DO STUDENT RESPONSES DECREASE IF TEACHERS KEEP ASKING QUESTIONS THROUGH STUDENT RESPONSE SYSTEMS: A QUANTITATIVE RESEARCH

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ABSTRACT

Student Response System (SRS) allows all students to have a chance to participate in the classroom with their own devices. While it is an effective tool for promoting active participation and classroom interaction, previous studies argue that overuse and over-dependence of the technology can pose a problem of student disengagement. This paper reports on a quantitative research about the relationship between the number of questions and the number of student responses, drawing data from a self-invented student response system that has been used campus-wide between 2012 and 2015 at The Chinese University of Hong Kong. Our results show that in general student responses are stable with virtually no significant drop at the end of the lessons regardless of how many questions are asked. To conclude, we refute the hypothesis that excess use of the technology would lower student participation.

KEYWORDS

Student Response System, Student Engagement

1. INTRODUCTION

Student Response System (SRS), also known as "Classroom Response System" or "Audience Response System", is a variety of sets of hardware and software that allows teachers to pose different kinds of questions to students in class, and students can submit their answer to the questions using handheld devices or even their own mobile devices or laptop computers through wireless network simultaneously. Teachers can collect and analyze all student responses instantly and convert them into different statistics (Kay and LeSage, 2009). Before the introduction of SRS, question-and-answering activities in the classroom are usually characterized by the teacher calling upon one student at a time to respond. In this setting, only a small number of students answer questions consistently, and the rest of the class is neglected and is subjected to passive listening (Fitch, 2004; Narayan et al., 1990). This technological innovation revolutionizes the question-and-answering activities in the classroom by providing opportunities for all students to respond to teachers in class.

The advantages of the SRS include stimulating students' participation, enhancing students' engagement, and refreshing students' attention span. Filer (2010) explains that SRS requires students to engage in the classroom, process information independently and commit to an answer, so it promotes active participation in class. Moreover, SRS enables anonymity that protects students from the embarrassment of making incorrect responses (Filer, 2010; Florenthal, 2018) and motivates introverted or anxious students to participate in more classroom activities (Stowell and Nelson, 2007; Stowell et al, 2010; Florenthal, 2018). Research also suggests that students' attention decreases dramatically after 20 minutes in the lecture, however, the use of SRS and the question-and-answering activities can serve as a break to students and refresh their attention span (Kay and Lesage, 2009). Hunsu et al. (2016) examine empirical studies on the use of SRS and confirms the positive effects SRS has on students' engagement and participation, attendance, and self-efficacy across different subjects.

Despite these advantages, teachers are warned against the potential danger of overusing the new technology. For example, Robertson (2000) believes that students' enthusiasm will fade away if they are presented with questions after questions, and Martyn (2007) also advises against asking too many questions. Regarding the number of questions, Premkumar (2009) suggests that 3 to 4 questions in a 60-minute lecture would be

adequate. Carnaghan (2011) prefers no more than 4 questions per hour of class. These warnings suggest that the overuse of SRS may diminish the benefits of the technology.

The current study investigates whether students' participation in class will decrease if teachers keep asking questions through SRS. This idea can be formulated into a research hypothesis: if the number of questions teachers ask increases, the number of student responses will decrease. A quantitative research on the data set of a self-invented SRS in The Chinese University of Hong Kong is undertaken. The research examines the quantity of questions teachers posed per session and the number of student responses. The research result disproves the research hypothesis, showing that there is no significant decrease in student responses as teachers ask more questions. That means students' participation can be sustained throughout the class with the help of SRS.

2. METHODOLOGY

2.1 Data Collection

Research data of this study comes from a self-invented, web-based SRS that has been in use campus-wide since 2012 at The Chinese University of Hong Kong. This SRS, uReply, is a cloud-based classroom communication system. Teachers can ask a question by simply typing the question on the spot or picking a ready-made question item from his/her personal question bank. Students can input their answers via their Internet-connected mobile devices or laptop computers. uReply supports multiple-choice questions, text questions without word limits, Likert scale, fill-in-the-blanks, and direct messages. Student responses are by default anonymous unless the teacher requires students to enter their name or student ID when they submit their response. The system also automatically records all activities for future use. At the time of writing this paper, the system consistently recorded more than 2500 student-visits per week during teaching days.

The researchers retrieved the raw usage data from the system recorded over a 3-year period from May 2012 to May 2015. The raw usage data contains 5370 sessions. One session stands for one activity that can last for a whole lecture, which is around two to three hours. A teacher can ask as many questions as they like in one session and they normally would close the session when their lecture ends. A total of 606 teacher users from all 8 faculties of The Chinese University of Hong Kong has contributed to these data.

2.2 Data Refinement

Among these 5370 sessions, two types of sessions are to be excluded from our research: the sessions that are not real classroom usage, and the sessions that contain data invalid for our research. The former type of sessions includes 1, sessions created by our development team when they built and tested the system; 2, teachers' trial usage sessions; 3, sessions without accurate information about the course, the teachers, and the students. The latter type of sessions includes 4, sessions that were used across multiple lectures; and 5, sessions that contain only one question and session groups that contain too few sessions for valid analysis. The refinement process of the dataset is divided into five stages as listed below:

In the first stage, sessions from non-teacher accounts, including team project users and developers were deleted. A total of 89 user accounts and 1911 sessions were deleted in this stage.

In the second stage, sessions with incorrect information regarding teacher users, course codes, and student IDs were deleted. These sessions were deleted because they could not be proven to be actual classroom usage. A total of 338 sessions were deleted in this stage.

In the third stage, we identified and deleted sessions of trial usage. Trial usage sessions were identified by the number of respondents in each session. Because the teachers would not create too many respondents in their trial usage sessions, these sessions should contain a fewer number of respondents. Therefore, we focused on five groups of sessions that had 2 to 6 respondents respectively. We randomly selected 30 sessions from each of these five groups as samples. All the questions and answers in these total 150 sessions were examined to judge whether they were trial usage or not. Some sessions were still unable to be classified because there was no clear evidence.

After that, we calculated the rate of real cases (TRUE session / (No. of sessions – undefined sessions) of each of the five groups. Table 1 shows the results of this analysis. It shows that in groups of sessions that had 5 or more respondents, more than 90% of the sessions are identifiable real classroom usages. We determined that 90% could be the acceptable margin for our study to balance off data quality and data quantity. Therefore, we deleted all the sessions that had fewer than 5 respondents. In this stage, 686 sessions were deleted.

Table 1. Analysis of identifiable real classroom usage for sessions containing 2-6 respondents

No. of Respondents	2	3	4	5	6
No. of Sessions	30	30	30	30	30
Real-usage Sessions	13	18	22	24	27
Trial-usage Sessions	12	5	3	2	2
*Undefined Sessions**	*5*	*7*	*5*	*4*	*1*
Rate of Real Cases (%)	52.00%	78.26%	88.00%	**92.31%**	**93.10%**

In the fourth stage, sessions that were used across multiple lectures were deleted. uReply allows users to reuse the session they created. But when a session is reused in another lecture, the number of respondents and questions differ from the previous use. Therefore, the data of reused sessions is not valid for analysis, so we also deleted these sessions. In this stage, 571 sessions were deleted.

Finally, the remaining 1864 sessions were grouped according to the number of questions asked in each session. The group of sessions that contain only one question was excluded because sessions containing only one question do not have any change in student response rate. Moreover, groups that contain too few sessions for a valid study were also excluded. These groups are mainly the sessions that contain over 20 questions. In this stage, 852 sessions were excluded. The remaining 1012 sessions are eligible for our analysis.

Table 2. The data refinement process

	Sessions excluded	Sessions remained
Total number of sessions		5370
Sessions from non-teaching accounts	1911	3459
Sessions with incorrect information	338	3121
Sessions with fewer than 5 respondents	686	2435
Sessions used across multiple lectures	571	1864
Sessions containing only 1 question and over 20 questions	852	1012
Total number of sessions for analysis		1012

3. RESULTS

In order to find out whether there are statistically significant differences in student responses between the beginning and the end of a session, it would be necessary to first define the “beginning” and the “end” portions for sessions containing various numbers of questions. As shown in table 3, the sessions in this study have numbers of questions ranged from as few as 2 questions to as many as 20 questions. Because the response of a single question may rise or fall drastically due to various reasons (as seen in Figure 3-5), this research avoids using solely the first and the last item for measurement except for the group of sessions containing 2 to 4 questions. This research defines the “beginning” and the “end” portion as roughly one-third to one-fourth of the whole session. For example, in sessions containing 7 questions, the beginning portion is the first 2 questions, and the end portion is the last 2 questions. In table 3, the columns on the left illustrate the number of responses received in the beginning portions, including the minimum value, the maximum value, and the mean; the columns on the right illustrate the number of responses received at the end of the course, including the minimum value, maximum value, and the mean. The result shows that the numbers of responses collected in the beginning and at the end of the class are quite close, indicating that students keep responding to the teacher while the number of questions increase. For example, in sessions that contain 7 questions, a mean of 1406 responses for each question are collected in the beginning portion (the first 2 questions) comparing to around 1360 at the end portion (the last 2 questions).

Table 3. Comparison of the number of student responses between the beginning and the end portions

No. of Questions in a Session	No. of Sessions	Question(s) in portion	Beginning portion				End portion			
			Min	Max	Mean	SD	Min	Max	Mean	SD
2	283	1	-	-	9121	-	-	-	9043	-
3	198	1	-	-	5585	-	-	-	5404	-
4	145	1	-	-	4039	-	-	-	4045	-
5	115	2	3082	3181	3131.5	70.0	3013	3035	3024	15.6
6	53	2	1286	1367	1326.5	57.3	1380	1454	1417	52.3
7	56	2	1366	1446	1406	56.6	1329	1392	1360.5	44.5
8	44	2	1752	1892	1822	99.0	1493	1563	1528	49.5
9	28	3	545	571	558	13	519	541	531	11.1
10	39	3	1373	1503	1438.7	65.0	1388	1408	1400.7	11.0
11	11	3	378	421	392.7	24.5	352	386	366.3	17.6
12	4	3	160	177	168.7	8.5	174	201	183.3	15.3
13	5	4	207	250	228	19.9	193	214	206	9.8
14	8	4	263	283	270.8	9.0	212	235	223.8	12.4
15	4	4	159	168	163.8	3.8	148	158	152	4.5
16	12	4	656	690	679.8	16.0	658	691	673.3	13.6
17	3	5	125	145	138.8	8.0	124	142	134.4	7.4
20	4	5	199	218	208.6	6.9	131	220	198.8	38.0
	1012									

From the first two columns of table 3, it can also be observed that teachers tend to ask fewer than 10 questions in a single session. Figure 1 below shows the distribution of groups of sessions according to the number of questions. Twenty-eight percent of the sessions contain only 2 questions, and sessions with 2 to 5 questions account for 73% of all sessions. For sessions containing 6 to 10 questions, they occupy another 22%. These sessions occupy a total of 95% of all sessions. Because of the small number of sessions containing more than 10 questions, the average number of responses for each question in these sessions rise and fall sharply, as shown in Figure 4 and 5. However, a significant trend of decrease between the beginning and the end portion is not notable in most of these sessions. Rather, the number of student responses varies between questions, suggesting that there are other factors affecting the number of student responses.

Table 4 below shows the result of t-tests to each pair of the beginning and the end portion for groups that consist of more than 20 sessions. As shown in table 4, most beginning and end portions of the sessions do not show statistically significant differences (set at .05) in terms of the number of responses collected, except the group of sessions containing 8 questions. It can be further observed from Figure 3 that the average number of student responses for the group of sessions containing 8 questions reach its peak on the 2nd question and starts to decrease from the 3rd question to the 5th question, afterward it remains stable. A similar phenomenon of sudden decrease immediately after the beginning portion of the sessions can also be observed in the group of sessions containing 13 questions.

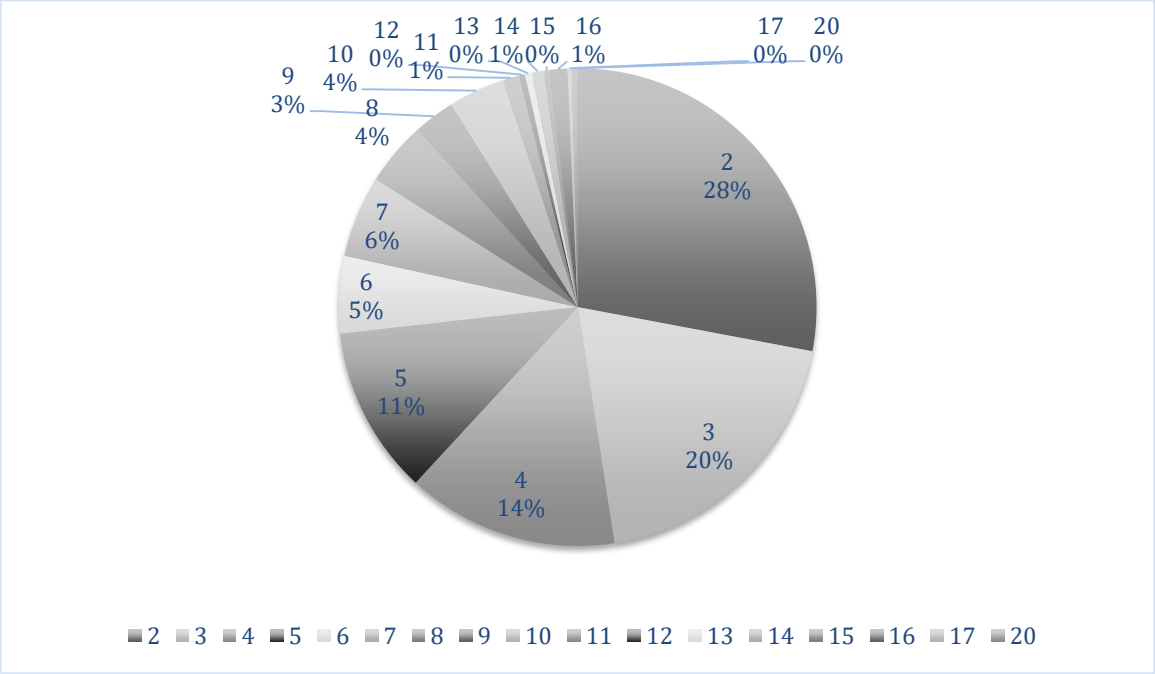

Figure 1. Distribution of sessions according to the number of questions

Table 4. T-test analysis to pairs of the beginning and the end portions for each group

No. of Questions in Sessions	No. of Sessions	T-Test Result	Range (Total Response)	Mean±SD
2	283	0.677	9043 – 9121	9082±55.2
3	198	0.397	5404 – 5670	5627.5 ±135.9
4	145	0.970	4039 – 4251	4146.3±120.4
5	115	0.195	3013 – 3181	3082.6 ±65.5
6	53	0.102	1286 – 1462	1382.3 ±66.9
7	56	0.375	1329 – 1467	1389.9±52.1
8	44	**0.032**	1493 – 1892	1654±149.5
9	28	0.235	519 – 571	545.2±16.4
10	39	0.437	1373 – 1503	1424.7 ±38.8
*11**	11	--	329 – 421	370.3±24.3
*12**	4	--	160 – 201	172.7±10.4
*13**	5	--	193 – 250	214.8±14.8
*14**	8	--	205 – 283	250.0±25.4
*15**	4	--	147 – 168	159.5±7.2
*16**	12	--	634 – 710	673.5±21.5
*17**	3	--	124 – 147	139.1±6.9
*20**	4	--	131 – 223	211±19.8

Figures 2-5 below show the average number of responses in each question for each group in graphs. Figure 2 plots the sessions with 2 to 5 questions; figure 3 plots the sessions with 6 to 10 questions; figure 4 plots the sessions with 11 to 15 questions; and figure 5 plots the sessions with 16, 17 and 20 questions.

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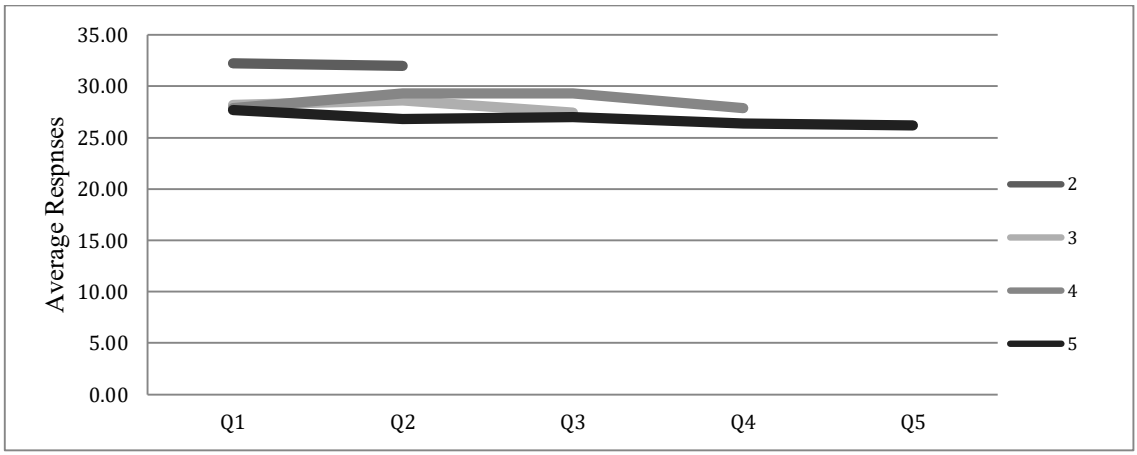

Figure 2. Average responses of each question for sessions with 2 to 5 questions

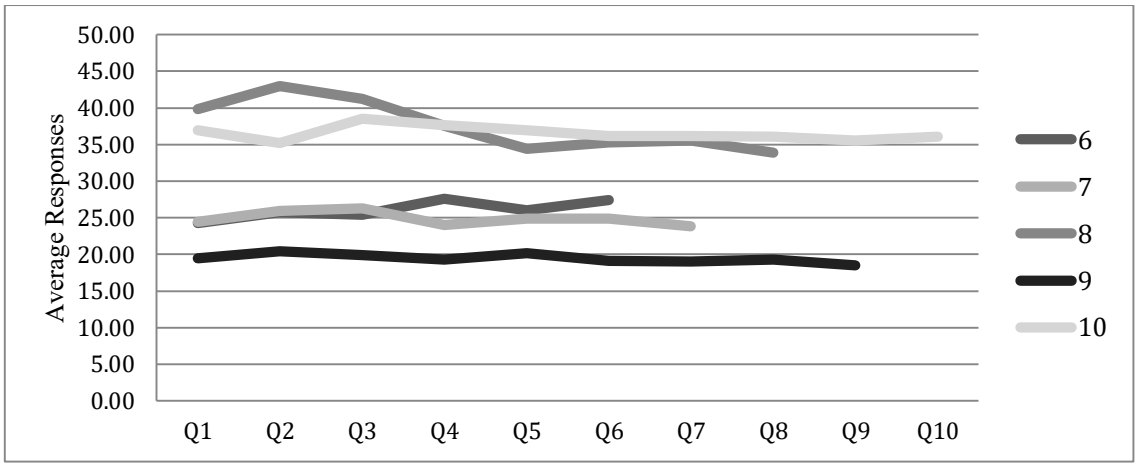

Figure 3. Average responses of each question for sessions with 6 to 10 questions

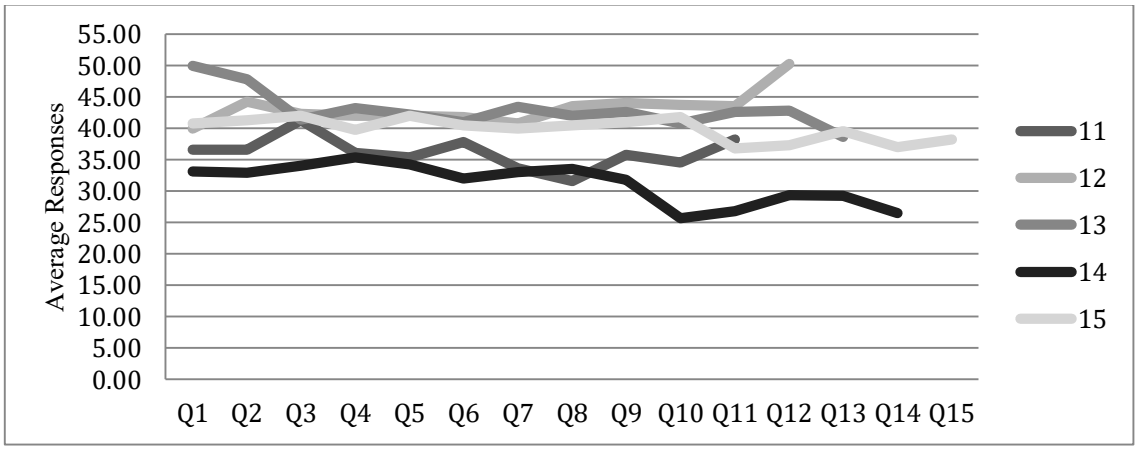

Figure 4. Average responses of each question for sessions with 11 to 15 questions

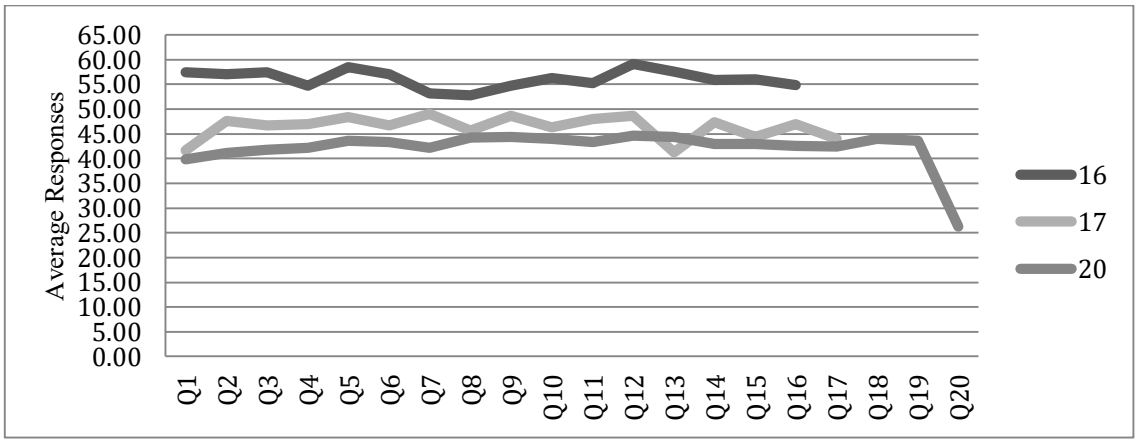

Figure 5. Average responses of each question for sessions with 16, 17 and 20 questions

It should be noted that there is a sudden drop of average responses for the last question in the group of sessions containing 20 questions. It is because there are only 4 sessions in this group. A significant drop of responses in a single session affects the whole statistic. The sudden drop of responses occurred only in session no. 1522. In this session, the first nineteen questions are multiple-choices question, but the last question requires students to respond in text form. The multiple-choice questions are easier for students because they allow some test-wise strategies, such as response elimination strategy. On the contrary, the constructive response questions that require students to produce text would generate test anxiety to students (Martinez, 1999). Therefore, the change of the question format is probably the cause for the decrease in the number of student responses.

4. DISCUSSION

The main discovery of our research is that there is no significant drop in the student responses with the increasing number of questions. This refutes the hypothesis that constant use of the technology will reduce students' participation. Our statistic disproves the hypothesis that "if the number of questions teachers asked increases, the number of student responses will decrease". Instead, it shows that the student responses rate for SRS is more sustaining than expected. For teachers concerned that keep asking questions may drive students away, the result of this research is a relief. It may encourage the teachers to use SRS more boldly and venture on different use of this technology. Another discovery is that teachers often favor a session containing questions ranging from 2 to 5. Figure 2 shows that the number of student responses remains stable in these sessions, which occupy 73% of all sessions. Figure 3 shows that the groups of sessions containing 8 and 10 questions experience a greater change in the average number of responses at the beginning of the sessions, which might due to issues related to time management. A detailed investigation of the time for each question being asked may reveal more on this change. Nevertheless, since 95% of sessions contain fewer than 10 questions, and the response rates for these questions are stable, we can conclude that the issue of losing students' participation and engagement is minimal for most of the sessions.

5. LIMITATION AND FUTURE WORK

There are a few limitations regarding this research. First, since the total number of students in each session is unknown, it is hard to estimate student engagement rate because the total response rate cannot be calculated. Due to this limitation, this research can only show that students who participated at the beginning of the session will continue to respond to teacher throughout the whole session. Second, the study cannot exclude the possibility that student responses are compulsory in class. It is reported that some teachers may use SRS to take attendance (Kay and LeSage, 2009; Hunsu et al., 2016). There is a function in uReply for teachers to collect registered students response. Under this function, students have to provide their name or student IDs

along with their answers. Because teachers may use these responses as evidence of students' attendance, students may feel compulsory to respond. Further research that separates the anonymous and registered student responses and focus only on anonymous data may exclude such a possibility. Third, the current study uses the data from the early stage of implementation of this system, hence the data sample is limited to a single university. With the use of uReply extending to other universities in Hong Kong, future studies on the uReply dataset may include samples from different universities through co-operation efforts.

The current study also observes that different factors may affect the quantity of student response. As seen from the example above, regarding the forms and types of questions, multiple choice may receive more responses than text questions (Martinez, 1999; Wong et al., 2018). Previous researches also speculate that other elements such as the difficulty level of the questions (Carnaghan, 2007), the time allowed for students to pose response (Wang et al., 2018), and the type of activities in the classroom may also affect students' response rate. Regarding the types of activities in the classroom, using SRS for competition and games may receive more positive reception (Wang et al., 2018; Newland and Black, 2019). Therefore, future research that focuses on how teachers design the sessions with high response rate may reveal what teaching practice with SRS can increase students' participation and engagement.

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