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Mobile-phone-based classroom response systems: Students' perceptions of engagement and learning in a large undergraduate course

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Using a Classroom Response System (CRS) has been associated with positive educational outcomes, by fostering student engagement and by allowing immediate feedback to both students and instructors. This study examined a low-cost CRS (VotApedia) in a large first-year class, where students responded to questions using their mobile phones. This study explored whether the use of VotApedia retained the advantages of other CRS, overcame some of the challenges of other CRS, and whether new challenges were introduced by using VotApedia. These issues were studied within three themes: students' perceptions of using VotApedia; the impact of VotApedia on their engagement; and the impact of VotApedia on their learning. Data were collected from an online survey, focus groups and student feedback on teaching and course content. The results indicated that using VotApedia retains the pedagogical advantages of other CRS, while overcoming some of the challenges presented by using other CRS, without introducing any new challenges.

Keywords: statistics; clickers; classroom response systems; CRS; teaching; engagement

1. Introduction

Engaging students in their own learning is critical for their academic success. For example, student engagement impacts student achievement, retention and success [1]. Since students typically engage through their studies via assessment [2], assessment is crucial to enhancing student engagement and thus learning assessments must become inextricably linked to the teaching process.

Using rapid, formative feedback is an ideal form of assessment [2], yet difficult to translate into practice, especially in larger classes. However, the use of Classroom Response Systems (CRS) allows instructors to provide immediate formative (and, in some cases, summative) feedback [3].

CRS are 'instructional technologies that allow instructors to rapidly collect and analyse student responses to questions posed during class' [3,p.1]. Typically, students are presented with a question and a small number of multiple-choice answer options, and students vote for one of the options using the electronic hardware. The instructor can display the results

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to the class immediately. Many CRS use special hardware (generically called *clickers*) to allow students to vote.

The advantages of using a CRS are summarized in two comprehensive literature reviews [4,5]. Here we give a brief overview, and direct the interested reader to the relevant references for more information.

The benefits of using a CRS include improving students' attitudes towards classes [5]; improving attentiveness [6]; improving attendance [7,8]; improving engagement with the course [9–12] when used well [13]; enhancing instructor–student interaction by providing immediate feedback [7,8,14] especially in large classes [15]; and allowing students to remain anonymous [16–19].

In summary, many advantages may flow from using a CRS, which are crucial to achieving successful teaching and learning outcomes in students. However, a number of practical challenges can arise with using CRS in the context of large classes.

The first challenge is cost. Traditional CRS require students to 'vote' using special hardware, which must be purchased either by students or the institution, with a corresponding cost burden. For institution-purchased hardware, instructors may be obliged to collect and distribute clickers in class, then collect and return the devices to a central location at the university ensuring none are lost. A further challenge is that instructors and students may need to be trained [5,7]. Specialist software may also be necessary, with the consequential demands of cost and on-going IT support.

Recent technological innovations allow mobile phones to be used as CRS devices. Some mobile-phone-based technologies are unique to specific publishers, such as Wiley's *ClickOn* (http://clickon.johnwiley.com.au/, accessed 07 June 2012). Other mobile-phone-based systems have associated costs, such as *Poll Everywhere* (http://www.polleverywhere.com/ accessed 07 June 2012; up to 40 responses are free). Free-to-adopt mobile-phone-based systems also exist which are not tied to any publishers, such as *VotApedia* (http://urvoting.com, accessed 07 June 2012). A related technology is available with eClicker (http://www.eclicker.com/, accessed 05 June 2012), which utilizes students' internet-enabled devices to enable voting. In this paper, we evaluate VotApedia, as its adoption is free for users and institutions, and the phone calls are all free within Australia (where the authors are based).

To use VotApedia, the instructor poses a question to the class on an overhead screen, with a short list of answer options each associated with a telephone number. Students select an answer by making a free phone call (the call always results in an engaged signal) to the phone number corresponding to the answer choice. The results are collated automatically on a remote server and can be displayed immediately on the overhead screen.

Using a free CRS is appealing, and this study explores whether VotApedia retains the advantages of other CRS, and if challenges with other CRS are overcome. However, a CRS that uses mobile phones may introduce further challenges into the classroom for students; in particular, mobile phones have the potential to be a distraction to students.

These considerations lead to three hypotheses: (i) VotApedia retains the advantages of a CRS; (ii) VotApedia overcomes some challenges of other CRS; and (iii) VotApedia introduces no major new challenges. To study these hypotheses, this paper focuses on the students' perceptions. The setting for the study is described first, followed by the data collection and analysis methods. Results are then presented, followed by a discussion of the hypotheses under the three major themes: (i) student perceptions on using VotApedia; (ii) student perceptions of the impact of VotApedia on their engagement in the course; and (iii) student perceptions of the impact of VotApedia on their learning.

2. Study setting

This paper reports on a case study of using VotApedia in SCI110 *Science Research Methods* at the University of the Sunshine Coast (USC) during Semester 1, 2011. USC is a young regional Australian university (established 1996), with approximately 7300 students in 2011. Class enrolments in SCI110 were 731, and each week students attended one of three essentially identical lectures on campus (the largest lecture hall seats 300). Students in SCI110 were mainly first-year, first semester students, from health, science and engineering disciplines.

Within this course, a VotApedia question was used two or three times each lecture (mean time spent per question: 7.1 min, SD: 2.2 min, including setup time, student thinking time and instructor post-survey discussion time). The VotApedia survey questions were sometimes used at the start of a lecture (for example, to review a topic from the previous week); sometimes partway through the lecture (for example, to review concepts introduced in the current lecture); and sometimes during the mid-lecture break (for example, to provide the students with a chance to discuss the content in the break and to refocus the class after the break). VotApedia was used for a number of different purposes within the class, including the revision of material, generating data, dispelling false impressions of the course and demonstrating course content. For more details of how VotApedia was used in SCI110, see [20].

3. Data collection

For triangulation purposes, data were gathered from three sources: an online student survey; student feedback on the course and on teaching in the course; and two focus groups conducted during the semester.

The online survey opened in teaching week 8 (in a 13-week teaching semester), to ensure students had ample exposure to the technology. The survey closed at the end of the teaching semester. The median completion time for the survey was 6 minutes.

The survey questions (available by request) were drawn from previously published surveys [6,11,16,21–26] to enable comparisons with similar studies, plus some of our own questions.

The survey contained 15 Likert-scale questions about students' perceptions of using VotApedia; ten Likert-scale questions about the impact of VotApedia on their engagement in the course; seven Likert-scale questions about their learning; two questions about usage habits; plus two general questions and three demographic questions. All Likert-scale questions used the five-point scale 'Strongly disagree', 'Disagree', 'Neither disagree nor agree', 'Agree' or 'Strongly agree' (coded when necessary as 1, 2, 3, 4 or 5 respectively, so that higher numbers indicate a higher level of agreement with the statement). Opportunities were also made for students to provide general comments, and to indicate reasons why the student chose to or chose not to use VotApedia.

The sample was self-selected, and participation was voluntary. The data were collected anonymously online using a survey-hosting site (SurveyMonkey; http://www.surveymonkey.net). All SCI110 students were encouraged to complete the survey, verbally in lectures and through posting on the course Learning Management System. Even students who did not actively use VotApedia were explicitly encouraged to complete the survey, because they had still been exposed to VotApedia, and we were interested in (for example) their reasons for not using VotApedia. Data from three students who did not give permission for their results to be used were not reported.

The second data source was the USC student evaluations of SCI110. Near the end of each semester, all USC students are asked to evaluate their courses (student feedback on courses: SFCs) and the teaching within their courses (student feedback on teaching: SFTs) using voluntary, anonymous, paper-based surveys during teaching week 11. These two surveys, not administered by the SCI110 teaching staff, consist of generic Likert-style questions not specific to SCI110 or VotApedia. Students may also write further comments; many students explicitly mentioned VotApedia in these comments. All comments, including those that mentioned VotApedia, were unsolicited. In total, 246 SFC forms were returned (160 contained comments, 27 mentioning VotApedia) and 267 SFT forms were returned (138 contained comments, 57 mentioning VotApedia). Thus a total of 84 unsolicited comments mentioned VotApedia (16.4% of all forms returned; 28.2% of all forms returned containing written comments).

The third source of data is information gathered from two focus groups. A research assistant conducted these focus groups during the middle and the end of the teaching semester, with the same students in both groups. The audio transcripts from these focus groups were professionally transcribed and de-identified before being presented to the authors. The first focus group informed the end-of-semester survey. The volunteers consisted of three females and three males; five first-year students and one fourth-year student; and students from each of the three lectures were represented. Five undergraduate programs were represented. The students were aged from 17 to 59, with three participants aged over 35. Two focus group members did not have a mobile phone (one borrowed his spouse's mobile phone later in the semester). In these focus groups, the students were asked broadly about the three hypotheses within the major themes of this study.

These three data sources enabled triangulation of results. In particular, the students' comments and the focus groups offered confirmation of the online survey results, and allowed further exploration of the results.

4. Analysis

Of the 731 enrolled in SCI110, 146 students (20.0%) responded to the online survey. However, a number of the enrolled students were inactive or did not attend lectures, and so had limited, or no, exposure to VotApedia [20]. In other words, the effective response rate from students exposed to VotApedia exceeds 20%. Interestingly, 8.0% of the respondents to the survey indicated that they did not usually participate in VotApedia voting, and 3.2% indicated that they did not normally attend lectures.

A summary of the demographic information for the students in the survey is shown in Table 1. By comparison, 65.2% of USC students are female, the average age of USC students is 25 years of age and 44% of USC students are aged under 21 (2011 figures; www.usc.edu.au/university/about-usc/key-statistics/, accessed 14 June 2012). The market shares of Telstra and Optus are approximately 43% and 31%, respectively [27]. Comparative data for all SCI110 students is not available.

Cronbach's alpha (α) was used as a measure of internal consistency of the questions within each of the three sub-sections of the online survey. In all cases, the Cronbach alpha values were satisfactory to excellent [28]: for the students' perceptions of using VotApedia $\alpha = 0.85$ over 15 questions; for the students' perceptions of using VotApedia on students' engagement $\alpha = 0.91$ over 10 questions; for students' perceptions of using VotApedia on student learning $\alpha = 0.79$ over seven questions.

Statistical analyses were performed using R [29].

Table 1. Demographic summaries of the data for the USC students in the survey.

		Number (percentage)
Total class enrolments		731
Respondents to survey		146 (20.0%)
Gender	Female	86 (62.7%)
	Male	51 (37.3%)
Age	Under 20	65 (47.1%)
	20 and over	73 (52.9%)
Usual voting method	Phone	111 (81.0%)
	SMS	15 (10.9%)
	Did not usually vote	11 (8.0%)
Phone provider	Telstra	55 (40.4%)
	Optus	48 (35.3%)
	Vodafone	15 (11.0%)
	Others	18 (13.2%)

5. Results

The questions in the survey assessed various aspects of the student experience with using VotApedia (students' overall perceptions; students' engagement perceptions; and students' learning perceptions) as a means to evaluating the three hypotheses.

Answers to the Likert-scale questions are summarized using the 'net percent agreeing' (NPA), which is the total percentage of students agreeing or strongly agreeing with the statement, minus the total percentage of students disagreeing or strongly disagreeing with the statement.

5.1. Effect of age and gender

Two questions asked in the online survey were broad: 'I would recommend that the lecturer continue to use VotApedia', and 'For me, the use of VotApedia helped increase the overall value of classes'. We consider *a priori* the answers to these two questions and determine whether the mean response differs by age, and by gender. The p-values, corrected for multiple testing using the method of Holm [30], from t-tests provide no evidence that age and gender are related to the overall student perceptions of using VotApedia (Table 2). This suggests that the appeal of VotApedia is not related to age or gender.

Table 2. The results (from Likert-scale questions) from testing four *a priori* hypotheses concerning the overall perception of VotApedia from the survey. All p-values are from t-tests, are two-tailed and are adjusted for multiple testing.

		Responses to: 'I would recommend that the lecturer continue to use VotApedia.'	Responses to: 'For me, the use of VotApedia helped increase the overall value of classes.'
Gender	Female mean	4.4	4.0
	Male mean	4.5	4.3
	Comparison	95% CI for diff.: -0.38 to 0.10 $t = -1.24$; df $= 134.6$; $p = 0.26$	95% CI for diff.: -0.54 to 0.0046 $t = -1.94$; df $= 134.1$; $p = 0.16$
Age	< 20 mean	4.2	3.9
	≥ 20 mean	4.6	4.2
	Comparison	95% CI for diff.: -0.58 to -0.052 $t = -2.37$; df $= 101.2$; $p = 0.08$	95% CI for diff.: -0.59 to -0.0024 $t = -1.97$; df $= 107.5$; $p = 0.16$

Table 3. The reasons given by students for voting and not voting in the VotApedia survey questions. Percentages are out of 146 students, the number of SCI110 starting the survey. The two reasons listed with asterisks were compiled from the answers given to the 'Other' option. Students could select multiple responses.

Reason for voting	Number (%)	Reason for not voting	Number (%)
I wanted to obtain feedback on my understanding of the concepts.	107 (73.3%)	I couldn't be bothered.	36 (24.7%)
I wanted to obtain practice at questions similar to those that might appear in the exam.	107 (73.3%)	I discussed the question with others students, and another student voted on behalf of us all.	35 (24.0%)
I wanted to consolidate the material learnt in lectures.	79 (54.1%)	I didn't know the answer, so didn't want to vote.	32 (21.9%)
It was fun.	73 (50.0%)	My phone reception was often poor.	25 (17.1%)
It was a break from the lecture.	64 (43.8%)	I had trouble reading the phone numbers on the screen.	24 (16.4%)
		No phone/phone access.*	16 (11.0%)
		Ran out of time.*	6 (4.1%)
		I didn't feel like thinking in lectures.	5 (3.4%)
		I wasn't sure that the calls were really free.	4 (2.7%)
		I didn't really care.	4 (2.7%)
		I think it is a waste of time.	3 (2.1%)
		I didn't believe that the calls were anonymous.	2 (1.4%)

5.2. Reasons why students chose to vote or not to vote

In the survey, students were asked why they chose to vote, and were given five options and asked to select all that applied. Students were also asked why they chose *not* to vote, and were given ten options and asked to select all that applied. In both cases, students were also able to add other reasons (Table 3).

6. Students' perceptions of using VotApedia

Students' perceptions of VotApedia were assessed using 15 Likert-scale questions (Table 4; in this section, all NPA come from this table, unless stated otherwise).

Students were strongly of the opinion that the lecturer should continue to use VotApedia (88.7%) and believed that using VotApedia increased the overall value of the classes (79.7%).

The results support the first hypothesis, that many of the general advantages of CRS noted by other authors were retained when using VotApedia: students enjoyed voting (71.1%; 50.0% of students indicated this was a reason for voting (Table 3)), and it increased their confidence in participating in class discussions (54.2%). Few students believed that using VotApedia in class was a waste of time (−81.6%).

In support of the second hypothesis, VotApedia overcomes some of the challenges with other CRS: students easily followed the expectations of using VotApedia (90.8%); the technology was easy to use (82.4%); the technology generally operated without technological

Table 4. The Likert-scale questions asked of students regarding their perceptions of using VotApedia. Items with an asterisk were reversed when computing Cronbach's alpha.

	SD	D	N	A	SA	Net percent agreeing	Mean score
Recommend keep using	2	1	10	52	76	88.7%	4.41
Easy to use	5	4	7	47	79	82.4%	4.35
Increases classes' overall value	4	3	14	74	43	79.7%	4.08
Increased enjoyment of lectures	5	3	25	62	47	71.1%	4.01
Mostly used when offered	9	12	15	46	60	59.9%	3.96
More confident to participate	5	5	45	54	33	54.2%	3.74
Prefer more questions	4	10	47	57	23	46.8%	3.60
Often had bad signal*	69	40	13	11	8	−63.8%	1.93
Distracted in class by others*	51	63	15	12	0	−72.3%	1.91
Distracted from class*	46	67	19	8	1	−73.8%	1.94
Didn't like using mobile*	57	58	17	7	2	−75.2%	1.86
Wasted too much time*	63	60	10	4	4	−81.6%	1.77
Too many technical problems*	69	55	12	3	2	−84.4%	1.68
Too difficult to use*	91	38	8	2	2	−88.7%	1.48
Expectations too hard*	81	49	9	2	0	−90.8%	1.52

problems (84.4%). These results imply that training in VotApedia for students is unlikely to be necessary; some insight is provided from a focus group student:

> **Student A:** Considering I couldn't use a computer back in July last year before I started [at university]. . . VotApedia's a walk in the park.

To compare VotApedia directly with other CRS, students could have been asked to compare the use of VotApedia with other CRS. However, most students were in their first semester at university, thus having limited opportunity for exposure to other CRS, so we did not explicitly ask students to make this comparison explicitly. However, two focus-group students did have exposure to a different CRS:

> **Student B:** They [clickers associated with a different CRS] are frustrating . . . every time we've gone to use them, you've got to put a dongle into the computer and it never works. . . I think we've gone to use it three times and it's never worked every time; so fraught with problems. . .

> **Student E:** Then sometimes people don't hand them [clickers associated with a different CRS] back, they just leave them on their seat.

In other words, the experience of these students in the focus group suggests VotApedia may indeed overcome some challenges identified with other CRS.

The third hypothesis explored whether the use of VotApedia introduced new challenges. Potential challenges considered *a priori* by the authors involved students being distracted by the explicit use of mobile phones; however, most students did not find that using their mobile phones in class distracted them (73.8%), nor were they distracted by other students using their mobile phones (72.3%). Only 19 students in the survey agreed that they often had bad signals (−63.8%).

In summary, support exists for all three hypotheses. Furthermore, students liked using their mobile phones in class (75.2%), and many students would have preferred more VotApedia questions in class (46.8%):

Table 5. The Likert-scale questions asked of students regarding their perceptions of the use of VotApedia on their engagement with the course.

	SD	D	N	A	SA	Net percent agreeing	Mean score
Obtained instant feedback	1	2	4	70	62	92.8%	4.37
Interaction effective	2	2	11	83	41	86.3%	4.14
Helped me be active in class	2	3	21	81	33	77.9%	4.00
Increased my frequency of participation	3	4	27	79	27	70.7%	3.88
Anonymity encouraged me to participate	2	5	29	63	41	69.3%	3.97
Helped me pay attention in class	2	8	37	64	29	59.3%	3.79
Increased my peer awareness	5	8	31	70	25	59.0%	3.73
Helped me concentrate in class	3	13	41	55	28	47.9%	3.66
Motivated me to learn	4	19	57	48	11	25.9%	3.31
Encouraged me to attend class	7	27	80	16	9	−6.5%	2.95

Interviewer: How often would you like to use VotApedia. . . do you think we've got the mix right?

Student C: I think you've got the mix right.

Interviewer: So it's about two to three times? [Note: In a two-hour lecture]

Student C: Yeah, two, three, four.

Interviewer: Two to four times a lecture?

Student C: I'd probably. . . well it's a two hour lecture, one every half hour; probably about four.

One student stated in the SFT and SFC comments that 'Breaking the lectures up with VotApedia . . . helped make what could have been boring more interesting and helped me keep my attention on learning'. Only 4.1% of students reported having insufficient time to vote (Table 3). Many students indicated that they voted most times when the chance was offered (59.9%).

In the course SFTs and SFCs, one student concluded that 'VotApedia should be continued; it makes the lectures more interesting'. Only one comment from the 84 SFTs and SFCs comments received was negative about VotApedia: 'VotApedia: I found it was used too frequently and was boring'.

7. Students' perceptions of the impact of using VotApedia on student engagement

Students' perceptions of the impact of using VotApedia on student engagement were assessed using ten Likert-scale questions (Table 5; in this section, all NPA come from this table, unless stated otherwise).

These results support the first hypothesis: students perceive the use of VotApedia as increasing the frequency of their direct participation in the course (70.7%); increasing their

in-class activity (77.9%); helping them to pay attention in class (59.3%); and helping their concentration (47.9%):

> I was able to discuss the question with people and come to a better understanding of the question and answer. (Comment in the online survey.)

When asked why they chose to vote, 54.1% indicated they wanted to consolidate material learnt in the lectures (Table 3). Their increased participation was aided by the anonymity of using VotApedia (69.3%):

> **Student D:** . . . not everybody really wants to stand up and give their opinion above everyone else, and with VotApedia at least you have people that aren't comfortable talking to . . . in front of everyone; really helps them.
>
> **Student C:** I think it's great because people who wouldn't ordinarily answer will speak up, albeit through a telephone.
>
> **Student F:** Yeah that's just it; without knowing that once you put your hand up everyone's looking at you, you kind of do it without everyone noticing. . .
>
> **Student A:** Just the fact nobody can look at you.
>
> **Student E:** If you make a mistake nobody knows you made a mistake.
>
> **Student B:** Hide behind anonymity.

In comparison with a lecturer asking students explicitly for answers, students found that the anonymity afforded by using VotApedia encouraged engagement:

> **Student C:** It [asking one student in a lecture] just isolates it to that student, and nobody else really gets a look in and then you can't hear, they don't talk clearly. . .
>
> **Student F:** Because in comparison with another class that I do, the lecturer kind of picks on the audience and everyone's like 'no, please don't choose me, no'.

Overwhelmingly students appreciated obtaining instant feedback on what they did and didn't know (92.8%):

> **Student F:** . . . you can also learn from making a mistake, so if you made a mistake you're more likely to remember that one. . .
>
> **Interviewer:** So it reinforces the learning?
>
> **Student F:** Yes, because you can think about things when you actually put it into practice. I actually learned from doing it and I'm participating. . .
>
> VotApedia – interactive and good feedback (SFT comment).

Over 73% of students gave this as a reason why they chose to vote (Table 3), while 73.3% also indicated that they voted to obtain practice at examination-like questions. A focus group student concurs:

Student C: I've had quite a few [VotApedia survey questions] wrong. It's great because [the lecturer will] go through... he's very good, he'll say 'look, if you've got [option] A... that's quite reasonable but that's not the best answer'. We think a little bit further, 'let's change that, change this, therefore that would have to be better but that leaves us two options', you know... my exam technique is way, way better.

Most students found using VotApedia an effective method of interacting in the large-class situation (86.3%):

Student A: Believe VotApedia enhances interaction.

Student D: The interactive side of it is very good. It's real time information back to you, which I think is very valuable for your learning curve at university.

Student B: It's amazing: most lectures you kind of sit there and listen. It [VotApedia] actually helps you to engage and get involved.

Student F: It [VotApedia] makes it [the lecture] more involved... it livens it up instead of always getting up and talking in front of everyone...

VotApedia made the lectures more interactive which was enjoyable (SFT comment).

VotApedia is a good idea – gets the class involved (SFT comment).

However, student responses were inconclusive about the impact of using VotApedia on their class attendance (−6.5%) and motivation to learn (25.9%).

Objective participation measures [20] showed that the average percentage of students (across three lectures) who voted was 46% of those that attended the lecture. Students were explicitly encouraged by the SCI110 instructor to discuss their answers with students seated nearby before voting, so more students actually participated in the classroom discussion than is reflected by this percentage. The most common reason for not voting (Table 3) was that the question was discussed in a group and someone else voted with the consensus view on their behalf (24.7%). The implied small-group discussions occurring in class was encouraging. Two students in the focus group commented:

Student C: ...in the past where a lecturer asks a question, because the lecturer's asked it, it tends to become a one-on-one – so I think that VotApedia, because everybody gets to look at the question and answer, it's [the participation rate's] a lot higher. I think even 30 students out of whatever was there is a lot better than every [other] lecturer gets...

Student E: Everybody wakes up and starts talking.

In other words, even low participation rates are superior to the lecturer asking one person in the class a question, which most students actively try to avoid answering.

Not all students were engaged every time VotApedia was used. When asked the reason why they chose *not* to vote, 24.7% of students (Table 3) indicated they could not be bothered, while smaller percentages said they didn't care (2.7%), thought it was a waste of time (2.1%), or didn't feel like thinking (3.4%). Many students (21.9%) didn't vote because they didn't know the answer, but this implies that they had engaged somewhat in the question to reach this conclusion. Perhaps the use of a 'Don't Know' option would still encourage these students to vote. This is a direction for future research.

Table 6. The Likert-scale questions asked of students regarding their perceptions of the use of VotApedia on their learning.

	SD	D	N	A	SA	Net percent agreeing	Mean score
Instructors used results to reinforce material not understood	1	4	5	81	48	89.2%	4.23
Helped me understand concepts	3	4	16	82	34	78.4%	4.01
Enhanced my learning	2	8	18	81	29	72.5%	3.92
Helped me think more deeply	2	8	28	79	21	65.2%	3.79
Gave me more control over my learning	2	18	51	52	15	34.1%	3.43
Often voted correctly, but without understanding	16	61	39	18	4	−39.9%	2.51
Would like to receive credit	47	41	33	11	7	−50.4%	2.21

8. Students' perceptions of the impact of VotApedia on student learning

Students' perceptions of the impact of VotApedia on student learning were assessed using seven Likert-scale questions (Table 6; in this section, all NPA come from this table, unless stated otherwise).

Support for the first hypothesis is again evident: students reported that using VotApedia enhanced their learning (72.5%), helped them understand concepts (78.4%) and think more deeply (65.2%). Few students indicated that they voted correctly without understanding (−39.9%). Students appreciated instructors using the results to reinforce the material that was not well understood (89.2%), therefore providing formative feedback to students:

> **Student C:** VotApedia, I think, gives us an opportunity to test the knowledge that we've got, and when he starts the lecture to recap the knowledge that we should have for the lecture.

> VotApedia questions helped to reinforce learning (SFT comment).

> VotApedia helps to understand many concepts (sic).

Students valued the instructor using and acting on the feedback to provide further information about the misconceptions revealed by the answers to VotApedia questions (the purpose of assessment *as* and *for* learning [31]):

> **Student B:** You can see exactly what you're answering straight away which is a big learning tool, I think.

> **Student A:** I can live with getting it wrong it's a case of *why* and I'll analyse it and tear it apart and then get it right.

Perhaps because of this, students were not in favour of using VotApedia questions for summative assessment (50.4% net disagreeing).

9. Discussion

Our first hypothesis was that VotApedia would retain the advantages of other CRS. The survey results, focus groups and student comments supported this hypothesis. Consistent with results from evaluation of other CRS, students reported VotApedia as easy to use [16,32],

enjoyable [16,23], increasing their participation, attention, activity and engagement in the course [6,11] and increasing their understanding and deep thinking about the content [25]. In this sense, using VotApedia retained the advantages of using other CRS as reported in the literature. However, students did not report that using VotApedia encouraged attendance (unlike the results reported in [7,8], which may have much to do with the course's content and connection with the students' primary program of study).

The second hypothesis (that using VotApedia would overcome some challenges with using other CRS) also found support. Students generally found VotApedia easy to use, so no training is necessary for students to use VotApedia; also, therefore (unlike some other CRS using specialist hardware [5,7]), time need not be spent training students to use the devices. Furthermore, registration of the devices is also unnecessary [3,p.168,7,33], as is required with using some similar mobile-phone-based technology. (Registration or some similar process is necessary if the CRS is to be used for summative feedback.)

Beyond these usage advantages, other advantages were identified. Using VotApedia does not require the purchase of specialist hardware and software by institutions or students, but the advantages are not simply financial. There is no need to distribute, collect and return devices after each class, which may become a significant burden. Indirectly, no IT resources are required to support the use of VotApedia (except a reliable internet connection).

The third hypothesis (that no new challenges would be introduced) was also supported. The authors were concerned that using mobile phones in class could be distracting. While clickers are not a distraction to students [32], mobile phones provide many distractions that dedicated clicker devices cannot: games, web browsers, SMS messages and so on. In the survey, few students reported that using mobile phones distracted them. One explanation may be that using a VotApedia question gave students an opportunity to (for example) check their emails or Facebook page during the lecture, so that they could then concentrate on the rest of the lecture. Alternatively, perhaps students are constantly engaged with their mobile phones whatever we do as instructors!

One challenge to using mobile phones in classes is that not every student has a mobile phone, or that they might not be able to use their mobile phones for various reasons (no credit, which precluded them from making even free calls; phone left at home; etc.). Only 11.0% of students indicated that the reason they did not vote was because they had no phone access (Table 3). Concerns about mobile phone access and signal problems were minimized in SCI110 because students were actively encouraged to discuss the questions in small groups, and often one student in the group voted on behalf of the group. Within these groups of two or three students, a high probability exists that one of the group has access to a mobile phone to vote. In any case, students can still be involved in the VotApedia session even without a phone – they can discuss the answer, and make a selection – without the need to formally vote by phoning. In this sense, VotApedia is simply a tangible mechanism for encouraging students to engage in class. One student in the focus group who did not have a mobile phone commented:

> **Student C:** I have never felt isolated from not being able to phone because I can still put my selection on there, talk to the guy next to me, he can vote and I can still peg it on that board; I don't need a phone to participate.

As with other CRS, technological challenges may exist from a students' perspective [5,6,11,18], and VotApedia is no different, though the types of challenges may differ. Some students reported problems with signal (17.1% of respondents gave this as a reason for not

voting (Table 3)). As with any technology, users of VotApedia may experience technological problems periodically, some due to VotApedia itself (for example, the VotApedia server failing), university-specific issues (the internet connection fails), or computer-specific issues (for example, slow browser response) [20].

Students did identify one challenge with using VotApedia: 16.4% indicated that they did not vote because they could not read the phone numbers on the screen (Table 3). Seeing the phone numbers may be difficult in large lecture theatres when students in the back rows are some distance from the overhead screen. While the instructor can increase font sizes in the web browser and use the browser in full-screen mode, limits exist as to how much these solutions help, because the VotApedia interface includes extraneous information that consumes substantial screen area [20]. Student A in the focus group had a simple solution to this problem: 'I always sit down the front', where (it should be noted) plenty of seats were always available.

Furthermore, while this paper has examined VotApedia from the students' viewpoint, VotApedia does introduce challenges for instructors. For example, the interface for preparing surveys has challenges in some circumstances. While these challenges were not insurmountable, they may become frustrating. For more details of these shortcomings, and workarounds for some of them, see [20]. Future work would involve fixing these identified shortcomings.

While students perceived using VotApedia as being an appropriate use of lecture time, instructors must balance the gains of using the CRS with time needed to do so. (Note that 4.1% of students in the survey stated that the reason they did not vote was that they had insufficient time to vote (Table 3).) We agree with [32], who observes that, when using a CRS:

> Arguably, a potential drawback is that less material can be covered in lectures. However, I feel that this is more than compensated by the greater awareness I have concerning the amount of material that students understand. . . using the [CRS] has enabled me to relate the pace of my presentation of material more closely to the pace of student understanding.

Furthermore, using VotApedia gives students (and instructors) a cognitive rest, which may actually increase the overall learning that takes place over the entire lecture [34,p.53, 35].

Students appreciated that VotApedia helped them obtain instant feedback on their learning, even in a large-class situation. Further, the way in which the instructor used the aggregated results to inform the students was appreciated, which may be more a reflection on *how* VotApedia was used. One student in the focus group agreed:

> **Student C:** You know, if I gave you four aces in a hand of poker and you didn't know how to play poker you still wouldn't do well. It's [VotApedia's] a tool. . . so I think if they [the instructors] engage with the tool, if they understand the purpose of the tool, they would be brilliant with it. . . In the way it's [VotApedia's] being used in the lectures. . . He's kept the VotApedia questions very relevant to the lecture and that has definitely kept my interest and kept me involved . . . I love the way he works through the answers.

The combination of ungraded and anonymous responses with instant feedback means that students are free to make mistakes without fear of social embarrassment (in front of peers, or the instructor) or fear of adversely impacting their grades. If for no other reason, we believe this is a significant advantage of using a CRS in a large class (compared to raising hands, for example). In this way, we see the use of a CRS such as VotApedia as a

practical way of implementing assessment *as* learning and assessment *for* learning [31] in large class situations.

Having made all these statements, actually showing that using VotApedia was responsible for improving student learning is difficult. Student grades in SCI110 improved from 2010 to 2011, but many reasons could explain this improvement: the course has changed substantially, the textbook is different, and the student cohort is much larger and more diverse. As a result, grades' summaries are not presented. So while we do not have any direct compelling evidence that VotApedia actually improves grades, we believe that it did partially contribute. Furthermore, even if students have the *perception* that using VotApedia improves their learning (and so perhaps their grades), as borne out by this study, this can do little harm to student grades.

A number of inter-related issues are contained in this paper that were difficult to tease apart. Separating the advantages of using a CRS in general, using VotApedia in particular, the way in which the instructor used VotApedia, and the overall teaching quality of the instructor is very difficult. The data gathered and discussed in this paper regarding VotApedia are inextricably linked to the manner in which VotApedia was used. Nonetheless, we have shown that the VotApedia retains the advantages of other CRS, while being free and easy-to-use, and introducing very few other challenges.

10. Conclusion

In this study, we evaluated the use of VotApedia from the students' perspective, pairing with the instructor perceptions report in [20]. VotApedia retains most of the advantages of other CRS, overcomes many of the challenges of other CRS and introduces very few new challenges. The success of using Votapedia as we did in this project can be reduced to four main aspects: VotApedia is mobile-phone based and free to use, thus accessible; students remain anonymous; the results are not graded; the feedback is immediate. Overall, the use of VotApedia for rapid feedback and formative assessment resulted in positive student perceptions of learning along with increased student engagement in lectures, with minimal associated costs.

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