Audience response systems as a data collection method in organizational research

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Abstract:

Audience responses systems are electronic devices allowing audience interaction and they are increasingly being used in educational and business settings to enhance various pedagogical and practical processes. This paper discusses how ARS technology may be used as a method of collecting data for research purposes. Specifically, this paper demonstrates ARS technology's potential utility by duplicating findings from two organisational studies, it discusses how ARS technology may be used to address three prevalent data collection problems, and it suggests how ARS technology may provide scholars with increased access to certain organisational settings, as well as greater integration between research and service activities.

Keywords: audience response system | personal response system | audience response technology | data collection techniques | data collection technology | organizational research methods

Article:

INTRODUCTION

Data collection is an important element of any research methodology. As scholars strive to understand behavioural phenomena in organisations, the need for data collection methods that are convenient to both scholars and respondents and which may be used to gather data from a wide variety of organisational settings becomes important. This is especially true given evidence suggesting that individuals are becoming less inclined to participate in organisational research (Bryman 2000). The purpose of this paper is to discuss how audience response system (ARS) technology may be used to collect data for research purposes.

This paper is in four parts. First, we review the literature on audience response systems and discuss how they are traditionally used. Second, we duplicate findings from two organisational studies to demonstrate how ARS technology may be used to test theory. Third, we discuss how ARS technology may be used to address three prevalent data collection problems. Fourth, we discuss other issues related to using an ARS for research, including limitations and benefits, such

as increased access to certain organisational settings and a greater integration between research and service activities.

AUDIENCE RESPONSE SYSTEMS

An audience response system is an electronic device designed to allow immediate interaction between an individual presenter and a large audience. An ARS typically has two parts. The first component is a remote control (or 'clicker') that audience members use to respond to questions. The second component is an electronic receiver (or 'hub') that records, and optionally, displays individuals' responses. An ARS allows for a large number of individuals to respond simultaneously (e.g. 1,000 people). Each individual response is recorded by the hub and can be displayed via projector or exported as a data file for use in other software. For example, a presenter during a board meeting could use an ARS to present a multiple-choice question to a group of partners, have each partner choose an answer, and then immediately display the number selecting each answer.

ARS technology in education

ARS technology was originally designed as a pedagogical tool to enhance student learning in elementary, middle- and high-school, university, and post graduate settings (Fies & Marshall 2006). Caldwell (2006) documents the use of ARS technology in fifteen different disciplines of higher education (e.g. medicine, physics, psychology; also see Duncan 2006). The growing use of ARS units reflects the many benefits they can provide for teachers and students. For example, Homme, Asay, and Morgenstern (2004) reported an increase in attendance and enthusiasm of resident doctors using an ARS for board review sessions. Similarly, Miller, Asher and Getz (2003) found that participants using ARS units reported greater presentation quality, speaker ability, and attention during professional education programs when compared to participants not using an ARS. Others have reported that use of an ARS benefits a range of classroom activities, including collecting demographic information, allowing students to share knowledge and experiences pertinent to course content, polling student opinions on various academic and public policy issues, testing comprehension of course material, giving in-class quizzes, and facilitating group discussion (Byrd, Coleman & Werneth 2004; D'Arcy, Eastburn & Mullally 2007). Overall, student involvement, attendance, and engagement appear to increase when ARS technology is used as compared to when it is not (See Fies & Marshall 2006, for a review of empirical evidence).

ARS technology in organisations

ARS technology is used in organisational settings, as well. There is a growing body of literature in the trade and management press advocating ARS use. A basic search of the EBSCOhost database using the phrases 'audience response system' and 'personal response system' found 105 pieces in the practitioner and academic press (search conducted February 24, 2009). Examination of these pieces showed ARS use in a variety of organisational contexts. For example, Krantz (2004) reported on marketing organisations using an ARS to receive feedback from potential customers at tradeshows. Hatch (2003) described the use of ARS technology in such activities as strategic planning, brainstorming, monitoring training effectiveness, and ice-breaking. ARS use

has also been reported to increase organisational efficiency and effectiveness in decision making and team planning meetings (Training and Development 2006). Organisations that have adopted ARS technology include Boeing, Academy of the US Federal Bureau of Investigation, IBM, John Deere, McGraw-Hill, National Academy Foundation, Prentice-Hall, Raytheon, Toys 'R' Us, United States Army and Navy, Walt Disney World, and YMCA (e.g. see http://www.einstruction.com for a list of firms using their particular ARS unit). The diversity of these organisations suggests the broad-based adoption and use of ARS systems by organisations.

ARS technology in academic research

Despite the growing use of ARS units in academic institutions, there has been little consideration of how an ARS may be used to gather data for research purposes. Some authors have mentioned the possibility, but most have not subjected the idea to rigorous consideration (e.g. Gamito, Burhansstipanov, Krebs, Bemis & Bradley 2005; Draper, Cargill & Cutts 2002). A notable exception is Bunz (2005), who compared data collection using machine-readable forms and an ARS. The results showed no difference between methods in time pressure effects on responses. In addition, students were more engaged in answering questions through the ARS and found the ARS no more or less difficult than traditional forms. Overall, Bunz (2005) supports the use of ARS technology as a data collection method, highlighting the benefit of quick, electronic data storage, and suggesting that because many university and businesses are adopting ARS units, their availability to scholars and response participants is increasing.

USING AN AUDIENCE RESPONSE SYSTEM TO TEST THEORY

One important limitation in Bunz's (2005) study was it did not investigate any behavioural phenomena or theoretical relationship among constructs. Because of the study's focus on respondents' competence and ability to use computer- mediated technology (Bunz 2005), it did not consider whether substantive research findings could be influenced by ARS technology use. In this section, we demonstrate how ARS technology may be used for theory testing.

Portions to two organisational studies were duplicated to show that ARS technology is a viable and unbiased method for collecting data. The first replicated study concerned volunteer behaviour (Murnighan, Kim & Metzger 1993). The second addressed group size effects in collective action (Franzen 1995). These studies are described below. The hypotheses are summarized briefly, the replication method is detailed, and then the ARS results are compared with the original findings.

Study 1: The volunteer dilemma

Murnighan and colleagues (1993) drew on game theoretical, organisational, social psychological and evolutionary perspectives to develop a variety of hypotheses about volunteer behaviour. Two fundamental hypotheses they tested in a series of studies were:

> Hypothesis 1. The proportion of volunteers will decrease as the size of the group increases.

Hypothesis 2. The proportion of volunteers will decrease as the payoff for volunteering decreases.

Hypothesis 1 reflects the logic of free riding (Olson 1965), since many volunteer situations require only one party to sacrifice (i.e. volunteer) before the entire group benefits. The presence of many potential volunteers makes each person less willing to volunteer. Hypothesis 2 is based on the assumption that volunteers incur costs that nonvolunteers do not (Diekmann 1985). As volunteering becomes increasingly costly, individuals are less likely to volunteer.

Murnighan and colleagues (1993) ran four experiments in a mixed-hybrid repeated measures design. The first experiment included Hypotheses 1 and 2 and the next three experiments replicated these findings and made various extensions. The results supported both hypotheses: as group size increased, the proportion of volunteers decreased; and as the payoff for volunteering decreased, the proportion of volunteers decreased. There were no interactions predicted or observed.

Study 2: The assurance dilemma

Franzen (1995) used a repeated-measures between-subjects design to test the effects of group size on various collective action problems. Group size was hypothesized, and subsequently shown, to reduce cooperation rates in situations where mutual cooperation always yielded higher payoffs than unilateral or mutual defection. Dilemmas with such a payoff structure are called 'assurance' dilemmas because coordinated action gives higher payoffs only if all actors cooperate. Therefore, each party wants to be assured of how the other party will act (Sen 1985). For example, in a union wage dispute, each worker would prefer to walkout and lobby for a pay raise (Heckathorn 1996); however the walkout strategy is only attractive if the worker is assured that everyone else will also walkout. Therefore, Franzen (1995) predicted that:

Hypothesis 3. Cooperation rates in assurance dilemmas will decrease as the number of players increase.

Group size has a negative effect on cooperation rates in assurance dilemmas because, as the group gets larger, the probability that someone will fail to cooperate increases (Franzen 1995). The fear that at least one person will not cooperate leads others to do the same in self-defense (Liebrand 1983). Franzen's (1995) results supported the hypothesis; cooperation rates fall as the number of players increased.

Data collection using an ARS

The ARS used in this research was the i-clicker (see Barber & Njus 2007; D'Arcy et al. 2007, for reviews and detailed descriptions). The i-clicker ARS has a hand-held, five-option unit for respondents (e.g. choose A through E) and an electronic hub that collects all respondent data. This particular ARS offers the option to display frequency histograms of responses, which individuals have responded, and what each individual response was. Data stored in the hub include the breakdown of responses for each question posed (including the text of the question itself), a question-aggregate spreadsheet of how each person responded to a given question, and

a person-aggregate spreadsheet of how each person responded to various questions posed on various dates.[1]

Thirty-three undergraduate students (12% female) enrolled in an introductory business course at a large public university served as the participants for both studies. All were third or fourth year students of various educational backgrounds. The majority of participants had work experience in organisational settings, and all were familiar with the ARS model being used. Informed consent for using data gathered from the ARS technology was acquired during the first lecture of the semester.

Upon entering, participants were welcomed and told they were going to participate in two exercises using their 'clickers.' Students were first asked to press option 'A' on their clicker to assure that the units were registering with the ARS hub. The first of six scenarios was then presented to the participants via an electronic projector. Scenarios were presented in random order.

A volunteer dilemma scenario was presented first, which was adapted from the volunteer dilemma game used in Experiment 3 of Murnighan and colleagues' (1993) study. This scenario involved a telecommuting work organisation where the manager needed only a certain number of staff (e.g. 10 people) to work extra hours on a project for a fixed sum of money (e.g. $100). However, the workers were unable to talk to one another, and the task was such that any excess workers would not be needed or paid. Because the work was telecommute-based (i.e. done remotely), the workers had to complete the task before learning whether they were needed or would be paid. The participants in the experiment took the role of potential workers and made the decision to work or not.

After reading the scenario aloud, the instructor activated the ARS hub to receive responses. Participants were asked to make their decision. The ARS hub displayed a count of the total number of responses. No time limit was set, but the time required for all participants to respond was less than 40 seconds in every scenario. Once all participants had responded, the instructor displayed the next scenario and repeated the procedure with three more volunteer dilemma scenarios. These scenarios were similar to the example above, except for variations in the number of workers needed (10 or 100) and the payment to those whose work was used ($100 or $1000).

Following the volunteer dilemma scenarios, the instructor then presented a series of assurance dilemma scenarios with payoffs similar to Franzen (1995). The scenarios asked participants to imagine themselves as representatives of various student organisations of the university and that they were all involved in a conference meeting where students may use their clickers to vote on resource allocation decisions for campus events. The procedure of asking for responses and

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[1] Of course, the researcher should always take caution as to protecting the identity and privacy of the participants using ARS technology. ARS units have the option of displaying participant responses either at the individual or group level and are designed to link responses to individual clickers while still maintaining the privacy of a participant to the other participants and researcher (if desired). In conducting both studies in this paper, the i-clicker was setup so that individual confidentiality was preserved, and only the researcher knew which clicker corresponded to an individual participant.

waiting until all participants had responded was used again. A second volunteer dilemma scenario was then read, identical to the first except for the number of student organisations involved in the activity (40 instead of 2).

Duplication from using an ARS

The pattern of ARS-collected responses duplicated those reported in both of the previous studies. As in the original (Murnighan et al. 1993), volunteer payoff had a significant positive effect on volunteering behaviour. Categorical data analysis showed that twelve percent of participants volunteered in the low payoff condition compared to 32% volunteering in the high payoff condition ($\chi^2_1 = 6.17$, $p < 0.05$). Group size had a significant negative effect on volunteering behaviour, with 12% volunteering in the large group condition and 32% volunteering in the small group condition ($\chi^2_1 = 6.17$, $p < 0.05$). There was no evidence of an interaction ($\chi^2_1 = 0.01$, $p = 0.93$). Similarly, in the duplication of Franzen (1995), a McNemar test was significant (Siegel 1956), showing that group size had a significant negative effect on cooperation rates: 85% cooperation in the two-player case versus 52% cooperation with 40 players ($\chi^2_1 = 6.67$, $p < 0.01$).

Taken together, these two studies yielded findings consistent with the original studies' results, despite the use of an ARS for data collection. This suggests that the ARS technology did not introduce methods bias, and that ARS is thus a potentially useful method for collecting data to test theoretical predictions.

AUDIENCE RESPONSE SYSTEMS AND THREE DATA COLLECTION PROBLEMS

In this section, three prevalent data collection problems are reviewed. These challenges are the cost-response problem, the large sample-size problem, and the data-entry error problem. We then discuss how ARS technology may resolve each of these problems.

Cost-response problem

Most traditional data collection methods (e.g. in-person and mail surveys) require a tradeoff between cost of implementation and rate of response (Sproull 1986). Mail surveys make data collection relatively inexpensive, but generate low response rates. In contrast, laboratory experiments and other in-person approaches enjoy higher response rates, but typically incur greater costs in terms of logistics and time.

Recognizing these tradeoffs, Sproull (1986) suggested that any new data collection method intended to alleviate the cost-response problem should have three features. First, the method must be accessible to respondents. E-mail is a good example of an accessible method, since it is a very common means of communication in organisational settings, and one that Sproull (1986) advocated using to administer survey and interview questions. The second criterion is that the proposed new method must engage respondents during data collection. Doing so would address the primary challenge of mail surveys, which tend to have low response rates because of the respondents' lack of engagement (Sproull 1986). Finally, the new method must produce results

comparable to those collected by traditional methods. That is, no method bias should be introduced.

Large sample size problem

A second data collection problem facing scholars is attaining sufficiently large sample sizes. Small sample sizes may suffer from low statistical power (Cohen 1988), generate imprecise estimates (Pedhazur & Schmellin 1991), and have a risk of weak statistical conclusion validity (Stone-Romero 2002). The obvious solution is to increase sample size. However, acquiring a large sample typically leads to greater costs in time, money, and effort (Shadish, Cook & Campbell 2002). As such, the large sample-size problem is linked with the cost-response problem; increasing sample size usually means expending more resources.

In laboratory studies, for example, researchers can attain a large sample size, but doing so typically requires running many waves of participants. Even the recent solution of using computers to collect lab data can still be prohibitive in terms of time costs. Studies using mail or e-mail for data collection similarly use multiple waves of requests and reminders to solicit higher response rates and thereby attain larger sample sizes (Dillman 2007). Many behavioural scientists have begun using online surveys as a way to decrease material costs but often continue to face the issue of low response rate (Rogelberg, Church, Waclawski & Stanton 2002).

Data entry error problem

Data-entry error has been an ongoing research concern for decades (e.g. Smith 1967; Czaja, Sharit, Nair & Rubert 1998). Data-entry errors may occur in any situation where responses recorded in one format are transferred to another (e.g. typing hardcopy into a computer; Feng 2004). At best, such errors increase research costs, because finding and correcting errors requires time and effort (James 1990). However, unrecognized data-entry errors may have far more devastating effects, leading to unintentional misrepresentation of results, false conclusions, and misdirection of subsequent investigation (Rosenthal 1994; Starbuck 2004). Data-entry error is a serious source of concern for researchers.

To address the data-entry error problem, scholars have posed a variety of methods. The three most pertinent to our discussion are double data entry, random selection data checks, and using electronic technology for data collection. Double data entry involves having all data entered independently by two persons. The two data sets can then be compared for differences. This method will alleviate data entry error, but it is potentially costly in time and labor (James 1990). Random selection data checks are similar, but use only a subset of the data: one person enters the data and then another chooses a random sample of entered data points to compare to the original data. This approach is less costly, but also more fallible. A more recent solution is to use electronic technologies to eliminate the risk of manual data entry error (Hansen & Hill 1998). Current best practice favors this electronic approach, using such devices as computers and the Internet to address data entry error (e.g. Rogelberg et al. 2002; Scandura & Williams 2000).

Using an ARS to address these three problems

ARS technology can address all three data collection problems. First, ARS technology fulfills Sproull's (1986) three requirements for overcoming the cost-response problem. Since many educational and business organisations are adopting ARS technology (Duncan 2006; Fies & Marshall 2006), the accessibility and convenience of ARS use is increasing (Draper et al. 2002). ARS units also meet Sproull's (1986) criterion of participant engagement: respondents in both education and business settings consistently report higher engagement and attention when using ARS technology than when not (e.g. Byrd et al. 2004; Miller et al. 2003). Sproull's (1986) third criterion was that the new technique does not introduce method bias. The results we presented above, duplicating previous findings, suggest that ARS technology does not introduce method bias.

The second data collection problem, attaining large sample sizes, may also be addressed through ARS technology, because it makes data collection from such large groups both convenient and efficient. At the authors' university, for example, there are typically two annual sections of the Introduction to Organisational Behaviour class, each with more than 550 students. An ARS is frequently used in this class to gather survey questionnaire data on attitudes, preferences, and behaviour responses to complex decisions. A key advantage of the ARS technology is that data collection and entry for even 1,000 respondents takes no longer than for a group of 30. Of course, ARS units will be most useful with respondents who are already familiar with the technology, but Bunz (2005) reports that respondents unfamiliar with ARS units can be taught to use the technology reliably in 10 minutes.

The third data collection problem, data-entry error, is eliminated by ARS units because all responses are automatically stored in the receiving hub and exported into traditional computer files for analysis (Bunz 2005). Barber and Njus (2007) reviewed six of the most commonly used ARS hubs and found that all can store and save response data along with the date and time of the response. Data-entry error is therefore eliminated by use of an ARS, since manual transfer is not required.

In summary, ARS technology has the potential to overcome three of the most common and important data collection problems facing researchers: the cost-response problem, the large sample-size problem, and the data-entry error problem.

ADDITIONAL CONSIDERATIONS OF ARS TECHNOLOGY

An ancillary benefit of using an ARS is its ability to integrate with other electronic technologies and events that are already present in organisational settings. For example, Krantz (2004) used ARS technology to acquire consumer feedback on products during a tradeshow; relevant research questions might easily have been added to this implementation. Similarly, ARS units are increasing in popularity in strategic decision planning and committee voting sessions in business organisations (Training and Development 2006). Both examples suggest opportunities to use ARS technology for the study of intact organisational groups in a way that is seamless, convenient and unobtrusive (also see Webb, Campbell, Schwartz & Sechrest 2000). If a team or department is already using an ARS in planning, researchers could easily access that data and integrate items of their own. Doing so offers many advantages, in terms of validity, simplicity, non-invasiveness, and ability to give back to research participants (Eden 2003).

These advantages are equally relevant in traditional student-based research, which offers the possibility of creating closer integration between teaching and research. There is a long history of viewing teaching and research as conflicting demands (Boyer 1990; Task Force on Teaching and Career Development 2007), such that teaching detracts from research productivity and prestige (e.g. Fox & Milbourne 1999; Armstrong & Sperry 1994; cf. Hattie & Marsh 1996). A common perspective is to treat decisions about teaching and research as a zero-sum game, wherein effort allocated to one must diminish the other (e.g. Kerr 1975; Murphy 1994). However, ARS technology may provide a way to integrate research and teaching (Magolda 1999). The study replications we presented above were also used for an in-class exercise where the students' data were immediately used to instruct students on social decision making. The two ends of teaching and research were served simultaneously. Similar applications could work in field settings, with scholars simultaneously collecting data and providing informative feedback to host organisations. This may help to address the growing reluctance to participate in organisational research (Bryman 2000).

Another potential benefit of using ARS technology applies to the study of controversial or sensitive topics in organisations such as sexual harassment, sexuality, and whistle blowing.[2] ARS technology could assist in the study such rare phenomena. For example, it would be possible to use an ARS to ask a room of 500 individuals (students or business people) if they had ever been sexually harassed, and then immediately present aggregate results while providing complete anonymity to individuals. Such anonymity may elicit more candid responses and less social desirability bias. Scholars could also potentially use such data to efficiently and quickly screen respondents for further research purposes.

Of course, no data collection method is perfect (Eid & Diener 2005), and ARS technology has its own limitations. One important challenge of ARS technology is the relatively high upfront cost in money and learning time (Barber & Njus 2007). A second potential challenge has been identified by instructors using ARS units in the classroom: cheating, wherein one student uses multiple clickers on behalf of absent classmates (Duncan 2006). A third challenge is that not all ARS units are alike in terms of options. While we do not advocate any particular ARS, we suggest that potential adopters be certain the technology fits their specific needs (e.g. collecting responses on a 9-item scale is not possible with an ARS unit that only has five key options). Scholars should select the ARS technology to match the desired form of data necessary for answering the research question. For example, the i-clicker only allows responses in the form of individual data points (e.g. multiple choice format), while other ARS technology allows participants to respond to questions using complete numerical and letter keypads - allowing for the collection of short open-ended responses(See Fies & Marshall [2006] for an extensive review and comparison of current ARS technology systems). Table 1 provides a summary of the potential benefits and challenges of using ARS technology.

In conclusion, we neither expect nor advocate that ARS technology will replace traditional data collection methods such as mail surveys or lab studies. Rather, we see ARS technology as a complementary addition to existing methods, offering strengths where other methods have

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[2] We are grateful to Ed Diener for bringing this potential benefit to our attention.

weaknesses. As such, ARS is probably best used in combination with other methods to help conduct a more complete study of various behavioural phenomena (Eid & Diener 2005).

Table 1. Benefits and challenges of ARS technology as a data collection tool

Benefits	Challenges
Increasing use of ARS technology by organizing provides researchers greater ease of using existing ARS units to collect data	Technical problems: poor signal perception; clicker malfunction
Ease of using ARS technology allows researchers to enter organizations and collect data in many regular business settings	Moderate to high upfront costs for ARS technology
Provides researcher with high response rates at low costs	Time required for scholar and participant to learn ARS use
Researcher may collect data from large samples quickly and efficiently	Organizations use different ARS technology
Accurately collects and stores data from audience respondents	Not all ARS technology allows participants to answer at their own pace
Provides a means for investigating behavioural contexts that typically are a challenge to researchers; e.g., large group, rare behaviour, field experiments)	Double sourcing: a person can answer for others using their clicker
	Possible awkwardness of using ARS technology in various organizational settings (e.g. religious settings, prisoners)
	Constraint on type of data collected contingent of ARS technology used to gather data.[3]

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[3] Although the specific data-input function of a particular system represents a potential constraint (e.g. a 5-button keypad prevents collecting open-ended responses), we note Ray Cooksey's insightful observation that such constraint may actually serve as an impetus to better research designs, by prompting more careful and/or creative thought about the data collection protocol.

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