# Investigating the effectiveness of short-duration workshops on uptake of inquiry-based learning

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Short-duration and long-duration professional development workshops on inquiry-based learning (IBL) were designed to increase participants' capacity to teach using IBL methods. This study used a sample of 66 participants in short-duration workshops (one day or less) and 199 from long-duration workshops (four days plus ongoing support) held from 2016-2019 to investigate the role of workshop duration in increasing IBL capacity, and in fostering uptake of IBL teaching practices. After participating in professional development, both short-duration and long-duration workshop participants reported comparable levels of IBL capacity—meaning the beliefs, knowledge and skills that prepare them to use IBL. However, short-duration workshop participants implemented IBL teaching practices less intensively than long-duration participants. These findings support the use of both short-duration and long-duration professional development as a means to increase instructors' capacity to use IBL and their adoption of IBL teaching practices.

Keywords: Inquiry-based learning, Professional development, Workshops, Teaching

# Introduction

Research-based instructional strategies (RBIS) have been shown to promote student learning and academic success in US undergraduate STEM education (Freeman et al., 2014; Ruiz-Primo, 2011). In undergraduate math contexts, a form of RBIS, inquiry-based learning (IBL), has been associated with positive student outcomes (Kogan & Laursen, 2014). However, use of RBIS by undergraduate STEM instructors is not common; approximately 20% use RBIS extensively (Stains et al., 2018; Eagan, 2016).

Prior research has shown that teaching-focused professional development (PD) can increase STEM college instructors' use of RBIS, including those of undergraduate mathematics instructors using IBL (Archie et al., 2021; Benabentos et al., 2020; Chasteen & Chattergoon, 2020; Manduca et al., 2017; Bathgate et al., 2019). The focus of these studies were long-duration PD experiences (e.g. multi-day workshops), rather than single instance "one-off" experiences. Duration has been identified as a "critical feature" of professional development (Viskupic et al., 2019), and research on PD in higher education settings has consistently demonstrated that PD is effective when it occurs over extended periods of time (Desimone, 2009; Allen et al., 2011; Ebert-May et al. 2015; Garet et al. 2001; Pelch and McConnell 2016; Postareff et al. 2007; Wilson 2013). A review of PD in higher education found that PD that takes place over an extended period of time results in more changes in instructor teaching practices than one-time PD activities (Stes et al., 2010). However, this review contained few studies focused on short duration, one-time events.

K-12 contexts also have shown similar findings. For example, Supovitz and Turner (2000) found that 40 hours or more of PD participation was needed to make a detectable impact on teachers' use of inquiry-based teaching practices. Other studies suggest ideas about teaching and

teaching practices change over time, rather than from "one-shot" workshops (Loucks-Horsley et al. 2009; Postareff et al. 2007). However, Kennedy's 1999 review of PD indicated that PD content was more strongly related to participant outcomes than duration.

While research indicates that long-duration PD is effective in generating change to teacher practice, few studies have shown that short-duration workshops were less effective in doing this, thus more research is necessary to determine the importance of duration in PD. This study addresses this gap by investigating the outcomes of short-duration IBL workshops for undergraduate math instructors. In this study, we compare short workshop findings to those from long workshops, which have been shown to be effective in increasing math instructors' capacity to use IBL and to increase their use of IBL methods (Archie et al.; 2021). Specifically, this study sought to answer the following research questions:

RQ1: Do short-duration workshop participants report the same gains and levels of IBL capacity (attitudes, knowledge, and skill) as long-duration workshop participants?

RQ2: Do short-duration workshop participants implement and use IBL teaching practices to the same degree as long-duration workshop participants?

## **IBL** workshop description

Long-duration workshops are an established, research-supported method of professional development for instructors to learn to use IBL. Participants travelled to workshops that occurred over four consecutive days, utilized consistent content and format, and featured ongoing support from workshop leaders and peers following the workshop (see Hayward & Laursen, 2018; Yoshinobu et al., 2021 for a full description of the long duration workshops). Long-duration workshops have been shown to increase participants' capacity to use IBL methods and subsequently, increase their use of IBL teaching practices (Archie et al., 2021).

Short-duration workshops were designed to complement long-duration workshops. Both models serve as professional development opportunities for mathematics instructors to learn about IBL and increase participants' capacity to use IBL teaching methods. The short workshops were intended to provide an introduction to IBL, while the more in-depth, long-duration workshops provided an implementation-focused experience. In both long and short workshops, leaders modeled IBL techniques through their facilitation. For example, leaders asked participants to engage in Think-Pair-Share activities to help participants understand how to use this technique in their own classrooms. Short and long-duration workshops were planned and led by the same facilitators. Between 2017 and 2020, the project supported 26 short workshops reaching at least 500 participants. The workshops were between 1-8 hours in length and were held at various institutions across the country, including two- and four-year colleges and sessions held at professional development conferences of the MAA and AMATYC. Short workshop content was non-standardized and varied by audience and facilitator preference, but most workshops provided a general introduction to IBL. A few workshops emphasized enhancing specific skills, such as assessment techniques, facilitating discussions, and generating classroom materials, and one centered on a particular student audience, instructors of pre-service elementary teachers. The primary goals of the short workshops were to: increase awareness of IBL methods, enhance component skills of IBL, recruit new audiences of faculty into IBL teaching, reach departments or groups not yet active in IBL, and offer an "on-ramp" to IBL practice.

## Methods

## **Data collection**

Long-duration workshop participants completed a pre-workshop survey about one month before their workshop, a post-workshop survey immediately after, and a follow-up survey about 18 months later. Of 293 long-duration workshop participants from 2016-2019, 291 (99%) completed the pre-workshop survey, 275 (94%) completed the post-workshop survey and 199 (68%) completed the follow-up survey.

Short-duration workshop participants completed a brief post-workshop survey immediately following the workshop. In all, 328 post-survey responses were collected from an estimated 470 participants from 24 workshops, for an overall response rate of 70%. A more extensive follow-up survey about IBL implementation was sent in late 2020 to all participants who provided contact information when they attended the short-duration workshops from 2017-2020 (n = 270). Sixty-six follow-up survey responses were collected for a response rate of 25%. While the response to the post-survey was high (70%) and likely representative of the workshop population, the follow-up survey had a lower response rate (25%) and cannot be considered representative. Moreover, the follow-up was sent to all workshop participants in late 2020, so there was variability in the time between workshop attendance and follow-up, ranging up to 3 years. Given this response rate, the high reports of IBL implementation in particular may be skewed due to non-response bias where the follow-up survey respondents are likely those participants who were most interested or enthusiastic about IBL.

# Measures

Measures of IBL capacity were used to answer RQ1 and are indicators of short-term outcomes resulting from workshop participation. Measures of IBL capacity include participants attitude about IBL, their knowledge of IBL, and their skill using IBL. Short- and long-duration workshops used identical measures of IBL capacity attitude, knowledge, and skills on follow-up surveys and on long workshop pre and post surveys. As a measure of IBL attitude we asked "To what extent do you believe inquiry strategies are an effective learning method?" and was measured on a four-point scale (1 = Don't know, 2= Not very effective, 3= Somewhat effective, 4 = Highly effective). IBL knowledge and skill were measured with similar separate measures which asked "How would you rank your current level of knowledge/skill in inquiry-based teaching" with both items sharing the same four-point response options (1=None, 2=A little, 3=Some, and 4=A lot). Thus, we can directly compare levels on these items at the follow-up timeframe and can compute gains for long workshop participants by comparing rankings across each interval.

Since short workshop participants did not complete a pre-survey, we instead asked them to rate their perceived gains in IBL attitude, knowledge, and skills on the post-workshop survey using a four-point scale (1= A lot less, 2= Less, 3=About the same, 4= A little more, 5= A lot more).

To answer RQ2, we directly measured short and long workshop participants' self-reported implementation of IBL and, as an indirect measure of their implementation of IBL, their self-reported teaching practices. On short and long workshop follow-up surveys, we asked respondents to self-report their implementation of IBL methods by asking "Have you implemented an IBL course since the workshop?" with the following response options: "No; Not a fully IBL course, but applied some approaches; Yes, one IBL course; Yes, more than one IBL course". Separately, we asked long workshop participants on the pre-workshop survey, and both short and long workshop participants on a follow-up survey, to indicate their frequency of use of

11 teaching practices using the following scale: 1= never, 2= once or twice during the term, 3= about once a month, 4= about twice a month, 5= weekly, 6= more than once a week, or 7= every class. As described in Hayward et. al, (2016), five teaching practices are classified as 'core IBL' practices because they characterize all variations of IBL that were emphasized in workshops: decreased use of instructor activities, including lecture and instructor problem-solving on the board, and increased use of student activities, especially student presentations of their own work and student discussion in small groups or as a whole class.

#### Data analysis

To answer RQ1 we computed frequencies of short workshop participants who reported gains in IBL attitude, knowledge, and skills in the post-workshop survey. For comparative purposes, we computed frequencies of the long-duration workshop participants who reported gains in IBL attitude, knowledge, and skills from pre-workshop and post-workshop surveys. We also calculated means of IBL attitudes, knowledge, and skill of short and long workshop participants from their respective follow-up surveys. We conducted an independent samples t-test to check for differences in follow-up survey IBL capacity measures by workshop duration.

To answer RQ2 we computed IBL intensity scores for each instructor based on their selfreported frequencies of the five core teaching practices as follows: IBL intensity= student group work + student presentation + class discussion - lecture - instructor solving problems. IBL intensity scores were computed at the follow-up time point for both short- and long-duration workshop participants. We conducted an independent samples t-test to check for differences in intensity of use of IBL teaching practices by workshop duration.

#### Results

To answer RQ1, we compared the proportion of report gains in IBL capacity measures by workshop duration. As shown in Figure 1, a majority of both short and long duration workshop participants reported gains in all three IBL capacity measures (attitude, knowledge, skill). Since we measured and calculated gains differently across workshop types, it was not appropriate for us to make direct statistical comparisons of gains in IBL capacity. However, it is evident that the relative gains in capacity (attitude, skill, and knowledge), are the same for both short and long workshops; that is, the greatest gains are in IBL knowledge followed by skill and IBL attitude.



Figure 1. Proportion of workshop participants who reported gains in IBL capacity measures by workshop duration

Also addressing RQ1, we conducted an independent samples t-test to check for differences in mean IBL capacity reported by workshop participants in respective follow-up surveys. Descriptively, short workshop participants reported lower mean IBL capacity than did long workshop participants (Table 1). However, the only statistically significant difference in the individual indicators that make up IBL capacity was in IBL attitudes, and the effect size indicates that this difference was minimal. We found no statistically significant differences in either IBL knowledge or skill by workshop duration.

Short workshop Long workshop (n = 53)(n = 189)SD SD **IBL** Capacity М М d t (df = 240)р Attitude **3.59** 0.50 3.71 0.51 -2.960.003 0.23 Knowledge **2.96** 0.65 3.24 0.61 -1.54 0.126 0.46 Skill **2.64** 0.74 2.80 0.64 -1.49 0.137 0.24

Table 1. t-test of mean IBL capacity follow-up measures by workshop duration

Note: d = cohen's d and is a measure of effect size.

To answer RQ2, we compared the proportions of participants who implemented IBL methods by workshop duration. As shown in Table 2, we found that a higher proportion of short workshop participants (19%) did not implement IBL than long-duration workshop participants (5%). A greater proportion of long workshop participants (29%) reported implementing IBL in one fully IBL course than did short duration workshop participants (13%).

	Workshop duration	
IBL implementation	Short ( <i>n</i> = 62)	Long ( <i>n</i> = 199)
No	19.4%*	4.5%*
Not a fully IBL course, but have applied some IBL approaches	53.2%	44.2%
Yes, one fully IBL course	12.9%*	29.1%*
Yes, more than one fully course	14.5%	22.1%

Table 2.Proportion of workshop participants who implemented IBL methods by workshop duration

\* short and long workshop proportions differ at  $p \leq 0.05$ 

RQ2 was also answered by comparing participants' intensity of use of IBL teaching practices after participating in their respective short or long workshops. An independent samples t-test indicated that average intensity scores after long workshops (M = 7.87, SD = 5.44) were significantly higher, (t(226) = 2.71, p = 0.007), than the IBL intensity scores after short workshops (M = 5.43, SD = 4.37. The effect size (Cohen's d = 0.46) indicated a moderate difference in the use of IBL teaching practices between long and short workshop participants.

#### Discussion

Both the long workshops and short workshops were designed to increase participants' capacity to use IBL teaching methods, and our findings suggest that short and long workshops may be effective in doing so. This study provided the opportunity to compare workshops that are driven by a shared philosophy and led by the same facilitators, but with different durations. However, the limited sample of short-workshop follow-up survey respondents (discussed in detail in the final section) provide a sense of the possible outcomes from short-duration workshops, while the robust sample of long-duration workshop participants provides a generalization of the typical outcomes from long-duration workshops. Therefore, direct comparisons of short and long workshops should be interpreted with caution.

Both short and long workshop participants reported the same pattern of gains in the three individual IBL capacity measures. The lowest gains by both groups were in IBL attitude; participants self-selected to participate and thus many participants already had a positive attitude about IBL, so their gains were small. Both short and long workshop participants reported higher gains in IBL knowledge than in skill. This is a logical finding considering that skills take time and practice to develop. Overall, both workshops seem to be improving participants' capacity to use IBL methods in a consistent way.

The lack of statistical and/or meaningful differences in follow-up measures of IBL capacity by workshop duration were unexpected and are inconsistent with prior research which has shown that long duration PD is more strongly related to outcomes than short duration PD (Stes et al., 2010). We expected that, in short workshops, the limited time participants had to acquire IBL knowledge and skill would translate into lower gains in IBL capacity than from long workshops. This finding is likely due to the small, and likely biased, sample of short workshop participants who completed a follow-up survey.

Findings related to RQ2 indicated that short duration workshop participants implemented IBL teaching practices to a lesser degree than long workshop participants. About 20% of short workshop participants who responded to the survey did not implement any IBL teaching practices, and a greater proportion of long workshop participants implemented one course they considered to be fully IBL. Follow-up reports of IBL intensity also showed that short workshop participants used particular IBL methods less intensively than long duration participants. These findings are consistent with prior research, which has shown that long duration PD is positively associated with changes in teaching practices (Stes et al., 2010). These findings were expected given that the long workshops were IBL implementation-focused: they used a consistent structure designed to meet implementers' needs, and they allowed participants work time to plan their own IBL course. Long duration workshop participants committed to four days, so they had a prior high level of commitment to implement IBL. Short workshops were less implementation focused; rather, they focused on creating broader awareness of IBL. Short workshops also required less participants commitment to implement IBL in their teaching and did not allow time for participants to plan how to implement IBL in their teaching.

#### Limitations and conclusion

While some aspects of these findings seem to support the efficacy of short workshops, several limiting factors of this research must be considered in interpreting these findings. The relatively small sample size from participants in short workshops (n = 66) is likely biased. Those short workshop participants who implemented IBL may have been more likely to respond to a follow-up survey than those who did not. Thus, the short workshop findings represent a best-case scenario for outcomes. They suggest that some participants respond to the workshops by implementing IBL methods in their own classrooms, but these findings should not be considered to be representative of all workshop participants.

While we measured pre workshop and follow-up IBL capacity and teaching practices, we did not collect corresponding measures for short-duration workshop participants (Archie et al., 2021). Since short-duration workshop participants were not required to pre-register, we were unable to administer a pre-workshop survey. This prevented us from knowing participants' initial levels of IBL capacity and their teaching practices before attending a workshop. Without this data, we can't be certain about how much short workshop participants gained and the degree to which their teaching practices changed. Although we can't know the outcomes for all participants of short workshops, these results suggest that for some participants, short workshops may be an effective way to build IBL capacity. Others have suggested that starting with less intense implementations and building over time may lead to more widespread adoption, a process known as "phased inquiry" (Yarnall & Fusco, 2014) or "trialability" (Rogers, 2003); one interpretation of the findings is that short workshop participants are moving through this process. And these results suggest that short workshops may serve as an effective "on-ramp" for instructors as they work towards full adoption of IBL teaching methods.

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