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# Effects of Data Collection Mode and Response Entry Device on Survey Response Quality

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Survey has been widely used as a data collection method for both academic and administrative research. Different modes of conducting surveys have been created and continuously developed (Groves, 2011). With the fast-growing penetration of smartphones and other mobile media, survey researchers are faced with the challenge of how to make use of them in surveys while ensuring high data quality and minimizing bias in the coverage (Watson, Zamith, Cavanah & Lewis, 2015). It is especially important to note that Web surveys are now displayed on different devices with different screen sizes and entry methods. So how response entry devices affect response quality is another important question for survey researchers. This study attempts to address these issues by examining the effects of survey modes and response entry device on response quality.

Our study aims to compare survey response quality between computer-assisted face-to-face interviews and interviewer-assisted self-administered Web surveys with provided response entry devices that can connect to the Internet to submit the answers (IASAD). We intend to figure out whether conducting surveys using IASAD can be a good alternative to current common methods of computer-assisted personal interviews and e-mail delivered Web surveys in terms of data quality. In addition, we compare the difference in data quality entered via smartphones and laptop computers, controlling demographic characteristics of the respondents.

In this study, we conceptualize mobile phones, specifically smartphones, not as a medium to deliver the survey to the respondents as a telephone, but as a visual questionnaire display and online response entry device for Web surveys similar to other researchers' conception of mobile web surveys (e.g., De-Bruijne & Wijnant, 2014; Link, Murphy, Schober, Buskirk, Childs & Tesfaye) and contrast it with the responses using laptop computers, the more standard device we expect respondents to fill out Web surveys. We also conceptualize self-administered Web

survey as a survey that can use interviewers to recruit respondents and provide assistance to respondents as needed, not necessarily delivered via e-mail or other online postings. This is similar to a paper and pencil survey in a captive setting in the past but with respondents entering data online directly by themselves. Our proposed method builds on the advantages of Web surveys while trying to overcome the limitations of Web surveys.

## Literature Review

### Advantages and Limitations of Web Surveys

Web survey is an increasingly popular self-administered survey method, which allows researchers to reach a large number of respondents at a low cost, and present survey content with multimedia (Couper, 2000; Ha et al., 2015). Hoonakker and Carayon (2009) defined Web survey as one that is stored in a Web server, and participants will be provided a link to complete the survey on a Web page and submit it to the researcher. Web survey has advantages such as easy access to a large population, faster speed, lower costs, less time and error in response entry, easy to administer, higher flexibility, more design options, and higher response quality. Web survey eliminates response entry burden and error on the researcher and can reach people in different locations at the same time. However, as Dillman, Smyth & Christian (2014) pointed out, it also suffers from disadvantages such as under-coverage of older and low education population and population without Internet access, difficult to conduct a random sample, measurement and nonresponse errors, the concern of anonymity, computer security and illiteracy, and deliverability. Research shows that recruiting iPhone users to complete a web survey is more difficult than computer recruitment (Buskirk & Andrus, 2014). Buskirk and Andrus explain that this is because the sample is recruited from an online computer panel. They did increase internal validity by only recruiting iPhone users, but they are sacrificing the generalizability because

there are different operational systems of different smartphones, and we cannot control what smartphones that our potential participants will use for completing a self-administered web survey. Is recruitment of other smartphone users also facing this issue? May be or may be not. So, it is necessary to develop a hybrid survey research method in terms of decreasing the difficulties of recruiting potential participants.

As a self-administered data collection method, Web survey is an improvement over other data collection methods with interviewer presence. Fricker, Galesic, Tourangeau, and Yan (2005) argued that self-administered Web survey is superior to the telephone survey in eliminating the influences from interviewers and people are more willing to answer sensitive questions. Schrum's (2007) study shows how cultivation effect research results can be totally different just by the pressure of interviewer presence. Yet one should also consider how Web surveys influence response quality because of the substantial difference between the Internet population from the general population (Couper, 2000). Additionally, respondents, survey design, and devices used to complete a survey may function together to affect web survey duration, which is a main indicator of response burden, a factor that may influence data quality (Gummer & RoBmann, 2015). Gummer and RoBmann (2015) found that respondent characteristics is the main factor that affects interview duration. We argue that controlling demographic variables, such as choosing subjects that shared similar ages and in the same regions, may decrease the impacts from respondent characteristics. This may help researchers to determine the effects of survey design and devices on interview duration. Also, their sample is based on the German Internet users who may share very different characteristics from American Internet users, so it is necessary to examine effects of devices and other factors on other populations.

Mobile phone users result in lower completion rates in self-administered web surveys than personal computer users, and mobile users have higher break off rate than PC users (Mavletova, 2013). Responses showed that it is are more difficulty for mobile users to complete the survey, but survey length does not affect completion rates and break off rates. The display of survey questions on mobile screens differently from PC screens may be a factor causing lower completion rates and higher break off rates of mobile users. Meanwhile, there is no big difference of socially undesirable and non-substantive responses (answers, like “I am not sure” or “I do not know”, both of single choice and multiple choice questions) of these two modes were found in Mavletova’s study. The sample of this study is from an online panel in Russia, so respondents may be cultivated to complete surveys well, and this maybe the reason of no statistical difference of socially undesirable between these two devices. Perhaps the general public population will result in a different result for testing social desirable as a variable. The same for non-substantive responses, panel samples may be more willing to provide answers. Hence, there is a need to develop a hybrid method that can combine the advantages of face-to-face interviews and self-administered Web surveys especially in light of the continuing decline in survey cooperation and increasing complexity in media use by survey respondents (Dillman, Smyth & Christian, 2014).

**Mode effects on Response Quality**

**A.** Web Survey and Face-to-Face Interviews

With the increased number and complexity of survey modes, there are several dimensions of different survey modes that need to be examined, which include the ease of contacting respondents, interviewer involvement, communication channels, the locus of control, respondents’ privacy and technologies applied in surveys (Couper, 2011). The use of mixed-

mode surveys, or the use of more than one survey mode in a study, is also a developing trend to maximize the reach of the respondents and improve response rates (Ha et al., 2015; Dillman, Smyth & Christian, 2014). Fowler, Roman, and Di (1998) compared effects of telephones survey, mail survey, and in-person survey. They found that almost half of survey question items on mail responses were significantly different from those same items on telephone responses. They also argued that data of more sensitive topics collected by personal interviews might be comparable to data collected by mail survey and better than telephone surveys. Because of the problem of incompatibility of data collected in mixed modes, it is time to develop a new hybrid survey method with a standardized data format that combines the strengths of several modes to optimize survey data quality.

Essig and Winter (2009) tested whether survey modes, survey administration, respondents' characteristics, and interviewers' characteristics are associated with item non-response to financial questions. Survey modes in their study mainly include computer-aided personal interview (CAPI) and paper and pencil (P&P) interviews. They offered pick-up and mail-back options of P&P surveys to respondents. They argued that "the mode of data collection" might influence some psychological variables including "privacy, legitimacy and cognitive burden" (p. 370). These psychological responses might further influence data quality, which includes accuracy, reliability and item non-response. They found that the more time a person use to complete a survey, the more elaborate the processes might happen, and the high the accuracy of responses. Hence, private interview mode might result in better data quality of sensitive questions on financial questions.

A study comparing face-to-face survey and Web survey by Revilla and Saris (2013) examined whether survey modes would influence response quality differently. They used

multitrait-multimethod (MTMM) to analyze survey data that were collected by these two modes. Their results showed that the response quality of single items does not vary much by the two modes. However, they did not explore survey modes effects on survey question formats such as matrix questions, close-ended questions, and open-ended questions. Respondents should be better in responding complex question formats by letting them browse the questions and answers by themselves at their own pace. But in face-to-face interviews, we may expect face-to-face interviews can achieve higher completion rates than self-administered surveys because the physical presence of the interviewer in face-to-face interviews creates pressure for the respondents to complete open-ended questions instead of skipping the questions.

Web survey has its advantages as we have discussed, and respondents can choose the time they would like to answer the survey (Couper, 2011; Revilla & Saris, 2013). Respondents and researchers do not have to communicate at the same time and place. However, nonresponse bias and generalizability are the issues need to be considered (Couper, 2000). The importance of considering paradata, other auxiliary data, and other contextual information when analyzing nonresponse related sampling weightings had been tested by Krueger and West (2014). They tested whether paradata and other auxiliary data were useful for nonresponse adjustment and found them effective for adjusting nonresponse bias. However, paradata are available only in Web surveys. Face-to-face interviews, unless they are computer-aided and responses are entered in a Web survey form, will not provide such data. Paradata for estimating data quality in our study are the date, time and duration of face-to-face interviews and IASAD, and smartphones/tablets entry and laptop computers entry. We argue that face-to-face interviews (CAPI) need more time to complete than self-administered surveys even respondents theoretically have more time to think when they are filling a survey by themselves. The reason is

that interviewers need more time to explain complex questions and use the same pace for every respondent, but some respondents can answer faster by themselves but have to wait for the interviewer to finish asking the questions.

Hence, researchers need to know the strengths and weaknesses of each individual mode. With the development of technologies, telephone mode and web mode are more difficult to be distinguished than before (Couper, 2011). Our proposed hybrid interviewer-assisted self-administered survey with response entry device provided (IASAD) has the advantage of standardizing the display and response entry. In addition, the presence of interviewers to invite potential participants can help researchers to achieve higher cooperation rates and/or completion rates than typical self-administered surveys which have no interviewer presence. The presence of the interviewer can avoid breakoffs commonly occur in self-administered surveys. When participants are completing Web-based surveys by themselves, they would not feel embarrassed in answering socially undesirable questions. This may help researchers to get more honest answers. Hence how the effects of these two modes affect data quality should be compared.

**B.** Mobile Phone and Landline Phone Surveys

Researchers' treatment of mobile phones as a survey medium has changed over time. Mobile phone survey is increasingly adopted by researchers as an alternative of other modes due to the high coverage rate of the population, but researchers need to consider cost-error relationships of using mobile survey as an alternative method (Vehovar, Berzelak, & Lozar Manfreda, 2010). A clearer model of considering survey costs that can apply in general situations still needs to be developed. Even mobile phone has a relatively higher coverage than other mass media, it does not mean that every individual has a mobile phone or every mobile phone user is using a phone that has Internet access. There are certain research populations that mobile phone does not

completely cover yet. These populations need devices that can access the Internet to be provided or need devices that can be used to complete a survey. Some studies view mobile phones as just another type of phone and compare landline telephone surveys with mobile phone surveys. Lynn and Kaminska (2013) examined whether these two types of phones have different impacts on survey measurement and find only small differences in results between these two modes. They also found that mobile phone data are slightly less subject to social desirability and satisficing than landline phone survey. The possible reasons could be that people could move to private and/or quiet place to complete the survey where they could answer survey questions more freely. But people who used landline phones but with the wireless headsets might also enjoy the same condition. Watson et al.'s (2015) comparison of the results of smartphone respondents and landline phone respondents found a significant difference in media use patterns which can affect research results tremendously. Even controlling the demographic variables cannot remedy the fundamental differences of respondents using the two modes.

**C.** Telephone and the Web Survey

In order to compare the mode effects of the telephone survey and Web survey on response quality, Fricker, Galesic, Tourangeau, and Yan (2005) divided the sample into three subgroups. They found that Web survey resulted in much lower response rates than telephone surveys. However, the lower response rates may be because the more contacts (potential participants) of telephone than Web survey has, and a non-response error is not necessarily caused by a non-response (Manfreda, Bosnjak, Berzelak, Haas & Vehovar, 2006). Hence, the participation rate of a survey is highly dependent on the effort of repeated contacts and/or presence of a human interviewer if the topic of the study is not highly relevant to the respondent.

Any new effective survey method must take this factor into consideration apart from using the latest technology available.

Fricker et. al.'s (2005) experiment shows that Web surveys have less item nonresponse and "no opinion" answers than telephone surveys, which means that Web surveys yield higher quality response than telephone surveys. Web respondents spent more time to complete open-ended questions, and Web surveys are more suited for respondents to answer high burden survey question formats such as matrix questions, a large number of multiple responses, and open-ended questions.

However, due to the presence of interviewers, we can expect both face-to-face interviews and our proposed IASAD method will achieve high cooperation rate than typical self-administered Web surveys. With the IASAD method, respondents should be better to respond complex question format by being able to browse the questions and answer by themselves. The physical presence of the interviewer also creates pressure for the respondents to complete open-ended questions in face-to-face interviews instead of skipping the questions.

Dutwin et. al.'s (2015) analysis of the American Association of Public Opinion Research Task Force research report shows that in-person interviews have fewer refusals than telephone interviews. So, both bringing a device to interviewees for completing a survey and face-to-face contact should decrease levels of refusals and facilitate survey participation due to the presence of interviewers. Typical self-administered Web surveys are hard for identify refusals because some people may just ignore emails of survey invitations. But the lower participation rate compared to other modes is a major drawback of using Web survey as a survey delivered online. Some researchers overcome the problem of low participation by setting up Web survey panels. Yet the survey panels result in "professional" or "trained" respondents who frequently answer

Web surveys and understand the question patterns and know how to skip questions to save time which jeopardize the data quality and the generalizability of the results to the target population (Jones, House & Gao, 2015; Toepoel, Das & Van Soest, 2008).

**Device Effects (Display Format and Response Entry Convenience)**

Survey quality is one aspect to evaluate a survey study based on total survey error. Biemer (2010) looked at the total survey error as a part of the whole survey design strategy. Biemer argued that dividing survey design into smaller parts and phases, and minimizing potential errors of each part might improve total survey quality. The interviewing error is one common source of errors in field survey, which means that interviewers could be a source of error. The error caused by interviewers also should be considered in designing a survey in order to minimize the measurement error.

Not only interviewers may bring errors to survey studies, respondents also can be a source of errors. Couper (2011) argued that measurement error might be caused by respondents or the instrument. Web survey provides convenience to respondents. However, we consider that this convenience depends on how the survey is designed and Internet accessibility, and, perhaps, the devices they are using. Essig and Winter (2009) found that CAPI survey has different ways of completing survey questionnaires. Even for a Web-based survey, there are different ways that respondents can fill a survey. Different types of smartphones will attract different populations, and different systems of mobile devices may influence respondents differently (Link et al., 2014). Tablets and smartphones may result in higher measurement error, which also is correlated to self-selection of devices (Lugtig & Toepoel, 2016). Lugtig and Toepoel (2016) state that there are no big increases of measurement error of from PCs to tablets or smartphones in individual level, and they conclude that the measurement error may be associated with device choices at the

sample population level. Tablets and smartphones users are more likely to have more measurement error than PC users. This may be because the sample of this study is in an Internet panel and they can choose using which device to complete a survey, so there are no great variations of personal characteristics in terms of choices of devices and habits of completing surveys (about 90% surveys are completed by PCs, and 26% respondents claim that they have PCs, tablets, and smartphones).

Their conclusions indicate that it is important to determine device effects in terms of receiving data with better quality with what type of mobile devices. Their latter conclusion mainly refers to tablets and smartphones, so comparisons between PC and mobile device effects on survey data quality need to be further explored. Also, as Lugtig and Toepoel (2016) mentioned, requesting respondents to use certain devices to complete surveys may result in different effects on measurement error, so we argue that this may also results in different device effects on data quality. So, the type of medium respondents use to complete the survey may also influence respondents' abilities and the ways of completing a survey (Peytchev & Hill, 2010). For instance, smartphones display words smaller than laptops, and people may choose wrong answers by mistake. Some contents will be displayed differently on different media platforms, which may influence respondents' moods and psychological burdens. Also, smaller screens may display less content than larger screens, and respondents tend to choose the more visible options. Visible option refers to the options of a survey question that is directly displayed on the screen that people do not need to scroll the screen in order to see the content.

Additionally, different media formats may also influence respondents' understandings about the same content. Although cognitive processing may be similar among respondents, there are some small differences in responses toward images presented on computer-administered and

mobile web surveys (Peytchev & Hill, 2010). The interesting thing is that Peytchev and Hill (2010) state that picture effects may be diminished on smaller screens, and some of their results confirm that small screen size affects responses, like choosing visible options or options that contain the most striking information. Their study failed to exam device effects on specific age generations (youth and elders). 75% of respondents in this study are aged from 18 to 44. It is important to determine media effects on certain age generations so that future survey designs can consider different age generations more thoroughly. A study shows that utilitarian value and perceived social pressures do not significantly influencing respondents' intentions of participation and actual participation (Bosnjak, Metzger, & Gräf, 2010). This means that the usage of devices may not influence people's participation in a survey study, and some studies show that mode effects between smartphone survey and computer web survey are limited, but smartphone users may not be so resistant to answer open-ended questions with short answers (Mavletova, 2013; Wells, Bailey, & Link, 2014).

Even there is no statistical difference between iPhone users and computer users in open-ended items completion, but after Buskirk and Andrus (2014) qualitatively analyzed lengths of provided answers of open-ended items, they found an interesting phenomenon. Although iPhone users spent averagely less time to complete a survey than computer users, iPhone users are not necessarily provide shorter responses than computer users. The mixed results of above studies show that there are some factors that may influence respondents' completion of surveys have not been considered or discovered yet. Perhaps, most smartphone users are willing to provide, even longer, answers to open-ended items, or maybe only users of certain types of smartphones may provide longer responses than PC users. Hence, it is necessary to further study whether media

platform that a respondent uses to complete a survey have impacts on data quality or not, and how devices affect data quality.

Link et al. (2014) report the trend that people using mobile browsers to complete online survey resulted in a higher abandonment rate than other modes. We believe that not just the browser but the device and display format have influences on response quality. Biemer (2010) how nonresponse error and measurement error can also be caused by different media platforms that people using to fill out a survey. Steinbrecher, RoBmann, & Blumenstiel's (2015) study on why people break off from Web surveys show that respondents complete questionnaires better via devices with larger screens. Technical problem is a predictor both of early and late breakoffs. Although they did not specify the technical problems in the published article, they are likely to be a connection to the Internet, display format, and the response time of operation systems, etc. Research shows that respondents will choose implausible options more than the alternative option if it is text input (Peytchev & Hill, 2010). For instance, if a multiple choice question contains implausible options, and an alternative option as one of these options requires text input, small keyboard users intend to choose implausible ones instead of typing texts. So, typing comfort may affect responses. Even the result of Pevtchev and Hill's attempt to increase completion rates of open-ended questions is not statistically significant, there are indications that using keyboard may increase respondents' willingness to provide longer responses. The smartphone (Samsung BlackJack) that they offer to participants is the Web accessible type, and has a keyboard with full letters, but without touch screen function. General public use different types of smartphones that have different kinds of keyboards, which may have different effects on survey responses. We argue that physical keyboards of smartphones may be more difficult to type than touch screen keyboards. However, because of the comfort of response entry on

keyboards of PCs, which is big enough for people to type comfortably, and reading the survey questions at own pace, we can expect laptop computers can facilitate a respondent to use less time to complete a survey than smartphones do.

De-Bruijne and Wijnant (2014) studied how to improve response rates for smartphone web surveys by comparing different ways of sending survey invitations and design of questionnaires. They found that response rates between using text-messages and e-mails as survey invitations are similar. However, completion rates of using smartphones are higher than other devices. Their study results contradict Link et al.'s (2014) study which means that completion rate can be influenced not just by screen size but also the accessibility of the medium. De-Bruijne and Wijnant (2014) also shows that respondents spend less time to complete a questionnaire that applying scrolling layout (a long scrollable page) than paging layout (respondents will answer questions on several separate pages).

Some researchers believe the future of survey data collection is by using smartphones and social media (Kosinski, Matz, Gosling, Popov & Stillwell, 2015). Smartphones and social media provide alternative and new data collection methods and tools to researchers. This may also be helpful for collecting augment information that cannot be collected with traditional methods. Link et al. (2014) argued that the mobile survey is a combination of “traditional computer-assisted interviewing (CAI) systems, online data collection, and additional new elements” (p. 781) and noted the method will favor younger and well-educated population. If our proposed hybrid IASAD method is shown to be a viable alternative method with similar or better data quality, then this method of bringing devices to respondents can provide poorer people and the elderly an equal chance to complete Web surveys.

**Personal characteristics**

Another factor that may influence survey quality is the individual characteristics of respondents (Gummer & RoBmann, 2015; Van Vaerengergh & Thomas, 2013). Different people have different response styles (RS), the tendency of a respondent to complete survey questions in certain ways without considering the content. Van Vaerengergh and Thomas's (2013) review on response style (RS) shows that RS is as a consequence of individual characteristics (education, age, gender, income and employment, race, personality, and culture and/or country level characteristics). In our study, we controlled these variables in the choice of population and in the statistical analysis of survey mode and device effects.

## Research Hypotheses

Based on the literature review on the advantages and disadvantage of different survey modes and device effects and the gap we found in research on these issues, we propose the following research hypotheses on our proposed hybrid method of IASAD in comparison with computer-aided personal interviews (CAPI):

H1. Modes of data collection have different effects on response quality.

H1a. Respondents spend more time to complete surveys in computer-aided personal interviews (CAPI) than the hybrid IASAD method.

H1b. CAPI performs better than the hybrid IASAD method in item completion rates.

H1c. The hybrid IASAD method performs better than CAPI in item completion of complex question formats such as matrix questions.

H1d. Respondents are more likely to provide answers for open-ended questions in the hybrid IASAD than the CAPI method

H1e. The hybrid IASAD method will have fewer social desirable answers than the CAPI method.

H1f. The hybrid IASAD method has higher satisficing occurrence in matrix questions than CAPI.

H2. Response entry devices have different effects on response quality.

H2a. Smartphones/tablets as response entry device will result in longer time to complete surveys than laptop computers.

H2b. Smartphones/tablets as response entry device will result in lower item completion rates than laptop computers.

H2c. Smartphone/tablets as response entry device will have higher item nonresponse in *complex question formats* such as matrix questions than laptop computers.

H2d. Smartphones/tablets as response entry device will have higher item nonresponse in *open-ended questions* than laptop computers.

H3. Survey mode and response entry device independently affect data quality as main effects.

H4. Demographic variables excluding age and education do not affect response quality in terms of item completion rate in open-ended questions.

## Method

### Sampling and Subject Recruitment

College students in a public university in the Midwest United States were chosen as the population to examine the mode and response entry device effects on response quality because they are digital natives and have high ownership of smartphones and computers. Using them as subjects would also control the variations caused by education and age variables. The original purpose of the study was to study their campus media use. But the design of the study allowed a controlled comparison of using different response entry devices and different survey modes.

To obtain a representative sample of college students to participate in the survey experiment, a cluster sampling of students' residence was used. The student population of the university was divided into on-campus housing and off-campus housing clusters using the campus and city map. Student interviewers were assigned to a different list of campus housing or off-campus housing and randomly selected available student residents there before 9 p.m. On-campus cluster list included all residence halls and Greek housing. Off-campus cluster list included both commuters out of the college town (who were recruited at the Student Union) and other apartments in the college town. The survey was conducted April 1 to April 21 in 2015.

Student interviewers were seniors enrolled in a capstone course in media management. They received training on how to recruit subjects and conduct computer-aided personal interviews and how to use the survey both on the computer and on the smartphone. They were instructed that the other purpose of the study included comparing CAPI and the hybrid IASAD method with different response entry devices such as computers, smartphones, and tablets. The quota per interviewer was 20 subjects.

The survey contained four matrix questions (supposedly difficult to view and input via smartphones), 29 closed-ended questions, five open-ended questions and an additional eight demographic questions of which one was open-ended (work hours) and seven were close-ended.

**Research Design**

The research design was a 2 x 2 factorial design (face-to-face vs. hybrid and smartphones/tablets vs. laptop computers). Interviewers were instructed to interview subjects alternatively in the CAPI and hybrid IASAD mode and use one particular device (either smartphone/tablets or laptop computer) to conduct the study. The smartphone/tablets and laptop assignment of interviewers was assigned equally so that each treatment have almost equal

sample size for comparison. The same interviewer used the same device but alternated the interview modes to interview each subject. So no interviewer effect should affect the result as the same interviewer used both survey modes equally.

In the face-to-face CAPI mode, subjects were asked the questions by interviewers like a typical face-to-face interview but the interviewer recorded the answers of the subjects on the laptop or smartphone/tablet directly like a typical CAPI. In the hybrid IASAD mode, interviewers were asked to introduce to respondents the purpose of the study and asked for informed consent to participate in the study. After they accepted the interview, the interviewer handed the subject the device (computer or smartphone/tablets) for the subject to read the questionnaire and enter the answers. The interviewer would not ask any questions and just stayed quiet at the location until the subject submitted the survey online and collected back the device from the participant. They could provide assistance if the subject needed any.

There were four matrix questions in the study which were supposed to be difficult to read and input on a small screen such as smartphones: “How often do you use the following sources to get information about campus news, campus life, and the [university] community?" (11 items in a 5-point scale) "How often do you use the following student and campus media?” (5 items in a 7-point scale) “How often do you read e-mail messages from the following sources?” (9 items in a 5-point scale) “How often do you use the following social media?” (6 items in a 7-point scale).

The survey instrument was implemented on Qualtrics, a popular online institutional survey software with the university logo and the display was compatible with mobile devices.

## Measures

### *Completion Time*

The duration of the study/completion time was measured by the automatically recorded paradata from the time the respondent/interviewer opened the questionnaire web page to the submission of the survey.

***Response Quality***

Two measures of response quality were used: Item completion rate (item-response rate) and the indication of satisficing. We computed the total percent of missing responses in each type of question format in the questionnaire as item response rate and computed the satisificing rate by the percentage of same value input to the matrix questions.

***Social Desirability Bias***

Social desirability bias was measured by the likelihood of the respondent's answering questions that are socially desirable for students. The two questions we examined for social desirability bias were "Are you involved in campus student organizations" (yes/no) and "How often do you read e-mails from University or Departments, Professors, academic advisors and university student organizations." A statistically higher likelihood of answering positively to these questions in the survey mode would indicate the social desirability bias of that mode in the study.

## Results

We found a high rate of cooperation (91%, refusal n=27) in both survey modes because the face-to-face recruitment captivated the subjects and subjects were unlikely to refuse to participate in front of a fellow college student interviewer's invitation which explained the project as a class assignment, unlike a typical self-administered online survey mode which only relies on the subjects' interest in the survey and self-motivation to complete without incentives. The cooperation rate was the same for both the CAPI and the hybrid IASAD modes.

However, cooperation rate differed by interviewers with females have higher success than males, which is typical in face-to-face interviews. A total of 276 valid responses were obtained, of which half of them was in CAPI mode, and half of them in hybrid IASAD mode. Among the smartphone/tablets interviewer group, 88% used smartphones as the device. Because we found no significant differences between smartphones and tablets in the results, we combined the smartphones and tablets as one group to compare with laptop computers.

**Effects of Survey Modes on Data Quality**

On average, it took respondents eight minutes to complete the survey. Although face-to-face interview's completion time was slightly longer (mean= 8.15 minutes for CAPI, SD=6.85 vs. mean=7.75 minutes for hybrid IASAD mode, SD=5.30), the difference is not statistically significant. Hence, H1a that face-to-face interviews took a longer time to complete is not supported.

Independent-samples t-tests were conducted to evaluate the hypotheses related to survey mode's effect on data quality in a scale from 0-1 where 1 is 100% item completion (see Table 1). Contrary to our expectation, the hybrid IASAD mode has higher item completion rates than face-to-face interviews. Nonetheless, CAPI ($M = 0.90$, $SD = 0.08$) and hybrid IASAD ($M = 0.96$, $SD = 0.08$) do not differ significantly on completion rates of all questions of this survey. CAPI have significantly lower item completion rates ($M = 0.79$, $SD = 0.06$) on all questions than IASAD ($M = 0.81$, $SD = 0.07$) ($t=-2.08$, $p < 0.05$). Hence, H1b that CAPI has higher item completion rate on all questions is not supported. To our surprise, there is no significant difference between modes on completion rates of matrix questions and CAPI (m=0.97, SD=0.08) even performs slightly better than hybrid IASAD mode (m=0.96, SD=0.08). H1c that hybrid IASAD mode performs better in complex question formats such as matrix questions in item completion rate is

not supported. But one should note that the matrix questions in this study were all about usage frequency rather than attitudinal statements in Likert-scales.

[Table 1 here]

As expected, the hybrid IASAD mode has higher item completion rate in open-ended questions (M=0.81, SD=0.07) than CAPI (M=0.79, SD=0.06, $t = 2.20$, $p < 0.05$). Hence, H1d that respondents are more likely to provide answers in open-ended questions in the hybrid IASAD mode than CAPI is supported. In addition, we also found that CAPI (M = 0.85, SD = 0.11) also resulted in significantly lower completion rates on close-ended questions than the hybrid mode (M = 0.88, SD = 0.12, $t= 2.08$, $p < 0.05$).

In terms of providing socially desirable answers, as shown in Table 2, face-to-face interviews indeed are more likely to yield more socially desirable answers in 4 out of 5 questions than hybrid self-administered surveys. After we adjusted the t-tests to one-tailed instead of two-tailed, all these four questions became statistically significant ($p < 0.05$). Hence, H1e that face-to-face mode is more likely to yield socially desirable answers than hybrid mode is mostly supported. The last response quality indicator is the probability of satisficing, answering the same value across a long list of items in matrix questions. We found a low rate of satisficing among our respondents and (less than 3% occurrence in three of the four matrix questions). In the matrix question with the highest satisficing rate (27%), we found a significant difference in satisficing between CAPI mode (M= 0.17, SD=.38) and the hybrid IASAD mode (M= 0.41, SD=0.49,
$t = 4.38$, $p < 0.01$). Thus H1f that hybrid IASAD mode has a higher rate of satisficing is supported.

[Table 2]

**Effects of Response entry Devices on Data Quality**

Independent-samples t-tests were conducted to evaluate the hypotheses related to response entry device effects on response quality (Table 3). To our surprise, there is no difference in completion time between response entry devices. It takes both interviewers and respondents less time using the smartphone (M=7.16 minutes, SD=5.21) to complete the survey than laptop computers (M=8.16 minute, SD=5.58), although the difference is not statistically significant. So H2a that smartphones take a longer time to complete the survey is not supported. Our results showed that only open-ended questions are adversely affected by smartphones/tablets response entry (M = 0.80, SD = 0.05). Laptop computers response entry achieves higher completion rate (M = 0.82, SD = 0.05) in open-ended questions than smartphones (M=0.80, SD=0.07, $t = 2.23$, $p < 0.05$). H2b that laptop facilitates open-ended response is supported. However, there are no significant differences in devices on completion rates of other question formats: close-ended questions, matrix questions, and the whole survey.

[Table 3]

Since modes and devices both have significant differences on the completion rates of open-ended questions only, we employed a two-way ANOVA test in order to see whether there is an interaction between these two factors. A significant main effect of response entry device on completion of open-ended questions was found, $F(1, 309) = 7.99$, $p < 0.01$ (See Figure 1). Meanwhile, a significant main effect of survey modes on completion of open-ended questions was also found, $F(1,309) = 7.99$, $p < 0.01$. Respondents in hybrid IASAD mode who complete survey questions by themselves have higher item completion rate than face-to-face interviews. However, the modes by device interaction was not significant, $F(1*1, 309) = 0.81$, $p = 0.37$. The higher slope of survey mode collection than the slope of response entry device means that the

effect of response entry device would be amplified in the hybrid IASAD mode than the CAPI mode. The device is more important when respondent entered the responses themselves for open-ended questions. Hence, H3 that survey mode and response entry have main effects on response quality is supported.

[Figure 1]

Finally, we examined the effect of the survey mode and response entry device by controlling the demographic variables in a multiple regression analysis. As expected, the survey mode ($\beta$=0.11, $p < 0.01$) and device effects ($\beta$=0.11, $p < 0.01$) are still significant in predicting item completion rates of open-ended questions after demographic variables such as class standing, gender, residence type, household income are included and controlled (See Table 4). In fact, none of these demographic variables affect item completion rates. Hence H4 that the survey mode and response entry device have significant effects on response quality with demographic variables controlled is supported.

Discussion

Survey mode effects have been discussed by scholars and researchers frequently. However, comparing differences of the effects of CAPI and our proposed new hybrid IASAD mode by including the presence of interviewer in a Web survey such as our study is the first attempt to experiment this survey mode. The results demonstrate that our proposed hybrid IASAD mode is almost better than the face-to-face mode in almost all indicators of data quality, with less socially desirable answers, higher item completion rate in all question formats except matrix questions. The major downfall is also with matrix question with higher satisficing rate than face-to-face CAPI mode.

Survey modes do not significantly impact on the completion of matrix questions, which means that CAPI and hybrid IASAD are similar in complex question formats. Survey modes also do not influence significantly on the completion time of survey. Although CAPI needs 0.4 minutes more to complete the survey than self-administered surveys with device provided, maybe this extra time was used for interviewers in reading every question to the respondents regardless of respondents' understanding of the questions and the additional task of entering the responses. Another reason of this phenomenon may be that the presence of interviewers may encourage the IASAD respondents to focus on the survey task and complete it faster than traditional self-administered surveys. The respondents may consciously know that they need to return the devices in a short time because there is a person waiting beside them. But it's important to note that their slightly shorter completion time does not affect their response quality.

Meanwhile, we are also pleasantly surprised at the similar performance in the data quality of smartphones and laptop computers as a response entry device in most questions except in open-ended questions. So smartphones as a response entry device is a viable means to survey researchers if no open-ended questions are used in the questionnaire. We note that our college student subjects probably are quite comfortable using smartphones so smartphones are a good medium both to deliver and display survey questionnaire for college population. There are several advantages of using smartphones as response entry devices over laptops for field work. First is its cellular Internet access has much wider coverage than WiFi in laptops (laptop computers can use extra mobile broadband or WiFi hotspot to get Internet access but they are not built in and less reliable). The larger tablets that are increasingly available in the market is a good alternative but it is less convenient to carry. More locations can be used to conduct the

study. Second, smartphones' battery life is longer than laptops and are more lightweight. Interviewers can carry them with ease without the worry of power source for a long time. Third, there is no need to have a desk or chair in entering the response using smartphones as many users are accustomed to punching directly on the screen on the palm of their hand without any support. These are important factors to consider in field work. Lastly, because typical Web surveys delivered via e-mails are now commonly opened with mobile browsers by respondents (Link et al., 2014), our proposed hybrid method is a good supplement to such Web-delivered method to boost the response rate as needed without worrying about the difference in response entry device. The absence of interaction effects between mode and response entry device effects and significance of mode and response entry device effect in the item completion prediction shows that each of these two factors must be considered separately in improving data quality.

## Conclusion

It is ironic that in this age of computer and mobile technology, we are proposing to bring back interviewers to Web survey. Yet the interviewer's role in our proposed hybrid IASAD survey mode will change from asking survey questions orally to, obtaining and recording responses from respondents to recruiting respondents and providing technical support to participants on demand. Interviewer's bias is minimized in this method compared to traditional telephone and face-to-face interviews. The proposed hybrid survey mode combines the strengths of the Web survey method and the face-to-face interview method. The hybrid method can assure respondents that their answers are anonymous because it is not from their own device but the interviewer's device so no traces of their identity can be found. This method is superior in privacy protection to email-delivered Web surveys which has low levels of anonymity with IP addresses recorded (Hoonakker & Carayon, 2009). Respondents will not be afraid that they will

be identified in the Web surveys. Another strength of this method is that it has the same as high in cooperation rates as face-to-face interviews by adding a sense of urgency and awkwardness of turning down a request for help in front of the interviewer (a stranger). Trust can be fostered through the self-identification of the interviewer. The self-pace in reading and entering the answers as shown in this study has a significant advantage of receiving fewer socially desirable answers. We understand that such method can work well only under the following conditions: 1) The interviewing locations must have online internet access or at least cellular data Internet access, 2) The sample is geographically concentrated in those locations so that it is economical to deploy interviewers, 3) The respondent must be comfortable to enter answers on a smartphone or computer. Hence this means the hybrid IASAD method works best in college campuses, urban areas, and rural areas that have cellular data coverage.

Although the cost of this hybrid method will be higher than regular Web surveys with the use of the interviewers, the much higher participation rate than normal Web surveys is worth the expenses if the stakes are high, when respondents may not have high interest in the topic and a large quantity of responses with fast turnaround is necessary for decision making such as customer satisfaction surveys and election polls. Table 5 summarizes the benefits and limitations of this hybrid interviewer-assisted Web survey with device provided mode (IASAD).

[Table 5]

Limitations and Suggestions for Future Research

Although our experiment shows that the data quality of Web surveys using smartphones as response entry device is as good as laptop computers except in open-ended questions, and the hybrid IASAD method performs better than CAPI in fewer socially desirable answers and more item completion rate in open-ended responses but higher rate of satisificing,

we have not compared the method with regular Web surveys delivered via e-mail. Future research should do a direct comparison to measure the actual gains of using this method over regular Web surveys in participation rate and data quality. In terms of device, we were unable to utilize the same model of smartphones and computers as input devices. Student interviewers only used their own device to conduct the interview. Future research using a standardize model of devices will rule out any other potential variations caused by differences in the models and operating systems. The effectiveness of the hybrid mode on population other than college students also need to be tested before it can be implemented as a common survey mode. Finally to test the effect of matrix questions, attitudinal Likert scale statements should be added to fully understand the dynamics of responding to matrix questions in different modes and response entry devices.

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**Figure 1 Two-way ANOVA on Completion of Open-Ended Questions by Modes and Devices Effects**

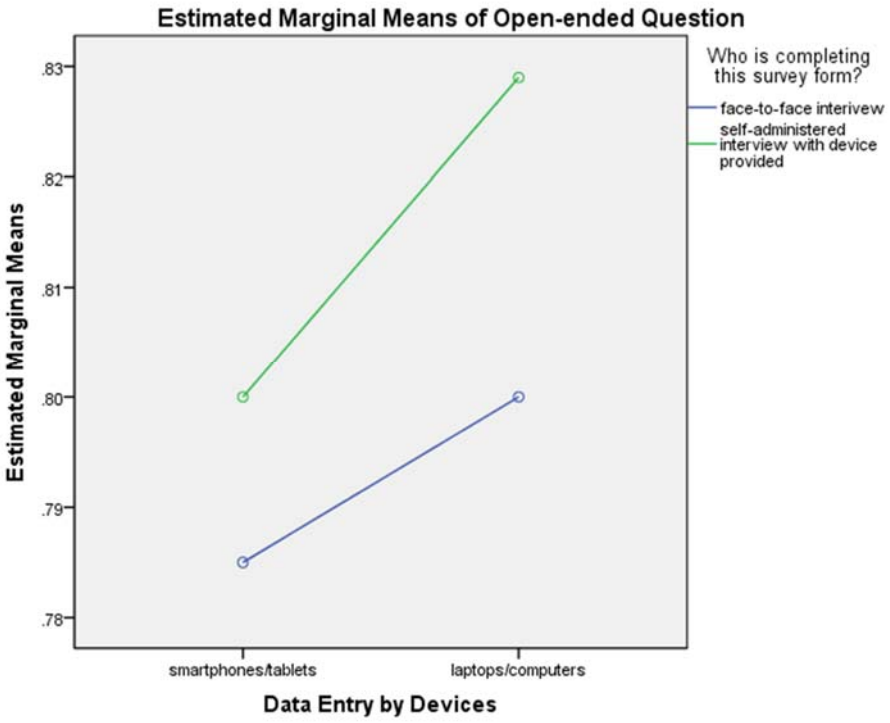

**Table 1. Item Completion Rates by Data Collection Modes and Question Format**

| | Data Collection Mode | | | | | | 95% CI for Mean Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| | CAPI | | | IASAD | | | | | |
| | M | SD | n | M | SD | n | | t | df |
| Open-ended | 0.791 | .059 | 134 | 0.809 | 0.072 | 136 | -0.034, -0.002 | -2.202* | 268 |
| Close-ended | 0.848 | 0.111 | 138 | 0.877 | 0.115 | 138 | -0.055, -0.001 | -2.076* | 274 |
| Matrix | 0.965 | 0.077 | 138 | 0.958 | 0.084 | 138 | -0.013, 0.026 | .677 | 274 |
| All Questions | 0.898 | 0.081 | 138 | 0.958 | 0.084 | 138 | -0.031, 0.007 | -1.212 | 274 |

* $p < .05$.

**Table 2. Socially Desirable Answers Comparison by Survey Modes**

| | Data Collection | | | | | | 95% CI for Mean Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| | CAPI | | | IASAD | | | | | |
| | M | SD | N | M | SD | N | | t | df |
| How often do you read email from university or department (1-5) | 3.71 | 1.095 | 136 | 3.73 | 1.095 | 179 | -0.258, 0.232 | 0.105 | 313 |
| How often do you read email from professors without Canvas heading* (1-5) | 4.52 | 0.761 | 135 | 4.36 | 0.808 | 177 | -0.019, 0.333 | 1.743 | 310 |
| How often do you read email from professors with Canvas heading* (1-5) | 4.50 | 0.800 | 135 | 4.34 | 0.796 | 178 | -0.026, 0.333 | 1.687 | 311 |
| How often do you read email from academic advisor* (1-5) | 4.10 | 1.010 | 136 | 3.93 | 1.045 | 178 | -0.067, 0.393 | 1.390 | 312 |
| Are you involved in any campus student organization* (1 no, 2 yes) | 1.39 | 0.488 | 135 | 1.30 | 0.458 | 179 | -0.017, 0.195 | 1.659 | 312 |

* $p < .05$.

**Table 3. Response Quality by Response entry Devices between Question Formats**

| | Response entry | | | | | | 95% CI for Mean Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| | Smartphone/Tablet | | | Laptop/Computer | | | | | |
| | M | SD | n | M | SD | N | | t | df |
| Open-ended | 0.798 | 0.049 | 118 | 0.816 | 0.071 | 122 | -0.034, -0.003 | 2.295* | 238 |
| Close-ended | 0.847 | 0.135 | 124 | 0.8767 | 0.113 | 124 | -0.061, 0.002 | -1.865 | 246 |
| Matrix | 0.956 | 0.093 | 124 | 0.9612 | 0.079 | 124 | -0.028, 0.016 | -0.545 | 246 |
| All Questions | 0.892 | 0.105 | 124 | 0.912 | 0.083 | 124 | -0.043, 0.004 | -1.614 | 246 |

* $p < .05$.

**Table 4. Predictors of Open Ended Question Completion Rate**

| | Standardized beta |
|---|---|
| Device | 0.16** (0.01) |
| Mode | 0.16** (0.01) |
| Gender | -0.06 (0.01) |
| Household Income | 0.09 (0.01) |
| Residence (on/off campus) | -0.10 (0.01) |
| Class Standing | 0.03 (0.01) |
| $R^2$ | 0.07*** |
| N | 314 |

*Note. Cell entries are ordinary least squares (OLS) standardized coefficients (β). Standard errors are in parentheses.*

* $p < .05$, ** $p < .01$, *** $p < .001$.

**Table 5. Benefits and Limitations of Hybrid Interviewer-Assisted Self-Administered Web Survey Mode with Provided Response entry Devices (IASAD)**

| Benefits | Limitations |
|---|---|
| Same high participation rates as face-to-face | Must be conducted in locations with at least cellular data access |
| Respondent is free from interviewer bias after being recruited | Population sample must be centrally located to deploy interviewers efficiently |
| Allow respondents to browse the questionnaire at their own pace and visual display of content | Respondent must be comfortable to enter answers on a smartphone or computer |
| Slightly less time required to complete the survey than Face-to-Face/CAPI | Inefficient if the questionnaire is too long (such as over 20 minutes) |
| Interviewer can show ID and display of questionnaire in front of respondent increase credibility and trust | High cost of hiring and training interviewers |
| Complete anonymity and no trace of the respondent's identity | Not suitable for surveys with many matrix questions (higher possibility of satisficing) |
| Provide assistance to respondent as needed and can reach out to the less advantaged groups without those devices | |
| Paradata available to check on interviewer and respondent | |
| Free from response entry errors by interviewers and reduce burden on interviewers | |
| Can offer tangible gifts as incentives to participate | |
| Gain advantage of multiple modes but with standardized question and answer format in one single mode, better than incomparable mixed mode data | |