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IDENTIFYING STUDENTS' PERCEPTION OF CLICKERS VIA BRING YOUR OWN DEVICE (BYOD) IN FLIPPED CLASSROOMS

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Abstract

The purpose of this Q-study is to identify and categorize learners' perception of the use of clickers implemented via a BYOD model in a flipped classroom at a university in Taiwan. Q-methodology was conducted for this study because it is a quantitative analysis of subjective data. Twenty-one trainees was surveyed and asked to rank-order 30 statements about their reflections on using the clickers via the model of BYOD in inverted classroom. Factor analysis was used to identify the number of factors and the correlations study attempts to identify the individuals who are highly correlated with one another in each specific factor. The data was processed and analyzed following the usual steps of Q-methodology by using the PQ Method software. The operant factors that represent participants with similar perceptions was identified. The results of the study indicated that all the students had brought smartphones into the classroom rather than laptops or tablets and the analysis of their Q-sorts yielded three distinctive factors. The value of Q-methodology in this research is to uncover the opinion types and perception differences through in-depth study. The results of this Q-methodology research can be used to design various hypothesis-testing researches for future studies.

Keywords: BYOD; Clickers; Flipped Classroom; Formative Assessment; Q-methodology

Introduction

Numerous studies have focused on utilizing clickers in higher education in the past two decades, and there is also a growing interest in the use of

m-learning in education (Buil, Catalán, & Martínez, 2017; Castillo- Manzano, Castro-Nuño, Sanz Díaz, & Yñiguez, 2016). Clickers are also known as student response systems, audience response systems, personal response systems, interactive response systems, classroom response systems, and electronic voting systems (Han & Finkelstein, 2013). To date, the pedagogical potential of mobile technologies remains one of the least explored functionalities of smartphones in higher education institutions (Kearney, Burden, & Rai, 2015). The subject of clicker adoption associated with students' personal mobile devices, such as laptops, tablets, and smartphones, has received increasing attention.

Fortunately, many university students use personal owned devices in their classrooms and it opens up an alternative model for teaching, known as Bring Your Own Device (BYOD). While a considerable volume of research has been undertaken on the utilization of clickers in teaching and learning practices (Chien, Chang, & Chang, 2016), few investigations have been made of the use of a Flipped Classroom (FC). However, it seems critical to explore students' views during the initial application of clickers via BYOD in "flipped classroom" approach in order to understand how technologies can best be integrated into the learning process. Therefore, the purpose of this Q-study is to identify and categorize learners' perception of the use of clickers implemented via a BYOD model in a flipped classroom at a university in Taiwan. The following research questions were guided the overall study:

(1) What are the learners' subjective opinions of this pedagogy?

(2) What are the factors that represent groups of learners who share a similar pattern of thought?

The research is divided into five parts: (1) The theoretical and empirical background of the study; (2) A review of the relevant existing literature; (3) Details of the methodological approach used to complete the study; (4) Results of the study; and (5) Discussion of the results. The limitations of the study are also highlighted in the final part of this report.

Literature Review

Using Student Response Systems in Education

Clickers, one of the most popular polling devices, have evolved in terms of their forms and capabilities to the latest smartphone polling apps (Stowell, 2015). Various clicker technologies (e.g. Mobile Qlicker, Kahoot, Plickers, Socrative, Zuvio, Cloud ClassRoom) are available for educational purposes since the technology was introduced in the 1980s. Considerable amount of studies has indicated the strengths of using clickers in the classrooms (Buil et al., 2017).

The green benefit of this approach is that there is no paper required to administer classroom quizzes (Premuroso, Tong, Beed, 2011). Clickers are also associated with students' motivation, learning and satisfaction (Buil et al., 2017) and provide more positive experiences in the classroom (Han & Finkelstein, 2013). The use of clicker

activities also encourages interaction and engagement (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013; Williams, Lewis, Boyle, & Brown, 2011), facilitate participation in class (Carnaghan, Edmonds, Lechner, & Olds, 2011), enhances classroom attendance and attention (Keough, 2012), and facilitates students' active collaborative learning. Furthermore, using clicker-based technologies help students to decide which areas to focus on when studying (Tong, 2012). Clickers can be used to promote flow experiences in academic settings and enhance the learning experience, support students with challenges that balance their skills, offer clear objectives for students to pursue, provide immediate feedback (Buil et al., 2017), encourage concentration, and enhance a sense of control and enjoyment (Rana, Dwivedi, & AlKhowaiter, 2016). Kapp (2012) suggests clickers also can integrate game elements into traditional lecture (e.g. reward structures and feedback). It encourages friendly competition among students (Buil et al., 2017).

Apart from the numerous potential benefits of clickers, previous studies also indicate certain challenges, such as heavier workload for the instructors, greater cognitive energy required from learners, potential technological problems (viz. when clickers do not function properly)(Buil et al., 2017), increased consumption of class time, forced or monitored attendance record, increased anxiety about using clickers (i.e. the scores are part of the course grade or unsure about if the answers were recorded properly) (Caldwell, 2007).

Implementing the Flipped Classroom for Teaching and Learning

Recently, there has been a wave of implementations of the FC approach in assorted educational institutions (Hew & Lo, 2018; Karabulut-Ilgu, Jaramillo Cherrez, & Jahren, 2018; Lo, Lie, & Hew, 2018; Shih & Tsai, 2017; Zheng, Kim, Lai, & Hwang, 2020). Various researchers have found that FC method can improve interaction, increase class attendance, improve academic performance and hold a positive attitude towards the courses adopted (Chen, Wang, Kinshuk, & Chen, 2014; Chen, Yang, & Hsiao, 2015; Hung, 2015). However, Chen, Chen and Chen (2015) argue that some learners may not have access to the Internet to watch videos at home. In addition, recent studies indicate that videos in FC are not inherently interactive, thus other technologies should be integrated to advance the FC model (Chen & Chen, 2018; Liou, Bhagat, & Chang, 2016).

Methodology

Trainer and Research Participants

The study was conducted during an 18-week course at a university in Hsinchu. Twenty-one undergraduates took part in the mandatory course. All participants had web-based learning experiences, and many knew each other and the facilitators. The researchers, who had experience of implementing a FC, were the instructors, the curriculum designers, and the moderators in the individual and focus-group interviews.

Description of the Course

This approach was implemented in an Investment Strategy and Analysis course, a required component of the undergraduate program in the Department of Technology Management. The course contents included cost concepts and design economics, cost-estimation techniques, the time value of money, evaluation of a single project, comparison and selection among alternatives, depreciation and income taxes, and price changes and exchange rates. The participants were assessed based on individual written assignments, formative/summative assessments and quizzes that incorporated the use of student response system, and a mid-term and a final exam.

Rationales for Using Zuvio Interactive Response System

The Zuvio interactive response system (i.e. IRS, also known as Clickers) was developed by the Electrical Engineering Department at National Taiwan University in 2012 (Lee & Shih, 2015). It was designed to increases the interaction between lecturers and students. Learners may respond to the questions posed by their teachers on their own devices (e.g. smartphones, tablets or laptops). Indeed, Zuvio is one of the most popular IRS in Taiwan, with 651,416 student users in December 2017 and more than 32,845 teacher users nationwide (https://www.zuvio.com.tw). Zuvio was used in this study because of the following features:

(1) Providing a cloud-based learning management system for both teachers and students.
(2) Supporting any internet-enabled device (viz. without using a traditional handheld transmitter).
(3) Taking attendance directly.
(4) Making "on the fly" instructional choices to encourage students' participation and engagement.
(5) Allowing anonymous questions and feedbacks.
(6) Tracking and analyzing individual/group learning outcomes with bar or pie chart.
(7) Providing various test formats (i.e. open-ended and multiple choice questions)
(8) Delivering and grading in-class quizzes efficiently.
(9) Facilitating group discussion and peer-assessment.

Instructional Strategies in the Flipped Classroom

Partial flipped classroom practice (i.e. Not flip an entire course) was used in this course. Eight self-paced flipped learning activities was introduced after classes. Each team consisted of two to four trainees, who was assigned segmented missions (viz., group problem-solving, peer review, and decision-making assignments). Formal groups were organized in this class. Learners are permitted to select their own partner or group, and they can work with their friends. Therefore, the peer groups gathered to develop and contribute to one another's mastery of various course topics by discussing the materials and supporting their group members.

Implementation of Zuvio Interactive Response System

This course consists three 1-hour sessions per week. The instructor used

Zuvio to take attendance at the beginning of each class. In addition, formative and summative assessment was conducted via Zuvio before and after each lecturer. The instructor can identify and address areas of confusion in order to adjust the pace of the course appropriately. Each formative assessment included five multiple-choice items; on the other hand, one to five open-ended and five multiple-choice questions were asked in every summative assessment session. Students were encouraged to spark discussion with their classmates before submitting their answers. They also can ask anonymous questions during classes. Followed by the voting results of the formative/summative assessments, the instructor provided them with explanations for correct and incorrect answers. On-the-fly questions (i.e. those not planned before class) and peer-evaluation was also integrated in order to check students' comprehension of the material during classes.

Measuring Subjectivity

Q-methodology was used in this study in order to identify the subjective standpoints of a few people by asking them many questions, rather than exploring the reaction of a large number of people to fewer questions (McKeown, 2001). A small sample size is rather common and acceptable when utilizing Q-methodology (Brown, 1996; Chen, 2016; Chen & Chen, 2018). The aim of Q-methodology is neither to uncover the cause nor to generalize demographic prevalence of variables to a large population. The three steps of Q- methodology are as follows:

(1) development of research tools: creating a set of statements to be sorted,

(2) data collection: sorting these statements along a continuum of preferences (viz., range from agree to disagree), and

(3) data analysis: analyzing and interpreting the data.

Data Collection

After finishing the course, 21 learners participated in a Q-study led by the researcher. Semi-structured interviews were conducted with all the students one week after the end of the training program in order to ascertain their perspective of the topic. The research instrument was based on a representative sample of 30 statements containing the key ideas from the interviews. Those 30 statements, which represented the final Q-set, was selected through a content analysis that characterized aspects of technology, content, and teacher/students. Q-studies can be implemented with as few as 10 statements because participants have the opportunity to convey their point of view (Cross, 2005).

Sample statements were reviewed by two domain experts and in order to ensure content validity. A pilot test was conducted with two volunteers who participated in the first interview in order to make minor modifications to clarify some Q-statements. The Q-set (viz. Q-methodology questionnaire) was then distributed to all learners to study the basis of their assessment of this innovative pedagogy. Without bias, and treating both disagreement and agreement issues alike, the participants were asked to

rank-order 30 statements into nine categories within the answer grid, ranging from Most Disagreeable (–4) to Most Agreeable (4). In other words, the participants constructed their viewpoints in Q-sorts on the sorting answer sheet (see Figure 1) (Chen et al., 2015; Chen, 2016).

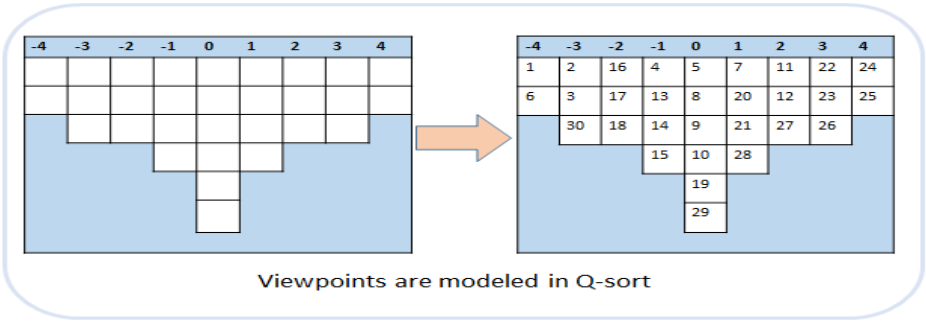

Figure 1. Q-sorting

Data Analysis

Data and Q-sorts were entered into the program as they was collected, thus producing different piles of statement numbers. Unlike the Likert survey technique, the statements related to one another are examined in Q- methodology. The data was analyzed using PQMethod statistical software, version 2.11, available at https://qmethod.org/. Various factor rotation and statistical procedure methods can be applied to safeguard factor reliability in Q-methodology. Correlation, a centroid factor analysis, and judgmental rotation (i.e., hand rotation) was employed to derive the major factors in this research. The relevant factors were selected and defined for a final analysis (Watts & Stenner, 2012).

Results

All the students had brought smartphones into the classroom rather than laptops or tablets and the analysis of their Q-sorts yielded three distinctive factors (see Table 1). Nineteen (90.47%) of the twenty-one students' Q-sorts were divided into three factors, while the other two were not considered to be statistically significant. It should be noted that three of the students (15.79%) whose Q-sorts were analyzed were identified as Factor 1 (involved and concerned with the physical infrastructure), while 9 of them (47.37%) were identified as Factor 2 (thinking and brainstorming enthusiast) and the remaining seven (36.84%) were Factor 3 (embracing records of learning and sharing). Factor 1 was bipolar, which indicated two different understandings of this teaching approach.

Factor 1: Involved and Concerned with the Physical Infrastructure

Factor 1 consisted of one female and two male students. Factor 1a (the negative pole of the factor) contained the views of Person 3 (factor loading of −0.63); in contrast, factor 1b (the positive pole of the same factor) contained the views of Persons 1 and 2 sorts on the same factor contained diametrically opposed views. The average final grade

of Factor 1 is 55.47 (SD = 22.93). The average IRS participation rate is 69.67 (SD = 21.67). The average IRS accuracy rate is 64.33 (SD = 7.93), and the IRS participation rate * accuracy rate is 46.07 (SD = 19.41). This group has the lowest IRS participation rate and the final grade.

The predominant feeling of the students in this group was that this method "blurred the boundaries between the formal and informal learning contexts and extended learning through IRS discussions in class and viewing online videos at home" (Statement 1, +4). They would like to be able to "watch the video clips for the whole semester to discover more" (Statement 30, +4). They were concerned about "I hope when the instructor uses his build-in pen of the laptop to draw or write on the touchscreen could run smoothly." (Statement 28, +3) and would prefer "more diversified questions related to real-world practice in the IRS system" (Statement 9, +3). They did not think that "the response time of the IRS was too short" (Statement 2, -4). Furthermore, they did not agree that "Zuvio helps me to raise my hand in the classroom and express myself without fear" (Statement 13, -3) or that "my main concern is not to learn the course contents, but to improve my autonomous behavior in class" (Statement 23, -3) (see Table 1).

Table 1. Trainees' Statement Scores by Factor/Opinion Type.

Statement		Factors (*)		
1			2	3
No	Factor A:			
1	This class will enhance my involvement in the content of the course through IRS discussions in class and viewing online videos at home.	4	0	1
30	I hope all the lecture-capture videos will be open for the whole semester so that I can discover more.	4	3	4
9	I hope the IRS system can contain more diversified questions connected to real-world issues, not just calculations.	3	0	1
20	The Zuvio system tracks historical records and allows me to construct my own learning journey.	3	1	3
28	I hope when the instructor uses his building-pen of the laptop to draw or write on the touch screen could run smoothly.	3	-2	-1
2	The response time of the IRS is too short so that students sometimes cannot answer the questions in time.	-4	4	4
12	I hope the Zuvio system will increase the music and sound effects.	-4	-4	-4
13	The Zuvio system can help me to express myself without being embarrassed or having to raise my hand.	-3	-1	0
15	I feel that it is very laborious to have to use the phone keypad to enter the answer.	-3	-4	-3
23	My main concern is not to learn the course content, but to improve my autonomous behavior in the class	-3	2	1
	Factor B			
2	The response time of the IRS is too short so that students sometimes	-4	4	4

	cannot answer the questions in time.			
4	I think the contents of the online class videos are detailed and comprehensive.	1	4	1
10	I hope the teacher will at least give a hint before I work on the IRS questions myself.	-1	3	3
11	I can brainstorm and exchange my ideas with classmates in group discussions.	1	3	-3
30	I hope all the lecture-capture videos will be open for the whole semester so that I can discover more.	4	3	4
12	I hope the Zuvio system will increase the music and sound effects.	-4	-4	-4
15	I feel that it is very laborious to have to use the phone keypad to enter the answer.	-3	-4	-3
22	Teachers should scold classmates who do not concentrate on using IRS in class.	2	-3	-2
26	I feel that when I use my mobile phone to answer questions about the Zuvio system, the screen is too small and it hurts my eyes.	-1	-3	-3
29	In fact, some students do not like to use the IRS to complete assignments.	0	-3	0
	Factor C:			
2	The response time of the IRS is too short so that students sometimes cannot answer the questions in time.	-4	4	4
30	I hope all the lecture-capture videos will be open for the whole semester so that I can discover more.	4	3	4
7	The instructor showed our answers on the screen and encouraged us to discover and learn from each other.	0	-1	3
10	I hope the teacher will at least give a hint before I work on the IRS questions myself.	-1	3	3
20	The Zuvio system tracks historical records and allows me to construct my own learning journey.	3	1	3
12	I hope the Zuvio system will provide better music and sound effects.	-4	-4	-4
14	When we hold group discussions, fast learners usually help others who find it difficult to grasp ideas.	-2	1	-4
5	This teaching method gives everyone a better chance to express their thoughts than other methods.	1	0	-3
11	I can brainstorm and exchange my ideas with classmates in group discussions.	1	3	-3
15	I feel that it is very laborious to have to use the phone keypad to enter the answer.	-3	-4	-3

Item rankings: -4 = most unimportant in this sample; 0 = ambivalent; +4 = most important in this sample.

Factor 2: Thinking and Brainstorming Enthusiast

Factor 2 was composed of three female and six male students. The average final grade of Factor 2 is 66.53 (SD = 14.87), and the average IRS participation rate is 79.78 (SD = 12.18). The average IRS accuracy rate is 76.33 (SD = 9.63), and the IRS participation

rate * accuracy rate is 61.41 (SD = 14.38). They felt that the "response time of the IRS is too short" (Statement 2, +4), "the content of the online class video is detailed and comprehensive" (Statement 4, +4), and "I hope the teacher was at least give a hint before I work on the IRS questions myself" (Statement 10, +3). They also liked the fact that they could "brainstorm and exchange ideas with classmates in group discussions" (Statement 11, +3), but they did not agree that "teachers should scold students who are not concentrating on using the IRS in class" (Statement 22, -3) or that "some students do not like to use the IRS to complete assignments" (Statement 29, -3) (see Table 1).

Factor 3: Embracing Records of Learning and Sharing

The average final grade of Factor 3 is 77.13 (SD = 11.18), and the average IRS participation rate is 82.14 (SD = 9.55). The average IRS accuracy rate is 73 (SD = 9.34), and the IRS participation rate * accuracy rate is 60.77 (SD = 14.58). Both the IRS participation rate and the final grade of this group are the highest in this class. The Factor 3 group contained four female and three male students, who agreed that "response time of the IRS is too short" (Statement 2, +4), "the instructor should show our answers on the screen and encourage us to discover and learn from each other" (Statement 7, +3), "The Zuvio system tracks historical records and allows me to construct my own learning journey" (Statement 20, +3), and "I hope the teacher was at least give a hint before I work on the IRS questions myself" (Statement 10). However, they disagreed that "fast learners usually help others who are finding it difficult to grasp ideas" (Statement 14, -4), "this teaching method gives everyone a better chance to express their thoughts than other methods" (Statement 5, -3), and "I can "brainstorm and exchange ideas with my classmates in group discussions" (Statement 11, -3) (see Table 1).

Consensus Statements

The students' statement scores by factor/opinion type were generated by the PQmethod statistical software. The three groups equally agreed or disagreed with some of the statements (i.e., those that do not distinguish any pair of factors), namely, Statements 12, 15, 18, 20, 21, 26, and 30. The participants in groups 1, 2, and 3 strongly agreed with Statement 18: "IRS enhances teacher-student interaction" and Statement 20: "tracks historical records and allows me to construct my own learning journey." They also agreed that lecture-capture video clips should be viewable throughout the whole semester (Statement 30). On the other hand, they disagreed with Statement 12: "need to increase Zuvio's music and sound effects", Statement 15: "Mobile devices make typing physically harder", Statement 21: "increases the level of student-student interaction", and Statement 26: "BYOD hurts my eyes."

Discussion and Conclusion

Q methodology facilitated an in-depth understanding of the perspective of a convenience sample of students in a flipped classroom. The results of a correlation and factor analysis illustrated that these learners shared a common view of embracing and be-

coming engaged with this newfangled pedagogy. They particularly appreciated the immediate feedback from the IRS, since it enabled them to assess their progress in the class in real-time. One key issue that remains important for instructors in flipped classrooms is how to encourage learners to participate in group discussions when using IRS. It is suggested in this study that this issue could be resolved by pairing high achievers with low achievers for particular assignments. Low achievers may benefit from high achievers' scaffolding during IRS sessions. Based on the results of the IRS participation rate and the final grades of those three groups, a contribution from this study is that students' IRS participation rate may be correlated with their final grades. Above all, this affirms the growing scholarship of educational literature, in which it is shown that BYOD and IRS-mediated pedagogical practices help teachers to engage students in a digital classroom. These innovative educational technologies enable instructors and administrators to efficiently improve the quality of service, focus on more cost-effective resources and facilities, and monitor students' satisfaction.

The findings of this study correspond closely to those of Kobus, Rietveld, & Van Ommeren (2013), who found that all students today are highly likely to own a mobile device that is sufficiently powerful to sustain their studies. This finding is also similar to that of Chou, Chang, and Lin (2017), who found that junior high school students' language learning was enhanced by integrating Socrative (i.e. another IRS system) and BYOD in the classroom. Most of the participants in this study described the use of Zuvio via BYOD in a higher educational context as a positive learning experience. As documented in Hung's (2017) quasi-experimental research, the results indicated that the gamified lessons had positive impacts on students' flipped learning in the language learning classroom. Hung (2017) further recommends to adopt IRS applications for only formative assessment since the students held reservations about utilizing clickers for summative assessments due to their occasional frustration with the technical complexity problems (e.g. Wifi infrastructure and internet speed). Conversely, the current study argues that the students in this study had positive feelings toward adopting clickers' application for both summative and formative assessments via the IRS system. As the technology develops in an exponential way, the link and hardware infrastructure had proved to be stable and fast before making a large-scale application of BYOD in a flipped classroom. The majority of students did appreciate the prerecorded lectures and lecture-capture. It is believed that if the instructor had used a more advanced and pressure sensitive pen to draw and write on the touch-screen of the laptop, the video-clips could have better quality. In sum, further longitudinal study designs are recommended to investigate if the usage of clickers implemented via a BYOD model in a flipped classroom might be important for predicting student performance.

Limitations of the Study

While the Q sort forced the learners to prioritize their feelings, one of the limitations of the study was that the

choice of statements needed to be sufficiently extensive to include enough negative statements, as well as positive ones, to represent the relevant opinions. Another limitation was the lack of assessment of learners' self-regulation skills because such an assessment would have enabled the students' study skills to be analyzed to determine if this was another constraint on their learning activities. Their familiarity with Zuvio prior to this study could also be considered as a limitation. The last limitation is the relatively small sample size applied to the researchers' class. The utilization of a larger sample from various levels (e.g. graduate schools) and more institutes of higher education would substantially increase the transferability of the study.

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