CUREs. This is a clear validation, from both a learning and student perspective, of the importance of objectives-oriented (i.e., “backward”) as in Wiggins, Wiggins, and McTighe (2005) curriculum design in undergraduate research.

The results also show, regardless of the type of experience, that skills need to be scaffolded properly for students to engage and respond positively to the experience. This is not surprising: decades of research (e.g., see for example Belland 2017; Belland, Walker, and Kim 2017; Jumaat and Tasir 2014) have demonstrated the importance of scaffolded design. This paper makes the point this literature applies equally to both traditional courses and field experiences. If a curriculum designer wants to emulate an existing FURE in a CURE-context, a first step must be identifying what elements of the FURE are essential to the research process and then adapting them to work in a course setting in a systematic way.

Finally, there is the important question of external validity: these findings are based on a study of specific program at a specific institution. The structure, student body, and faculty at that institution are important factors in how these students perceive their experiences and the kind of things they are asked to do. The extent to which other curriculum designers can confidently apply these results to their situation is likely going to be based on how similar it is to the institution under discussion—and how closely their discipline matches the experience in economics.

## CONCLUSIONS

In this paper, I have shown that in the economics department at a large research university, there are no large differences between CUREs and FUREs—and where there are differences, they tend to favour CUREs. This challenges the understanding of CUREs and FUREs as existing on an authenticity continuum, and indicates that verisimilitude in learning experiences may not be unambiguously desirable from a curriculum design perspective. Further research understanding the relationship between authenticity, learning effectiveness, and research would be valuable to understand this point.

This paper is limited by the fact that external validity and conclusions for other disciplines need to be recontextualized to map the setting (economics) into the other discipline in question; while economics is situated between the humanities and physical sciences, some aspect may not be very similar, particularly in the research point of view. Complementary studies adding other disciplinary perspectives would be valuable. Additionally, due to the sample size, this study cannot rule out small- or modest-sized differences between CUREs and FUREs. Finally, it cannot speak to the ways alumni and current students' understandings of research has evolved post-graduating—an interesting possibility for future research.

Overall, I find the relationship between CUREs and FUREs is more complicated than we might expect and favours careful, pedagogically focused curriculum design over a desire to mimic an “authentic” research experience.

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## ETHICS

This research was approved by the UBC Human Ethics Approval Board as project H18-03082.

## NOTES

1. This debate over the distinction, often explained as “authenticity” is a frequent point of discussion regarding CUREs; see Rowland et al. 2016 for a discussion.
2. However, see the discussion in Beckman and Hensel (2009) regarding how and why undergraduate research can be defined, especially in the educational context.
3. In discussing this subject with colleagues, a full professor recalled their first research assistant position largely involved photocopying and not much else.
4. At UBC, faculties manage admission to majors in several different ways. The most common is a “graduated” admission process where students initially apply to a faculty when they join the university, and then subsequently apply (after a year or more of studies) to a specific major. Direct-admission programs allow students to apply directly to a specific major or program without first generally applying to the faculty. This results in a situation where the VSE has BIE students in the first through

fourth years of their programs, but only BA students in years three and four; BA students in years one and two of their programs have not yet selected a major.

5. Currently, the VSE offers formal combined majors in economics and philosophy, economics and political science, economics and mathematics, and economics and statistics.
6. UBC has three major categories of faculty members: research, teaching, and educational leadership. Research faculty are (with a few rare exception) tenured or tenure track, with responsibilities for research, service, and teaching—with an emphasis on their research output. Teaching faculty are contract faculty with assigned teaching loads; depending on their position they can be responsible for teaching and service or just teaching. Educational leadership faculty are tenured or tenure-track, with responsibilities for teaching, service, and educational leadership. This encompasses a variety of roles such as curriculum development, technological innovation, scholarship of teaching & learning, mentorship, etc. This are sometimes called “teaching stream” faculty at other institutions.
7. UBC has changed guidance for preferred language for Indigenous or Aboriginal individuals from “Aboriginal” to “Indigenous.” This study used the older, now-deprecated language.
8. The low response rate for wave two is likely due to the fact that the alumni mailing list being used had not been maintained until a year or two before the study began; therefore, many of the 2,500 individuals’ accounts may be inactive. In addition, the VSE (as an independent institution) only dates to 2012 and therefore does not have a strong alumni relationship.
9. These results are generally similar if we replace this with a comparison of the mean response, although this does not have a sensible statistical interpretation

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