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BallotShare: An Exploration of the Design Space for Digital Voting in the Workplace

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Abstract Digital voting is used to support group decision-making in a variety of contexts ranging from politics to mundane everyday collaboration, and the rise in popularity of digital voting has provided an opportunity to re-envision voting as a social tool that better serves democracy. A key design goal for any group decision-making system is the promotion of participation, yet there is little research that explores how the features of digital voting systems themselves can be shaped to configure participation appropriately. In this paper we propose a framework that explores the design space of digital voting from the perspective of participation. We ground our discussion in the design of a social media polling tool called BallotShare; a first instantiation of our proposed framework designed to facilitate the study of decision-making practices in a workplace environment. Across five weeks, participants created and took part in non-standard polls relating to events and other spontaneous group decisions. Following interviews with participants we identified significant drivers and limitations of individual and collective participation in the voting process: social visibility, social inclusion, commitment and delegation, accountability, influence and privacy.

Keywords: Decision making, e-voting, social voting, HCI.

1 Introduction

Throughout the many years of the evolution of democratic decision making, many configurations of voting have been proposed, adopted and discarded on the basis of contextual considerations that have reflected the changing needs of stakehold-

ers. In recent times, digital technology has been applied to voting in order to realize benefits that primarily relate to the convenience (of access) and efficiency (of deployments). However, whether technology is fulfilling its potential to support voting practices is still a matter of much debate, with political theorists arguing that simply using it to remove barriers to participation will not increase the quality of the resulting participation [39]. This suggests that encouraging participation in voting situations cannot be achieved simply through provision of convenient access to a digital interface.

The need to reach some form of consensus is a common requirement of the everyday lives of groups of people, and decisions regarding who can vote, and how they can vote, are fundamental to the acceptance of decisions made by the group. The configuration of any poll amongst a group reflects the specific values of, and challenges faced by, that group. The needs and values of the polls' participants are revealed through trade-offs in the design of voting processes, including the way voters are able to express their preferences, which can range from a direct collection of opinions to a more deliberative discussion of the issues at stake. Technology has facilitated voting in scenarios ranging from political debate, television talent shows, to the agreement of meeting times between collaborators. In such cases, digital technologies have in general only served to increase the spatial and temporal "reach" of conventional polls (i.e. amongst spatially distributed groups of individuals). However, we identify that the potential of digital technology to enhance voting-based decision making is relatively untapped, and that methods of digital voting provide the opportunity to re-envision voting as a social tool that can better serve democracy by exploiting the context-specific stimuli of participation. Despite the diversity in how different communities reach consensus, there is currently little research into how design of digital polls can impact the overall experience of voting, and influence participation.

In this paper, we first explore a range of instantiations of voting systems across a wide spectrum of decision-making contexts, from institutional (e.g. political elections) to informal (e.g. social media polls, idea management systems etc.). On the basis of this exploration we then propose a framework with which to describe the design space of voting from the perspective of designing for participation. We then introduce *BallotShare*, an initial instantiation of our proposed design framework that serves as a technology probe [21]; its purpose is to explore decision making practices through a system that incorporates social media dynamics alongside the act of voting. We report on a five-week deployment of *BallotShare* during which time we collected 578 user interactions within polls whose purpose ranged from the organization of social activities to more spontaneous act of decision-making such as the naming of a robot. Interviews were conducted to explore voting behaviors and drivers of participation. Our findings highlight the importance of individual and collective efficacy in voting and we identify significant drivers and limitations of individual and collective participation in the voting process: social visibility, social inclusion, commitment and delegation, accountability, influence and privacy.

2 Related Work

The technological mediation of voting as a process of group decision making has received considerable attention from researchers of different disciplines: computer scientists explore the security requirements of digital voting in elections; political scientists study the use of voting in deliberative systems to facilitate consensus; psychologists have considered voting as a form of computer supported cooperative work and computer mediated communication (CMC); and more recently human-computer interaction and interaction design researchers have examined how the introduction of voting channels, such as SMS voting and situated devices in communities, can enhance citizen engagement.

Electronic voting (e-voting) has received considerable scrutiny by the computing security community. After highlighting the lack of elementary security practices of direct recording electronics widely used in a number of countries for voting in national elections [22,32], computer security researchers focused on the development of end-to-end verifiable e-voting systems that aim to ensure the auditability and verifiability of the electoral system. The underlying assumption of the introduction of e-voting systems in governmental elections is that it will make the voting process faster, more usable, and provide multiple channels of participation (thereby increasing participation). A number of secure verifiable systems have been proposed (e.g. [10,25]), the security of which is widely supported by security researchers. However, due to false perceptions of voters about the functionality of the system, a number of unanticipated security and usability issues have come to light [5,8,35]. The origins of the prevailing disinterest in applying these systems in binding elections in many democracies are not well understood, and range from the political (e.g. funding provided to large software and hardware companies without the security expertise) to the administrative (e.g. difficulties in administrating and supporting the voting system by electoral officials lacking the required expertise). Furthermore, the ability of these systems to facilitate participation is questionable as has been demonstrated in recent studies of voters' perception of, and trust in, electronic voting [8,17].

Political scientists' studies of digital voting have generally focused on the facilitation of consensus building through deliberative systems [16]. Deliberative decision making and deliberative democracy puts deliberation in the center of decision making (as compared to mere voting). However, the size of modern democracies and the diversity of opinions that can be found in healthy democracies mean that decision making through large-scale deliberation alone is infeasible. The relationship between a deliberative process and voting is an ongoing debate, and one in which the predominant view of voting is as tool that is only appropriate for the resolution of a partially successful, or unsuccessful, deliberative process. Where voting is used, deliberation is still considered to have an important impact on decisions, as voters cast more informed votes as a result. However, for most conceptions of the accomplishment of deliberative democracy, citizens have to already be engaged to participate in intense processes of information and opinion exchange.

In practice, in most national or local democracies only elite members of society or elected representatives actually practice deliberation. The use of digital technologies in this process is still in its infancy, and only a relatively small number of examples (e.g. [12,13]) have attempted to exploit the 'accessibility' of the internet to involve more citizens in the deliberative process of political decision making.

Over the last twenty years, the advances in computing and communication technologies have revolutionized group meeting and computer mediated communication (CMC) [3]. Questions continue to be explored as to how CMC affects group decisions and group performance, and a number of studies have suggested that CMC systems could theoretically yield superior results to face-to-face communication (with some exceptions, e.g. anonymity of members) [3]. Recent studies have considered real-world data sets from collaboration systems such as Wikipedia [7,24,40] to examine how consensus is achieved in open source (collaborative) projects, and how different variables such as group size, group formulation, and experience can lead to better decisions. The main findings suggest that larger groups, with more diverse contributions, and more experienced members are more likely to arrive at better decisions.

In the human-computer interaction community there has also be an active program of exploration of the ways in which e-voting can be used for wider engagement in different contexts, from decision making in the working environment to citizen engagement in local communities and activism [38]. In-situ technologies have been deployed in libraries [31], classrooms [11] and other public spaces in attempts to promote and support different forms of civic engagement [20,27,36]. Taylor et al. [36] demonstrated how simple situated voting interfaces can encourage participation in local communities and identified a number of key design considerations for such systems, including efficacy, credibility and a range of practical matters related to the design and physical location of voting devices. Mechanisms for promoting perceived efficacy – the belief that voters have that there action will effect a change [9] – was considered the key design parameter for decision making and voting systems. Saad-Sulonen et al. [33] used collaborative design and "design of politics" [15] to explore how the design of an interactive system could reflect on citizen participation in urban planning. They conclude that it is possible to affect citizen participation by developing flexible systems and by applying technological participatory design that allows adaptation of the system by its users. Voting and collective decision making, using digital technologies, have to a limited extent been studied in the context of idea management systems (IMS), primarily in formal contexts (e.g. work environments). For example, Bailey & Horvitz [2] described value of idea management systems within a large organization and proposed design recommendations for the design system to support grassroots participation in IMS. Indeed, IMS are a particularly good example of a class of system that incorporates voting not only as the means by which to reach the end point of a deliberative process, but also as a tool to support deliberation.

3 Design Framework

Instantiations of digital, and also conventional, voting can be found in a wide variety of forms, including social media polls, online scheduling, idea management systems, shareholder meetings, family decision making and national and local binding elections. These can be binding/non-binding, reoccurring/spontaneous, deliberative/direct, off-situ/on-situ etc. and are not only designed to be appropriate for specific contexts, but also to support different types of user participation. For example, for social media polls, 'liking' stories online and online petitioning realize the direct collection of opinions, whereas forums for policy making or consultation try to mediate a more deliberative style of participation. Voting by raising hands in contexts such as family and workplace meetings is used to highlight the individual choices of members of the group, whereas voting in modern day local and national (political) elections involves more private voting formats to avoid coercion of voters (even though in earlier democracies more open systems have been used). Taking into account all the different contexts in which some form of voting is applied, we take a necessarily broad definition of e-voting: the use of technology to facilitate consensus by allowing voters to express their *consent* or *dissent, during* or *after* a process of decision making.

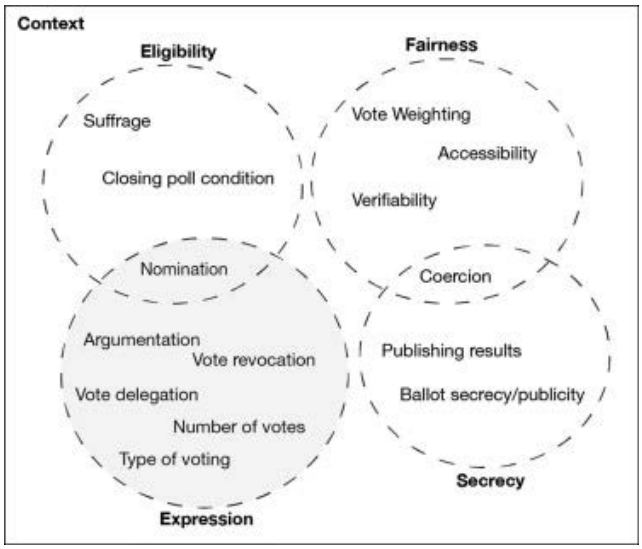


Fig. 1. The design space of voting for participation.

3.1 Configuring the Poll

There appears to be a rich yet largely underexplored design space to enable poll organizers to configure and affect participation according to the needs of a particular context. Ironically, most of the existing focus on e-voting system design for participation is to be found in computer security research. Computer security experts, in their attempt to prevent 'participation' of unauthorized users, have systematically unpicked the possible avenues for someone to participate in such systems and the possibilities that we have if we consider voting in a broader sense. One of many examples can be found in [19], which provides a definition of the constitutional requirements and design principles of e-voting systems; this identified the design principles of generality, freedom, equality, secrecy, directness and democracy as the requirements of voting systems. These principles, which are considered necessary for national binding elections, are not necessarily appropriate in less formal contexts. Figure 1 illustrates our proposed framework to capture the design space of digital voting for participation. The framework is derived not only from security research but also by reviewing the features of a number of widely used e-voting systems such as SMS voting, polling for scheduling [30] and idea management systems [2] (amongst others). Our framework is tractable, and thus easily extensible by other researchers. Each one of the design categories in the framework consists of a set of attributes of digital voting systems that can be found today across a broad spectrum of decision making contexts as discussed above. We consider the important decisions to be made in the configuration of any poll to be based upon the design categories of *eligibility*, *fairness*, *secrecy* and the method of *expression* given to voters.

3.2 Eligibility

The criteria by which someone is judged eligible to participate in a poll is one significant determinant of the credibility of a result. In political votes the principle of universal *suffrage* is commonly applied, which allows all adult citizens to vote. The choice of who is eligible to vote can significantly impact on participation where there is a concern that the voters are not representative of those upon whom the result would have the most impact. Participation can also vary according to context and hierarchy, for example, in a workplace setting, where only members of the board of directors might have a say on significant decisions. Digital voting systems can be designed to either facilitate this hierarchy or question it.

A typical *closing poll condition* is time-based and is normally fixed. In many political elections remote voting, such as voting by mail or in some cases Internet voting can "extend" this polling duration. In other voting contexts an event such as reaching a set number of votes can itself be used as termination condition. In gen-

eral, the question of which termination conditions are necessary to have a desired impact upon participation is context-specific.

3.3 Fairness

Considerations of fairness are based upon the perception that those eligible to vote have a proportional impact upon the result. If a voter does not feel their vote is having this impact the imperative to participate will be reduced. The one-person one-vote principle is characteristic of modern day political votes in western societies, yet there are many occasions where it might be considered unfair to assign all votes equal weight. The use of *weighted votes* is common where there exists a hierarchy of stakeholders with different levels of investment in a decision. For instance, voting within the council of the European Union is weighted so that the votes of countries with larger populations are "worth" more than votes from the smaller countries.

Accessibility seeks to ensure that eligible voters are able to cast a vote. Methods to maximize accessibility include proxy voting (where a delegated person can vote on the behalf of another person under extenuating circumstances) and remote voting (voting can take place away from a central voting location). Attacks on accessibility, such as voter suppression, attempt to influence a poll result by lowering participation. Typical suppression techniques include making it difficult for voters deemed "undesirable" to exercise their vote e.g. by introducing specific barriers to registration for voters from certain socio-economic groups [5]. There is an assumption that digital voting technology inherently promotes accessibility to the voting material, although in practice it risks disenfranchising members of digitally excluded communities. Remote voting, and more specifically Internet voting, is a particularly salient example as it is generally considered to have the potential to greatly reduce participation costs and increase the reach of the voting process (for a review of remote e-voting see [23]). However, the impact of Internet voting on levels of participation is a topic of some debate, with a number of studies indicating a negative effect for reasons such as the loss of ritual and locality [28].

Recent interest in e-voting has led security researchers to explore mechanisms to electronically verify the integrity of polls and allow voters to check that their vote was indeed counted – *verifiability* (see [19] for security requirements of e-voting systems). In most cases these verification techniques involve the use of mathematically strong proofs to verify the vote outcome. In most conventional voting systems (i.e. paper ballots), and in everyday decision-making, such mechanism are rarely found, most likely because the practical difficulty of performing a wholesale attack. Instead, conventional voting systems use other socially acceptable mechanisms to verify the correctness of the outcome (e.g. party representative or random citizens participating in vote counts).

3.4 Secrecy

Secret ballots are widely used to alleviate social effects (such as peer pressure) and avoid repercussions that may later face voters who have voted in a manner that is unfavorable to some institution, group or individual. In political votes, secret ballots also have implications for *coercion* resistance; when voters sell their votes, no documents are provided to verify that the vote has been cast a certain way. In other contexts being able to prove that a vote had been cast a certain way may be beneficial to gain support for future polls, or to show interest in a particular topic. Indeed, social media polls publicly show participants to increase social pressure for participation. In some cases it might be important to know that particular individuals have voted to give the results credibility. For example in small decision making panels, the casting of votes by experts about an issue in their field, even without having higher numerical value, gives the result additional reliability.

Another aspect of secrecy involves rules relating to the *publication of interim results* prior to the end of a poll. Sociological studies have indicated that such social stimuli can positively affect the quality of decisions made [37]. A recent study found that banner messages on a social network site about friends who had voted in government elections drove more than 280,000 more people to vote [6]. Moreover, by allowing participants to review the results before they vote we can increase their perceived self-efficacy and ultimately reflect on voters' participation [1,9]. Yet studies have demonstrated [34] that by publishing articles about the strength of leading contenders or opinion polls, a bandwagon effect [26] can be stimulated that leads voters to choose one of the 'apparent' winners.

3.5 Expression

Expression refers to the ways voters are permitted to express their preferences. Even though this is a key element of a users interaction with a voting system and is an important driver of perceptions of efficacy, only a small number of studies have explored the impact of different forms of preference expression [30,38].
Nomination refers to the way participants nominate options in a poll. In most Western democracies, voters have no mechanism of adding and managing spontaneous options to the ballot slip, although they may choose to spoil the ballot paper to register a protest or may be permitted to vote in favor of reopening nominations. On the other hand, candidate nomination in less significant polling contexts is much more dynamic as candidate options can be added almost anytime (e.g. social media polls, doodle etc.).

Vote delegation (or vote transferring) is another possible method of expression. In elections, votes cannot be transferred without extenuating circumstances. In the last few years however, initiatives such as LiquidFeedback [12] used by the Pirate

Party in Germany and lately in Italy by the Five Star Movement show the potential of vote delegation as an alternative or complement of representative democracy.

In most cases votes cast are non-*revocable* – a voter cannot change his mind after a vote is cast. Revocable votes have lately been proposed to cope with some of the security concerns (voting under the threat of an interested party) of remote Internet voting. As vote revocability allows voters to revisit their choices before the closing of the poll; voting can then be perceived as a longer process instead of finishing after the vote is cast. This can motivate effective discussion and argumentation between participants during the polling period as they explore further arguments to support their vote.

The *type of voting* is also an important decision that is often overlooked. Most of the voting systems today are approval-voting systems (the participants vote for a candidate instead of against one) that may lead to a plurality win or a proportional representation. An alternative is disapproval voting. Indeed, in ancient Greece one of the first forms of voting was disapproval voting - once a year citizens voted to decide who would be exiled for ten years. For technology mediated decision making systems negative voting could increase perceived self-efficacy by allowing individuals to demonstrate their objection to, or disagreement with, an item. Actions such as spoiling votes emerge due to the need for voters to express themselves in a manner the voting system does not allow. In addition to adding alternative options dynamically, negative voting could open a dialogue of possible alternatives that could lead to a new nomination phase. Finally, an under-explored area of research is the way in which items can be chosen by the voter e.g. whether voters can rank candidates or select one or more. Also the way that results are interpreted (proportional or single winner) likely affects participation and voting patterns.

In many cases each of the participants has the same *number of votes* to use (in most cases one vote per eligible voter). Depending on context, a more flexible system could lead to a result that better reflects the engagement of the participants who voted. For example, users of Viewpoint [14] suggested that allowing multiple votes per person was an effective way of capturing how strongly individuals felt about a community related issue. There is also an assumption that votes cannot be transferred to other polls. If this were allowed, the act of voting might become more challenging, as voters would need to consider strategies across a number of decisions rather than engaging in single-topic democracy.

Finally, whether a poll is designed to allow *argumentation* around the issues on debate and how this argumentation is presented is pivotal to the type of participation that the system motivates. By requiring a certain level of discussion before voting additional barriers of participation are added. Yet participation should be more effective as the decision is more carefully considered and the participants will be informed by the debate. In other cases it might be sufficient only to register participants' opinions through the vote.

4 BallotShare

BallotShare is a voting tool that allows a group of people to arrive at decisions (see Figure 2). As a first exploration of the proposed design framework - with a particular focus on the design category of expression - we designed BallotShare to reflect on the decision-making qualities of a workplace environment. Generally, in a workplace setting the group members are familiar with each other and situated for at least a few hours a day. This makes workplaces particularly social and inviting to discussion and collaboration. More specifically the working environment in which we deployed this first instantiation of the design framework (more details on the study's participants in the User Study section) is particularly sociable with most of the employees working in the same open space. The decisions in the group are made publicly but are in most cases driven by the more senior members of the group. The system is configured to support some of these practices (e.g. taking the decisions publicly) but also to provoke some others (e.g. the non-democratic nature of some of the decisions) and aims not only to support participation in everyday decision-making in mundane contexts but also to further democratize these contexts as a result. Wide research has been conducted on the effect of the workplace environment on democratic beliefs and practices [29], with findings suggesting that workplaces are pivotal environments for educating citizens in participation.

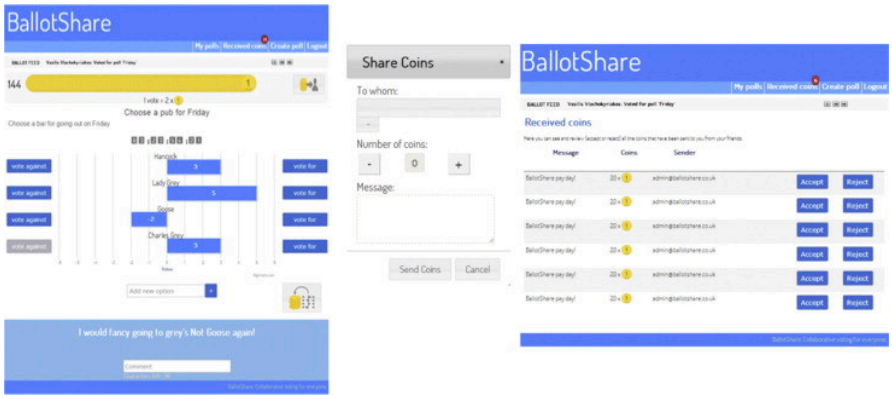


Fig. 2. Left: An open poll showing current results and options. Right: interface for vote delegation (sharing coins on the left, accepted and rejecting coins on the right).

A number of BallotShare's features are implemented in acknowledgement of the social and open characteristics of this workplace environment (see Table 1 for implemented voting features and the framework categories we are interested in probing). More specifically, by showing publicly the actions of the users (commenting, voting, revoking votes etc.) we intend to provoke social pressure for participation and discussion. Even though the vote casts are private (the system

doesn't link one's name with a vote cast), whether and when a participant voted for a poll, are public to the group. In addition, multiple voting and vote delegation can increase the collective efficacy of the group or a subgroup of participants with a shared goal. We expect the familiarity of group members to facilitate the creation of tactics between the participants by delegating votes to each other, voting multiple times for options etc. Multiple voting in combination with other implemented features such as vote revocation and vote delegation can open up new spaces of engagement in the workplace. Other implemented features such as dynamically adding candidates and negative voting were implemented in anticipation of increasing self-efficacy.

Rather than single votes, users were provided with a number of tokens that could be used for voting in different polls, where a vote is assigned a particular cost. These tokens could either be distributed evenly or unevenly as desired to reflect the level of authority and influence that can be found in different decision making contexts. Users were also able to send tokens to other participants, potentially opening a new space for engagement. Finally, snippets of participants' actions - such as voting, commenting, revoking - are displayed publicly in a list of recent activity to provide social pressure for participation.

The significance of the polling occasion and governance over the voting system can be additional determinants of participation. Defining which decisions are significant is problematic as it is widely subjective – for example even though political elections are assumed to be of increased importance, the majority of the electorate are unlikely to be more interested about national politics than for everyday decisions [29]. This applies for the workplace environment as well, as one decision may have more affect on an individual than the group, and others may affect the group as a whole. Thus we perceive the content of a poll (i.e. what is being questioned) as an aspect of the poll that is not open to direct configuration.

Table 1. BallotShare's features, descriptions of how these features can be used and reflection on the categories of the framework we are probing.

Features	**Description**	**Reflection on framework**
Voting coins	Each user has a number of coins in their virtual wallet, which can be used to vote (negatively or positively) across polls. Each vote cast costs one coin for every user for all the polls of this case study. A fixed number of coins was given to all participants of the study at the beginning of the study which they had to manage across the five weeks of the study.	Expression; Fairness; Eligibility
Positive voting	Users of the system can vote positively on the candidate options of each poll. Voting positively increases the total number of votes of the candidate option while decreasing the personal wallet of the user by one coin.	Expression

Negative voting	Users of the system can vote negatively on the candidate options of each poll. Voting negatively reduces the total number of votes of the candidate option while decreasing the personal wallet of the user by one coin.	Expression
Vote revocation	Vote revocation allows users to revoke their vote(s) before the end of the polling period from a poll. Voters are also reimbursed the coins that they spent to cast the vote(s). Users after revoking their vote(s) are able to reassign their vote(s) or keep their coins for future decisions.	Expression
Open nomination	Users are able to add candidate options to the polls during the polling period. For both regular and spontaneous polls users can add additional candidate options.	Eligibility; Expression
Intermediate results	The intermediate results of the polls are publicly visible while the users vote (see Figure 2 left).	Secrecy
Vote delegation	Users can send coins – and thus delegate some of their votes - to other participants (see Figure 2 middle for sharing window and right for coins accept/reject page).	Expression
Multiple voting	Users can vote multiple times for a candidate option or multiple candidate options. Users are free to cast as many votes as their coins allow them to.	Fairness; Expression
Public actions	All the above-mentioned actions are visible to all other study participants. An "actions feed" page provides a list of actions of other participants (e.g. John voted for poll "birthday planning", James sent votes to John etc.)	Secrecy
Commenting	Users are able to comment on each of the polls' pages.	Expression

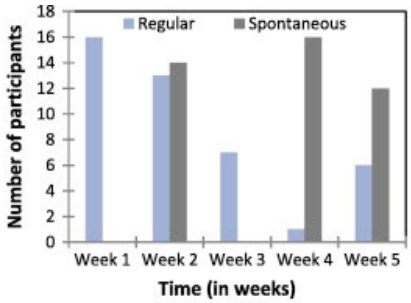
5 User Study

BallotShare was deployed amongst staff and postgraduate students in our research institute, an environment that we could observe closely in order to explore how participants interacted with the system and what social interactions the system provoked. This approach clearly has limitations, however, considering the paucity of work in this area, we wanted to gain an initial understanding of the e-voting design space and identify issues for further research.

Staff and postgraduate students in our research institute (N=18) used BallotShare to vote on polls ranging from social activities to other spontaneous decisions that were required (eight polls in total). As inventing abstract decisions would add biases, over a period of five weeks, five weekly scheduled polls about already common social activities were created (e.g. "Choose a place to go out on Friday after work"). In addition three polls were created by request (naming a robot, choosing a colleague's birthday gift, and deciding the type of cake being made by

another colleague). These polls had a more personal focus, as they had impact on specific members of the research group. Notification messages were sent to participants through email and an online messaging system to notify them when they were invited to a poll and to remind them during the week, as well as shortly before the poll closed.

E-mail invitations were sent to a total of 12 people by using a group's mailing list. The system was introduced as a research prototype that will facilitate decision making in the group. A further six people asked to be included after noticing that they were not registered in the system (as their emails were not on the mailing list) leading to a total of 18 participants. From those 18 invitations, 16 of them participated at least once in a poll. The mean participation for the weekly scheduled polls was 8.6 people, with the highest participation being 16 and the lowest being one. In general participation in the weekly social activity polls decreased over time (see Figure 3). The mean participation for all polls, including polls created by participants, was 11.



	Week 1		Week 2		Week 3		Week 4		Week 5	
Poll type (Regular, Spontaneous)	R	S	R	S	R	S	R	S	R	S
Num. of participants	16	N/A	13	14	7	N/A	1	16	6	12

Figure 3. Active participants for regular weekly and spontaneous polls (by request).

As shown in Figure 3, turnout was relatively high at the beginning of the study. This could be attributed to the novelty of the system. After the first two weeks, participants seemed to disengage from the regular polls. By the third week the decision was not being followed by the participants and active participants dropped from 16 to seven. By the fourth week participation was even lower with just one active participant from the group. By comparison, participation in the spontaneous polls was quite high (14, 16 and 12 active participants), even when being run in parallel with the less popular social activities polls. According to the interviews and questionnaires, spontaneous polls were perceived to be more significant as they were affecting an individual from the group personally.

Even though the system could be used remotely, collocation of participants in the working environment appeared to affect participation. Usage logs show that the participants used the system only during office hours and the majority of activity occurred within two hours after the invitation had been sent. The duration of the poll did not affect participation. Users tended to vote shortly after the creation of the polls and reconsider their vote shortly before voting closed. Other than voting, the most popular features of the system were vote revocation, negative voting and adding alternative options. Commenting on polls and vote delegation were less popular than expected (see Table 2).

Table 2. Usage of BallotShare's features.

Usage of features (%)	**Regular**	**Regular**	**Spontaneous**	**Regular**	**Regular**	**Spontaneous**	**Regular**	**Spontaneous**
Votes cast (negative and positive)	77 (45)	46 (74)	85 (77)	24 (80)	8 (88)	68 (94)	34 (93)	74 (86)
Vote revocation	62 (36)	13 (21)	10 (9)	4 (14)	1 (12)	4 (5)	2 (6)	7 (8)
Comments	17 (10)	1 (1)	12 (11)	0 (0)	0 (0)	0 (0)	0 (0)	3 (4)
Vote delegation	7 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Added candidate choices	9 (5)	2 (4)	3 (3)	2 (6)	0 (0)	1 (1)	1 (1)	1 (1)
Total	172	62	110	30	9	73	36	86

5.1 Interview and Questionnaire Data

In order to gain a greater insight into behaviors and attitudes regarding the system, we distributed questionnaires to all users regarding usability, features of the system and engagement with the polls. We received 13 responses to this questionnaire. This was followed by 10 semi-structured interviews, each lasting for approximately 30 minutes and serving to gain a richer understanding of users experiences with the system and the group decision-making process.

To analyse the interview data we carried out a hybrid thematic analysis [18]. Hybrid thematic analysis incorporates theoretical deductive analysis with an inductive coding process to refine codes and themes. Core underlying psychological theories of decision-making (such as self-efficacy and collective efficacy) and aspects closely related to voting (such as privacy) were identified as the initial coding themes. A thematic analysis was then applied to the collected data, taking into consideration the predefined theoretical concepts.

5.2 Findings

When asked whether they felt that their votes mattered in the decisions, 62% of participants agreed or strongly agreed, with 23% being neutral and 15% disagreeing. Participants were also asked to what extent they agreed that their votes changed the outcome of the poll, with the majority of responses following the same pattern (54% agree or strongly agree, 31% neutral and 15% disagree). Thus participants felt both the value and influence of their actions. However, when participants were asked whether they felt that the decisions made by the group were affected by the system, their responses were more evenly distributed from 'agree' to 'disagree' (30% agreed, 38% were neutral and 23% disagreed). Thus, although there appears to be a high level of self-efficacy (i.e. the perceived ability of an individual to succeed in their goals [4]), there are lower levels of collective efficacy (i.e. the belief that users are able to effect a change through their actions as a group [9]).

In this section, we explore the discrepancy between individual and collective efficacy through the thematic analysis of interview data. Based on this analysis, we identify significant drivers and limitations of individual and collective participation in the voting process. All names used in the results are aliases.

5.3 Social Visibility

The design of BallotShare promotes the visibility of voting actions. However, more than this, the presence of BallotShare within the voting context reifies the decision-making process. Consequently, a reciprocal relationship exists between BallotShare and the social context. As Jack comments *"a lot of the times that I went and voted was because I had a conversation with someone* [in the lab]*"*. The visibility of the actions conducted on BallotShare and the capability of revisiting votes and monitoring voting as a process therefore drives engagement. For one participant the ability to observe others fostered participation:

"when I heard about it [a poll] I was like, I have to get into this vote, to have a look of how is going see what people are voted so far" George [M, 23].

The opportunity to observe the polling process could also drive those who would not directly benefit from the decision. Participants who were not motivated to vote enjoyed monitoring the results: *"I may not go to the pub certain weeks* [...] *although I wasn't voting I would check who is winning* [...] *I found that interesting"* [Jack, M, 30].

Social interaction during working hours was widely discussed by the participants, with quantitative data from the system indicating that all the activity (with just two exceptions) occurred during working hours. One participant suggested that this happened because a *"conversation that I had with people about things that we are voting on inspired me to look at the website and then mess around and*

fiddle with the vote [...] *I guess being around the people that are involved in the decision makes a big difference on how you engage with it and when"*.

5.4 Social Inclusion

While operating within a social context, BallotShare was seen as a way of empowering group members', especially for new members of the group, to voice their opinions about certain topics. For example James, a relatively new member of the group, stated *"I think it's a nice way for people voicing their opinions, especially for people that are quite new* [...] *nicer than necessarily voicing out to the group"*. Yet the potential for the system to support social inclusion also contributed to social exclusion. In addition to the empowerment of new group members, a contradictory feeling of disempowerment was observed for group members who normally had a say about social activities but had not initially been invited to the system. Sophia commented, *"I wasn't one of the people invited and* [...] *I was like, I want to be involved* [...] *I felt left out and I wanted to be involved so I asked for an account"*.

In this regard, BallotShare could be used to destabilize existing social hierarchies. Another new member suggests that although social activities "*might usually be decided by a few* [...] *by having this polling system* [...] *it gives more opportunity for other people have a say for a new* [activity]*"*. However, on other accounts some participants did not believe that the polls were effective. As Jack clearly identifies: *"...people were saying we will not go to the pub that wins anyway"*. Other participants questioned whether the choice of social events was truly a democratic process. Alexia suggested that *"I don't think we really have a choice* [...] *we go for the most convenient option and we are not really affected by the vote"*.

5.5 Commitment and Delegation

Participants regularly cited a reduced sense of efficacy as one of the main reasons for their decreased participation in the recurring social activity polls. At times, polls were completed, with uncertainty about whether the outcomes would be followed:

"...the Friday one [scheduled poll] *was a bit annoying in a way, because we made these votes without knowing if we will actually go"* Jack, M, 30.

Furthermore, Dennis believes that the dynamics of the group effected the efficacy achieved through the system. For him, the system also needed someone to enforce the decisions: *"we need a leading voice* [...] *I don't remember if somebody looked at the poll when we went on a Friday"*. Delegation of responsibility for the decision, rather than of the votes, was seen to achieve greater accountability. However, for others the issue was individual commitment. When commenting on

limitations of the polls, Albert comments: *"I think negative voting is a bad thing* [in more important decisions], *but I think more important than that is your vote has to be definitive"*.

5.6 Accountability

Features of the poll may contribute to the lack of finalized votes. For instance, multiple voting led participants to question the fairness of the final decision with one participant saying *"when I see a lot of votes for one option I don't know if a lot of people voted for that or it was just one person who thinks that this is a very good option"*. Thus, although through the process of voting the system reveals individuals' actions, the completed poll does not. In this way, the final decision is not attributable to a due process.

This due process was also understood to necessitate open discussion. Some participants viewed BallotShare as opening up discussion: "*it* [BallotShare] *is a process and voting - usually at least in my head - isn't a process [it] is something I do once"*. For others though, it was not: *"in the comment I tried to start an argument* [...] *I wasn't talking to anybody just making a statement* [...] *no discussion happening"*.

Feelings of dishonesty also kept some of the users from employing BallotShare's features to influence decisions. However these feelings would probably be diminished if the actions were completely private. This observation could be found in some users such as James, who did not use any strategies or use influence tactics. James stated: *"having it more anonymous would probably tempt me even more and be more inclined to[...] put coins to different things, rearrange stuff"*. In addition, Alexia believed that *"if it was more anonymous people would be more adventurous with it"* even though *"in this circumstance nobody would be embarrassed to put anything in because we know each other"*.

While discussing one of his tactics to save votes for later decisions, one participant suggested *"it seemed to have an unfair advantage. I think I would prefer if I had certain amount of coins for each poll. I think the equality aspect appeals to me more"*. After saving some votes from previous polls, participants stated that they felt they had the power to completely affect the final result, even though they chose not to. This contradicts previous findings and literature regarding the negative impact that low self-efficacy of participants can have on participation. It seems that increasing self-efficacy is fundamental when attempting to encourage participation, but simultaneously may present too much power to change the final decision.

5.7 Exerting Influence

In addition to the implications for social interaction at a wider level, participants were also aware of - and sometimes directly involved in - social manipulation of the poll. In most cases participants tried to influence others by using BallotShare's features, including multiple voting and resetting. For example, Jack explained how he used multiple voting and resets to influence others and save votes for other polls:

"*I was introducing new options to the poll and voting heavily for them and waiting to see if someone would actually go with it* [...] *I was just thinking if whatever it is that I am voting for has a chance to win* [...] *another thing I did one time was just before the vote got sealed I reset my votes and just added back the least amount needed to make it win"*.

Being able to see the results before the end of the poll generally influenced participants to vote tactically. For example, taking back votes that would not influence the final result or redistributing votes in order to have an effect. It was very common for polls that were open for a couple of days to have votes distributed to all the options, but to have votes distributed between only a small number of options by the time the poll closed.

Many features of BallotShare promoted tactical voting and participants used various strategies to change the outcome of the polls, including coalitions with other participants and attempts to influence others through voting and commenting. Coalitions were the less common tactic and took place either through agreements to vote for the same options or attempts to convince participants to send their votes to others. One of the participants reported that another voter *"emailed me saying 'I really want to go to this pub can you send me your votes', so it was like an insider externalized trading"*.

Although users enjoyed voting tactically, they were pensive about applying these strategies to more important decision-making and political polls. For example, Albert mentioned, *"it depends what the vote is for. If it's something that as a group we want to agree on, seeing the results and being able to negate votes is useful but if it is something you want to know the individuals opinion then it won't be so useful"*. In addition, Jack, who was one of the most strategic 'players' of the game, said, *"I wouldn't do the same* [for a more important poll] *because it has a different kind of consequence"*. Although during the interviews most of the participants mentioned issues that would probably arise in more important polls or elections, when asked how much they agree that the system could be used in more important decisions 69% "agreed" or "strongly agreed", with only 14% disagreeing.

5.8 Contextual Privacy

Participants had diverse opinions about the privacy of the system, with 46% disagreeing or strongly disagreeing that the system is private, 31% agreeing or strongly agreeing, and the final 23% being neutral. Although the questionnaires indicated that participants tended to agree that the system violated the privacy of individuals— because most of the users' actions were publicly displayed and the content of someone's vote could be disclosed by combining actions of users and preliminary results— this tendency was not replicated in the interviews.

According to the interviews, participants did not feel their privacy had been violated. However, they did report that perception of privacy is directly related to the environment and context of the polls. These observations can be summarized by Jack's comment: *"I didn't really have a problem, I knew that someone could figure out by seeing the ridiculous amount of votes I put in one go sometimes but I didn't really feel any privacy concerns; that might be different if the votes were a lot more sensitive or they had wider implications"*. Most of the participants agreed that the context of the polls and the social dynamics of the group are tightly related to the appropriation of measures to ensure privacy. There was a feeling that even for more important decisions, familiarity of participants in the group would make strict privacy measures somewhat unnecessary—possibly due to the fact that interaction with the group would lead to the disclosure of group members' favorite candidates. For example, when asked about possible privacy issues, Albert said, *"because we know each other that's not an issue* [...] *even for more important decisions"*.

6 Discussion

The goal of BallotShare was to explore how a carefully configured e-voting system can support participation in decision-making practices. BallotShare allowed participants to revoke their votes; to vote multiple times both positively and negatively; to add candidate options dynamically; to delegate votes to other members of the group; and to check intermediate results and other participants' actions. In this section we reflect on the outcomes of the deployment of BallotShare with regard to the proposed design framework.

6.1 Eligibility

In terms of eligibility, the small number of users initially registered raised objections in some of the rest of the group, as they felt socially excluded from the decisions being made. The initial allocation of voting power to a random set of people

(by using a mailing list) and the discussions that followed in the workplace, revealed hierarchical structures that were not visible in the group before. As the system was designed not to support these hierarchical structures – every participant had the same number of coins to use across the polls – the decisions were not followed by a group of people either because they opposed the decided action or because of a lowered perceived efficacy. In contrast, new members of the group perceived the system as a socially non-invasive way to have their opinions assimilated into the group and were more active in the decision-making and subsequently the social activities. Thus this democratic and non-hierarchical configuration of the voting system served in further democratizing the context in which it was applied. Even though we acknowledge that in some contexts the organizers of a poll might require the hierarchical structures to be reflected on the voting system (e.g. shareholder voting), in other contexts such horizontal and bottom-up configurations can be used to question hierarchical structures and power (e.g. activism in local communities). Thus, configuration of voting systems for participation is not only dependent on context but also on the governance of the voting system. Future work is needed to further explore the impact that specially configured voting systems can have on hierarchical structures within an organization.

The closing poll condition, which in this case was time based, didn't have any impact on participation as nearly all the activity happened during working hours where the participants were collocated.

6.2 Fairness

The ability to own and cast multiple votes both negatively and positively, in combination with the publicity of the results during the voting period, resulted in undermining the perceived fairness of the system by some participants (who were directly affected by the outcome of a poll). In general, even though multiple and negative voting increased self-efficacy of the participants, our findings suggest that if the voting system provides too much power over the final decision, participation is negatively impacted. This is due to the perception that an individual could use that power to undermine the result. For more important spontaneous decisions that were polled, a conventional configuration (one vote per person) was perceived as more appropriate as the decision would have a personal effect on someone in the group. A better configuration for future deployments would put an upper custom barrier to the number of votes that someone can cast per poll. This can be configured to either one vote per person for more important decisions, or to more votes per person for a more interactive voting process.

Finally, even though verifiability of the voting process will be necessary for more critical decisions, due to the publicity of the actions, intermediate results and the collocation of the participants, unscrupulous acts become visible to the group and appear less likely. Even so, the visibility of some more sensitive actions such

as delegating voting power to other members of the group was identified as less appropriate and would have been used more if they were private.

6.3 Secrecy

As discussed, intermediate results affected perceptions of the fairness of the voting process. In combination with other characteristics such as vote revocation and offline discussions, intermediate results contributed to a more interactive voting process. Privacy concerns were not prominent in the study, even though users' voting actions were visible on the system. Clearly such concerns are contingent upon the context and familiarity of the group members. Overall, inconsistent attitudes towards privacy were uncovered, with more senior members of the group claiming that the partial violation of privacy engaged them to participate and to announce their views, whereas less affiliated members saying that total anonymity would have been more appropriate. These findings reflect on the power structures of the group and further support that the application of specially designed technology results in the further democratization of the context. Further research is required to understand how manipulation of the design to provide privacy in the poll according to the context's hierarchy could support participation.

6.4 Expression

Multiple voting and voting both positively and negatively was widely used and was one of the most important determinants of increasing self-efficacy. As mentioned earlier, putting an upper limit on the number of vote casts per poll per voter would have contributed in increasing the perceived fairness of the system. Voting against candidate options was used for tactical reasons (i.e. lowering an opposing candidate's total) or for publicly showing dissent from the rest of the group. Even though negative voting was one of the successful features of the system that made the process of decision making more engaging, the cost associated with voting (the coins spent per vote cast) contributed in limiting the number of negative votes cast. A possible configuration to maintain the interactivity that negative voting adds and at the same time increase negative voting would be assigning less cost on negative vote casts, or having special coins only to be used for negation instead of positive voting. Adding candidate options dynamically was used less than expected, however when used, the added candidate options had a significant affect over the outcome of the poll. Obviously the use of open nominations during the polling is contingent upon the question being asked.

Some qualities of BallotShare, such as commenting and vote delegation, were included with the intention of motivating discussions online, but neither supported this process despite our expectations. The interviews highlighted the need for a

way to better support online argumentation; however the collocation of participants in the same workplace setting motivated offline discussions that later stimulated users to revisit their options online. In future work a more adequate online commenting mechanism or a form of argumentation to support vote casts could complement better the offline discussions. In terms of vote delegation even though the feature wasn't used as expected, it motivated interesting discussions with the participants during the interviews. According to the interviewed participants and our observations combining unlimited vote casts per poll user, with equal distribution of coins to all users makes sending coins to others irrelevant, as a voter would have used this feature only to support another voter with the same opinions about the polled issue. Putting upper limits in multiple voting per user per poll will change this as a voter reaching the upper limit can donate coins to voters with the same preferences. In addition a feature of requesting in addition to donating coins could increase sharing (one of the participants of the study asked another for coins by email).

Vote revocation in combination with these offline discussions allowed for a more interactive voting process, as conversations during the day led people to revisit the polls, revoke their votes and recast them accordingly. Some participants noted that the high number of vote revocations that occurred per poll diminished the purpose of visible preliminary results as the results were shifting regularly. Adding a cost on vote revocations (i.e. withholding a percentage of the coins instead of giving the full amount of cast votes back) can limit the number of revocations thus contributing in more balanced voting results.

We perceive that a number of expression features contributed to creating the experience that voting was a process, rather than a single action, thus engaging participants in a more meaningful democratic process.

7 Limitations

In this paper we revisited digital voting for participation and proposed a design framework to facilitate further research in the area. By proposing this design framework we acknowledge and highlight that every decision-making context has unique qualities that has to be reflected on the voting system being used. We do not support that the proposed framework is exhaustive and further research and support from multiple disciplines could expand this framework to cover all the possible instantiations of voting.

Our case study serves as a first instantiation of this design framework and our results are context specific. This configuration is chosen to reflect on the workplace environment context that we deployed the prototype system by either supporting existing practices or questioning them, thus the system and its configuration acts as a technology probe [21] rather as an ideal configuration for e-voting. The results of the undertaken case study are applicable in small and local voting

contexts with the participants of the polls being collocated and familiar to each other. Future work is necessary to explore this contextual enquiry.

8 Conclusions

Digital technologies are currently not fulfilling their potential to support participation in digital voting. In this paper we proposed a framework that highlights the parameters of a typical vote and discusses their impact with respect to participation. We then designed a voting system as a first instantiation of this framework to explore the impact of the selected features on participation. After five weeks of deployment, we uncovered several aspects in its configuration that supported participation. We considered how multiple voting, voting negatively and positively, and vote revocation supported the expression of the participants and made voting more of a democratic *process* rather an transient *action*; while publicity of actions and intermediate results motivated discussion that was supported by the collocation of participants in the open workplace environment. Through the proposed design framework we suggest that a poll can be configured within the parameters of *eligibility*, *fairness*, *secrecy* and the method of *expression* given to voters. Our goal was to create a new sensitivity on how the design of digital voting technologies should reflect the values of the social group within which they are deployed, to appropriately facilitate involvement in the voting process.

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