Teaching and Teacher Education 51 (2015) 147–161

Contents lists available at ScienceDirect

Teaching and Teacher Education

journal homepage: www.elsevier.com/locate/tate

The distinction between inquiry-based instruction and non-inquiry-based instruction in higher education: A case study of what happens as inquiry in 16 education courses in three universities

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HIGHLIGHTS

- We did a collective case study of inquiry in 16 preservice teacher-education courses.
- Purposively sampled instructors said they took an inquiry-based approach or not.
- Data included interviews, instructional plans, syllabi, and classroom observations.
- Inquiry instruction differed most in course planning, learning-assessment, and roles.
- Co-construction and small-group participation in instructional activities differed.

ARTICLE INFO

Article history:
Received 16 March 2015
Received in revised form
3 June 2015
Accepted 30 June 2015
Available online 12 July 2015

Keywords:
Inquiry
Inquiry-based instruction
Undergraduate instruction
Preservice teacher education
Classroom observation
Qualitative research
Case study

ABSTRACT

This collective case study describes instructional plans and observed inquiry-based instruction (IBI) in 16 undergraduate education teacher-preparation courses purposively sampled from instructors who said they did or did not take an IBI approach. Open coding and content analysis of interview transcripts, recordings of observed instruction, syllabi, and cross-case comparisons informed what was alike, different, and unique for IBI and non-IBI. We used negative cases, data triangulation, audit trail, and interrater reliability for 25% of the codes. IBI and non-IBI differed most in course-planning, student-learning assessment, co-construction of instruction, and the nature and quantity of teacher and student roles and talk.

Research, scholarship, and teaching are the cornerstones of universities' primary mission. However, undergraduate students' engagement in inquiry has been a direct research object only since the 1980s (Barrows & Tamblyn, 1980). Personal experiences with inquiry and learning to teach with inquiry are both relevant to teachers', including higher-education instructors', ability to create inquiry-based learning situations for their students. Inquiry-based instruction (IBI) embraces several models in the literature, but three defining characteristics appear to be common across the models and descriptions of IBI: (a) Student's interests contribute to what happens in classrooms, (b) at least some of the curriculum is coconstructed, and (c) there is exchange, diversification, sharing, or adoption of new roles by learners and teachers (Aulls & Shore, 2008). However, these common characteristics are not meant to be limiting because individual higher-education instructors, a population generally not formally educated as teachers, might bring a number of inquiry practices to their classes from their disciplinary scholarship. To date, no research has empirically distinguished IBI and non-IBI dimensions in a range of teacher-education courses, or described the common and unique underlying dimensions of instruction that occur in courses taught by instructors who say they incorporate inquiry learning in their undergraduate instruction in general and specifically in teacher education. Spronken-Smith, Walker, Batchelor, O'Steen, and Angelo

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http://dx.doi.org/10.1016/j.tate.2015.06.011
0742-051X/

(2012) observed that their survey-based study of inquiry outcomes in 15 courses in different disciplines obtained data only from IBI classes, therefore the contribution of IBI beyond other approaches could not be estimated. We used L. W. Anderson and Burns's (1989) model of six dimensions of instruction to frame our analysis of interviews, classroom observations, and artifacts such as written course syllabi distributed to students. We focused on what actually happens as inquiry in the classes.

International use of common terms varies, sometimes totally reversed. We used "instruction" rather than "teaching" to focus not only on what the teacher does but also on what students do, instructor–student interactions, and the learning context. We used the North American term "course" for what is elsewhere referred to as a "subject" or "module" within a program of study and normally involving about three hours of weekly instructor contact with a group of students over approximately four months.

1. Literature review

There has not been prior research directly on the topic of this study, but there are many studies that have informed the work and provided theoretical context and models for its conduct.

1.1. Inquiry instruction and learning in undergraduate higher education

Research reports exist about undergraduate IBI in the USA (e.g., Ball & Pelco, 2006; Boyer Commission, 1998; Handelsman, Miller, & Pfund, 2007; Park Rogers & Abell, 2008; Stokking, Van der Schaaf, Jaspers, & Erkens, 2004), Canada (e.g., Aulls & Shore, 2008; Barrows & Tamblyn, 1980; Chichekian, Hua, & Shore, 2013; Redden, Simon, & Aulls, 2008), New Zealand (e.g., Spronken-Smith, Bullard, Ray, Roberts, & Keiffer. 2008–this paper also presented examples from the USA and UK; Spronken-Smith et al., 2011; Volkmann, Abell, & Sgagacz, 2005), and the UK (e.g., Brew, 2003; Healey & Jenkins, 2009). This research was largely limited to qualitative case studies of single courses and quasi-experimental studies comparing two approaches to inquiry instruction or one IBI and one non-IBI course (Spronken-Smith & Walker, 2010); Spronken-Smith et al.'s (2012) study is a notable exception. Spronken-Smith et al. (2011) claimed that they could only identify two research reports on the use of inquiry throughout an undergraduate degree program, one in the Health Sciences (Ai et al., 2008) and one in microbiology (Lee, Hyman, & Luginbuhl, 2007).

Renewed impetus to study undergraduate inquiry instruction and learning was provided by the Boyer Commission (1998) recommendations that undergraduate students in any discipline should have the opportunity from the first year of university to learn about and experience inquiry, and that research-intensive universities should lead the way. Some universities enacted several Boyer-report suggestions, but the overall impact was spotty (Boyer Commission, 2001; Katkin, 2003). Before Boyer, opportunities for undergraduates to learn about and experience inquiry were provided primarily through student-initiated, faculty-supported research projects, and the initiatives of individual instructors who made efforts to improve their learners' experiences without explicitly tying these to notions of inquiry. For example, the Undergraduate Research Opportunities Program at the Massachusetts Institute of Technology began in 1969 (Cohen & MacVicar, 1976). These were conducted outside courses contributing degree credit.

A relatively small body of research has addressed undergraduate inquiry instruction. Spronken-Smith et al. (2008) reported three studies offering evidence of positive undergraduate student-learning outcomes (Justice, Rice, Warry, & Laurie, 2007; Prince & Felder, 2006; Spronken-Smith & Walker, 2010). One meta-analysis of science undergraduate courses provided evidence for the use of small-group instruction in science courses. Superior higher-order learning outcomes ensued, one frequently noted dimension of IBI models. IBI was related to similar general outcomes (Ball & Pelco, 2006; Levy & Petrulis, 2012; Spronken-Smith et al., 2008), with more positive impact on learning than non-IBI courses (Justice et al., 2007). Students rated some kinds of IBI most highly, for example, open, discovery-oriented inquiry (Spronken-Smith et al., 2012). Case-based and project-based learning were associated with more evidence of positive learning outcomes than other kinds of inquiry such as problem-based learning (Loyens & Rikers, 2011).

Growing emphasis on IBI educational reforms in K-to-12 education also prompted interest in using IBI approaches within undergraduate courses. More matriculating students will be prepared to engage in IBI and expect professors to use and build upon their inquiry-specific thinking skills and provide course-time for student participation in projects they or others initiate. This is especially likely if students spent extended time doing a research project within their secondary education; survey data (Kurotsuchi Inkelas, Swan, Pretlow, & Jones, 2012) confirmed that undergraduate students who systematically engaged in doing a research study in the arts, humanities, or sciences in an International Baccalaureate (IB) program believed they were better prepared to undertake university inquiry requirements than students who had other secondary schooling experiences. IB graduates reported more involvement in doing research, and more highly valued the opportunity to engage in undergraduate inquiry.

1.2. Inquiry instruction and learning in undergraduate teacher education

Multiple meta-analyses spanning 20 years clearly supported the importance of designing undergraduate teacher-education courses that help K-to-12 preservice teachers learn how to teach content and skills through IBI processes in ways that lead to enhanced higher-order thinking and learning outcomes (e.g., American Association for the Advancement of Science, 1993; Bredderman, 1983; Furtak, Seidel, Iverson, & Briggs, 2012; National Research Council, 1996, 2000, 2012; Organization for Economic Cooperation and Development, 2009; Schroeder, Scott, Tolson, Huang, & Lee, 2007; Shymansky, Hedges, & Woodworth, 1990). Minner, Levy, and Century's (2010) synthesis of 138 K-to-12 qualitative research studies also reported a "clear, positive trend in favor of inquiry based-teaching" (p. 474).

Nevertheless, the issue arises of whether or not undergraduate student-teachers typically have been exposed to preparation and engagement in inquiry projects and are provided the opportunity to learn how to actually do or teach through inquiry as opposed to merely becoming informed about it. In a year-long qualitative study of 60 students in two research-intensive British universities (Wray, 2013), all the first- and second-year undergraduates reported not having experienced any IBI or being asked to use their earlier-learned, higher-order, inquiry-relevant skills. Wray's results challenged the claim that students' prior experiences directly influence education professors' inquiry-instructional practices, yet confirmed that IBI-trained secondary graduates expect to encounter situations in which inquiry skills are needed. Alkaher and Dolan (2011) also reported lack of awareness of IBI effects in several disciplines. More large-scale qualitative studies are needed to describe whether education professors have a rich conception of inquiry as a process and as instruction, and how well what happens as instruction during a course aligns with their conceptions of inquiry.

Instructors' conceptions of what they desire to teach can be

related to their enactment of undergraduate instruction (e.g., Devlin, 2006; Gebre, Soroyan, & Bracewell, 2014; Gow & Kember, 1993). It also is important to determine if education instructors' conceptions, instructional plans, and classroom enactment of plans are related to and influenced by expert models of inquiry instruction. In addition, are the conceptions influenced locally by other professors in their field, or inferred from personal experience in undergraduate teaching?

Inquiry instruction used to prepare preservice teachers to do IBI can be more demanding and complex than many other kinds of instruction (Windschitl, 2002, 2004). Senior student-teachers who learned about inquiry through pedagogy and psychology undergraduates who did an inquiry-based research project similarly understood the demands of doing inquiry, but the preservice teachers better articulated how to teach others to learn through inquiry (Aulls & Pelaez, 2013). Qualitative and longitudinal case studies of preservice teachers indicated that a high proportion of undergraduate education students evaluate inquiry learning as very important but regard IBI planning and enactment as too challenging to commit to adopting as central to their instruction (e.g., Crawford, 1999, 2000; Davidson & Bruce, 1993; Schulz & Mandzuk, 2005; Windschitl, 2003). Being predisposed to use inquiry, planning IBI, and actually doing it are different actions. These findings may also apply to higher-education instructors and their courses.

Alkaher and Dolan (2011) review of barriers to IBI planning or implementation proposed that multiple conceptions of inquiry confuse some instructors. Others believe they do not have the expertise necessary for IBI or are not aware of its benefits (e.g., R. D. Anderson, 2002, 2007; Crouch & Mazur, 2001; Dancy & Henderson, 2008; Dehann, 2005). Therefore, some IBI models, even when learning evidence is strong, may be used less often in undergraduate courses because they require more time, effort, and special resources (Park, Rogers, & Abell, 2008).

We propose that a primary problem in the research literature on IBI in undergraduate education courses, as in other degree programs on which the preceding research was based, is the lack of clarity about what happens as inquiry instruction in education courses, what distinguishes them from noninquiry courses, and what kinds of IBI are useful in such courses. For example, is IBI student- or process-centered? Do IBI models differ across education subject matter? Can teacher- and content learning-centered courses be inquiry-based?

1.3. A framework to elaborate dimensions of instruction related to inquiry enactment

L. W. Anderson and Burns (1989) reviewed models of instruction to articulate what happens in classrooms and what variables constrain teacher-student coconstruction of the instructional process during a course: (a) subject matter, (b) activity demands, (c) instructional format, (d) grouping, (e) time allocation and pacing, and (f) teacher and student behaviors and interactions. Furtak et al. (2012) used a similar framework in a meta-analysis of experimental and quasi-experimental studies of inquiry-based instruction to clarify what dimensions are and are not included or emphasized in purportedly different models of IBI. Their results provided elementary and secondary education-level support for the Anderson and Burns (1989) constructivist-learning framework. What the teacher does is only one dimension of the evolving process of instruction comprising a sequence of classes in a university course; what the teacher does in planning and in the classroom constrains what happens as inquiry instruction and learning.

2. Purposes of the study

1. To empirically distinguish between common dimensions of inquiry-based instruction (IBI) and non-IBI dimensions.
2. Within courses taught by instructors who describe themselves as making IBI part of their instruction, to identify the common and unique underlying dimensions of instruction that explain what kind of IBI is being provided.

If the Anderson–Burns model is valid, then the six dimensions should occur in all courses but qualitatively differ between IBI and non-IBI courses. Such differences could arise when a different time emphasis is given to some dimensions, or when some are present in IBI courses but not in non-IBI courses. Instructional dimensions can be combined differently, or instructors may hold different goals for student learning corresponding to the kind of IBI provided.

Because literature descriptions of IBI instruction reflect a “messy construct” (Spronken-Smith & Walker, 2010), the Anderson–Burns model may afford a tool to clarify what instructional dimensions are actually qualitatively different and how. Furtak et al. (2012) were adamant that clear descriptions of courses and classes purporting to use IBI were essential to determining what instructional inputs were related to learning-outcome differences.

3. Methodology

We employed an instrumental and collective case-study design (Stake, 1995). One goal of an instrumental case study is to relate results to existing models or theory–in our case, the Anderson–Burns model of instruction. Participants were selected from a purposive, convenience sample of courses required for an undergraduate degree in education and instructors engaged in the teacher-certification programs of three universities (two in eastern Canada and one in the northeastern United States). The 16 professors who consented to participate were then categorized as IBI or non-IBI based on their self-descriptions. As a collective study, it described each case using multiple embedded units (Yin, 2003) representing the Anderson–Burns framework for describing what happens in each class, and then compared the descriptions of each course to the other. The data sources were derived from (a) interviews about the perceptions of each course and its instruction by the instructor, (b) formal written course outlines given to students, and (c) classroom observations by researchers, video-recorded and in fieldnotes. Each data source produced numerous categories and enabled complex within-case analysis (IBI only or non-IBI only) and between-case analysis (IBI versus non-IBI) of instructors' courses. The comparison of more than two cases in each group and then between groups afforded a stronger basis for testing the validity of Anderson and Burn's (1989) framework for classroom instruction in higher-education classrooms and for generalizations about the results of the inductive analysis of cases reported by the participants to entail IBI and how these are different from courses described as not inquiry-based. Cross-case analysis with the IBI courses alone also allowed the detection of different kinds of approaches to promoting inquiry teaching and learning across different education departments and universities. Thus, the strength of the collective case-study design is based on replication logic (Yin, 2003). Literal replications of one or more instructional properties, the absence of one or more instructional properties, or qualitatively different variations on the same property or properties across many cases, offer evidence of what is likely to be alike and different about IBI compared to instruction in courses the instructors view as not inquiry-oriented. Furthermore the within-IBI case analysis described precisely how some courses

using inquiry-based instruction were unique from other courses using IBI. Theoretical replication occurs when the absence of a replication can be explained on the basis of theory, for example, Anderson and Burn's (1989) model. On the other hand, the complexity of the data collected and analyzed precluded a rich portrait in the research results for each single case in terms of its surrounding context, detailed descriptions of the course, and the like (Yin, 2003). Although the single-case data were gathered and analyzed for each case, they were not reported. Instead, they were used through analyses that meet the goals of the instrumental and collective case-study design, namely, to test theory in terms of what happens in IBI classrooms that is different from non-IBI classrooms and to determine the variability in how education instructors view inquiry, its place in their teaching, and the context they create for student engagement in inquiry learning.

Dimensions of instruction were the primary unit of analysis in comparing the 16 courses. By relying on inductive derivation of the categories forming instructors' conceptions of inquiry instruction, actual plans they created for the enactment of the course, the course outline describing each course, and enactment of one class in each course, it was possible to represent the instructors' and researchers' memories and thoughts about the nature of instruction in the courses.

Comparing cases allowed separation of IBI and non-IBI courses and kinds of IBI courses through constant comparison of the inductively generated categories derived from the participants' voices, artifacts, and actions. Claims for what IBI courses entail that non-IBI courses do not, and the variation in the kinds of IBI courses used to promote student-teaching expertise, derived primarily inductively rather than deductively. This enhanced validity because it did not depend solely upon the researchers' thinking.

The researcher's philosophy must be disclosed in qualitative research because he or she is the primary tool for both collecting and analyzing data. We hold a social-constructivist learning philosophy (Vygotsky, 1978) that influenced selection of a broad framework for conceptualizing what happens in university courses as instruction.

3.1. Ethics

Research-ethics approval was obtained from all three universities.

3.2. Sample

Sampling strategy was purposive and criterion-based. The sample included 16 undergraduate courses taught by education instructors in two Canadian and one US universities that varied from medical-research-intensive to comprehensive-doctoral to regional-undergraduate, thus adding contextual variety. Twelve instructors claimed to make a place in the observed course for inquiry-based instruction and four stated they did not. They were not preselected but, after agreeing to participate, identified themselves as one or the other based in the last interview topic: the place of inquiry in the course to be observed. This was also a convenience sample of full-time, tenure-track instructors willing to be interviewed, share instructional documentation, and be observed and videorecorded. Teaching assignments varied due to sabbatic and other leaves, administrative and other assignments, therefore the total potential sample comprised at the peak approximately 70 instructors (23% participation). Each instructor selected one compulsory, preservice, teacher-education course as the focus.

3.3. Data collection

3.3.1. Interviews

A semistructured interview, at a place designated by the instructor to be distraction-free, was completed in approximately 60 min, and questioned:

1. how instructors generally viewed effective instruction;
2. the nature of inquiry and its place in the courses described in the course outlines;
3. how the instructors planned and enacted their instruction;
4. the acquaintance they thought the typical student may have had with inquiry during prior formal schooling; and
5. the acquaintance their departmental colleagues may have had with teaching using an inquiry approach to instruction.

3.3.2. Classroom observations

One author observed and a research assistant videorecorded one entire class per course. The observer made fieldnotes identifying the start and end times, who said what to whom, when, where, and how, for each class event. An event denoted introduction of a new topic or activity. Videorecordings and audio-transcriptions of the classroom lesson were merged with the fieldnotes. Times were allocated to event topics, event activities, and categories of questions and roles emerging within all events comprising the class.

3.3.3. Artifacts

When interviewed, each instructor was asked for a copy of the course syllabus. This was digitized to facilitate open coding and constant comparison of emerging categories among the cases.

3.4. Data analysis

3.4.1. Open coding

Analysis began inductively using open coding (Strauss & Corbin, 1990) of interview transcripts, course outlines, and discourse from classroom events identified in lesson videorecordings. Open coding enabled reducing these data into themes or categories within which other categories elaborated on their meaning from the participants' perspectives, including responses to questions and probes. Following Aulls (2002), transcripts for each class event were open-coded to determine codes for units of teacher-student dialog contributing to classroom discourse, and to inductively derive roles identified through teacher and student participation in each classroom event.

Finally, course outlines were open-coded to describe (a) categories of goals for student-learning outcomes, (b) activities for students to accomplish, (c) teacher and student roles, and (d) assessment categories the instructor used to assign marks to individual students and weights for these assignments in overall grading.

3.4.2. Content analysis

Content analysis following Mayring's (2000) procedures employed the Anderson–Burns framework to establish six dimensions of classroom instruction that, considered together, created a variety of instructional patterns. This was done separately for IBI and non-IBI instructors.

3.4.3. Constant comparison of cases

Using fieldnotes and coded transcriptions of class events, constant comparison of all 16 courses used the six Anderson–Burns classroom-instruction dimensions to compare cases within then

between each university. Based on videorecordings and fieldnotes, we coded and compared (a) time allocated to teacher-class dialog, teacher monolog, and student–student dialog as a whole class or in small groups; (b) the nature of activities occurring in the class; (c) main topics arising in each event; (d) what the teacher did; (e) kinds of dialog arising in the class; and (f) different roles played by the teacher and students during an entire class.

3.5. Validity considerations in the instrumental-collective case design

3.5.1. Interview order

Asking instructors to first express their understanding about inquiry could have biased their descriptions of what they considered as highly effective instructional practices used in their classroom instruction. Therefore, participants were guided by the interviewer to describe their course, how they planned it, and what they considered as highly effective instructional practices, then explain their personal conception of inquiry and its place in the observed course.

3.5.2. Interrater reliability of the coding

Interrater agreement for 25% of the transcripts was .90; intrarater coefficients were .95 and .88 respectively for two coders. Peer debriefing (Creswell, 2007) enhanced the accuracy of accounts of each case.

3.5.3. Negative-case analysis

To clarify what inquiry instruction is and is not, instructors who stated they did not use inquiry in the observed course can be regarded as negative cases. Comparisons of IBI and non-IBI cases within each university were analyzed first. It was not assumed that, when instructors think they are not using IBI, they will be alike in the instructional dimensions we analyzed. However, instructors who claim they use an IBI approach should be able to demonstrate in the observed class that dimensions of their instruction enabled student- and process-centered instruction (e.g., as noted earlier, that build upon students' interests, enable students to share in building part of the curriculum, or describe new roles for the learners and instructors that can include roles traditionally associated with the other). Finally, the course outline must include activities or assignments that meet such IBI criteria and receive more grading weight.

3.5.4. Data triangulation

Triangulation can be of data sources, theory, or method to offer evidence of the dependability and credibility of the obtained results (Corbin & Strauss, 2008; Creswell, 2007). Effective instruction that promotes positive evidence of student learning should include meaningful and noncontradictory alignment among plans for teaching and learning, enactment of plans, and evaluation of learning (Biggs, 2003). Data-source triangulation was used to verify correspondence among what instructors said in the interview they did to create a plan for instruction, course syllabi–especially academic and social requirements for course credit, and what was observed in cooperation with students during a typical class.

For methods triangulation, descriptive open-coding results were compared to content-analysis results; negative cases were used to confirm that the qualitative differences among the six dimensions of instruction distinguished kinds of IBI. Triangulation also distinguished IBI overall from instruction that was sufficiently different to constitute non-IBI instruction.

4. Results

What common dimensions of instruction distinguish instructors who reported using IBI in their course from those who reported that they did not use IBI? And what was the extent of variability of IBI practices?

If the two groups differed qualitatively on all six dimensions of instruction, there would be strong reason to infer that the instruction differed between the IBI and non-IBI classes. If only some dimensions differed, there would be evidence that IBI and non-IBI instruction differed on particular dimensions. If only one or no dimension was qualitatively different, the evidence could not support a contention that instruction is sufficiently different from that in non-IBI instructor courses.

4.1. Instructional dimension 1: perceptions of the most important quality of instruction

We asked, “What do you regard to be the most important quality of instruction in undergraduate classes?” before questions about inquiry instruction and learning, in order to create a reflective response mode on the first question.

IBI instructors reported qualities of instruction that fell into six in vivo categories (using participants' own language) that absorbed virtually all the variability in the total response pool. These categories were to

1. get them to think;
2. set up situations that encourage them to learn;
3. know the content and deliver it clearly;
4. link real-life experiences to theory;
5. link learning experiences in class to students needs; and
6. make the content come alive to them.

Categories 1, 4, and 6 resembled responses of non-IBI instructors. For example, the category “to get them to think” was similar to non-IBI instructors' statements “to engage students in critical reflection” and “to stretch their brains.” However, categories 2, 3, and 5, unique to the IBI instructors, referred to ways to design course conditions that motivate students to engage in inquiry.

IBI instructors generated 10 other unique categories not found in non-IBI instructors' responses, reflecting three broad dimensions of instruction:

- What the teacher does to more actively engage students, included to
  7. get students to do more;
  8. listen more and lecture less;
  9. observe where students are having difficulties;
  10. be flexible in decision making and pacing lessons;
  11. teach students how to reflect; and
  12. help them be successful learners.
- Social dimensions of instruction, dependent on the student's behaviors, included to
  13. get students discussing issues;
  14. create a comfortable social climate; and
  15. work in small groups as a community.
- Cognitive dimensions of instruction, included just one, to
  16. to have them use knowledge in the future.

Non-IBI instructors' responses reflected only what the teacher did and omitted influences from classroom social dimensions, but most IBI instructors noted both. Second, IBI instructors reported many unique instructional practice categories. Third, IBI instructors' responses focused on instruction and learning processes,

whereas non-IBI instructors' mentioned only the content to be taught and heavily represented the teacher's thoughts and actions. IBI and non-IBI instructors had different views of what is generally important to effective instruction.

4.2. Instructional dimension 2: course planning

"Do you follow a sequence or series of steps when you plan your course?" Only one non-IBI instructor concurred, but all IBI instructors said yes. Probes followed: "What did (will) you do to plan the course I (did or will) observe?" IBI instructors planned either the whole course or weekly, class-by-class, reflecting on the previous class. They described how they plan. Their plans indicated what the student does, thereby making the student rather than themselves the center of the instruction. Non-IBI instructors addressed the content with little consideration of how students learn to process that content. Their responses were also considerably briefer. This suggests that they spent less time planning than IBI instructors and were not overtly focused on students' active participation in classes. Almost all IBI instructors said they planned the course considerably before the first class; no non-IBI instructor made this claim.

All 16 instructors used one or more of the following six planning categories to describe what the instructor does, derived from their exact words:

1. organizing activities to engage students in content;
2. imagining situations to get students to respond or reflect on response to the situation,
3. adapting the enacted plan through reflection in action;
4. leaving part of the content to be generated by the student, or part of an activity or situation, filling in from one's own experience or principles recently taught in a prior lesson;
5. adapting the next lesson through reflection on the last class as a whole and projection to the next one, or what was described in the course outline for each class of a course; and
6. getting lecture content ready.

The most typical categories IBI instructors associated with their planning were:

1. constant reflection on how best to present and what to include in the course;
2. ongoing question asking ("What needs to be done? How best to do it? What resources might be needed?");
3. student involvement;
4. various planned activities to be included;
5. open-mindedness to change;
6. willingness to relinquish control;
7. wanting to instill autonomy by empowering the students; and
8. assigned mandatory readings for execution of activities.

Non-IBI instructors focused on "what and how to teach." Even one non-IBI instructor who mentioned that "the student population is considered in choosing activities and style of delivery," continued, "I like to provide structure and direct teaching due to the mixed ability of the group." Another non-IBI instructor said, "No, there isn't much planning needed … all I'm doing is trying to keep up with the other six sections of the course, which is very prescriptive–same textbook, same course outline, PowerPoint templates, etc.,. . . so planning just seems to be redundant." He called his planning "formulaic." Another non-IBI instructor followed a pre-existing plan that had been available to staff for years. She also followed a general class pattern without much deviation, for example, "heavy lecturing in the beginning of the class, followed by hands–on activities towards the end." She did, however, "make notes on problems experienced by students" and "tries to address them on a regular triweekly basis." In contrast, IBI instructors mentioned or elaborated on many student or instructor behaviors that support inquiry learning. The response categories are listed in Table 1.

The major planning categories describing IBI and non-IBI instructors were substantially different. This strongly suggests IBI instructors undertook more elaborate planning processes well before teaching a course, and employed many more unique "best practices" of teaching and learning in undergraduate courses (e.g., Instructors 1 and 2, Table 1).

4.3. Instructional dimension 3: classroom dialog and discourse

Active learning entails verbal participation during instruction among students and with the instructor. It can occur with varying frequency in any course and be analyzed into categories that describe specific patterns of dialog that emerge into discourse. This dimension was derived from videorecordings of the observed classes and directly reflects coconstruction of the learning environment. Table 2 shows eight categories of verbal classroom events found in the IBI and non-IBI classroom transcripts. The first four categories were initiated only by the teachers as instructor monolog without expectations for students to actively coparticipate. Categories 5 and 6 included dialog initiated by teacher or student, and may lead to discourse between the instructor and students, or among students. Categories 7 and 8 represented individual student monolog, such as students' presentations to the class and teacher, normally without expected audience response–however in IBI classes there were responses during and after presentations and these were coded. When talk is balanced between the teacher and students, greater emphasis is given to events in categories 5 and 6. In category 5, the instructor or students who ask questions or make statements more likely produce sustained discourse that hierarchically relates concepts and ideas. Category 6 was dialog mostly among students with the instructor as a facilitator.

In both IBI and non-IBI cases, students extensively mediated academic thinking through whole-class discussion and student-directed small-group discussion. Individual instructors varied widely in both groups.

However, as shown in Table 2's Instructor and Student Totals columns, IBI-courses student talk time was 70%, teachers' alone 30%. In non-IBI courses students talked 45% and teachers 59% of total verbal-interaction time. Generally, but with exceptions, IBI classes spent considerably more time in whole-class discussion and small-group participation. Instructor explanations and directions, and students' presentations, occupied more non-IBI class time. IBI and non-IBI classes differed in the amount of student talk time and in what kind of student and instructor talk occurred.

4.4. Instructional dimension 4: projects and learning activities

The most unique dimension of IBI courses was that students were required to engage individually or collectively in projects over an extended period of time, at least four weeks, resulting in curriculum units such as (a) a classroom-management guide, (b) classroom-assessment tools, or (c) a research question and investigation followed by data collection and analysis.

Table 3 presents evidence from syllabi listing all "academic projects" in bold type plus all "academic activities" in the IBI and non-IBI courses. Both included a "research report" project category. Although distributed over 11 weeks and due at the end of the course, these did not enable students to apply course knowledge to the immediate development of the solution to a classroom

Table 1
Major categories representing IBI and Non-IBI Instructor's course planning.

	Planning steps articulated
IBI	
1	•Selects and schedules principal content, readings, and assignments weeks in advance (entire course outline is online) •Planned activities include: learning cells, small and large group activities, mini-lectures, and demonstration activities
2	•Maps the concepts or content from the textbook •Reflects about multiple ways of doing activities, what students need to know, visualizes how best to bring it across •Remains open to suggestions from students, emphasizes activities •Believes in students' ability to learn without lecturing
3	•Maps concepts/content from the textbook; decides how to brake them down, what basic information activities require •Reflects on how they can be taught weekly or daily •Tries to keep a balance between lecture and activity
4	•Looks at content •Reflects on at what point to get students involved •Models behaviors •Interrelates student experience to teaching
5	•Not really involved in planning (using another instructor's course outline) •Reflects on things the students should know and get them engaged •Believes in interactive teaching •Puts abstract ideas into practice
6	•Reflects on goals and what students should take out of it •Remains open to suggestions from students •Decides whether it is a lecture or a lab, what information or skills are required, and then plans situations •Provides plenty of examples and experiences
7	•Modifies existing plan according to class but follows a general pattern •Heavy lecturing in beginning of course/class but more practical hands-on activities toward middle and end •Reflects on notes taken from previous years about problem areas
8	•Introduces concepts at the beginning of course •Reflects on what is happening in class •Believes in student autonomy so gets students involved in developing curriculum •Develops resources and respect for knowledge of others •Plans small-group activities
9	•Starts year planning and creating lesson plans and tries to bring in all types of concepts or content •Reflects on what needs to be done, how to teach ways of teaching, and the subject content •Includes activities and science content •Keeps reflecting an ongoing activity–shuffling and improving
10	•Develops lesson plans, introduces and then breaks into smaller units •Reflects on what to do and decides on appropriate resources, e.g., guest speakers, type of media services •Believes in using a constructivist approach •Involve students in group work
11	•Follows a four-year-old course outline •Reflects on self, receptiveness of students, and any changes that may be required
12	•Involves students in planning of the course by getting them to develop questions related to the syllabus •Reflects and assesses level of course and timing •Changes readings all the time
Non-IBI	
13	•Refers and reviews another teacher's outline •Reflects on type of interaction required with students •Keeps in mind what subjects students are majoring in
14	•Plans day-by-day •Four to five assignments throughout course •Reads assignments or reflections
15	•Looks at content of class •Studies type of student population •Decides on kinds of activities and style of delivery •Uses mostly direct teaching because of mixed ability •Links between lecture and textbook (because of comfort level of students) • Likes to give them structure
16	• Formulaic planning process; syllabus modeled on previous instructor's • Tries to keep same pace as the other seven sections of the same course which all use same textbook • Uses available template “PowerPoint” presentations

educational problem or the creation of something new for the students to use soon in their own classroom, such as a curriculum unit. Research reports based solely on library access do require undergraduates to read research on a topic or question of interest, write a summary of the evidence, or compare the available evidence, however, there is usually no direct application of the knowledge acquired. Limited knowledge about making sense of research can lead to misconceptions about inquiry or IBI.

Academic activities refer to a problem space, set of directions to follow, and a production (Doyle, 1983). We counted 110 academic activities that we organized into 16 qualitative categories. The average number in IBI syllabi was 5.76, and 4.75 for non-IBI. IBI students experienced more opportunities than non-IBI learners to be more active learners and received frequent feedback on academic learning through small-group peer interactions and written or verbal professor feedback. A difference of one weekly activity can generate an hour of preparation and 10–40 min of class time per student to verbally interact about the activity's product or process–that totals 1300 min, not an inconsequential number.

Table 2
Minutes and percentages of total talk time on kinds of talk generating monolog, dialog, and discourse.

Instructors	Talk Category (min./%)																						Total class talk (min.)
	1		2		3		4		Instructor totals		5		6		7		8		9		Student totals		
	Lecture time		Instructor explanations		Instructor directions		Instructor review				Whole class discussion		Small group discussion		Student presentation		Student Independent study		Other				
IBI																							
1	0	0	10	17	5	8	0	0	15	25	10	17	0	0	35	58	0	0	0	0	45	75	60
2	0	0	0	0	0	0	0	0	0	0	20	40	30	60	0	0	0	0	0	0	50	100	50
3	10	17	5	8	0	0	0	0	15	25	22	37	8	13	0	0	0	0	15	25	45	75	60
4	32	53	0	0	0	0	0	0	32	53	23	38	5	9	0	0	0	0	0	0	28	47	60
5	0	0	0	0	0	0	0	0	0	0	60	100	0	0	0	0	0	0	0	0	60	100	60
6	2	4	10	20	5	10	15	31	32	65	17	35	0	0	0	0	0	0	0	0	17	35	49
7	43	88	0	0	0	0	0	0	43	88	0	0	6	12	0	0	0	0	0	0	6	12	49
8	0	0	30	50	0	0	0	0	30	50	20	33	10	17	0	0	0	0	0	0	30	50	60
9	0	0	0	0	0	0	0	0	0	0	31	86	5	14	0	0	0	0	0	0	36	100	36
10	20	32	0	0	1	2	0	0	21	34	38	63	2	3	0	0	0	0	0	0	40	66	61
11	4	7	0	0	0	0	0	0	4	7	50	91	1	2	0	0	0	0	0	0	51	93	55
12	0	0	0	0	0	0	0	0	0	0	35	92	3	8	0	0	0	0	0	0	38	100	38
Total min.	111		55		11		15		192		326		70		35		0		15		446		638
% of total	17		10		2		2		30		51		11		5		0		2		70		100
Non-IBI																							
13	0	0	10	22	1	2	0	0	11	24	8	17	5	11	19	41	0	0	3	7	35	76	46
14	0	0	41	66	5	8	0	0	46	74	0	0	0	0	16	26	0	0	0	0	16	26	62
15	15	25	0	0	8	13	0	0	23	38	38	62	0	0	0	0	0	0	0	0	38	62	61
16	34	70	0	0	5	10	0	0	39	80	0	0	4	8	0	0	5	10	1	2	10	20	49
Total min.	49		51		19		0		119		46		9		35		5		4		99		218
% of total	22		23		9		0		55		21		4		16		2		2		45		99[a]

[a] This falls short of 100% because of accumulated rounding.

Table 3
Comparison of all assigned IBI instructors' and Non-IBI instructors' Academic tasks identified from course syllabi.

Instructor	Academic tasks[a]	Description of inquiry-based activities
1 IBI	Concept Maps 10%; Learning Cells 10%; Essay 25%; Annotated Bibliography 5%; **Teaching Idea binder and Fair 15%; Observation Log 25%;** Quiz 10% No exams	**Teaching Idea binder and Fair:** "The assignment is for your permanent Staff Committee to create, over the 13 weeks of the course, a real "3-ring binder" of ideas you can use in student- or real teaching" **Observation log:** "A psychological observation log from your three weeks in the schools in November. Your task is to record your observations of as many as possible events or actions."
2 IBI	Welcome Letter or Inclusion Manifesto (15%); Discussion Questions/Participation (10%); Article Review (20%); **Resource Fair/Poster Session (25%);** Class Assignments (30%) -Lesson Plan activity (15%), I.E.P. activity (15%); No exams	**Resource Fair/Poster Session** "A group (max 2 persons) or an individual presentation of a resource for inclusive education." "Presentation stations will be organized so that presenters will be available for questions during a specific time frame."
3 IBI	**Three case studies (Group) 15%**; **Lesson Plan & Fair 20%**; Concept Map (Individual/Group) 10%; Two Article reviews 20%; Quiz 20%; Participation and Attendance 15%; No exams	**Three case studies (Group)** "The case study is designed to help inform your decisions about everyday teaching practices based on educational psychology theories. Your group will be working on six real cases that other teachers or parents have actually encountered in their teaching or parenting. . . . In your group, discuss the case and come up with the best possible solution that you can think of, based on what you have learned from the course to date. You need to justify your solution with theories and principles of educational psychology." **Lesson Plan & Fair** "At the end of the term, we will have the Lesson Plan Fair and Awards. Students will display what they have created throughout the course and exhibit as well as circulate the room to look at others' work. At the end of the day, we will nominate and vote for the best lesson plan. A peer evaluation rubric will be provided."
4 IBI	Response to Readings (Individual) 20%; Response to Guests (Individual) 20% **Building a Personal Discipline Program (Individual) 25%;** **Building a Discipline Profile (Group) 25%;** Attendance and Participation 10%; No exams	**Building a Personal Discipline Program (Individual)** "Drawing from readings, discussions, class lectures, presentations, in other words a synthesis of both this course and the ongoing Field Experience, you will describe the personal management/discipline approach that you feel best for yourself and the diverse students that you teach." "Describe a difficult discipline situation that you have either witnessed or personally encountered. Write a short critique of how it was handled." **Constructing a Discipline Profile (Group work):** Written component: "construct a discipline approach from their text and journal readings and their ongoing experience in the classroom." Group presentation: "Each presentation will be orchestrated by the group itself, and decisions, for example, regarding visuals, methods, exercises, activities etc. are left to the group's discretion"
5 IBI	**Response to Readings (Individual) 20%;** **Response to Guests (Individual) 20%** **Building a Personal Discipline Program (Individual) 25%;** **Building a Discipline Profile (Group) 25%;** Attendance and Participation 10%; No exams	**Building a Personal Discipline Program (Individual)** "Drawing from readings, discussions, class lectures, presentations, in other words a synthesis of both this course and the ongoing Field Experience, you will describe the personal management/discipline approach that you feel best for yourself and the diverse students that you teach." "Describe a difficult discipline situation that you have either witnessed or personally encountered. Write a short critique of how it was handled." **Constructing a Discipline Profile (Group work):** Written component: "construct a discipline approach from their text and journal readings and their ongoing experience in the classroom." Group presentation: "Each presentation will be orchestrated by the group itself, and decisions, for example, regarding visuals, methods, exercises, activities etc. are left to the group's discretion"
6 IBI	**Lab questions & Group project (paper or WebCT) 30%**; Participation in lab 10%; Participation in lecture and on WebCT 10%; Mid-term exam 20%; Final exam (cumulative) 30%	**Lab questions** "Following each lab there will be a small number of questions to answer. These will either be listed in your Lab Manual or posted on WebCT, and they are due by the beginning of your next lab session." **Group project** "Groups will be formed in lab to develop a 5E lesson to use with elementary students. The lesson topic must be relevant to the QEP, and it must help students understand a Big Idea of science."
7 IBI	Written assignments: 1) **Development of learning targets (Individual) 10%;** 2) **Development of a test (Group) 15%; Development of a performance assessment (Group) 20%; Assessment and grading plan (Individual) 10%;** Four In-class peer assessment exercises 12% (4% each) Three Online quizzes 33% (11% each)	No evidence available
8 IBI	Reading Responses (30%); **Thematic Unit Project Proposal, Development, Presentation & e-Portfolio 60%);** Participation (10%); No exams	**Thematic unit:** "planning of the cross-curricular content of the unit. The unit must include two lesson plans and an inquiry project that are linked to them." **e-Portfolio** "General goals … related to your own education & career)
9 IBI	**Journal 40%; Lesson Plans 30%**; Web Quest 10%; PDS Reflection 20%; No exams	**Journal** "Moon watch" activity: "Continue until you can no longer see the moon at the time you selected. Maintain a log of your daily observations. Observations should be detailed enough to enable you to identify 3 patterns."

(*continued on next page*)

Table 3 (*continued*)

Instructor	Academic tasks[a]	Description of inquiry-based activities
		Lesson Plans "Shadow watch" activity, Obtaining a soil sample for soil and sand analysis, Seed planting, "Analysis of website lesson plans," "Misconception project."
10 IBI	**Analysis of childhood paper**; **Observation paper proposal and evaluation form**; Quizzes and discussion assignments.	**Analysis of childhood paper**; **Observation paper proposal and evaluation form** Childcare center observation (5 h, 5 visits) Classroom observation (K-6 public schools)
11 IBI	Class participation 10%; Annotated bibliography and study guide 20%; **Curriculum module 35%**; Midterm exam 20%; Final exam 15%	**Curriculum module** "Create a literature based curriculum module to be implemented in the classroom."
12 IBI	Response papers 20%; Active participation (discussion, questions and reading responses and notes) 10%; **Analysis paper 20**%; Final (Grand Debate) 30%; Two take home exams 10%; Mid-term 10%	**Analysis paper 20**% (Field experience/Classroom experience discussion) "After completing 15 h in the classroom you should write a narrative report summarizing, in a reflective manner your observations and experiences in the classroom. You will develop two drafts, which will be discussed with your groups for feedback."
13 Non-IBI	Class and online group discussion 10%; 2 Interpretive Reflections 20%; Concept Map 10%; Group Presentation (Rationale-Design-Teaching) 15%; Final Project (Design-Rationale-Reflection) 15%; 3 Exams 30%	No evidence available
14 Non-IBI	Web assignment#1 Lexicon of Learning–5 marks; Web assignment#2 Multiple Intelligences and Learning Styles–10 marks; Web assignment#3 Disciplinehelp.com–5 marks; Web assignment#4 Motivation–10 marks; Group assignment#5–5 marks; Article Review–10 marks; Class Presentation–25 marks; Quiz#1–20 marks; Quiz#2–10 marks	No evidence available
15 Non-IBI	**Research paper (or option) 30%** ; Library experience 5% ; 2 examinations 40%; 5 Short quizzes 25%	**Research paper**[b] "The student must: (a) choose a topic that it within a SPECIFIC area of educational psychology, (b) consult and review 10 to 15 research studies, (c) summarize the research findings, and (d) formulate conclusions from the existing research findings presented."
16 Non-IBI	**Research paper 30%** ; Library experience 5%; 4 Reading responses 20% ; 4 examinations each 10% (40%)	**Research paper**[b] "The student must: (a) choose a topic that it within a SPECIFIC area of educational psychology, (b) consult and review 10 to 15 research studies, (c) summarize the research findings, and (d) formulate conclusions from the existing research findings presented."

Notes.
[a] Tasks in **bold font** are inquiry- or project-based.
[b] In this type of paper students do not originate their own questions.

4.5. Instructional dimension 5: roles of teachers and students

An important difference between IBI and non-IBI instruction is the number and quality of roles teachers and students play during course enactment (Aulls & Ibrahim, 2012; Aulls & Shore, 2008; Spronken-Smith et al., 2008; Syer, Chichekian, Shore, & Aulls, 2013). Roles reflect social and cognitive responsibility for learning in a classroom, and whether scaffolding of instruction is occurring. When teachers' or students' roles change during a course, so does the balance of responsibility for completing academic tasks. Students obtain higher marks in IBI education courses when they expect the teacher and students share responsibility for learning (Aulls & Shore, 2008).

Table 4 shows the categories and the frequencies for roles undertaken by all instructors and the students, derived from lesson videorecordings and instructor interviews. Both IBI and non-IBI instructors included these nine roles: questioner, commentator, explainer, humorist, listener, manager, note taker, reasoner, and role player. Seven roles occurred exclusively in IBI instructors' classes and interviews: observer, caregiver, collaborator, facilitator, modeler, summarizer, and paraphraser. Non-IBI instructors revealed two unique roles: pair-share and resource provider. When prompted, none of the non-IBI instructors expected their roles or the students' to change during their course, but 11 of the 12 IBI instructors expected the teacher's and students' roles to change in emphasis or kind. The differences in role-change or diversification expectations were associated with the quality of the unique roles each group described. The numbers of instructor and student roles were considerably larger for IBI courses.

Listener and synthesizer of discussion ideas roles arise from coconstruction of the classroom and together imply ways to scaffold learning. Planning and providing opportunities for, or facilitating, what students intend to do can occur without student classroom interaction. In non-IBI classes, facilitating was done relatively more often through explaining and giving directions. In IBI classrooms, proportionately more time was spent in student-led, small-group activities and classroom discussion; teacher's listening and synthesizing offered more opportunity for scaffolding and inquiry.

Everyday ways of doing and knowing that become shared reflect classroom culture (Geertz, 1973; Heath, 1982; Weade & Green, 1989). In IBI classes, students were shown how to question, respectfully challenge others' ideas, challenge themselves, communicate what they did or did not understand, and share responsibility. They learned academic ways of knowing and the nature of knowledge in each subject. This inference was supported only by IBI instructors in reference to the importance of their roles in students' learning.

Both IBI and non-IBI instructors valued students becoming more independent and autonomous learners through course participation, as Spronken-Smith et al. (2012) noted among IBI instructors across disciplines, but only non-IBI instructors expected students' to accomplish this by themselves. Unique IBI instructor roles, and their expectation that instructor and student roles will evolve during a course, suggested that they attempt simultaneously to help students learn how to learn and to scaffold students' social and

Table 4
Observed roles enacted by Instructors (I) and Students (S).

Roles		IBI instructors (1–12)												Non-IBI instructors (13, 14, 16[a])			Total IBI	Total Non-IBI
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	16		
Brainstormer	I																0	0
	S	√	√														2	0
Caregiver	I	√	√		√	√	√		√	√			√		√		8	0
	S		√							√							2	0
Collaborator	I		√				√		√	√		√		√			5	1
	S	√	√						√			√	√				5	0
Commentator	I	√		√				√	√		√	√		√	√		6	2
	S	√	√	√		√			√			√	√	√	√	√	7	3
Discusser	I				√	√					√						3	0
	S	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	12	3
Evaluator	I	√													√		1	1
	S																0	0
Explainer	I	√	√	√	√	√	√	√	√	√	√		√		√	√	11	2
	S	√	√			√		√			√	√	√	√	√		7	2
Facilitator	I	√	√				√	√		√		√	√				7	0
	S																0	0
Humorist	I	√	√			√					√		√			√	5	1
	S	√	√			√								√			3	1
Listener	I	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	12	3
	S	√	√	√	√	√	√	√		√	√	√	√	√	√	√	11	3
Manager	I	√	√	√	√		√		√			√		√			7	1
	S																0	0
Modeler	I		√				√		√			√	√				5	0
	S																0	0
Note Taker	I		√														1	0
	S			√			√	√	√	√					√	√	5	2
Observer	I	√	√	√		√		√		√	√	√					8	0
	S																0	0
Organizer	I	√	√		√	√	√	√	√		√	√	√	√	√	√	10	3
	S																0	0
Paraphraser	I	√	√						√		√	√	√				6	0
	S																0	0
Pair-Share	I																0	0
	S													√	√		0	2
Presenter	I																0	0
	S			√	√		√					√	√	√		√	5	2
Questioner	I	√	√	√	√	√	√	√	√	√	√	√	√		√	√	12	2
	S	√	√		√		√	√	√	√		√		√		√	8	2
Reader	I																0	0
	S	√											√				2	0
Reasoner	I					√		√		√		√		√	√	√	4	3
	S																0	0
Resource Provider	I															√	0	1
	S																0	0
Reviewer	I	√					√			√							3	0
	S																0	0
Role Player	I																0	0
	S	√	√											√	√		2	2
Summarizer	I						√	√				√					3	0
	S	√							√	√		√					4	0
Synthesizer	I						√					√					2	0
	S																0	0
Writer	I	√		√							√	√					4	0
	S		√														1	0
Total Roles	I	14	13	7	7	9	12	9	10	9	10	14	9	6	7	7		
	S	12	11	5	4	5	5	6	7	6	4	8	7	10	5	6		

Note.
[a] We did not observe Non-IBI instructor#15 in class.

cognitive activity.

4.6. Instructional dimension 6: academic evaluation

All non-IBI syllabi specified both midterm and final examinations, and assigned these a major proportion of the course grade, signaling that the end goal students must fulfill is to pass the examinations by memorizing and recalling the facts, concepts, and relationships among concepts in the course-assigned readings and lectures. No IBI instructor used both midterm and final examinations as the primary learning measures. No non-IBI course weight was given to (a) active participation throughout the course, (b) learning how to inquire in a discipline, (c) thinking processes common to experimentation or investigation such as identifying a research question or evaluation and interpretation of evidence, or (d) social and cognitive strategies entailed in solving ill-structured problems over extended time.

IBI assessment practices encouraged and rewarded regular class

participation. All IBI instructors asked students to engage in projects and shorter academic tasks throughout the course. Table 3 summarizes the projects from the course outlines. Credit for participation and shorter activities might lower student anxiety about expectations to be active in coconstruction of each class in a course, and taking on more academic risks, roles, and responsibilities as part of engaging in projects or investigations that also are prominent in evaluation requirements. A consequence of empowering students to take a consistently more active role in coconstruction of learning is that they must be more active than in non-IBI courses. Misalignment of learning goals and assessment tools could be especially devastating in an IBI approach to learning and instruction due to the risk and ambiguity inherent in the inquiry process. In non-IBI courses, formal evaluations were unambiguous and clearly communicated that all students were accountable for information, concepts, and ideas presented, however, non-IBI students might be able to memorize enough information and concepts to pass examinations without connecting much of their new to prior knowledge.

5. Discussion, conclusions, and implications

5.1. Evidence of differences between IBI and non-IBI courses

IBI and non-IBI education instructors provided qualitatively different interview descriptions of the most important instructional practices for undergraduate courses. IBI instructors' planning was more thorough and not directly tied to a textbook. They scaffolded their courses through activities and evaluation of student learning. Instructor and student roles supported students as active social and cognitive participants, and provided opportunities for students to gradually accept more responsibility for what and how they learned. This claim was supported by triangulated evidence from the roles, discourse, and activity dimensions of instruction.

No previous study of undergraduate preservice teacher-education courses has empirically distinguished what dimensions of IBI and non-IBI instruction differ as implemented across a wide range of courses. The Anderson-Burns (1989) instructional dimensions differentiated undergraduate education courses in which IBI is used or not. Furthermore, the model's six dimensions allow teachers to self-assess how they might gradually transform a non-IBI approach into an IBI approach to teaching, addressing one dimension at a time: (a) subject matter, (b) activity demands, (c) instructional format, (d) grouping, (e) time allocation and pacing, and (f) teacher and student behaviors and interactions.

Triangulation of interview, classroom-observation, and analyses of course-syllabi data consistently indicated that, for courses designed to programmatically confer complex professional knowledge and skills, IBI education instructors perceive IBI to be part but not all of each of the content taught, course task or activity demands, or the system to evaluate students' learning. This finding is new among qualitative investigations. Perhaps other qualitative studies are about undergraduate courses and disciplines other than education and in which students hold different professional goals.

IBI is part of the repertoire of instructional approaches that promote student learning most broadly and in which students learn how to become scholars in their discipline. Some dimensions of instruction consistently recurred in the IBI courses but did not occur in any non-IBI course:

1. students undertook projects within a course;
2. instructors carefully planned student's active participation and did not rely on a textbook;
3. instructors and students play at least six different roles in order to construct the events of a class in a way that offers scaffolding of student learning and shifts responsibility for learning to the students;
4. the proportion of time spent by the teacher and by students verbally interacting as a whole class or in small groups shifts toward students; and
5. the design of an IBI course includes typically five or six assignments that are evaluated and aggregated rather than a total course grade based solely on midterm and final examinations; this allows regular weekly feedback on student accomplishments, varied activities supporting particular kinds of inquiry experience, and credit given for sustained student participation.

Dimensions consistently present in non-IBI instruction were:

1. instructors spend the majority of class time giving explanations or directing students to respond to their own or experts' thinking;
2. students spend more time passively participating due to the absence of small-group activities; and
3. students are not asked to demonstrate what they know except on midterm tests and final examinations.

None of the self-identified non-IBI instructors used an inquiry approach to instruction, based on classroom observation, teaching practices instructors deemed most important, quality of their perception of how to plan instruction, and the disproportionate allocation of class time to teacher lecturing and student note-taking. This outcome supported the initial decision to purposively sample instructors on the basis of self-designation as employing an IBI or non-IBI approach, and supported their self-categorizations.

Non-IBI instruction puts the teacher and the content in the center of what happens in courses. IBI instruction places the student and the learning process in the center.

5.2. Relationship of findings to other higher education research

Whether the learner and learning process versus the instructor and the content are the main foci of what happens in university classes bears a strong and welcome resemblance to student-centered or teacher- and content-centered instructors (e.g., Kember, 1997). However, the student-centered literature is about teacher beliefs or conceptions whereas IBI focuses on the enacted curriculum. An inquiry-oriented instructor is necessarily student-centered, and also has dispositions, knowledge, and skills to implement IBI.

Our findings align with higher-education research that compared how education instructors differ from instructors in other disciplines. Ballantyne, Bain, and Packer (1999) surveyed 708 professors in 10 disciplines from a representative sample of Australian universities; 89 were educators. Participants nominated by their department chairs described in writing their most exemplary teaching experiences, the context for these practices, how they monitored student practice, how they improved their instruction, and their overall views of teaching and learning. Education professors least often of all mentioned lectures, consistent with their overall disciplinary responsibility to teach and model instructional practices appropriate at least to elementary and secondary schools (we propose also undergraduate education). Teaching methods most often cited as exemplary practices were: (a) cooperative or collaborative learning (e.g., Abrami et al., 1995; Kagan, 1994; Qin, Johnson, & Johnson, 1995; Schermerhorn, Goldschmid, & Shore, 1975; Schermerhorn, Goldschmid, & Shore, 1976), (b) experiential learning (Kolb, 1984), and (c) self-directed learning (Piskurich, 1993). In our study, small-group instruction and self-directed learning through projects distinguished IBI from

non-IBI courses. Case studies were also mentioned by Ballantyne et al. (1999) as exemplary teaching methods; only IBI instructors included case studies among the activities.

Our data suggested more diversity among education instructor's instructional strategies than Ballantyne et al. (1999). IBI instructors' quality of planning and curriculum design were richer and more extensive than non-IBI instructors'. As with Ballantyne et al., our data suggested several underlying, pervasive themes. All IBI instructors appeared to sufficiently value students' perspectives to provide frequent opportunities to engage in academic conversations with the instructor and each other in class. IBI course planning and enactment fostered students as active learners inside and outside the classroom. In IBI courses there was more whole-class discussion, small-group work, and student engagement in independent and collaborative learning projects; projects were dispersed and entailed at least four weeks to complete during the 13–15 weeks of one semester. Projects did not occur in non-IBI courses.

Spronken-Smith et al. (2008) identified several instructional dimensions critical to successful IBI in noneducation courses. Most essential was scaffolding instruction so students could become active inquiry participants. Both scaffolding and active student participation were supported in the current study within IBI. The present study also added precision to Spronken-Smith et al.'s observation that inquiry instructors favorably regarded students increasing their autonomy in learning. Non-IBI instructors expressed the same goal but only the IBI instructors took responsibility through the course design and how they enacted their curricula as a process in a class to help bring this about.

5.3. Implications

5.3.1. Future research on inquiry instruction in higher education

Courses in this study educated future teachers. Content included educational psychology, science instruction, mathematics instruction, inclusive education, language-arts instruction, and teaching English. IBI courses in this study resembled what the Boyer Commission (1998) described as inquiry-based learning in the first and second year of university:

> Inquiry-based learning enables students to take increasing control of their own learning as they progress through their degree programs. . . . It views students initially as active participants in the learning process, and once equipped with the right tools, as active participants in the investigation and analysis of problems, issues and evidence. (p. 17)

Even within our single IBI class observation per course, we often observed students using inquiry tools or strategies. However, due to the study's design, we did not observe every class in each course to determine what students actually learned through IBI instruction, if inquiry was consistently built into assigned activities across a sequence of classes, or how well learning outcomes were tied to evaluation procedures. However, students in non-IBI courses were not observed using inquiry tools or strategies.

Hua and Shore (in press) reported that first-year teachers struggle implementing inquiry instruction. This suggests that future research should employ longitudinal case studies or ethnographies to observe multiple classes in one course to determine (a) what happens when teaching inquiry knowledge and procedures to education students, (b) how it is done, and (c) if it makes a difference to what students learn and their motivation to incorporate inquiry into their own instruction as preservice then new teachers. A metasynthesis of existing qualitative research focused on classroom processes, and particularly case studies, is also needed to address these three topics.

Research in nonuniversity education settings suggests that case-study forms of IBI lead to distinctly different learning outcomes in higher-order thinking than open, structured, or guided inquiry instruction (Furtak et al., 2012). We found case-study inquiry used less frequently than projects to engage preservice teachers in learning about and conducting the process of inquiry. Future research should compare courses using projects and case studies to describe what students learn in each about how to teach content through IBI and how to teach elementary or secondary students to self-regulate the various inquiry-process skills.

Evidence for scaffolding learning was present in some of our IBI courses but not in any non-IBI course, supporting Spronken-Smith et al.'s (2008) prediction that scaffolding is necessary to IBI success in all disciplines. The extent to which scaffolding is taught, and what students learn about how to do it in preservice teacher education, has not yet been studied. Future mixed-design research should examine whether and how the quality and type of scaffolding varies from preservice to first-year teachers, and the consequences of these results for how to design successful undergraduate inquiry instruction.

5.3.2. Practice

Changing higher-education instructors' practices requires taking into account their knowledge, beliefs, and conceptions about teaching and their roles (e.g., Muis & Sinatra, 2008). As limited adoption of the Boyer recommendations demonstrated, this is a slow and challenging process. It involves further supporting instructors who already exhibit some inquiry in their instruction and identify themselves to some extent as inquiry-oriented, then–likely more challenging–approaching instructors who do not extensively use inquiry and do not so identify themselves. We cannot change instructors' earlier inquiry experiences nor prior conceptions of inquiry, but we might be able to influence their conceptions of what this has to do with teaching and learning in their courses through conversations among colleagues, and with students where possible, especially within disciplines. Part of this process could include clearly articulating the dimensions of the Anderson–Burns model of instruction and alternative ways to orchestrate them so their students can more actively engage in learning domain-specific concepts and how to inquire. This study clearly showed that IBI can take different forms when viewed through the broader lens of instruction (as defined) rather than teacher actions alone.

From an instructional-development perspective, the practical objective is to increase the amount of inquiry-based university instruction in all disciplines so that non-IBI instructors will (a) increase their pedagogical content knowledge to be able to teach through inquiry and (b) identify themselves as inquiry instructors.

Where do we start? Insights from the present study's outcomes suggest planning the course syllabus. Syllabus content might be driven by program requirements, but the instructor has considerable control and many choices about its delivery and often about some or all of the content. The professional-development strategy would be to offer a menu of a manageable number of activities and ways of using small groups, even within large classes, that are important and ubiquitous in inquiry-based instruction in higher education. Examples include the basic process of planning ahead, lesson-by-lesson, to outline not only content to be "covered" but how students can learn how to learn that content and become aware of how to use it, building upon qualities central, even if not always exclusive, to IBI. Second, the common or shared practices of the IBI courses we observed offered insights into what happens in IBI courses taught by education faculty. Their instruction commonly offered students the following opportunities: (a) Engage in purposeful dialog with each other about the content–this can be a few

minutes of side-to-side discourse to identify key concepts, explaining them to each other, or recalling additional examples from their experience; (b) expressing interests in the subject matter by offering choices in essay or project topics; (c) sometimes working in groups, not exclusively on their own, (d) diversifying their roles and engage in activities such as giving each other feedback about ideas and otherwise practicing evaluation elements; and (e) building into the curriculum decision points at which students can set some of the goals they should be accomplishing–for example a five-minute conversation in class, or an exchange on a course's electronic bulletin board.

As instructors become comfortable and practiced including some or all of the preceding opportunities in their courses, then systematically, but slowly, add dimensions of instruction we observed only in the IBI courses and that did not occur in any of the four non-IBI cases in our study: (a) Make student projects part of a course, (b) build the curriculum with resources beyond a core textbook, (c) identify multiple roles for the instructor and students in class events and together shift responsibility for learning from the instructor to students, (d) shift the proportion of teacher talk time spent versus students verbally interacting as a whole class or in small groups, and (e) base overall evaluation not just on midterm and final examinations but on multiple activities including inquiry-based events.

The identified instructional dimensions arose from the words and actions of 16 education instructors who each taught a teacher-preparation course. The unique IBI cases provided models for all university instructors to envision and learn how to become involved in IBI. For instructors already taking an inquiry-based approach to instruction as highlighted in this study, the results offer an opportunity to reflect on instructional dimensions that may be orchestrated by systematically varying properties of their own IBI course design and its enactment in the classrooms in which different contexts arise such as the class size or place in which the course is offered (e.g., classroom versus lecture hall).

Acknowledgments

This research was supported by grants from the Social Sciences and Research Council of Canada (1240211, the Fonds Québécois de la Recherche sur la Société et la Culture, and McGill University.

We thank all the professors who allowed us into their classrooms, Marcia A. B. Delcourt for arranging access to one of the universities, Diana Tabatabai for coordinating transcription and coding, Emma Lee for transcribing interviews, and Dawit Getahun for assisting with coding.

References

Abrami, P. C., Chambers, B., Poulsen, C., DeSimone, C., d'Apollonia, S., & Howden, J. (1995). *Classroom connections—Understanding and using cooperative learning*. Toronto, ON: Harcourt Brace.

Ai, R., Bhatt, M., Chevrier, S., Ciccarelli, R., Grady, R., Kumari, V., et al. (2008). *Choose your own inquiry*. Lanham, MD: University Press of America.

Alkaher, I., & Dolan, E. (2011). Instructors' decisions that integrate inquiry teaching into undergraduate courses: how do I make this fit? *International Journal for the Scholarship of Teaching and Learning, 5*(2). Article 9. Retrieved from http://digitalcommons.georgiasouthern.edu/ij-sotl/vol5/iss2/9.

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press. Retrieved from http://www.project2061.org/publications/bsl/online.

Anderson, R. D. (2002). Reforming science teaching: what research says about inquiry. *Journal of Science Teacher Education, 13*(1), 1–12. http://dx.doi.org/10.1023/A:1015171124982.

Anderson, R. D. (2007). Inquiry as an organizing theme for science curricula. In S. K. Abell, & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 808–830). Mahwah, NJ: Erlbaum.

Anderson, L. W., & Burns, R. B. (1989). *Research in classrooms*. Oxford, England: Pergamon Press.

Aulls, M. W. (2002). The contribution of co-occurring forms of classroom discourse and academic activities to curriculum events and instruction. *Journal of Educational Psychology, 94*, 520–538.

Aulls, M. W., & Ibrahim, A. (2012). Pre-service teachers' perceptions of effective inquiry instruction: are effective instruction and effective inquiry instruction essentially the same? *Instructional Science: An International Journal of the Learning Sciences, 40*, 119–139.

Aulls, W., & Pelaez, S. (2013). *Student Perceptions of the Impact of the IB Program and the Extended Essay on the Academic Demands of First Year in University*. Report to the International Baccalaureate Board Directors. July, 2013.

Aulls, M. W., & Shore, B. M. (2008). *Inquiry in education (Vol. I): The conceptual foundations for research as a curricular imperative*. New York, NY: Erlbaum (now Routledge).

Ballantyne, R., Bain, J. D., & Packer, J. (1999). Researching university teaching in Australia: themes and issues in academics' reflections. *Studies in Higher Education, 24*, 237–257. http://dx.doi.org/10.1080/03075079912331379918.

Ball, C. T., & Pelco, L. E. (2006). Teaching research methods to undergraduate psychology students using an active cooperative learning approach. *International Journal of Teaching and Learning in Higher Education, 17*, 147–154. http://www.isetl.org/ijtlhe/.

Barrows, H. S., & Tamblyn, R. (1980). *Problem-based learning: An approach to medical education*. New York, NY: Springer.

Biggs, J. (2003). *Teaching for quality learning at university: What the student does* (2nd ed.). Buckingham, England: Society for Research in Higher Education and Open University Press.

Boyer Commission on Educating Undergraduates in the Research University. (1998). *Reinventing undergraduate education: A blueprint for America's research university*. Stony Brook, NY: State University of New York at Stony Brook for the Carnegie Foundation for the Advancement of Teaching. Retrieved from: http://naples.cc.sunysb.edu/Pres/boyer.nsf/.

Boyer Commission on Educating Undergraduates in the Research University. (2001). *Reinventing undergraduate education: Three years after the Boyer report*. Retrieved from http://www.sunysb.edu/pres/0210066-Boyer%20Report%20Final.pdf.

Bredderman, T. (1983). Effects of activity-based elementary science on student outcomes: a quantitative synthesis. *Review of Educational Research, 53*, 499–518. http://dx.doi.org/10.3102/00346543053004499.

Brew, A. (2003). Teaching and research: new relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research and Development, 22*(1), 3–18. http://dx.doi.org/10.1080/0729436032000056571.

Chichekian, T., Hua, O., & Shore, B. M. (2013). Inquiring minds in undergraduate instruction: An expression of the teaching-research nexus. In D. J. Salter (Ed.), *Cases on quality teaching practices in higher education* (pp. 146–180). Hershey, PA: Information Science Reference (IGI Global), ISBN 978-1-4666-3661-3. Invited chapter in http://dx.doi.org/10.4018/978-1-4666-3661-3.ch010.

Cohen, S. A., & MacVicar, M. L. A. (1976). Establishing an undergraduate research program in physics: how it was done. *American Journal of Physics, 44*, 199–203. http://dx.doi.org/10.1119/1.10456.

Corbin, J. M., & Strauss, L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, CA: Sage.

Crawford, B. A. (1999). Is it reasonable to expect a preservice teacher to create an inquiry-based classroom? *Journal of Science Teacher Education, 10*, 175–194. http://dx.doi.org/10.1023/A:1009422728845.

Crawford, B. A. (2000). Embracing the essence of inquiry: new roles for science teachers. *Journal of Research in Science Teaching, 37*, 916–937. http://dx.doi.org/10.1002/1098-2736(200011)37:9<916::AID-TEA4>3.0.CO;2–2.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Crouch, C. H., & Mazur, E. (2001). Peer instruction: ten years of experience and results. *American Journal of Physics, 69*, 970–977. http://dx.doi.org/10.1119/1.1374249.

Dancy, M., & Henderson, C. (2008). Pedagogical practices and instructional change of physics faculty. *American Journal of Physics, 78*, 1056–1063. http://dx.doi.org/10.1119/1.3446763.

Davidson, J., & Bruce, B. C. (1993). *Inquiring about inquiry*. Urbana, IL: Center for the Study of Reading, Technical Report No. 588.

Dehann, R. L. (2005). The impending revolution in undergraduate science education. *Journal of Science Education and Technology, 14*, 253–269. http://dx.doi.org/10.1007/s10956-005-4425-3.

Devlin, M. (2006). Challenging accepted wisdom about the place of conceptions of teaching in university teaching improvement. *International Journal of Teaching and Learning in Higher Education, 18*, 112–119. http://hdl.handle.net/10536/DRO/DU:30006685.

Doyle, W. (1983). Academic work. *Review of Educational Research, 53*, 159–199. http://dx.doi.org/10.3102/00346543053002159.

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: a meta-analysis. *Review of Educational Research, 82*, 300–329. http://dx.doi.org/10.3102/0034654312457206.

Gebre, E., Soroyan, A., & Bracewell, R. J. (2014). Students' engagement in technology rich classrooms and its relationship to professors' conceptions of effective teaching. *British Journal of Educational Technology, 45*, 83–96. http://dx.doi.org/10.1111/bjet.12001.

Geertz, C. (1973). *The interpretation of culture*. New York, NY: Basic Books.

Gow, L., & Kember, D. (1993). Conceptions of teaching and their relationship to

student learning. *British Journal of Educational Psychology, 63*, 20–23. http://dx.doi.org/10.1111/j.2044-8279.1993.tb01039.x.
Handelsman, J., Miller, S., & Pfund, C. (2007). *Scientific teaching*. New York, NY: Freeman.
Healey, M., & Jenkins, A. (2009). *Developing undergraduate research and inquiry*. York, England: The Higher Education Academy. Retrieved from http://www.heacademy.ac.uk/assets/documents/research/DevelopingUndergraduateResearchandInquiry.pdf.
Heath, S. B. (1982). Ethnography in education: defining the essentials. In P. Gilmore, & A. A. Glathorn (Eds.), *Children in and out of school* (pp. 33–55). Washington DC: Center for Applied Linguistics.
Hua, O., & Shore, B. M. (in press). Chemistry professors' descriptions of the impact of research engagement on teaching. *Higher Education Research and Development*.
Justice, C., Rice, J., Warry, W., & Laurie, I. (2007). Taking an "inquiry" course makes a difference: a comparative analysis of student learning. *Journal on Excellence in College Teaching, 18*, 57–77.
Kagan, S. (1994). *Cooperative learning*. San Juan Capistrano, CA: Kagan Cooperative Learning.
Katkin, W. (2003). The Boyer Commission report and its impact on undergraduate research. *New Directions for Teaching and Learning, 93*, 19–38. http://dx.doi.org/10.1002/tl.86.
Kember, D. (1997). A reconceptualization of the research into university academics' conceptions of teaching. *Learning and Instruction, 7*, 255–275.
Kolb, D. A. (1984). *Experiential learning*. Englewood Cliffs, NJ: Prentice Hall.
Kurotsuchi Inkelas, K., Swan, A. K., Pretlow, J., & Jones, J. N. (2012). *Exploring the benefits of the International Baccalaureate extended essay for university studies at the University of Virginia*. Charlottesville, VA: Center for Advanced Study of Learning and Teaching in Higher Education. Retrieved from https://web7.ibo.org/es/research/policy/programmevalidation/diploma/documents/finalfullUVAIBreport10-18-12.pdf.
Lee, V. S., Hyman, M. R., & Luginbuhl, G. (2007). The concept of readiness in the academic department: a case study of undergraduate education reform. *Innovative Higher Education, 32*, 3–18.
Levy, P., & Petrulis, R. (2012). How do first-year university students experience inquiry and research, and what are the implications for the practice of inquiry-based learning? *Studies in Higher Education, 37*(1), 85–101. http://dx.doi.org/10.1080/03075079.2010.499166.
Loyens, S. M. M., & Rikers, R. M. J. P. (2011). Instruction based on inquiry. In R. E. Mayer, & P. A. Alexander (Eds.), *Handbook of research on learning and instruction* (pp. 361–381). New York, NY: Routledge.
Mayring, P. (2000). Qualitative content analysis. *Forum: Qualitative Social Research, 1*(2). Retrieved from http://www.utsc.utoronto.ca/~kmacd/IDSC10/Readings/text%20analysis/CA.pdf.
Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—What is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching, 47*, 474–496. http://dx.doi.org/10.1002/tea.20347.
Muis, K. R., & Sinatra, G. M. (2008). Universities' cultures and epistemic beliefs: examining differences between two similar countries. In M. S. Khine (Ed.), *Knowing, knowledge, and beliefs: Epistemological studies across diverse cultures* (pp. 137–150). Dordrecht, Netherlands: Springer.
National Research Council. (1996). *National science education standards* (7th ed.). Washington, DC: National Academies Press.
National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: National Academies Press. Retrieved from http://www.nap.edu/catalog/9596.html.
National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.
Organization for Economic Cooperation and Development. (2009). *Education at a glance 2009: OECD Indicators*. Paris, France: Author. Retrieved from http://www.oecd.org/edu/skills-beyond-school/educationataglance2009oecdindicators.htm.
Park Rogers, M. A., & Abell, S. K. (2008). The design, enactment, and experience of inquiry-based instruction in undergraduate science education: a case study. *Science Education, 92*, 591–607. http://dx.doi.org/10.1002/sce.20247.
Piskurich, G. (1993). *Self-directed learning: A practical guide to design, development, and implementation*. San Francisco, CA: Jossey-Bass.
Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: definitions, comparisons, and research bases. *The Research Journal for Engineering Education, 95*, 123–138. http://dx.doi.org/10.1002/j.2168-9830.2006.tb00884.x.
Qin, Z., Johnson, D. W., & Johnson, R. T. (1995). Cooperative versus competitive efforts and problem solving. *Review of Educational Research, 65*, 129–143. http://dx.doi.org/10.3102/00346543065002129.
Redden, K. C., Simon, R. A., & Aulls, M. W. (2008). Alignment in teacher education: Identifying contextually dependent student presage factors and associated learning outcomes. *Teacher Education Quarterly, 34*(3), 149–174.
Schermerhorn, S. M., Goldschmid, M. L., & Shore, B. M. (1975). Learning basic principles of probability in student dyads: A cross-age comparison. *Journal of Educational Psychology, 67*, 551–557.
Schermerhorn, S. M., Goldschmid, M. L., & Shore, B. M. (1976). Peer-teaching in the classroom: Rationale and feasibility. *Improving Human Performance, 5*(1), 27–34.
Schroeder, C. M., Scott, T. P., Tolson, H., Huang, T.-Y., & Lee, Y.-H. (2007). A meta-analysis of national research: effects of teaching strategies on student achievement in science in the United States. *Journal of Research in Science Teaching, 44*, 1436–1460. http://dx.doi.org/10.1002/tea.20212.
Schulz, R., & Mandzuk, D. (2005). Learning to teach, learning to inquire: a 3-year study of teacher candidates' experiences. *Teaching and Teacher Education, 21*, 315–331. http://dx.doi.org/10.1016/j.tate.2005.01.004.
Shymansky, J. A., Hedges, L. V., & Woodworth, G. (1990). A reassessment of the effects of inquiry-based science curricula of the 60s on student performance. *Journal of Research in Science Teaching, 20*, 127–144. http://dx.doi.org/10.1002/tea.3660270205.
Spronken-Smith, R., Bullard, J. O., Ray, W., Roberts, C., & Keiffer, A. (2008). Where might sand dunes be on Mars? Engaging students through inquiry-based learning in geography. *Journal of Geography in Higher Education, 32*(1), 71–86. http://dx.doi.org/10.1080/03098260701731520.
Spronken-Smith, R., & Walker, R. (2010). Can inquiry-based learning strengthen the links between teaching and disciplinary research? *Studies in Higher Education, 35*, 723–740. http://dx.doi.org/10.1080/03075070903315502.
Spronken-Smith, R., Walker, R., Batchelor, J., O'Steen, B., & Angelo, T. (2012). Evaluating student perceptions of learning processes and intended learning outcomes under inquiry approaches. *Assessment and Evaluation in Higher Education, 37*, 57–72.
Spronken-Smith, R., Walker, R., Dickinson, K. J. M., Closs, G. P., Lord, J. M., & Harland, T. (2011). Redesigning a curriculum for inquiry: an ecology case study. *Instructional Science, 39*, 721–735. http://dx.doi.org/10.1007/s11251-010-9150-5.
Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.
Stokking, K., Van der Schaaf, M., Jaspers, J., & Erkens, G. (2004). Teachers' assessment of students' research skills. *British Educational Research Journal, 30*, 93–116. http://dx.doi.org/10.1080/0141192030010001629983.
Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage.
Syer, C. A., Chichekian, T., Shore, B. M., & Aulls, M. W. (2013). Learning "to do" and learning "about" inquiry at the same time: Different outcomes in valuing the importance of various intellectual tasks in planning, enacting, and evaluating an inquiry curriculum. *Instructional Science, 41*, 521–537. http://dx.doi.org/10.1007/s11251-012-9242-5.
Volkmann, M. J., Abell, S. K., & Sgagacz, M. (2005). The challenges of teaching physics to preservice elementary teachers: orientations of the professor, teaching assistant, and students. *Science Teacher Education, 89*, 847–869. http://dx.doi.org/10.1002/sce.20077.
Vygotsky, L. S. (1978). *Mind and society: The development of higher psychological processes*. Trans. M. Cole. Cambridge, MA: Harvard University Press.
Weade, R., & Green, J. (1989). Reading in the instructional context: an interactional sociolinguistic/ethnographic perspective. In C. Emihovich (Ed.), *Locating learning across the curriculum: Ethnographic perspective on classroom research* (pp. 17–56). Norwood, NJ: Ablex.
Windschitl, M. (2002). Framing constructivism in practice as negotiation of dilemmas: an analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research, 72*, 131–175. http://dx.doi.org/10.3102/00346543072002131.
Windschitl, M. (2003). Inquiry projects in science teacher education: what can investigative experiences reveal about teacher thinking and eventual classroom practice? *Science Education, 87*, 112–143. http://dx.doi.org/10.1002/sce.10044.
Windschitl, M. (2004). Folk theories of "inquiry": how preservice teachers reproduce the discourse and practices of an atheoretical scientific method. *Journal of Research in Science Teaching, 41*, 481–512. http://dx.doi.org/10.1002/tea.20010.
Wray, D. (2013). *Student perceptions of the value of the International Baccalaureate extended essay in preparing for university studies*. Final report. Coventry, England: University of Warwick. Retrieved from http://www.ibo.org/research/policy/programmevalidation/diploma/documents/THEIBEXTENDEDESSAYPROJECT_finalreport_Wray.pdf.
Yin, R. K. (2003). *Case study research: Design and method* (2nd ed.). Thousand Oaks, CA: Sage.