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Class participation: Using technology to enhance efficiency and fairness

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Class Participation, Using Technology to Enhance Efficiency and Fairness

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Class participation can be considered as contribution to discussion, attendance, presentations, unsolicited responses, questions, comments, etc. What counts may vary across individual teachers. The more students participate, the less memorization they do, and the more they engage in higher levels of thinking, including interpretation, analysis, and synthesis. However, only a handful of students in many classrooms participate regularly, a phenomenon dubbed as "consolidation of responsibility". This study provides a literature review of in-class participation, as well as pedagogies and technologies that enhance participation. Pedagogies such as active learning, group learning, project-based learning and flipped classroom. Technologies to automate attendance taking, raising hand as well as for online learning to detect participation, analyze participation, and provide participation feedback.

We introduce SKOR, a class participation system that automates fair student participation without wasting class time. We conducted an experiment to know if SKOR kept student updated on their participation points and if it is more efficient and fairer at collecting participation. Our finding is that using SKOR did not have any significant difference on student perception of class participation. However, teacher influences the perception more. Students like shared learning, fairness, and more participation options. They dislike limited opportunity, apprehension and assessing quantitative participation over qualitative participation. These are aligned with our literature review. We hope our review and experiment provide teachers with ideas to improve participation in their classroom.

Class participation, active learning pedagogy, technology enhanced participation, fair student participation, teacher influence.

I. Introduction

As teachers, we experienced times when students participate frequently and times when it is a struggle to get students to participate. As the class progress, only the same few students participate. This may feel like a success, but some students still find it a struggle to participate. Wade [43] considered the "ideal class participation" as one in which almost all students participate and are interested, learning, and listening to others' comments and suggestions. Rocco [37] conducted a thorough review of in-class participation literature for the past 50 years before 2010, across disciplines to answer this question: "What can teachers do to increase participation in their own classrooms?" It provided a comprehensive overview of what is in-class participation, the benefits, the issues, and the recommendations.

Building on Rocca's multi-disciplinary study over 12 years ago, we extended the study with recent computing education literature review of popular pedagogies and technologies used to enhance class participation. We conducted an experiment with our class participation system, SKOR to evaluate its effectiveness and compared our findings with recommendations from the literature review. The following section compile a comprehensive review of the literature. Section 3 explains SKOR. Sections 4 and 5 present the research method and results. Finally, section 6 concludes.

II. Literature Review

This section begins with a summary of Rocca's study on in-class participation. This is followed by a review of participation in active learning pedagogy and technology enhanced participation.

A. In-Class Participation

What counts for in-class participation vary across teacher. While most may find it easier to collect quantitative means of grading participation, the quality of student participation is as important. However, it is also much more subjective and a challenge to grade. Grading in-class participation may be recorded each day (which may interfere with the chemistry of the class), random days (not telling students when they are assessed) or at the end of the term (which relies on memory and increase the likelihood of biases). The teacher, TA, student peers, mentors, tutors, etc. can grade the participation (each with their own biases and variation of what counts as participation).

1) Benefits

Students are more motivated, learn better, become better critical thinkers, and have self-reported gains when they are prepared and participate. The more they participate, the less memorization they do, and the more they engage in higher levels of thinking, including interpretation, analysis, and synthesis. Students who participated also showed improvement in their communication skills, group interactions, and functioning in a democratic society. Students have been found to earn higher grades as their participation increases. Liao et al. [22] studied differences in study habits between high performers and low performers. They found that self-regulation related habits (attendance, being proactive in getting their doubts solved, asking instructors for feedback, etc.) are highly correlated with student performance.

2) Issues

Though students see participation as important, and one-third would like to participate more, research suggests that it is not happening, as it is only a handful of students in any given classroom who participate regularly, a phenomenon dubbed consolidation of responsibility [21, 27, 43]. Nunn [27] found that an average of only around one minute of a 40-minute class period was spent in student participation. Other variables that affect student participation are logistic, course policy, and confidence.

a) Logistic

Students are more willing to participate, less anxious about participating, and less likely to be able to hide in smaller than

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larger classes. Traditional row and column seating allows for less participation than a U-shaped seating. Participation is less likely to occur in night classes, especially those that meet only once per week. Students are more likely, and instructors are less likely to initiate participation as the term progresses.

b) Class policy

Student participation depends on how much participation counts toward their final grades. Some classes give extra credit rather than requiring participation, allow student to be a part of the participation grading process (self-grading), provide midterm assessment, and/or "randomly select" participant. Rocco [37] found these to increase participation. However, Lorås & Arlberg's [23] study found that in-class participation when not mandatory and did not count towards the grade, seems to go down after the first two weeks. This indicates that the way students are assessed largely impacts when, where, and how they participate.

c) Confidence

Karp & Yoels [21] noted that students may feel intimidated or inadequate in front of their classmates and teachers, and thus choose not to participate. Student confidence is the most motivating factor for their participation [43]. Individuals who may not be particularly high in communication apprehension as a trait are frequently anxious in certain situations (e.g., public speaking, meetings). There is evidence that the teacher contributes to students' levels of participation, and students believe that their teachers influence their participation based on the ways in which the teachers communicate with them.

3) Recommendations

What can teachers do to increase participation? Here are some recommendations [27, 37]:

- Cap classroom size at 35-40. Increase participation by breaking students into smaller groups, use lab settings, meet outside of class, or use clicker systems (e.g., Kahoot). Seats can be arranged in a U pattern with alternated row/column to accommodate those high in communication apprehension.
- Establish participation points or extra credit policies. Consider allowing students to formulate participation grades and conduct midterm participation point check-in.
- Class time should be broken up to allow for participation activities at least every half hour.
- Students should be given opportunities for success very early in the term to increase their confidence. Allow for preparation prior to speaking in class via give assignments before class, small group exercise, journal their thoughts, etc.
- Teacher should engage in immediacy behaviors. Such as eye contact, smiling, engage in small talk before class, remember individual student (name/doubt), praise, probing for elaboration, vary the types of questions asked, accepting/ repeating answers, correcting wrong answers, listen with respect, refrain from judgments, be gender sensitive, etc. Avoid verbal aggression, sarcasm, or negativity. Sometimes, challenging students may be perceived as aggression.

Posing a question, recruiting a response, and evaluating the response during class time have limitations. They can make it difficult to engage more than a few students at a time resulting in consolidation of responsibility. There is much to consider: grading participation, dealing with apprehensive students, deciding which pedagogy strategies to use, and so on [28]. A participation transgression often momentarily suspends classroom activity, can invite moral and psychological evaluation, and may threaten the social status of the participant responsible [17].

B. Active Learning Pedagogy

In general, active learning involves actively engaging students to participate [7, 33, 41]. The learning responsibilities shift to the student with guidance from the teacher.

1) Activities

Active learning activities vary widely. They can be in the form of introducing pause activity into lecture such as questions, reflections/1-minute paper, polling, clicker systems and wrap-up/journals; or deeper engagement such as case study, peer review, debate, group problem-solving, worksheet/tutorial, and studio/workshop [7, 12, 33, 41]. O'Connor [28] suggests deep engagement activities that gets students out of their seats such as graffiti walls (many students answering a question on the white board together), inside-outside circles/fish bow (divide students to inner/outer circles to discuss, mix and discuss, and whole class debrief), and think-pair-shares (student think individually, discuss in a pair, and share with class). Choosing the right active learning activities needs to be tightly interconnected with the material taught [45] and with size (individual, small, or large group) [41].

2) Active learning classroom (ALC)

Comparing lecture halls with ALC space, Seyda et al. [40] found no significant differences in student grades nor students' ability to hear the teacher well and ease of getting help. However, students in ALC have much better ability to interact with peers in groups.

3) Group

Group discussions help exchange ideas and clarify misconceptions. Group can be collaborative or cooperative [33]. Reckinger & Hughes [35] found CS students prefer and perform better in class programming group collaboration (pair programming) or cooperation (may cooperate but graded individually) than when they do work individually. However, Gan et al. [14] found that group meetings have weak correlation to performance in capstone course. Engineer et al. [11] classified collaboration into categories: perceived utility (productivity and success) and social environment (social belonging and comfort levels), subdivided into lower-level categories: attendance, collaboration dynamics, and sense of community. This classification provides insight to teachers seeking to engage students in group via collaborative in-class activities.

4) Project/problem

Project promotes student engagement and motivation. It can be for an online object-oriented system course that allows student to practice C++ programming skills [39]. It can be a Robotic project in an engineering course to apply math knowledge [6]. The project may even span across multiple courses, offered by different faculty, where projects aid active learning approaches [34].

5) Flipped classroom

Moore et al. [26] described flipped classroom as pre-class independent, self-driven component. Students may watch lecture videos and complete reflection questions. The class lecture is replaced with active discussions and problem-solving sessions. Gan & Ouh [13] found 86% agreed with flipped classroom for beginner programming course. However, teachers should avoid overwhelming students with extra exercises and should cater to the 14% who disagree with flipped classroom.

6) Benefits

Freeman et al. [12] analyzed 225 studies of undergraduate (STEM) courses comparing traditional lecturing versus active learning. The average exam scores improved by 6% in active learning, and traditional lecture students were 1.5x more likely to fail. Prince [33] found empirical support for active, collaborative, cooperative and problem-based learning with improved student academic achievement, positive student attitudes, foster a deeper approach to learning and helps students retain knowledge longer than traditional instruction.

7) Issues

Politically conservative, religious, or commuting student perceive lower inclusion in active-learning environments, while students who identify as queer report negative experiences in groups. Targeted efforts, such as equitable teaching strategies, will benefit students who might feel marginalized [19]. Female students are more likely to participate in less public settings [4].

C. Technology Enhanced Participation

We begin with technology in the classroom: attendance (using face recognition) and raising hand (using vision). Continue with online learning (pre-recorded videos, virtual office hours, and virtual mentoring). Lastly, we explore online participation tools (Piazza forum, interactive textbook, or tutorials): detecting (using vison, and speaker identity labelling), analyzing (using chat frequency, keyword count, graph cohesion and transversal), and feedback on participation (using topic analysis and dashboard).

1) Attendance

The manual management of attendance is laborious for crowded classrooms. Mery et al. [25] and He et al. [18] took images and use face recognition in a smartphone camera to save time and to prevent fake attendance.

2) Raised Hand

Ahuja et al. [1] developed EduSense, to capture both audio and video streams using low-cost commodity hardware that views both the instructor and students. It built on custom vision classifiers that detect theoretically motivated features associated with effective instruction. These include detection of hand raises, body pose, body accelerometry, and speech acts. Unfortunately, they found only six body instances with hand raised (representing 0.3% of 1797 total body instances).

3) Online Learning

Studies on online learning are mixed with some success and some failures. Exploring online tools, we found increased student online participation still leads to better learning and performance.

a) Online vs F2F

During the pandemic, many studies evaluated the effectiveness of online learning activities to sustain student engagement [3, 20, 29, 32, 42]. Technologies such as Kahoot, clicker, Piazza worked to keep some students engaged in virtual classrooms [3, 20, 29]. Online presence using pre-recorded videos with instructors [20], virtual group mentoring [29], and informal peer interaction [42] worked. However, students found faculty support inside of class more helpful than virtual office hours [42]. Group-based physical exercise practices must be redesigned if it does not have an online substitute [29].

Irani & Denaro [20] indicated that there was no loss in student performance in the online course. Basu et al. [3] were not able to detect specifically which had better engagement. Patricia et al. [32] found 80% of students prefer a face-to-face approach. While Ouh & Gan [29] found only 38%. Still, not everyone prefers online learning. Perhaps, blended learning is the way to go.

b) Online Tools

Besides Piazza, interactive textbooks or tutorials are online tools with focus on student participation.

Smith et al. [38] found students' active interactions with the interactive computing textbook, including changing, adding, and executing code in addition to manipulating visualizations, were significantly stronger in predicting student performance than conventional reading metrics. Ouh et al. [30] studied 84 students using an interactive web-based playback environment for programming tutorials. His result showed that increased interactivity can help students learn better over a video-based tutorial. These studies seem to show that increased online participation leads to better learning and performance.

c) Detecting Participation

While login can identify online participants in chats, forums, and social media; detecting participation from a group requires more sophisticated technology. Examples are EduSense [1] use of vision to detect hand raises, and Ghazal et al. [15] use of smartphones to identify speaker from merged multiple audio recordings.

d) Analyzing participation

The quality of participation is subjective, prone to bias and is a grading challenge. Technology can enhance the analysis of participation quality.

Wu & Chen [44] designed a model which combines three grading factors: the quality of course work, the quantity of efforts, and the activeness of participation. They were measured based on keyword contribution, message length, and message count to compute a performance indicator score for each student. Their result showed high correlation between scores and actual grades.

Dascalu et al. [9] assessed participation using cohesion graph from a social knowledge-building perspective as a longitudinal analysis of ongoing conversation. They assessed collaboration from a dialogical perspective as the intertwining of voices from different speakers, enabling a transversal analysis of subsequent discussion slices. Dubbaka & Gopalan [10] used webcams to record students' facial expressions whilst they watched educational videos to analyse their learner engagement levels. Gottipati et al. [16] presented an automated discussion analysis framework to provide analysis such as question-answering systems, recommendation systems, summarization systems, opining mining systems and information retrieval systems.

e) Participation Feedback

Technology can enhance monitoring of student participation, so that teacher and student can adapt based on the participation feedback.

Parks-Stamm et al. [31] analyzed the frequency posts in 500 online courses. They found instructor participation is necessary in smaller classes to achieve equivalent levels of student engagement. Chen et al. [8] found asynchronous online discussion can drift away from the discussion topic, making the class participation too narrow. Their Topic Analysis Instant Feedback System helped learners grasp the change of overall discussion topics in real-time and see the similarities and differences of the discussion among different groups. Results showed significantly better discussion performance, complexity, and perspectives.

Marwan et al. [24] developed an Adaptive Immediate Feedback (AIF) system to give real time personalized positive and corrective feedback to students. They found AIF significantly increased engagement (as measured by their lower idle time). Alzoubi et al. [2] developed TEACHActive, a dashboard that provides instructors with visual classroom analytics about the active learning facilitation strategies they use. It uses data from EduSense [1]. Its dashboard helped instructors identify their actual behaviors in classrooms and encouraged them to work towards engaging students with more active learning strategies.

III. SKOR Design and Implementation

Our literature review shows that in-class participation is an important part of learning, motivation, and critical thinking. The quantity and quality of participation depend on the learning activities and pedagogy used. Technology is used to enhance participation: detecting, analysing and feedback. We conduct an experiment to compare the perception of using technology to enhance in-class participation.

We developed an in-class participation system called SKOR to facilitate students to raise hands using the system, to allow teacher to call students who participated less, and to provide real-time feedback of class participation. Our learning management system (LMS) is used to mark attendance, SKOR is used to grade quantitative participation, and the teaching assistant (TA) uses SKOR to grade the participation quality. The dashboard provides participation feedback and allows the TA to call upon students who have participated less or have been prioritized by the teacher. This design addresses consolidation of responsibility. SKOR is designed to work in traditional lecture, active learning, group collaboration, project work as well as flipped classroom. Students can login, check their participation points and raise their hands using SKOR. They will be notified when they are called upon and see their participation points updated. In a way, SKOR gamified their class participation.

SKOR is hosted within the university server. The administrator manages student and class list by importing/exporting to the LMS. SKOR is customized for our university term schedule, course-classroom structure, teacher-teaching assistant-student relationships, and participation grading structure. We have included customization for email notification, university email security, maximum participation points, error reporting, and importing and exporting of student list and scores. SKOR is designed for ease of use, is user centric and adopt the agile/lean methodology [36]. The ease of use includes aesthetic look and feel that encourages student to participate. SKOR 1.0 is purposedly a minimum viable product, with just enough features to be usable for early adopters who can feedback for future product redevelopment. Figure 1 shows the screenshots of SKOR.

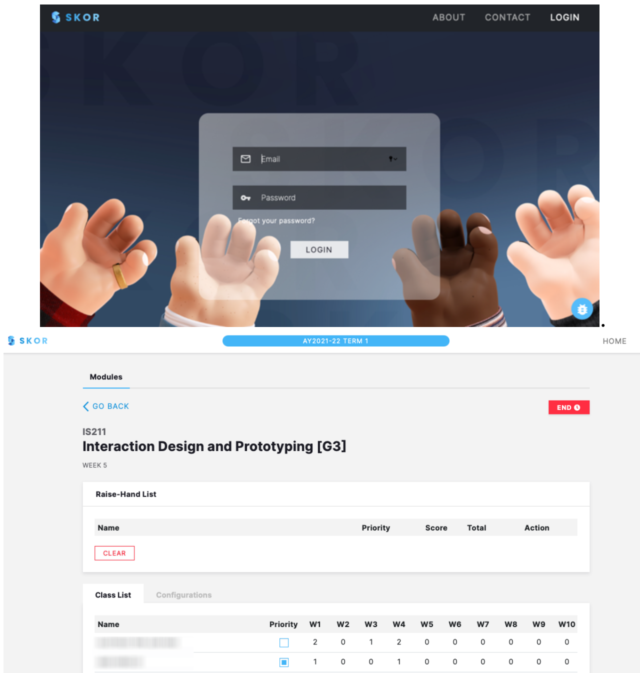

Fig. 1. SKOR Login and Select Raised Hands Pages

IV. Research Method and Questions

We conducted a randomized experiment across matched population. We randomly select matched year 2 undergraduate students from 12 Interaction Design and Prototyping classrooms based on similar teacher, major and timing (e.g., same teacher for CS students during mid-week afternoons). One classroom is the control group without using SKOR, and the other is the treatment group using SKOR.

The class participation policy is the same for all sections and established on the first week of class. Participation grade is 10% based on weekly attendance (1 point), in-class participation (2 points) and discretionary (1 point) which involve reflection or research report. The active learning activities are in-class exercises/quizzes, term-long group project, short problems, flipped videos and online messaging via LMS forum or Telegram.

The research study is institutional review board (IRB) approved by our university. We sent an email to all students in selected classroom to fill out a google form. IRB approved that the class participation policy is the same whether they use or not use SKOR. This research aims to answer the following questions.

R1. Is SKOR better/worse in keeping student *updated* on their class participation progress?

R2. Is SKOR better/worse in perceived *efficiency* of grading class participation?

R3. Does SKOR improve the perceived *fairness* of class participation?

R4. What are students' *perceptions* of class participation?

Experiment 1 surveyed selected students and accepted (n=99) valid responses. The survey questions are:

Q1. How do you feel about the class participation? Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

A. I know my class participation points.

B. I know how to get my class participation points.

C. I am interested in participating in class.

D. Class participation is efficiently done in class.

E. Class participation works for this class.

F. Points are fairly given to all students.

G. Points are given to the loudest student.

H. I get my participation points in class.

I. I get my participation points outside of class.

J. I cannot get participation points.

K. I engage more in class with class participation.

Q2. What do you like and dislike about participating in class and assessment of class participation?

Q3. Please suggest improvement.

Q4. What is your expected participation point?

Experiment 2 surveyed the usability and usefulness of SKOR. We accepted (n=11) valid responses from teachers, teaching assistants, and students who have used SKOR. The survey questions are listed below. The system usability scale (SUS) is based on reference [5].

Q5. Which SKOR features are useful?

Q6. What do you like and dislike about SKOR and Why?

Q7. Please suggest a new feature you like to see in SKOR 2.0?

Q8. Ten System Usability Scale questions for SKOR. Likert scale from 1 to 5.

V. Research Results and Limitations

For experiment 1, we compared Q4 expected and actual participation points to answer R1, keeping student updated with their participation progress. Figure 2 shows the average expected and actual participation points for all respondents (n) and for each teacher.

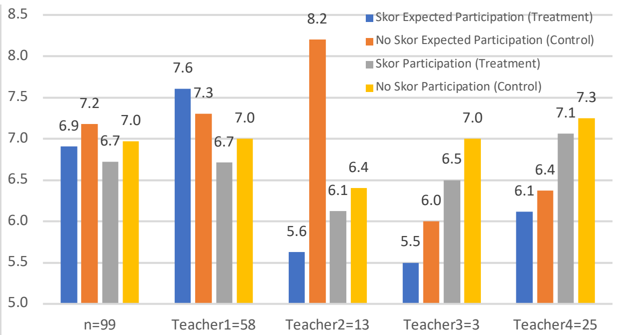

Fig. 2. Expected (Q4) vs Actual Participation Points

Our result suggests that *teachers may influence student expectation of participation points more than the display participation point feature in SKOR*. The standard deviation of the gaps between expected and actual participation supports this claim. The standard deviations for teachers are (0.9, 1.0, 1.53, 1.8). Compare that with standard deviations for control students without SKOR (1.1) and treatment (1.4), with SKOR. Thus, teacher standard deviation ranges from 0.9 to 1.8 and is wider than SKOR range from 1.1 to 1.4. The teacher standard deviation of their standard deviation is 0.4 vs SKOR at 0.155.

The control group standard deviation (1.1) is less than for treatment group (1.4). This is an unexpected result since in treatment group students are supposed to be able to find their participation points using SKOR, leading to smaller gaps between expected and actual participation points. Thus, *R1 (updated) is worse for SKOR*. Where gaps are >2 points, *treatment group is more positive about their participation points*. This may be due to the gamification of their participation points when using SKOR.

Figures 3 & 4 show the sorted average ratings for Q1 between control-treatment groups and between teachers respectively. A quick glance of the average rating variations in both figures support prior suggestion that *teachers may influence student perception of participation more than the use of SKOR*.

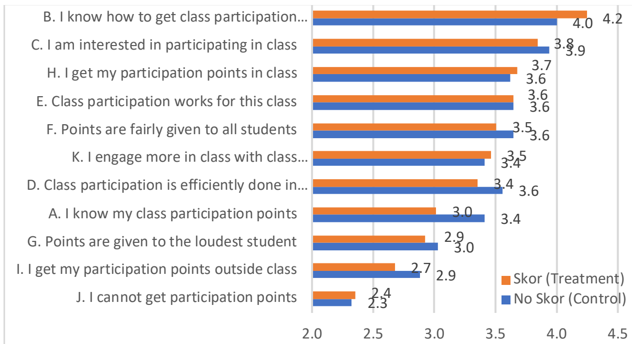

Fig. 3. Q1 sorted ratings between control-treatment groups

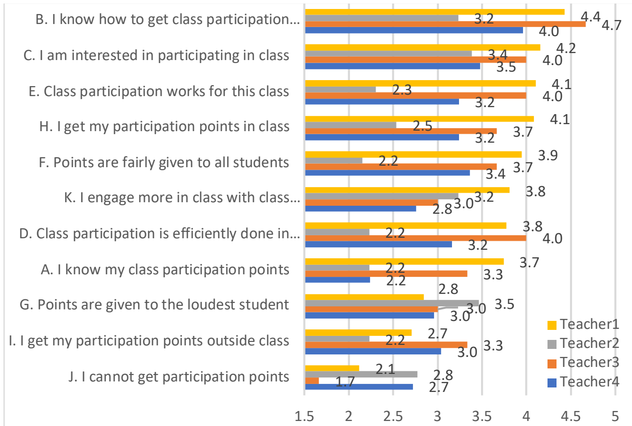

Fig. 4. Q1 sorted ratings between teachers

The students answering, "I know my class participation points" (A) score (3.4) for the control group which is better than treatment group (3.0). This supports our earlier unexpected result that the control group predicted their participation points better, supporting that R1 is worse for SKOR. The standard deviation of A for control is 1.4 and for treatment is 1.5. The standard deviation of that is 0.1, smaller than 0.4, the standard deviation of teachers' standard deviations (1.1, 1.5, 2.1, 1.2). This supports our earlier claim that teacher influence is stronger than SKOR influence for keeping student updated on participation points.

For R2, we refer to *efficiency* (D) with control group (3.6) perceived that participation grading is more efficient than treatment group (3.4). This is unexpected as we assume technology (SKOR) is perceived to help make class participation more efficient. Thus, *R2 (efficiency) is worse for SKOR*. The standard deviation of D for control is 1.3 and for treatment is 1.3 The standard deviation of that is 0.0, smaller than 0.3, the standard deviation of teachers' standard deviations (1.1, 1.4, 1.7, 1.2). This supports our earlier claim that *teacher influence is stronger than SKOR influence for perceived efficiency of grading class participation*.

For R3, we begin with *fairness* (F) with control group (3.6) perceived slightly more fairly than treatment group (3.5). Fairness is the 5th highest average rating for both control-treatment and teachers. On the flip side, *loudest* (G) is the 3rd lowest. Less treatment group students (2.9) perceived participation points are given to the loudest than control group students (3.0). This balance out: student rate fairness highly, more for control and rate loudest lowly, lower for treatment. Thus, *R3 (fairness) is neutral for SKOR*.

For R4 (*perception*), we now look at the top four Q1 average ratings (B, C, E, H). They suggest that students are interested in class participation (C), know how to get their participation points (B), get their participation points in class (H), and think that class participation works (E). Thus, *R4 students (perception) are interest, know how, get in-class points and thinks class participation works*.

Comparing control and treatment groups, control did better in interest (C) and fairness (F). However, treatment did better in knowing how to get participation points (B) and getting it in class (H). They tie in participation works for this class (E). Interesting that SKOR helped student who know how (B) to get in class points (H). Lastly, (J) cannot get participation points is the lowest average rating. This low score support student perception that class participation works.

The standard deviations of (B, C, H, E, F, G, J) for control are 1.1, 0.9, 1.2, 1.2, 1.3, 1.4, 1.2 and for treatment are 0.9, 1.1, 1.1, 1.3, 1.2, 1.4, 1.3 respectively. The standard deviations of the control-treatment standard deviations are 0.2, 0.1, 0.1, 0.0, 0.0, 0.0, 0.1 respectively, smaller than 0.4, 0.3, 0.3, 0.3, 0.3, 0.3, 0.5 standard deviation of teachers' standard deviation respectively. This supports our earlier claim that *teacher influence is stronger than SKOR influence for class participation perception*.

For R4 (*perception*), we compared all Q1 responses between control and treatment to look for any statistically significant differences by using t-test when there is normal distribution, or Mann-Whitney U (Wilcoxon rank-sum) for between-subject (control/treatment) when there is non-normal distribution. We found no two tailed p-value smaller than 0.05 (α). *Our result shows no significant differences between control and treatment groups*.

We continue by looking at correlations between all Q1 responses and focus on coefficient greater than moderate value of 0.6. We got correlations: B-F=0.62, C-K=0.67, D-E=0.76, D-F=0.71, D-F=0.63, and E-F=0.63. We further screen for statistically significant differences with p-value smaller than 0.05 using t-test or Wilcoxon signed rank for within subject (e.g., same student response for B and F). We found significant correlation (p=1.05074E-07) for B-F knowing how to get participation and points are fairly given; (p=0.006557925) for C-K interested in participation and engage more in class; and (p=0.0160812) for D-E class participation is efficiently done and works for this class. The B-F significant correlation suggest *fairness in class participation when students know how to get participation points*, C-K suggest *interested in class participation could lead to good engagement in class, and D-E suggest better class participation efficiency can increase perception that participation works*.

We now look at our qualitative responses for Q2 and Q3. Figures 5 and 6 shows the sorted coded likes and dislikes about class participation respectively. 19 students mentioned that they like *sharing ideas and getting feedback* during class participation, 16 liked the f*airness such as the 2 maximum points*, and 15 liked that it *makes them think more*. 24 disliked that they have no or *less opportunity to participate* such as due to limited time, 14 disliked the *apprehension, pressure, intensity, competitiveness*, and 12 disliked *grading on quantity instead of quality*. There were still 11 who thinks it is unfair. These responses coincide with our literature reviews.

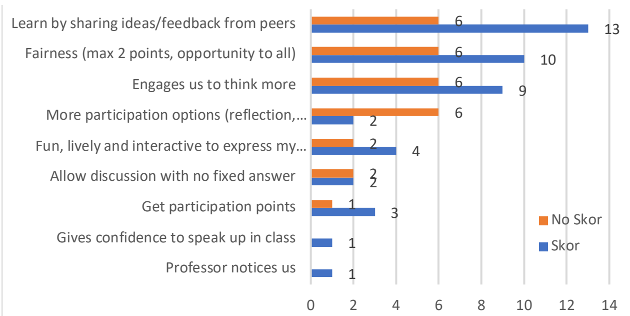

Fig. 5. Q2 What do you like about participating in class?

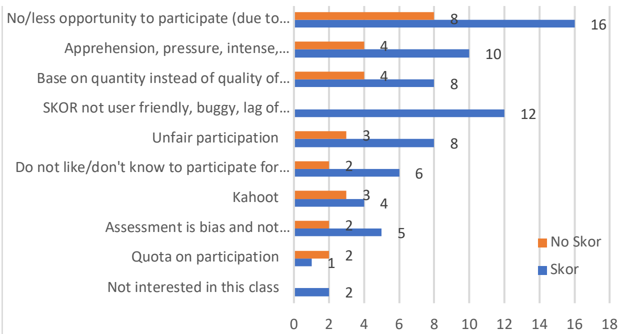

Fig. 6. Q2 What do you dislike about participating in class?

Experiment 2 surveyed (n=11) TAs and instructors on the usability of SKOR main features: students can participate, check their scores and TAs are able to see sorted dashboard and select raised hands. Figure 7 (Q5) confirmed the usefulness of the main features, while figures 8 and 9 list the likes and dislikes of SKOR (Q6). 5 teachers liked that they could *track participation easily* while 4 TA students liked that they *could see their participation points*. *Equal participation opportunity* and *minimizing human errors* were the other likes. However, the dislikes were *lack of better features*, SKOR as *another program* on top of the LMS, and *usability can improve*. The lacking features (Q7) mentioned were for a better leader board to *list inactive ranking*, recording of *participation by groups*, *undoing* a participation point, chatbot, integrating SKOR to zoom/LMS, faster batch import of class list, etc.

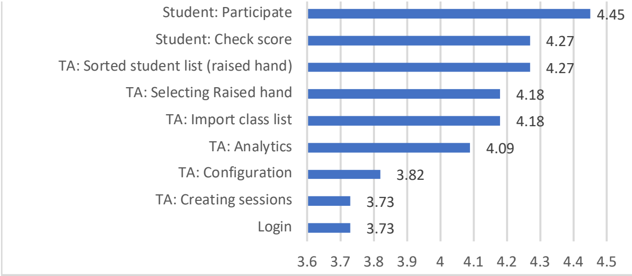

Fig. 7. Q5 Which SKOR features are useful?

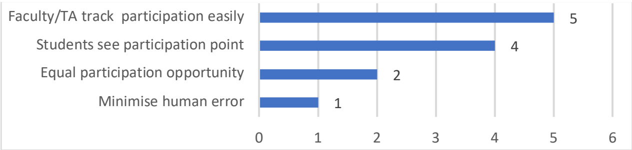

Fig. 8. Q6 What do you like about SKOR?

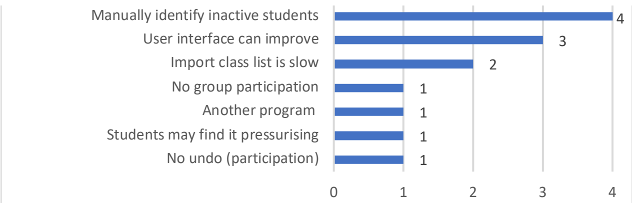

Fig. 9. Q6 What do you dislike about SKOR?

The System Usability Scale (Q8) [5] for SKOR is at a respectable 73 percentile but it can be improved as identified in figure 9 (Q6) with 3 dislikes stating the user interface can improve.

Our experiments are susceptible to the usual external validity concerns since they are based on our environment such as SKOR, course participation policy, students, and teachers' characteristics. Please refer to our findings as a special case study. Generalizability across different classroom environment is not guaranteed.

VI. Conclusion and Future Work

This paper presents a recent literature review of class participation and active learning engagement using technology. Although SKOR did not fare well in our experiment, the lesson we should take away is that technology needs to be supplemented with the right course policy and teaching strategy when it comes to class participation. Teacher plays a major part and universities should focus on training teachers to improve their class participation.

Our experiment results suggest that teacher may be a bigger influence on class participation points than using technology (such as SKOR). We found no significant differences between control and treatment groups, even with a respectable 75% on SKOR system usability scale. On average, SKOR did not improve in keeping student updated or able to predict their class participation points. It also did not improve the perception of class participation on efficiency or fairness. However, students using SKOR are more positive on their participation points.

The findings on teacher influence are aligned with our literature review which recommends that we should establish clear participation policy, take time in class for participation, and teachers should engage in immediacy behaviours to encourage participation [27, 37]. Pedagogy such as active learning, collaboration, and problem-based learning enhance academic achievement and positive student attitudes [33].

Our class participation policy and pedagogy are aligned with the recommendations and show high overall student perception of fairness and low consolidation of responsibility. We found significant correlations that are insightful to understand class participation: 1) fairness in class participation is correlated to students knowing how to get participation points, 2) when students are interested in class participation, it could lead to good engagement in class and 3) better class participation efficiency could increase perception that participation works.

For future work, we hope to develop a new SKOR 2.0 by adding desired features such as grading qualitative participation by detecting, analysing, and giving better feedback on class participation. Another direction is the gamification and virtual reality of participation to encourage students high in communication apprehension as a trait. Virtual reality with teacher avatar can engage in more immediacy behaviours. This is particularly important for teachers who are less approachable.

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