

Design and Evaluation of the I-SCAN Faculty POCUS Program

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Research article

Keywords: Point-of-care Ultrasound, Medical Education, Program Assessment

Posted Date: October 5th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-74923/v1>

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Version of Record: A version of this preprint was published on January 6th, 2021. See the published version at <https://doi.org/10.1186/s12909-020-02453-2>.

Abstract

Introduction

Point-of-care ultrasound (POCUS) is becoming widely adopted with increasing accessibility of courses. Little is known about the optimal design of the introductory course or longitudinal training programs that are critical to success.

Aim

To evaluate the effectiveness of a comprehensive hospitalist POCUS training program

Setting

Four hospitals at an academic medical center.

Program Description

The program consisted of a 2-day introductory course and a longitudinal phase comprising clinical POCUS practice, clip uploading with online feedback, hands-on teaching, and monthly ultrasound conferences. Assessments were performed immediately before and after the 2-day course and after one year.

Program Evaluation

Knowledge increased from baseline to post 2-day (median score 58% and 85%, respectively, $p < 0.001$) and decreased slightly at one year (median score 81%, $p = 0.012$). After the 2-day introductory course, the median score for hands-on image acquisition skills, the principal metric of learner success, was 75%. After one year, scores were similar (median score 74%). Confidence increased from baseline to post 2-day (1.5 to 3.1 on a 4 point Likert scale from Not at all confident (1) to Very confident (4), $p < 0.001$), and remained unchanged after one year (2.73). Course elements correlating with a passing score on the final hands-on test included number of clip uploads ($r = 0.85$, $p = 0.001$), attendance at hands-on sessions ($r = 0.7$, $p = 0.001$), and attendance at monthly conferences ($r = 0.50$, $p = 0.03$).

Discussion

The I-ScaN POCUS training program increased hospitalist knowledge, skill and confidence with maintained skill and confidence after one year. Uploading clips and attending hands-on teaching sessions were most correlative with learner success.

Introduction:

Point-of-care ultrasound (POCUS) is becoming widely adopted across the field of hospital medicine after becoming well established in fields with competency overlap such as Emergency Medicine and Pulmonary/Critical Care.^{1,2} The reduction in procedural complications, improvement in diagnostic accuracy, and an increase in provider and patient satisfaction has pushed POCUS expansion.³⁻⁷ In addition, the

availability of less expensive ultrasound devices and the increasing accessibility of training programs have facilitated the growth of POCUS within general medicine, both in the inpatient and ambulatory settings.^{2,8-10}

A 2013 survey of internal medicine program directors found that POCUS was considered valuable for diagnostic and procedural use and many residency programs had either adopted formal curricula or had planned to.¹¹ A similar study of UME leadership in 2014 reported general consensus that POCUS is an important skill worth teaching in medical school.¹² A recent position statement from the Alliance of Academic Internal Medicine recommended the integration of POCUS across the longitudinal training environment for UME, GME and CME in internal medicine.¹

However, the training of faculty has emerged as a key barrier to adoption into hospitalist groups.^{2,13-15} Published reports of comprehensive faculty POCUS training programs demonstrate immediate short-term gains as would be expected, however, there is limited data on durability of these gains.¹⁴⁻¹⁷ The CHAMP program reported that skills learned in the introductory course tended to wane over time, with participation in monthly scanning sessions/and or portfolio completion being associated with skill retention.¹⁴ The recent position statement issued by SHM advocates for attendance at a local or national hands-on training program, which should be followed by a longitudinal study phase with hands-on instruction.² Educational outcome data to guide faculty POCUS program development are lacking.

To address these concerns we developed and implemented the Integrated Sonography Course at NYU (I-ScaN), a longitudinal POCUS training program for hospitalist faculty. We describe the design, implementation and one-year outcomes of the first cohort of the I-ScaN program.

Methods:

Setting and Participants

The NYU Department of Medicine encompasses four teaching hospitals, NYU Langone Health (Tisch/Kimmel and Brooklyn campuses), Health + Hospitals/Bellevue, and the VA New York Harbor Health Care System/Manhattan. Each campus has a unique structure of teaching and non-teaching services and populations served. All physicians who identify as hospitalists at these sites were invited after being nominated by their directors.

Program Description

I-ScaN is a train-the-trainer program with the goal of developing a cohort of faculty proficient in POCUS who then can supervise the medical trainees. The program consists of four elements: 1. Introductory course including didactics, image interpretation and hands-on instruction; 2. Supervised practice with patients; 3. Competency assessment; 4. Skill maintenance and quality assurance.¹⁸ I-ScaN adheres to ultrasound applications and a training structure advocated by SHM.²

I-ScaN began with a period of self-study upon program registration, where participants were referred to relevant chapters from a POCUS textbook,¹⁸ online videos and selected articles to review. The self-study was

followed by an intensive 2-day course. The course consisted of didactic lectures reviewing theoretical concepts, interactive image-based sessions of interpretation and clinical integration, and hands-on training on human models. Systems covered in the course included cardiac ultrasound, lungs/pleura, abdomen, and leg vasculature.

Following the 2-day course, participants began the longitudinal portion of the program. Each participant was given access to an ultra-portable ultrasound device with the ability to upload ultrasound clips to a HIPAA-compliant website. Learners were advised to scan patients daily when on service and upload all clips, anonymized to avoid sharing protected health information, to secure servers allowing comments and expert review. For each uploaded clip, participants were asked to provide the anatomic site and a clinical interpretation. The clips were reviewed by an expert (HS) who provided online feedback on both of these domains. Participants used these clips to create a personal portfolio in accordance with national standards set by SHM.¹⁹

Hands-on teaching sessions were led by local experts, primarily Pulmonary/Critical Care faculty, with a 1:3 teacher to learner ratio. Sessions typically lasted one hour with the entire time spent at the bedside scanning a patient known to one of the learners. Each of the four hospitals arranged these sessions according to learner and teacher availability with the aim for weekly supervised scanning.

Ultrasound conference was held monthly with remote viewing capability. Led by the course director (HS), participants presented their clips along with prepared teaching points. Topics were rotated each month.

Assessments:

We sought to assess learner outcomes at multiple levels of Miller's Pyramid: basic ultrasound knowledge, application of this knowledge to patient care, demonstration of the technical skills of image acquisition, and integration of these new skills into everyday situations.²⁰ The timeline of program assessments is outlined in the Figure.

Attendance was recorded for monthly conferences, including those who joined remotely, and at hands-on teaching sessions at each site. Total number of uploaded clips was recorded for each learner.

We assessed participants' knowledge of basic ultrasound knowledge, image interpretation, and clinical integration using a 20-item online test. The same test was administered prior to beginning the program, at the conclusion of the 2-day course and again after one year. The test was given three times to first measure the impact of the 2-day course and then to assess for durability or decay of knowledge over the year.

We evaluated participants' POCUS skills using a hands-on test on human models that was proctored by faculty from the Pulmonary/Critical Care division. Skills were evaluated by the proctors, using a checklist adapted from the CHEST Certificate of Completion program.²¹ The hands-on assessment was rated using a three point scale of poorly done, partially done, or well done. All proctors received an orientation on the assessment tool by the course director.

We assessed participant confidence in image acquisition and clinical integration using a retrospective pre-post-survey at the completion of the 2-day course and again after one year (Appendix 1). Responses were rated based on a 4-point Likert scale from Not at all confident (1) to Very confident (4).

We also examined participants' barriers to using POCUS. The barrier survey was developed from pilot interviews to address reasons participants may not adopt various aspects of POCUS (i.e. clinical use or clip uploading (Appendix 2)).

Participants completed a questionnaire regarding overall satisfaction with the program and individual elements.

Successful completion of the I-ScaN program required three components: 1) Achieving a score of 80% or greater on the final knowledge test 2) Receiving a score of 80% well done for all items on the hands-on test and 3) Submitting an image portfolio based on SHM guidance.¹⁹ Passing scores were established at these values through author consensus of clinical relevance and review of published data.¹⁴

Statistical Analysis:

Pre- and post- 2-day knowledge scores (Cronbach's $\alpha = .68-.74$) and confidence in ultrasound use (Cronbach's $\alpha = .79-.84$) were summarized. Scores from knowledge were reported as percentages and confidence scores reported on a 1-4-point scale. Differences between pre- and post-values for 2-day course variables were assessed by using 2-sample paired Wilcoxon signed rank tests with a 95% confidence level. Data were reported as median and interquartile range for 2-day and year end assessments (Table 1).

Table 1
Assessment scores before and after 2-day course and after 1-year

	Pre 2-day Median (IQR)	Post 2-day Median (IQR)	p
Knowledge (% correct)	58 (27)	85 (21)	p < 0.001
Confidence (1-4 Likert)	1.5 (0.55)	3.1(.62)	p < 0.001
	Post 2-day Median (IQR)	1-year Median (IQR)	
Knowledge (% correct)	85 (21)	81 (24)	0.012
Confidence (1-4 Likert)	3.1 (0.62)	2.73 (0.85)	NS
Hands-on (% well done)	75 (28)	74 (30)	NS
Abbreviations: IQR; interquartile range			

Table 2
Correlation between course components and hands-on test

	Post 2-day hands-on		1-year hands-on	
	r	p	r	p
Post 2-day knowledge	0.53	p = 0.018		
Post-2-day confidence		NS		
1-year knowledge			0.78	p < 0.001
Attendance at hands-on teaching sessions			0.70	p = 0.001
Attendance at monthly conference			0.50	p = 0.03
Clip uploading			0.85	p < 0.001
Confidence at 1-year (n = 18)			0.55	p = 0.02

Hands-on assessment was conducted at the end of 2-days (Cronbach's $\alpha = .84$) and at the end of the program (Cronbach's $\alpha = .93$). Scores were summarized. At the end of the program, knowledge (Cronbach's $\alpha = .74$) and confidence (Cronbach's $\alpha = .91$) were reassessed and compared to post-2-days scores. Hands-on and knowledge scores were summarized and reported as percentages, while confidence scores are reported on a 1-4-point scale. Differences between 2-days and end of program were assessed by using 2-sample paired Wilcoxon signed rank tests with a 95% confidence level. Data were reported as median and interquartile range for 2-day and year end assessments (Table 1).

Spearman's Correlation was performed on year-end hands-on assessment and knowledge, confidence, lectures, clips uploads, and hand-on lectures to understand the relationship between performance using POCUS and other reported metrics.

We considered a passing score on the final hands-on test to be the single best summative assessment to determine competency in POCUS skill as learners must demonstrate understanding of the ultrasound machine settings, demonstrate acquisition skills of each view, and identify key structures in each view.

The I-ScaN program qualified as a quality improvement project by the NYU Grossman School of Medicine's Institutional Review Board criteria using a self-certification process to ensure the data were not collected for research purposes. The primary goal of the project was to assess and improve teaching performance of the I-ScaN program.

Results:

Twenty-three hospitalists from across the 4 hospitals participated in the 2-day introductory course. Sixteen of the participants (72%) reported prior ultrasound training, with a range of 2–80 hours (median = 4 hours); 3 reported more than 5 hours of prior training. Three reported active clinical use of POCUS though none of them had more than 5 hours of prior training. The group averaged 4.5 years of clinical practice (range = 1–

13 years). Only the nineteen hospitalists who completed the assessments at the 1-year mark are included in the subsequent analysis (3 left the institution, 1 voluntarily dropped out due to time commitments).

Approximately one year after the introductory course and at the time of the final hands-on test, participants had uploaded a total of 2787 clips (range 0-876), one had completed the image portfolio. At the time of writing four participants have satisfied all course elements.

Participant knowledge increased from before the 2-day course to post-course (58% and 85% correct, respectively, $p < 0.001$). Knowledge scores fell slightly at one year (81% correct, $p = 0.012$).

There was no change in POCUS skills as measured by the hands-on test from immediately after the 2-day course to one-year (75% and 74% well done, respectively).

Confidence ratings increased from 1.5 pre- to 3.1 post-course (out of possible 4, $p < 0.001$) and were 2.73 at 1-year (NS for incremental change).

Performance on the 1-year knowledge test correlated highly with results of the 1-year hands-on test ($r = 0.78$, $p < 0.001$), while correlation between the knowledge and hands-on tests post-2-day course was only moderate ($r = 0.53$, $p = 0.018$).

Participant confidence at 1 year positively correlated with hands on performance at 1 year ($r = 0.55$, $p = 0.02$), however confidence post 2-day course did not correlate with hands on performance after the 2-day course.

There was a correlation between passing the 1-year hands-on test with the number of clip uploads ($r = 0.85$, $p < 0.001$), attending hands-on teaching sessions ($r = 0.7$, $p = 0.001$), and with attendance at monthly conferences ($r = 0.5$, $p = 0.03$).

Practice Patterns

At 1-year, 13/19 (68%) of participants strongly agreed or agreed that they felt confident using POCUS to make clinical decisions. Two (11%) reported using POCUS daily, 7 (37%) every 2–3 days, 1 (5%) weekly, and 9 (47%) “only with the right patient”. More than half of participants reported uploading 0–24% of scans (53%). Lack of time during the workday was reported by 68% as the principal barrier to clinical use of POCUS. Scanning in front of house staff was reported infrequently as a deterrent (21% agreed or strongly agreed).

In responding to the prompt that “POCUS takes too much time”, participants perceived vascular studies to be the most time consuming and lung to be the least (37% and 11%, respectively). Planning to obtain a scheduled formal study was reported as a deterrent to performing POCUS for 21% of participants for cardiac views and 53% of participants for vascular views. Only 5–11% of participants reported not performing POCUS due to the physical exam alone being sufficient to make diagnoses across views.

Participants agreed or strongly agreed that the ultra-portable device, when compared to a traditional machine, poses less of a barrier regarding device access (16% and 53%), ability to carry/transport (5% and 79%), ease of uploading (26% and 74%), and labeling recorded images (53% and 63%).

Program Evaluation:

At 1-year, participants rated I-ScaN with an overall score of 4.6/5. Individual course elements were rated as follows: 2-day course 3.9, hands-on sessions 3.9, and monthly conferences 3.4 (1 not at all useful to 4 very useful).

Discussion:

Limited experience exists for the ideal POCUS training program for hospitalists. Maw and colleagues described a 10-week pilot program resulting in immediate improvements in ultrasound acquisition and interpretation though long-term outcomes were not studied.¹⁵ The authors concluded that a longitudinal structured mentored training program would be required for learners to develop mastery. Cochard and others described a hospitalist POCUS training program where, of the 35 completing a survey out of 58 total who took the course, confidence waned at six months and 26% reported never using POCUS in their hospitalist practice.¹⁷ Mathews, reporting on the CHAMP Ultrasound Program, found that of the learners participating in a voluntary 1-day refresher course following the initial 3-day introductory course, skill retention was most effectively maintained by those who attended any monthly scanning session or who had started an image portfolio.¹⁴ I-ScaN was designed to maximize the effectiveness of the longitudinal phase while shortening the introductory course to 2 days.

I-ScaN found that a 2-day introductory course was effective at improving hands-on skill, knowledge and confidence, without a decline in skill following a longitudinal year-long curriculum. Our results provide support for a 2-day introductory course rather than the typical 3 day courses commonly offered. The critical portion of successful POCUS skill and knowledge acquisition lies in the longitudinal phase of the curriculum. The sample sizes are too small to determine which program elements led to learner success, though similar to the results of the CHAMP program, we found that skill retention on the hands-on test correlated with attendance at monthly conferences, hands-on teaching sessions and image uploading. We believe that incorporation of scanning into clinical workflow immediately after the course along with routine direct supervision are the key elements that result in learner success in POCUS.

Participant confidence in using POCUS at 1-year correlated with their performance on the hands-on test at 1 year but not at the conclusion of the 2-day course. These findings suggest that participants developed an awareness of their strengths and weaknesses over time as they progressed along the Dunning-Kruger curve.²² Provider confidence may serve as a means of assessment when considering an individual's scope of practice who has routinely integrated POCUS into clinical practice.

A strength of our study is the comprehensive data collection for all assessments and surveys of all 19 participants, save a single confidence assessment, representing a diverse faculty across 4 distinct practice settings, including those both highly and minimally engaged during the longitudinal portion of the curriculum. The studies reviewed above either report short-term results or only the highly-engaged fraction of the total cohort of long-term participants.

We attempted to mitigate common barriers to ultrasound adoption through provision of ultra-portable devices to learners and by bringing teachers to the bedside of learners' patients. Responses to the survey did not reveal a clear barrier apart from time, though did reveal that the ultra-portable device was less of a barrier than a traditional machine for accessibility, portability, and ability to upload and label clips.

Study limitations include a relatively small sample size encompassing a single cohort of learners, as is common in faculty development programs. The small sample size limits our ability to predict why some individual learners succeeded while others did not.

Despite ongoing encouragement and assessment of barriers throughout the longitudinal portion of the course, we found wide variance in learner participation in program elements and practice patterns. Participants rated all elements of I-ScaN highly, reinforcing that it is the time spent between course elements that predicts durable gains. Getting learners to the bedside following an introductory course to practice on patients and upload clips for feedback will yield the greatest results.

Conclusions:

I-ScaN demonstrates that POCUS skill development learned after a 2-day introductory course can be achieved through a longitudinal mentored program consisting of access to ultrasound devices, hands-on teaching sessions, and monthly case conferences. The lowered costs of ultra-portable ultrasound devices and availability of a growing population of instructors will facilitate the expected growth of hospitalists learning POCUS.

Declarations

Authors' contributions:

MJ, AD, CSK, KH, DC, SZ and HS all made substantial contributions to the conception and design of the work, analysis and interpretation of data, and have substantively revised the manuscript draft.

Acknowledgements:

The authors would like to acknowledge the Education for Educators (E4E) program, the Program for Medical Education Innovations and Research (PrMEIR), NYSIM, and the Division of General Internal Medicine & Clinical Innovation.

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Appendix

Appendix Table 1. Retrospective Pre- Post Survey

Prior to taking this program

How confident were you in your ability to: (all responses Not at all confident, Only a little confident, Somewhat confident, Very confident)

acquire ultrasound (US) images of the heart?

acquire US images of the lungs?

acquire US images of abdominal organs?

acquire US images of deep veins?

interpret US images of the heart?

interpret US images of the lungs?

interpret US images of abdominal organs?

interpret US images of deep veins?

Prior to taking this program

How likely were you to use ultrasound to? (all responses Not at all likely, Only a little likely, Somewhat likely, Very likely)

evaluate dyspnea?

evaluate abdominal pain?

evaluate hypotension?

evaluate volume status?

evaluate for DVT?

perform a paracentesis?

insert a peripheral venous catheter?

POCUS Questions:

1) Have you received prior training in point of care ultrasound? (Yes/No)

1a) If you answered yes to the question above, how many hours have you received in prior training? (free text)

2) Do you use point of care ultrasound (Yes/No)

Now that you have completed this program

How confident were you in your ability to: (all responses Not at all confident, Only a little confident, Somewhat confident, Very confident)

acquire ultrasound (US) images of the heart?

acquire US images of the lungs?

acquire US images of abdominal organs?

acquire US images of deep veins?

interpret US images of the heart?

interpret US images of the lungs?

interpret US images of abdominal organs?

interpret US images of deep veins?

Now that you have completed this program

How likely were you to use ultrasound to? (all responses Not at all likely, Only a little likely, Somewhat likely, Very likely)

evaluate dyspnea?

evaluate abdominal pain?

evaluate hypotension?

evaluate volume status?

evaluate for DVT?

perform a paracentesis?

insert a peripheral venous catheter?

Appendix Table 2. I-ScaN One-Year Course Assessment

How useful did you find the following course elements? (all responses Not at all useful, Only a little useful, Somewhat useful, Very useful, N/A)

Introductory 2-day course

Monthly conferences

Hands-on teaching sessions

Brightspace site

Do you feel you are competent to use POCUS to make clinical decisions (Strongly Agree, Agree, Disagree, Strongly Disagree)

Overall how would you rate this course? (One of the worst, Below average, Average, Above average, One of the best)

I feel comfortable with my POCUS skills (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Abdomen

Cardiac

Lung

Vascular

Performing POCUS takes too much time (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Lung

Cardiac

Abdomen

Vascular

I don't use POCUS when I'm going to obtain a formal study (e.g. TTE) (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Cardiac

Lung

Abdomen

Vascular

I don't use POCUS because my PE is sufficient to make the diagnosis (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Cardiac

Lung

Abdomen

Vascular

A barrier for me with traditional portable US is: (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Uploading images

Carrying/transporting US

Labelling images

Access to a device

A barrier for me with Butterfly is: (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

Uploading images

Carrying/transporting US

Labeling images

Access to a device

I don't feel comfortable using POCUS in front of the house staff (all responses Strongly Agree, Agree, Disagree, Strongly Disagree)

When on service, how often do you scan? (Daily, Every 2-3 days, Once a week, Only with the right patient)

What percentage of scans do you upload? (0-24%, 25-49%, 50-74%, 75-100%)

What are your barriers to performing US when you are on service? (free text)

What are your barriers to uploading the images? (free text)

How can we help you perform more US and upload more images? (free text)

Did you meet your learning goals? (free text)

Reflecting on this program, what worked well and what didn't work for you? (free text)

Did you receive sufficient support from this program? (free text)

Did you receive sufficient feedback on your skill development? (free text)

Figures

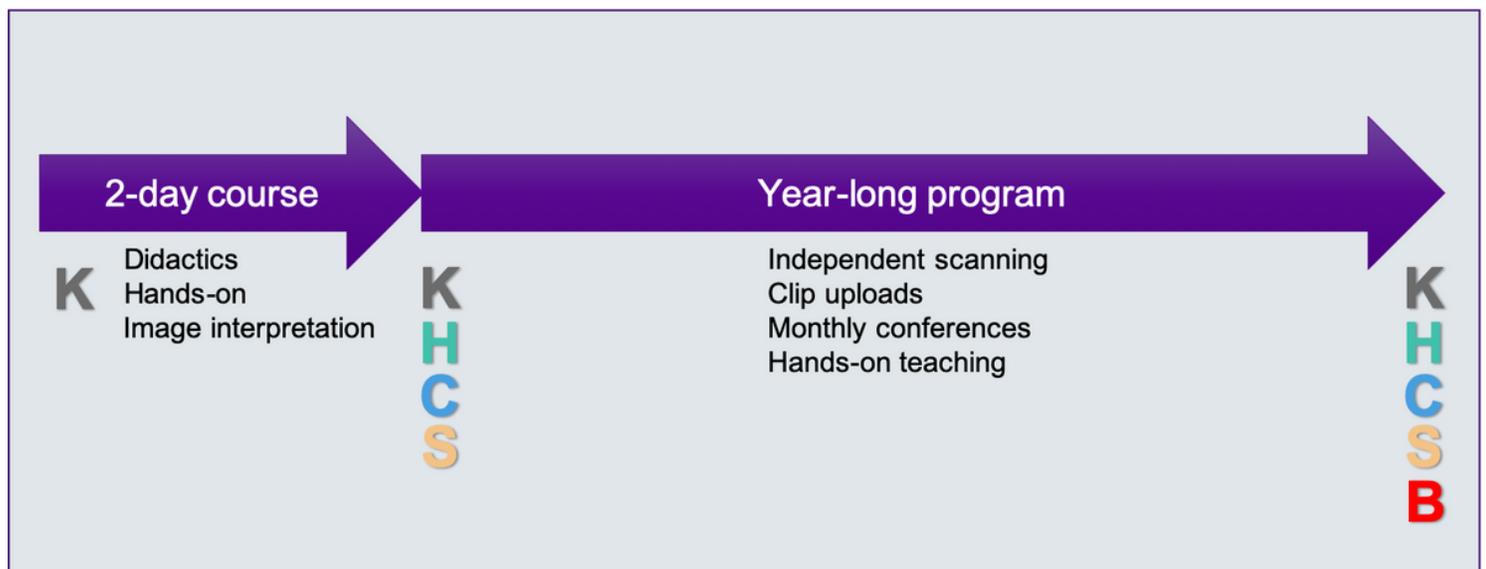


Figure 1

Abbreviations: K, Knowledge test; H, Hands-on test; C, Confidence survey; S, Satisfaction survey; B, Barriers survey