A Study of Perceptional Typologies on Computer Based Assessment (CBA): Instructor and Student Perspectives

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ABSTRACT

This study explores and describes different viewpoints on Computer Based Assessment (CBA) by using Q methodology to identify perspectives of students and instructors and classify these into perceptional typologies. Thirty undergraduate students taking CBA courses and fifteen instructors adopting CBA into their curriculum at a university in Korea, were chosen as participants in this study. As a result of the study, firstly, four types of learners were identified and given the following descriptive labels: (I) CBA Dissatisfaction Type, (II) CBA Friendly Type, (III) Adjustment Seeker Type, and (IV) CBA Apprehensive Type. Secondly, three types of instructors were classified and given the following descriptive labels: (A) CBA Preferred Type, (B) Supplementary Need Type, and (C) Yes-But Mixed Type. Educational and pedagogical implications of these results are discussed in the context of CBA course design.

Keywords

Computer-based assessment (CBA), Blended learning, Users' perspectives, Q method, Typology

Introduction

Student assessment is considered an integral part of the learning process, which can be used for learning evaluation, student motivation and grading, and program adaptation (Emmanouilidou et al., 2012). The application of supporting technologies such as computer based assessment (henceforth referred to as "CBA") has mainly been used in a blended learning environment in order to assess student learning, as well as to enhance students' self-directed learning (McBain, 2001). CBA has become a crucial aspect of overall assessment strategy as well as blended learning for students (Waddell et al., 2012). The rationale for this strategy is that CBA increases and improves student's participation and attendance (Marriotte & Lau, 2008). Therefore, the application of CBA to various learning environments, and the issues involved with doing so, are the subject of much discussion.

CBA offers enormous prospects for innovation in learning, testing, and assessment such as self-evaluation, useful feedback, space and time flexibility, and multimedia usage. Paper based formative assessments are currently complementing, or have already been replaced by innovative and powerful CBA instruments these days (McDowell, 2002). Despite the numerous benefits just listed, paper-based evaluation is still commonly used in contemporary learning environments. (Hole-Elders et al., 2008). The enhancement of CBA will positively influence teaching effectiveness; therefore, diversified efforts should be made to establish CBA in the learning environment.

Despite many studies on the application or effectiveness of CBA, research on users' perspectives toward CBA is still inadequate. CBA has been evaluated from the instructor's perspective in the existing literature (e.g., Magliano and Graesser, 2012; McKenna, 2001), but research into learners' viewpoints about CBA is limited. The effective development of CBA depends on both instructors' and students' acceptance. Consequently, there is a need for a more formal approach to understanding the perceptional perspectives of instructors and learners with CBA. The purpose of this paper is to first analyze the learners' perceptional typology regarding CBA. In other words, this study purposes to investigate and categorize the learner's perception of CBA, ultimately investigating the learner's particular typology with regard to CBA. Secondarily, the perception of professors and instructors who are currently conducting CBA was analyzed to investigate their perceptional typologies and compare the differences between instructors and learners. With the aim of providing a typological analysis of users' perspectives, this study used Q methodology to identify different viewpoints on CBA.

Originally evolving from factor-analytic theory, Q methodology combines aspects of both qualitative and quantitative research traditions as a way to study the subjectivity involved in any situation (e.g., Kim, 2012). This method is ideal for deeply exploring areas of complex perceptions or opinions. Participants are asked to sort and rank a sample of statements concerning the subject of research (i.e., Q sorting). Then, the Q sorts are correlated and factor

analyzed, resulting in different types that are qualitatively interpreted, providing accounts of understandings of the subject (Brown, 1980).

The result of this study partially contributes to the effective application of CBA when designing classes, as well as offering benefits on research objectives and settings. This study was conducted on full-time students taking blended learning courses and instructors actually performing CBA at a regular university, excluding part-time students who are taking 100% online courses.

Literature review

What CBA is

CBA utilizes computer technology, including the Web for assessing student learning (Bull & McKenna, 2000) and provides flexibility in style and content with reduced tutor dependency (Boud, 2000). It is also defined as a technique which "encompasses the use of computers to deliver, mark or analyze assignments or exams" (Sim et al., 2004, p. 217).

CBA can be categorized into formative and summative assessments. Formative assessment is designed to aid learning through familiarizing students with course contents, informing them about gaps in their learning, and providing feedback to guide the direction of learning. This occurs during the course of instruction. Providing formative assessment has been considered a significant benefit to student learning and leads to enhanced learning outcomes (Black & Wiliam, 1998; Rolfe & McPherson, 1995; Sadler, 2010). On the other hand, the goal of summative assessment is to evaluate student learning. Summative assessment measures what students have learned at the end of an instructional unit and is concerned with accountability and certification. It helps to establish whether students have attained the goals set for them. Summative assessments, which are generally high stakes, provide little opportunity for effective learning through feedback. (Economides, 2009; Ellery, 2008). So, CBA includes adaptive testing, analysis of the content of discussion boards, automated essay marking, delivery of exam papers, multiple choice testing, and so on (Sim et al., 2004).

CBA plays a strong role in overcoming the spatial limitations of formative assessment using multimedia, drawing automatic results, improving educational applications through the analysis of questions and evaluation results, providing immediate feedback, reducing errors in evaluation, increasing the speed of results, tracking students performance, and more (McKenna, 2000). However, its application in the learning environment still lags behind. This is because of a lack of technical knowledge and skills to develop CBA, a lack of the instructor's time or desire to apply CBA, a lack of resources, and a lack of computer facilities to execute CBA (Hole-Elders et al., 2008).

Users' perceptions of CBA

The previous studies on CBA have addressed many aspects of CBA: effective application strategies for CBA (Bull & McKenna, 2000; Hole-Elders et al., 2008), educational effects (Zakrzewski & Bull, 1998), quality assurance of CBA such as clarity, validity, and reliability (Conole & Warburton, 2005), viewpoints on CBA (McKenna, 2001; O'Hare, 2001; Waddel et al., 2012), interaction/feedback issues (Wang, 2007; Yorke 2003), and technical issues (Boyle & O'Hare, 2003; Magliano & Graesser, 2012). For example, ineffective tutor feedback in the early stage is being replaced by qualitatively superior electronic feedback (Yorke 2003). Regarding the effects of CBA, there is some evidence that formative CBA can improve final test results (Zakrezewski & Bull, 1999) but there is also a finding that frequent high stakes assessment has a negative motivational impact on learning (Harlen, 2005). In addition, proper computer hardware, and infrastructure are needed to effectively adopt CBA. Moreover, the establishment of a clear evaluation purpose, the security to prevent the external leakage of tests, the provision of proper feedback and training of instructors, the evaluation of CBA and the use of item banks have been suggested for the effective application of CBA (Hols-Elders, Bloemendaal, Bos, Quaak, Sikstermans, & Jong, 2008).

Regarding the perspective of professors and their opinions, the question format of CBA was the main issue. Student-constructed responses, such as essays and short-answer questions, can be useful tools to gauge student learning outcomes and comprehension strategies. However, multiple-choice items remain the most widely and commonly

used item format in CBA due to the difficulty of grading for essay format and differences in criteria that humans versus computers use (Magliano & Graesser, 2012). The application of various evaluation methods, other than multiple-choice questions, that enable instructors to measure the higher level skills of students, such as synthesis or analysis, have not yet been adopted by CBA (Conole & Warburton, 2005). Of course the development of high-quality multiple choice items is still a difficult skill to acquire (Boyle & O'Hare, 2003); the objective style testing within CBA is well established for standardized assessment across all levels of education (Bennett, 2002). However, Nicol & Macfarlane-Dick (2006) strongly claimed the theoretical basis of CBA is still inadequate and the concept of assessment is still far behind.

Instructors regard computer based summative assessment as a means of improving students' participation and attendance, and also as key to developing self-regulation and independence in the education experience (Marriott & Lau, 2008; Novakovich & Long, 2013). Similarly, McKenna's study (2001) indicated that most instructors applying CBA to their classes are using it for the purpose of performing a formative assessment and they have said the reason they adopted CBA is to promote student's regular learning. The instructors revealed that the improvement of self-driven learning improves students' interaction with the instructor during class and allows students to deeply study the concepts they could not understand from CBA. Time savings for large class sizes and the flexibility of time and space for students were other reasons to adopt CBA. Several reasons were given for not adopting CBA, including its unsuitability for discursive courses, its inability to assess problem-solving skills, its question design limitations, and department regulations preventing CBA for final tests. The instructors voiced their concern over CBA's mechanistic approach to learning that encourages students to care more about the correct answer than the knowledge they should learn. CBA was rather suitable for evaluating basic knowledge and comprehension. Also, the instructors found it difficult to create CBA questions and update new questions; they mentioned the need for staff development in question design or, if possible, utilization of question banks (McKenna, 2001).

The use of CBA in humanities is limited compared to other disciplines. In the Computer-assisted Assessment (CAA) Centre national survey, humanities users have focused on CBA's role as supplementary material, not key material (McKenna, 2000). In a study conducted by Broughton et al. (2013), instructors applied CBA to their classes for the following key reasons: saving time, enhancing students' responsibility, departmental influence, and inheritance from existing modules. The instructors recognized CBA as an effective tool in assessing large groups of students but they also pointed out their difficulty in determining whether students really completed the tests on their own or by engaging in plagiarism. In order to overcome the drawbacks of CBA and its limitations in measuring the in-depth understanding of students, it has been reported that the instructors have used other assessment techniques such as coursework or projects as supplementary methods and reduced the weight of computer based summative tests.

Further, CBA should look for ways to prevent cheating in online assessments. Methods such as blinker screen invigilation, interleaving participants using different tests, and randomizing item and response orders have been proposed (Bull & McKenna, 2000; Conole & Warburton, 2005). In addition to the cheating issue, the security issue is regarded as an essential issue in CBA. Now it is hard to protect security since the test data is being sent across the internet. Therefore, in order to ensure that individuals cannot access unauthorized materials, encryption techniques can be used to ensure the security of the questions and answers. Examinations can be loaded onto the server at the last minute (Sim et al., 2004).

Lastly, regarding the administrative support, Boyle & O'Hare (2003) claimed that most professors and instructors are responsible for creating CBA questions on their own; however, the training or education for them to produce more clear and reliable questions is significantly inadequate. In addition, adequate technical and administrative support from school staff is needed to apply CBA to classes.

Compared to the perceptions of professors, the studies on CBA from the learner's perspective are limited. In terms of students' viewpoints, just like the use of CBA is initially time consuming for faculty, students recognize online classes are more time consuming and require more effort compared to other traditional classes (Knight et al. 1998 cited by Liu, 2012). However, students considered CBA to offer relatively fairer assessment than paper-based tests. The immediacy of the feedback and the relaxed way of learning are the key advantages of CBA (McKenna, 2001). The inclusion of high quality graphics was cited as an advantage of CBA by students in a study about student views of CBA. The majority of respondents answered "neutral (neither agree or disagree)" to the question whether CBA is more challenging compared to traditional classes, while showing a fairly equal number of respondents who either agreed or disagreed on the same question (O'Hare, 2001). In another empirical study, about 70% of students

responded that CBA is the one of the best methods of examining students and they were also highly and moderately acceptable to apply CBA in their learning. 90% of students felt that CBA did not disadvantage them even in a high-stakes situation (Escudier et al., 2011).

In a focus group session, students explained that having a series of low stake assessments was beneficial to them. That is, the tests are a study aid helping them to build up knowledge and read the course materials in small chunks without too much stress. The students stated that with CBA it was more relaxing to do the test at their own pace than it would be in an exam context. However, they suggested more detailed feedback on their answers, especially if they got them wrong (Waddel et al., 2012). This perception of the lack of effective feedback in CBA is in line with instructors' perception in a study by Broughton et al. (2013). In the Broughton et al. study, instructors felt that more improved individualized feedback, along with general comments should be provided to students in CBA. As Black and William (1998) suggested, giving proper feedback to guide the direction of learning is essential in CBA, especially formative assessments. If a CBA database system is equipped with well-designed feedback data, it can provide learners with more effective feedback and facilitate learning (Wang, 2007). However, some studies have raised a question regarding the quality of feedback to students in CBA. For instance, compared to paper based tests, some academic staff members felt there was a lack of individual comments in CBA with a lengthy written answer format. The process of typing text in a textbox on screen caused a slowdown in grading thus was not used (Sheader et al., 2006). Similarly, instructors commented that one of the disadvantages of CBA was the feedback to students because it is hard to provide meaningful feedback in analysis or synthesis of information (McKenna, 2001). Another empirical study on attitudes of CBA feedback conducted by Wong et al. (2001) found that students perceived that feedback or explanations provided by web-based assessment system were useful, however, some respondents suggested that more detailed feedback should be given.

Terzis and Economides (2011) created the following categories to investigate students' intentions while studying the students' behavioral intention to use CBA: perceived usefulness (e.g., using CBA will improve my work), perceived ease of use (e.g., my interaction with the system is clear and understandable), facilitating conditions (e.g., when I need help to use CBA, someone is there to help me), content (e.g., CBA's questions were useful for my course), perceived playfulness (e.g., using CBA gives me enjoyment), behavioral intention to use CBA (e.g., I plan to use CBA in the future) and so on.

Study context

This study was conducted at the Ulsan National Institute of Science and Technology (UNIST) in Korea. UNIST has adopted a blended approach combining online and offline instruction to meet the needs of educational efficiency since 2010. The university employs the term "e-Education," to refer to the self-driven and intensive learning support system based on the Blackboard learning management system (LMS). UNIST is the only school to adopt the Blackboard system in Korea. In order to support e-Education, the Center for Teaching and Learning at UNIST provides training, workshops, technical maintenance, and support. The center leads and encourages blended course. There have been blended course offerings implementing CBA since 2010; these are mainly large enrollment courses for first-year students including basic science, math, IT, arts, humanities, and social science courses (e.g., Practical IT, Statistics, Communication, Philosophy, Music). By 2013, approximately 15% of the total course offerings are now blended learning courses. These courses are designed and taught by individual faculty members, and facilitated by assistant instructors under the supervision of a professor.

Blended learning classes reduce face-to-face time in the classroom by 30% to 50%. That is, the courses at UNIST incorporate online classes as part of the course where students engage in independent study each week. Accompanying classroom lessons, these online sessions require learners to perform the following tasks mostly via Blackboard: browse the Internet, view online lectures or streaming media content, read various course materials, participate in asynchronous online discussions, take online quizzes and tests, engage in group problem-solving and collaborative tasks, share content and perform peer evaluations, submit written assignments, and receive feedback on those assignments. The university provides free WiFi wireless technology on campus where most students reside, and enables students to access the Blackboard LMS by using the iPhone, thereby facilitating Internet access and constant online connectivity

The professors at UNIST who are applying CBA to their classes utilize the low-stake summative assessment, scored formative online end of chapter quizzes, and unscored practice tests. The weight of CBA scores is not that significant; most of them range from 10% to 25% of the total grade. That is, CBA is used as a complementary tool rather than a substitute tool for student evaluation. For IT courses, the professors apply CBA after finishing each unit and use the Adaptive Learning Environments Model (e.g., Wang and Walberg, 1983) that allows those students reaching at least 80% of academic achievement in assessment to move on to the next unit. For those who are evaluated as inadequate to move on, individual supplementary instruction is provided.

Methodology

Research question

This study is to investigate the user's perception and attitude of CBA and the typology of these perceptions. To do this, Q methodology was used. Q methodology differs from R methodology (survey and questionnaires) in that the latter asks respondents to express views on isolated statements. The Q methodology, instead, is a research method used to identify respondents' views on particular statements in the context of the valuation of all statements presented. Scholars who rely on Q methodology criticize the use of predetermined scales in ordinary R methodology studies. Furthermore, as opposed to R methodology, Q methodology traditionally intends to give a picture of the perspectives that exist among the population, rather than analyzing the level of support for those perspectives among the population. This implies that the procedure for sampling respondents is usually different from that in R methodology. Rather than random sampling with large sample sizes, Q methodology relies on purposive sampling with smaller sample sizes (Kim, 2008).

This study sought answers to the following research questions.
Q 1. What types can be discerned in students' perceptions of CBA and what are the characteristics of each type?
Q 2. What types can be found in instructors' perceptions of CBA and what are the characteristics of each type?

Q statements (Q sample)

The procedure of Q methodology comprises several stages. The first stage is defining the concourse, that is, the full range of discourses on the particular issue under study. For derivation of the concourse, preliminary research was conducted through a review of the academic literature on CBA, a focus group, informal conversation, various sources including oral and written opinions, and reflection on personal experiences. The focus group consisted of three students and two faculty members who were asked to discuss freely their experiences with CBA. A total of 94 statements for students' views and 86 statements for instructors' views were derived from the preliminary research. The statements were checked for duplication, comprehensibility, and similarity. Then, in order to reduce the statements to a manageable number, a Q sample which was used in the main study, was drawn from the concourse. The Q sample consists of 42 statements for students and 33 statements for instructors, selected for their representativeness and suitability in reflecting the diversity of statements in the concourse (refer to Table 1 and 2). These statements were self-referent, that is to say, they were expressions of opinion rather than factual descriptions, so that a respondent could project him- or herself through them.

Participants (P sample)

The next stage, which plays an important role in Q methodology, is the selection of a P sample, namely, respondents who perform the task of sorting Q statements and participate in in-depth interviews. Q methodology handles the difference of importance within individuals and not between individuals, so there is no limit to the size of the P sample; the size of the P sample can be different according to the purpose of the study or the number of factors, but it follows basic research design principles and small sample principles (Brown, 1980).
Participants for students' perspectives were recruited from the university. There was recruitment advertising for the research on campus and also an assistant researcher recruited participants from several large-scale classes. Among the volunteers, a total of 30 students was selected after considering gender and school years. The students were full-time students in various majors and from various years of enrollment at the university. The average age of the

student P sample was 21.3 (*SD* = 1.34); 63.3% were men, 36.7% women. Freshman participants constituted 36.7% (*n* = 11) of the sample, sophomores 30% (*n* = 9), juniors 23.3% (*n* = 6), and seniors 10% (*n* = 3).

Moreover, a purposive sample of 15 instructors who used CBA for their course was selected for this study. The respondents for instructors' views included 8 full-time professors and 7 assistant instructors. The assistant instructors in this school are not graduate students; they are full-time faculty who are hired to assist the main instructors with teaching. Their career in education ranged from 1 to 34 years, with a mean length of 6.4 years. The subjects they are teaching are basic science courses (math, chemistry, biology, IT, statistics and computer programming) and humanities courses (communication, society and culture, literature, management, philosophy and arts).

Data collection (Q sorts)

At each site where participants were interviewed, a large table was used for the Q sorting task. Participants received instructions and familiarized themselves with the statements regarding CBA printed on index cards. Then, firstly, each respondent (in the P sample) performed the Q sorting task. This task involves sorting well-composed statements about CBA in the Q sample after reading them, by using a compulsive classification method. The classification method required respondent to sort the statements on a scale ranging from "most agreed" (+4) to "most disagreed" (-4); the participants in the survey modeled their cognition by themselves. Once finished, respondents participated in an in-depth interview about CBA to provide a fuller understanding of the characteristics of each type. That is, an investigator conducted a post-sort interview offering participants the chance to offer additional statements. In this process, the investigator questioned each participant about his/her Q-sort reasoning and further opinions. After the Q sorts were obtained through the sorting work, they were analyzed using the computer program QUANL. The in-depth interviews and Q sorts for this study were conducted during the fall semester in 2013.

Table 1. Q statements and *z*-scores of learners' typology

Q Statements	Z scores by Types			
	I	II	III	IV
1. I think CBA has a fairer grading system than the traditional test.	.0	-.2	.1	-1.7
2. Currently CBA is mainly composed of multiple-choice questions but I think these multi-choice questions can't exactly evaluate student's ability.	.2	-1.6	.1	.2
3. Diverse assessment methods, not only paper-based tests, but also problem-solving ability evaluation, team work evaluation, oral tests, and field application evaluation, should be needed and introduced in order to evaluate student ability.	1.3	-1.4	1.8	.7
4. CBA courses made me nervous throughout a semester due to their heavy assignments and lots of work to do.	.2	.1	-.5	1.9
5. CBA needs to be improved in many aspects (e.g., diversification of question types).	.5	-.3	.5	.2
6. I don't think CBA helps student-professor interaction during the class.	-.9	-1.2	-.6	-.5
7. CBA is a good evaluation method to allow student flexibly to choose study time and place.	-.0	-.2	1.6	-.4
8. Anyone can take CBA regardless of computer utilization of each student. In other words, one's skill at computers has no correlation with test results	-.2	1.4	-.3	.3
9. CBA significantly helped me to understand and learn the courses.	-.1	-.0	1.5	-.3
10. There are subjects more suitable to CBA.	.8	-.9	.6	.6
11. CBA is very convenient because it allows students to check the incorrect answers and grades right after taking a test.	.0	1.6	1.8	.4
12. CBA is a very innovative method. It should be more widely used in learning environment.	-.9	.3	-.3	-1.6
13. CBA gives a unique, interesting experience to me.	-.5	.8	.3	-1.4
14. CBA is only good for mechanical learning, which leads me to select the right answer, rather than giving me an opportunity to learn what I really have to learn.	1.7	-.1	1.1	1.6
15. Assistant instructors or administrative support in CBA doesn't really help me while	-.4	-2.0	-.8	-.2

taking a test.				
16. My anxiety became much less intense when taking a CBA that allows me to look up references and internet while taking a test compared to taking a test at the same time, in a real-time manner.	.1	.0	1.1	1.6
17. Questions or instructions given in CBA are clear without any confusion.	-.4	2.1	.7	.4
18. I am worried what if errors occur while taking a computer based test. For example, the answers I marked are not saved in the system or unexpected errors in the server that make my computer crash in the middle of a test.	.7	-1.2	1.9	1.5
19. CBA should be used for practice tests rather than important tests or grading.	.7	-.3	-.1	.3
20. I prefer more detailed feedback on answers, especially if I got them wrong.	1.0	0	1.1	2.0
21. I am mostly satisfied with the current technical environment of CBA tests including the network connection and computer utilization.	-.2	1.9	-.5	-.2
22. I think CBA is a useful assessment method since I could take a test containing high quality graphics, images and videos.	-.0	2.3	-.7	.4
23. CBA results may produce totally different results than paper-based tests, mid-terms or final examinations given once or twice a semester.	.2	-.1	.4	-.8
24. I wish CBA became a supplementary method in evaluating students.	1.9	-.5	1.3	1.2
25. I guess CBA will be more widely used in the learning environment than the traditional test.	1.4	.3	-.1	-.3
26. I have trouble reading documents online. Therefore, I usually print the data and read.	1.4	.2	-.0	.2
27. I think I was more active when participating in CBA class than traditional classes.	-.8	.2	-1.5	-1.1
28. I'm not satisfied with the IT-dependent tools, such as CBA or online classes.	.2	-.6	-1.0	-.3
29. I would choose a paper-based test rather than CBA if I had an opportunity to choose from those two options.	1.7	-.5	-.6	.2
30. Face-to-face feedback from the instructor should be increased rather than the feedback given through the computer.	1.4	-.3	-1.3	.3
31. I think my responsibility or autonomy for learning has been improved through CBA.	-2.2	1.4	-.7	-1.4
32. CBA should be included in more varied subjects compared to current status, including the core subjects.	-1.2	-.2	.0	.0
33. I don't think CBA is a useful and valuable activity in student evaluation.	-.2	-1.6	-1.5	.1
34. CBA should be limited to basic courses, such as testing basic knowledge and terminology.	1.6	-.2	.5	-1.4
35. CBA didn't require me to spend more time and effort compared to traditional classes.	-2.0	-1.7	-1.8	.5
36. The weight of the CBA score out of the total points should be higher than now.	-1.2	-.7	-1.9	-2.0
37. I don't really care about CBA since the courses applying CBA are not major courses and their scoring weights are not that high.	-.4	.2	.4	-1.0
38. Questions on CBA are too easy and simple.	-.3	-.1	-.9	-.8
39. I don't really care if it's a paper-based test or CBA. Because I believe the results do not depend on the assessment method.	-1.1	.8	-1.1	-.9
40. I am interested in all computer or internet based activities, including computer utilization training, class or test.	-1.5	.3	-.1	-.4
41. I became less burdened by study because I could be assessed in each unit.	-.4	.9	-1.0	.6
42. I think CBA allows students to engage in cheating much more easily.	.9	.9	.5	1.6

Table 2. Q statements and *z*-scores of instructors' typology

Q Statements	Z scores by Types		
	A	B	C
1. I would have a hard time operating CBA without administrative support from AI or faculty in the Center of Teaching and Learning.	-.9	1.4	-.6
2. CBA saves my time on grading tests for large class sizes.	1.5	.7	-.8
3. The most typical question type in CBA, the multiple-choice question, has no significant problem in evaluating students.	-.5	-1.1	-.4
4. Not by recommendation from school or department, I initiatively adopted CBA.	-.5	-1.2	-1.7
5. I don't think a professor's computer utilization affects the adoption of CBT.	.7	-1.3	-.4
6. I found no significant difference in test results between CBA and traditional tests.	.4	-.9	-.7
7. I think my acceptance of blended classes or CBA is lower than other instructors.	.2	-.1	-.0
8. CBA may become a mechanical activity or study for students focusing on providing the right answer rather than in-depth analysis or learning.	-2.1	1.2	-.7
9. Currently CBA is a supplementary method for student evaluation but should be the main method in the near future.	.6	-1.3	-1.8
10. CBA cannot really test synthesis to any great level so it should be improved	.3	1.2	.4
11. The questions type of CBA (multiple-choice question) is somewhat limited; therefore, new evaluation methods such as class activities or projects should be combined.	.5	1.7	.9
12. The feedback provided by CBA is much more useful than lecture notes or textbook.	-.3	-1.6	1.3
13. It is hard to apply CBA to all courses. I think there are particular subjects suitable for CBA.	-1.0	2.2	2.0
14. CBA is an effective assessment method that allows students taking test containing high quality graphics, images, and videos.	1.4	-.2	-.5
15. I don't think CBA improved my interaction with students during the class.	-1.4	.6	.2
16. Professors can perform CBA without timing or spatial limitation and this can help professors to managing classes.	1.4	-.0	.6
17. CBA improves student's participation and responsibility for learning.	1.3	.1	.3
18. CBA tailored to the characteristics of each student should be performed.	-.5	1.0	1.2
19. It is useful to operate class since CBA allows me to track student's academic activities.	-.5	-.7	1.0
20. It takes a lot of time to make and update CBA questions; therefore, I don't think CBA is an effective educational tool.	-1.3	-.9	1.3
21. Resources to set CBA questions are not enough..	.6	1.1	1.1
22. I would like to recommend adopting CBA for other colleagues.	1.1	.7	-1.1
23. CBA is a new paradigm in learning; personally, it is very interesting to me.	1.1	-.4	-.7
24. I think students' academic achievements have been improved through CBA.	1.3	.5	1.0
25. I am concerned CBA allows more cheating attempts than traditional test.	.4	1.1	.4
26. CBA is more suitable to formative assessment compared to summative assessment.	-1.4	-.5	1.3
27. I don't think students are complaining about CBA and quizzes given more often.	-1.0	-1.5	-1.2
28. CBA will be adopted in more learning environments than now with the development of technology.	1.2	-.5	-1.4
29. I find CBA very useful with fast test results and saving, easy accumulation, etc.	-.0	.4	-.0
30. The score weights of CBA should be raised (high stakes assessment).	.4	.0	-.1
31. I prefer traditional testing methods.	-1.3	-.9	.8
32. I think the current level of CBA is enough considering the technical level of CBA.	-.7	.1	-1.7
33. CBA is most suitable for testing basic knowledge, terminology, and comprehension for skill oriented topics.	-1.0	-.7	-.2

Results

The QUANL program was used to analyze the typology of students' awareness of CBA. As a result of performing QUANL to analyze the Q typology, 30 respondents in the student P sample were divided into four types (refer to Table 3). In this study, the four groups are given the following descriptive labels: (I) CBA dissatisfaction Type, (II) CBA Friendly Type, (III) Adjustment Seeker Type, and (IV) CBA Apprehensive Type. The overall predictable variation of the four types is set to 62.21%; the number of people in each type is: 11 for type I, 6 for type II, 8 for type III, and 5 for type IV. However, no significance should be attached to the number of persons for each type; because the sample size is small, we should not draw any hasty generalizations. This study uses Q methodology only to discern the presence of these types. The factor weight of people who belong to each type is given in <Table 3>; a person with a high factor weight in their type indicates the typical person who can serve as a representative of the type that she or he belongs to. For example, this means that #6 (female, sophomore) and #9 (male, freshman) in the P sample are the typical learners (they have factor weights of 3.473 and 3.788 respectively) representing Type I; #23 (male, sophomore) is the person with typical characteristics of Type II.

Next, QUNAL was performed to analyze the typology of professors' awareness. As a result, P samples of 15 professors have been classified into 3 typologies with factor 1 explaining 25.48% of total variance, factor 2, 20.30%, and factor 3, 6.76%, thus resulting in a total variance explained of 52.54%. Of the 15 respondents, 7 were clustered and interpreted in Type A, 4 in Type B, and 4 in Type C. Factor weight scores for each instructor participant are represented in <Table 3>. The three groups of instructors' perception were given the following descriptive labels: (1) CBA Preferred type, (2) Supplementary Need type, (3) and Yes-But Mixed type.

The characteristics of each type can be identified by looking at the average score of agreement or disagreement level for each type among the 42 and 33 Q statements. The aim was to understand the characteristics of each type by extracting a strong agreement (with an average score over +1) and a strong disagreement (with an average score under -1) for statements within the type, in the process of comparing how each type appears for all items (refer to Table 1, 2).

Table 3. Variable assignments with factor weight

Students' Typology						Instructors' Typology				
Participant	Type I (N = 11)	Type II (N = 6)	Type III (N = 8)	Type IV (N = 5)	Factor Weight	Participant	Type 1 (N = 7)	Type 2 (N = 4)	Type 3 (N = 4)	Factor weight
9	.877*				3.788	I	.765*			1.849
6	.866*				3.473	G	.733*			1.587
30	.770*				1.890	O	.696*			1.352
15	.711*				1.439	A	.662*			1.178
27	.671*				1.219	J	.621*			1.011
7	.658*				1.160	M	.611*			.975
26	.631*				1.049	C	.583*			.882
3	.576*				.862	H		.831*		2.686
5	.552*				.794	F		.596*		.924
18	.454*				.572	N		.517*		.705
19	.358*				.411	D		.427*		.522
23		.864*			3.395	L			.811*	2.365
1		.852*			3.099	K			.698*	1.360
20		.837*			2.805	E			.572*	.850
24		.820*			2.499	B			.461	.585
14		.781*			2.005					
22		.503*			.672					
29			.909*		5.221					

25	.845*		2.964
28	.767*		1.867
12	.716*		1.472
17	.678*		1.256
4	.578*		.868
13	.518*		.708
21	.451*		.565
11		.849*	3.045
16		.791*	2.108
10		.765*	1.846
2		.657*	1.158
8		.519*	.710

Note. * = Loading factor scores by each type.

Characteristics of students' typology

Type I: CBA dissatisfaction type

Type I ($N = 11$) is named the CBA Dissatisfaction Type. The respondents of this type had a somewhat negative view of CBA. This type tended to prefer face-to-face feedback and paper-based assessment while realizing CBA as a secondary method for student evaluation. They had a skeptical view of students more voluntarily and positively participated in academic learning through CBA; at a time, they considered CBA to be more suitable for basic courses to learn the basic terminology or knowledge. The type and its characteristics of these respondents were clearly revealed in Q statements they strongly agreed with - Q24 (z score = 1.90), Q29 (z = 1.70), Q14 (1.69), Q34 (1.62), Q26 (1.44), and Q30 (1.35), as well as in Q statements they strongly disagreed with - Q31 (z score = -2.20), Q35 (-1.98), Q40 (-1.47), and Q25 (-1.43). The characteristic of Type I is clearer from students' comments in an interview expressing:

> I had a hard time to complete heavy assignment in other subjects. It might be because of my passive personality, I would consider CBA as another assignment given to solve, rather than another opportunity to learn something new. I just completed the CBA assignment formally; I don't think my autonomy has been improved. (#30, male, freshman)

> If I don't know the answer for a particular problem, I look into the question until I find the answer. But CBA tells the right answer immediately, and this bothers me more. (#6, female, sophomore)

> I am used to basic computer activities, such as word processing; however, in my case, a paper-based test helps me to more focus on the test. When I look the question on the computer, I don't really catch its intention so I write the question down on paper again. I don't like CBA for math class because I have to rewrite the solving process on the paper. When I learn something new, I print it out, underlin the key points with highlighter, and organize them in my own way. (#27, male, senior)

Type II: CBA friendly type

Type II ($N = 6$) learners, who are labeled as CBA Friendly Type, expressed positive views about their CBA experiences, which they found stimulating and meaningful. In contrast with Type I, the learners of Type II reported that they have exerted more time and effort on CBA and their academic autonomy has been improved. They are mostly satisfied with the access to CBA and its infrastructure. They found the differences between CBA and paper-based tests, including its provision of graphics, images, and video, to be useful. This Type stated the improved interaction with students and instructors. The respondents in this Type were also satisfied with the support and assistance from their Assistant Instructor. This Type strongly agreed with the Q statements Q22 (z = 2.25), Q17 (2.09), Q21 (1.92), Q11 (1.64), Q31 (1.40), and Q8 (1.39), whereas they strongly disagreed with Q statements Q15 (-

1.97), Q35 (-1.74), Q2 (-1.61), Q33 (-1.57), Q3 (-1.36), and Q6 (-1.18) (Refer to table 1). In the in-depth interview additionally conducted, respondents of Type II have confirmed their views on CBA as follows.

"I had an opportunity to perform a very simple CBA in this one class. CBA allowed students to take a test while studying the subject at the same time. This was a great help on our final examination and much more helpful for me to understand the class compared to the traditional classes." (#14, male, junior)

"Frequent quizzes through the CBA helped students to review and prepare for the classes, much more effectively than general test. I am skeptical of improving academic ability if students cram for one or two-times before big exams." (#23, male, sophomore)

"My professor uploaded class materials for each chapter in advance to induce students to prepare and pre-study the subject. My professor also gave more practice tests or quizzes. I think this was an opportunity for me to engage in a closer interaction with my professor and other classmates compared to other traditional classes." (#20, female, sophomore)

Type III: Adjustment seeker type

The third perspective ($N = 8$) is labeled Adjustment Seeker Type. This Type mixed both positive and negative aspects of CBA. This Type recognized the advantages of CBA and at the same time also pointed out the task CBA should solve. As can be seen from the Q statements this type strongly agreed with Q18 ($z = 1.91$), Q11 (1.79), Q3 (1.76), Q7 (1.58), Q9 (1.48), Q24 (1.29), and Q20 (1.13). The Adjustment Seeker Type appreciates CBA's flexibility in time and space, improvement of academic comprehension, and immediately feedback test results while pointing out the need for precise feedback and various evaluation methods. This Type strongly disagreed with Q36 ($z = -1.91$), Q35 (-1.78), Q27 (-1.52), and Q33 (-1.51), indicating the mixed perspectives they have. They considered CBA to be a useful and valuable assessment method and at the same time, they also showed a negative perspective on the test weight to be raised. This is echoed in the following comments from type III respondents:

"Basically I think CBA is more useful in evaluating students that allows me to control my time and place for study and receive the feedback for that. However, the detailed feedback on answers I made incorrect is not enough for some particular subject. In my opinion, it is ineffective for professors to give individual feedback to each student during the class; therefore, the detailed feedback provided by CBA should be improved." (#29, male, junior)

"I used many other references, internet or textbook, while taking an individual CBA test. It relives my tension and reduces my effort to study compared to the general test; however, I think CBA should be the supplementary method, not the main method in evaluating students. I think test requiring everyone to come to a particular place at the same time is fairer than CBA" (#17, male, freshman)

Type IV: CBA apprehensive type

Type IV ($N = 5$) is named CBA Apprehensive Type. The respondents of Type IV voiced their strong concerns and worries over heavy tension and cheating attempts. The CBA Apprehensive type had less interest in CBA (Q13, $z = -1.41$) but a strong desire to get better grades (Q37, $z = -1.00$). Therefore, they found CBA courses highly stressful throughout the semester because they gave students more assignments to do (Q4, $z = 1.90$). This type does not trust the system stability of computers in CBA (Q18, $z = 1.52$) and does not consider CBA a fair assessment either (Q1, $z = -1.97$), compared to traditional tests, for its high association with cheating attempts (Q42, $z = 1.56$). The students of this type gave statements as follows.

"2 years ago, I experienced with the vulnerability of servers when everyone in class took a mid-term exam at the same time. A few days ago, I lost my answers in the middle of taking the quiz with my laptop due to my disconnected WIFI." (#2, female, junior)

"CBA made students attempt cheating in the absence of exam invigilators. Some were sharing their solutions, discussing with others, or taking the exam for others with its simple personal identification procedure. Students always produce a higher average in CBA tests while resulting in under average on paper-based tests. For the math

course, there is an online website that solves mathematic problems instead of the examinee. It is difficult to prevent cheating attempts that are developing from time to time." (#16, male, sophomore)

Characteristics of instructors' typology

CBA preferred type

The respondents for instructor's typology sorted as Type A ($N = 7$) are labeled CBA Preferred Type. The instructors of this type focused on the benefits of CBA and are satisfied with the CBA they have adopted, showing a positive view of CBA in general. They recognized the advantages of CBA, including the flexibility in class design and operation, utilization of various data, easy grading, improvement of student's responsibility and academic achievement, and increased interaction between instructors and students. The instructors in this type considered CBA as an interesting and innovative educational tool and responded that they would like to recommend this to other instructors. This type is well revealed in the Q statements with which they have strongly agreed or disagreed: Q2 ($z = 1.54$), Q16 (1.41), Q14 (1.37), Q24 (1.35), Q17 (1.32), Q8 ($z = -2.07$), Q15 (-1.44), and Q26 (-1.43). This is also well presented in the following comments.

"I had an opportunity to investigate the status of e-Education at all universities in Korea while preparing e-Education at UNIST. UNIST takes the initiative in Blackboard, such as two-way communication in class with the application of e-Learning contents. Many other universities were also interested in these blended courses and also preparing to adopt them. Therefore, I am sure more innovative and diversified educational tools based on the virtual learning system will be widely used in the learning environment." (J, Assistant Instructor of Business IT)

"I am combining online and offline classes. I gave my students CBA open-book tests online almost every week. In online classes, I saw my students engaged in individual research activities and self-initiated study by reviewing and looking up new data. My students showed improved academic achievement in the final examination compared to the previous semester without conducting CBA classes." (O, Professor of Statistics)

Supplementary need type

Type B ($N = 4$) is named as Supplementary Need Type showed a strong agreement with the following statements: "There are subjects particularly suitable for CBA - Q13 ($z = 2.21$)"; "Other assessment should be combined in class activities since the question type in CBA is limited - Q11 ($z = 1.69$)"; "Resources to create CBA questions are inadequate - Q21 ($z = 1.10$)"; "Cheating is a big concern compared to traditional tests - Q25 ($z = 1.08$)". On the other hand, the respondents of Type B strongly disagreed with Q statements Q12 ($z = -1.62$), Q27 (-1.45) and Q3 (-1.11), realizing the need for improved CBA feedback and essay type questions, and greater workload required from students. The instructors of this type were strongly convinced of the need for assistants and administrative support and didn't positively adopt CBA, in contrast with Type A (Q4, $z = -1.25$). This Type recognizes current CBA needs to be improved but prefers CBA as a supplementary tool for evaluating students. This Type is well represented in the following comments from the post interview.

"Multilateral, complex evaluation is essential in improving the validity of evaluation; however, CBA is useful for objective tests or participation evaluation. Cheating attempts or technical errors are the issues to be improved. For now, it is good to apply CBA to evaluate students' preparation for math or physics courses (as basic problems)." (H, Assistant Instructor of Arts)

"It is my idea to selectively, supplementarily apply to some particular subject rather than all subjects." (N, Professor of Mathematics)

"I could never adopt CBA in the absence of administrative support from the Center of Teaching and Learning, introduction of Blackboard system, assistant instructor's help in managing online classes or tests. All the support became a great help. However, regardless of their support, I would be better at managing my CBA class if I could utilize the Blackboard system well, including the skills to create, edit, and manage the online questions." (F, Professor of Philosophy)

Lastly, the third typology of instructor (N = 4) is named the Yes-But Mixed Type. Four instructors loaded significantly onto Type C, showing a positive viewpoint of CBA for improving student's academic achievement (Q24, z =1.02), easy tracking of academic activities (Q19, z = 1.01), and satisfactory feedback (Q12, z = 1.29), while presenting the negative perception of CBA for its lack of resources (Q21, z = 1.08) and applicability of subject (Q13, z = 2.05). The inductors in this Type have responded that CBA ultimately needs to be tailored for each students' characteristic and is more suitable for formative assessment that helps and monitors students, rather than the summative assessment that measures students' academic achievement. As Type B claimed, they revealed CBA should be a supplementary tool in evaluating students. The following comment in the interview confirms previous claims:

> "I use CBA for exercise or attendance check rather than for student evaluation. This CBA is very useful in drawing students into self-initiated study; however, it is not yet suitable for evaluating students properly. It is important to participate in class or team projects for my class. I don't think CBA should replace the traditional test method." (K, professor of communication)

Conclusion and discussion

The purpose of this study is to provide help in better planning CBA by analyzing the current state of affairs in light of users' cognition and typology. As a result of this study, four groups for students' typology were analyzed and given the following descriptive labels: (I) CBA Dissatisfaction Type, (II) CBA Friendly Type, (III) Adjustment Seeker Type, and (IV) CBA Apprehensive Type. Regarding instructors' typology, three groups were sorted and named: (A) CBA Preferred Type, (B) Supplementary Need Type, and (C) Yes-But Mixed Type. This result shows the diversity of respondent types, from users reluctant to use such learning instrument (CBA) to users preferring and focusing on CBA and its advantages.

Common opinions and characteristics drawn from each type of instructor and student have been organized in <Figure 1> and <Figure 2>. CBA learners mostly agreed with the Q statements, "I prefer more detailed feedback on their answers, especially if they got them wrong (Q20)", "mechanical approach to learning (Q14)" and "CBA should be a supplementary tool (Q24)" (only the CBA Friendly type feebly agreed). Types I, II and III responded that a lot of time and effort is required for CBA (Q35), whereas types I, III, and IV commonly agreed that increasing the scoring weight of CBA was not needed. Characteristics and common perceptions of each type were also found in the perceptional typology of instructors. All three types commonly recognized the lack of CBA resources (Q21) despite the availability of open education resources (Anderson & McGreal, 2012). Improvement of academic achievement (Q24) and intense workload required from students (Q27) were also commonly shared beliefs among the types. In particular, Type B and C shared a common perception that CBA should be a supplementary tool in evaluating students. If investigating individual characteristics of each type, the difference between each type can be seen as follows in Figure 2 (for example: Type A disagreed with Q8 whereas Type B agreed with it).

The features identifying each of the perceptional types are mostly supported by earlier works, but some distinct features have emerged from this study. For example, the students commonly recognized CBA requires more time and effort than other traditional tests and this fact is in line with the results drawn from the previous study (Liu, 2012). However, a Type IV (CBA Apprehensive) strongly disagreed with the fairness of CBA due to concerns over cheating, showing a completely opposite result to McKenna's study, which strongly claimed CBA as an extremely fair assessment method for the clarity of its grading scale. In contrast with results claiming student's improved responsibility for learning through CBA (Marriott and Lau, 2008), more learner types who view CBA as a mandatory and forceful learning tool than an aid to their autonomy or responsibility were found in this typology study, whereas instructors responded their students improved their academic achievement, indicating a result corresponding to the previous study (Zakrzewski & Bull, 1999).

To summarize the present typology study, instructors and students showed mixed viewpoints from welcoming or enjoying to reluctance or dissatisfaction. Each individual type for instructors and students showed distinct characteristics; however, both students and instructors agreed to use CBA as a supplementary tool in evaluating students. Also, both groups commented that CBA needs more time and mental effort than traditional assessments. Studying online learning materials and frequent CBA quizzes or assignment for students and designing and

implementing blended courses for instructors caused high workloads for them. Shared beliefs among student types point out their excessive workload and the need to improve feedback quality, while the instructor types share viewpoints of students' excessive work just like the students, as well as the lack of CBA resources. Generally, both instructors and students perceived the benefits of CBA and they expressed pitfalls and needs for better application as well. The differentiation between instructors and students types is that instructors tended to seek technical support such as CBA sources, while students were fairly sensitive about the application of CBA. Although there is a CBA friendly type, the shared beliefs among student types shows their apprehensiveness.
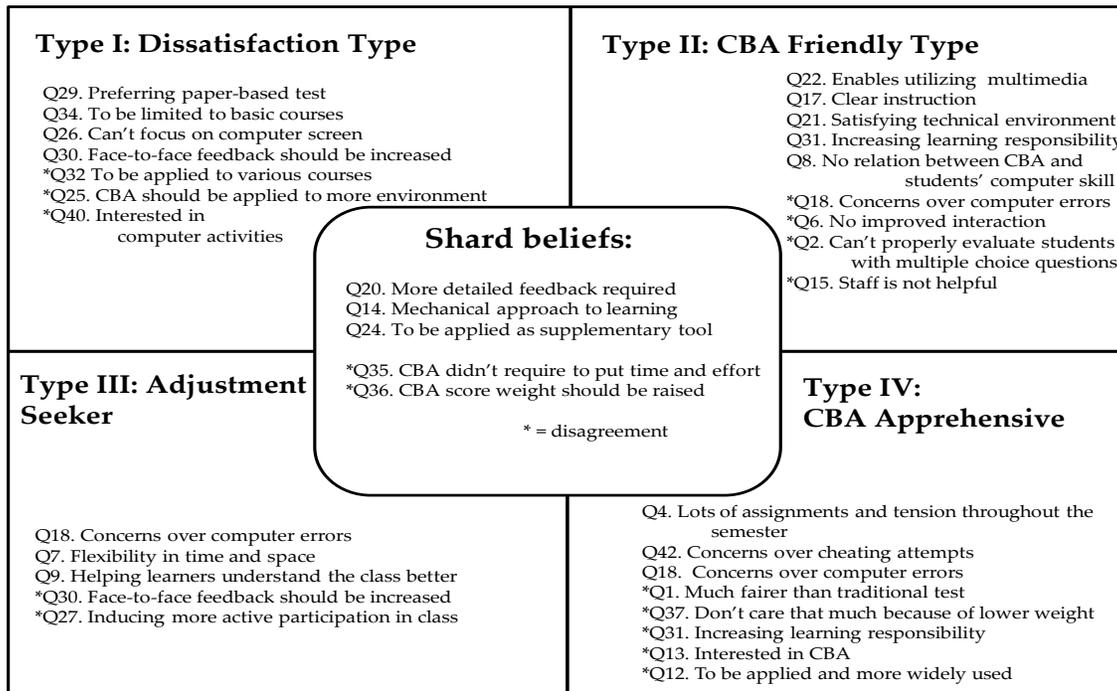

Type I: Dissatisfaction Type

Q29. Preferring paper-based test
Q34. To be limited to basic courses
Q26. Can't focus on computer screen
Q30. Face-to-face feedback should be increased
*Q32 To be applied to various courses
*Q25. CBA should be applied to more environment
*Q40. Interested in
    computer activities

Type II: CBA Friendly Type

Q22. Enables utilizing multimedia
Q17. Clear instruction
Q21. Satisfying technical environment
Q31. Increasing learning responsibility
Q8. No relation between CBA and
    students' computer skill
*Q18. Concerns over computer errors
*Q6. No improved interaction
*Q2. Can't properly evaluate students
    with multiple choice questions
*Q15. Staff is not helpful

Shard beliefs:

Q20. More detailed feedback required
Q14. Mechanical approach to learning
Q24. To be applied as supplementary tool

*Q35. CBA didn't require to put time and effort
*Q36. CBA score weight should be raised

* = disagreement

Type III: Adjustment Seeker

Q18. Concerns over computer errors
Q7. Flexibility in time and space
Q9. Helping learners understand the class better
*Q30. Face-to-face feedback should be increased
*Q27. Inducing more active participation in class

Type IV: CBA Apprehensive

Q4. Lots of assignments and tension throughout the
    semester
Q42. Concerns over cheating attempts
Q18. Concerns over computer errors
*Q1. Much fairer than traditional test
*Q37. Don't care that much because of lower weight
*Q31. Increasing learning responsibility
*Q13. Interested in CBA
*Q12. To be applied and more widely used

Figure 1. Perspectives of four types on CBA (Students' typology)

Type B: Supplementary Need Type

11. Various evaluation activities required
1. To be difficult without administrative
    support
10. CBA to be improved
    8. Mechanistic approach to learning
25. Concerns over cheating
    attempts
*12. Good feedback
*5. Instructor's computer skill
    affects the CBA
*3. No problems with
    multiple choice test

Type A: CBA Preferred

2. Easy to grade, saving time
16. Helpful in managing class
14. Effective utilization of
    multimedia
17. Improving students'
    responsibility
28. To be applied to more
    learning environments
22. Recommended to other
    colleague
23. Interested in CBA
*8 Mechanistic approach to
    learning
*15. No improved interaction
    during the class
*26. Suitable for formative assessment
*20. More time required to create
    questions
*31. Preferring traditional test
*33. Suitable for testing
    basic knowledge

Shared beliefs:

Q24. Improved students ' achievement
Q21. Lack of CBA resources
*Q27. No complaints received from
    students on frequent quizzes
*Q9. CBA to be main tool
    in evaluating students

Type C: Yes-But Mixed Type

12. Good feedback
26. More suitable for formative assessment
20. More time required to create questions
19. Easy tracking of students learning
*32. Adequate technical level of CBA
*28. To be applied to more learning
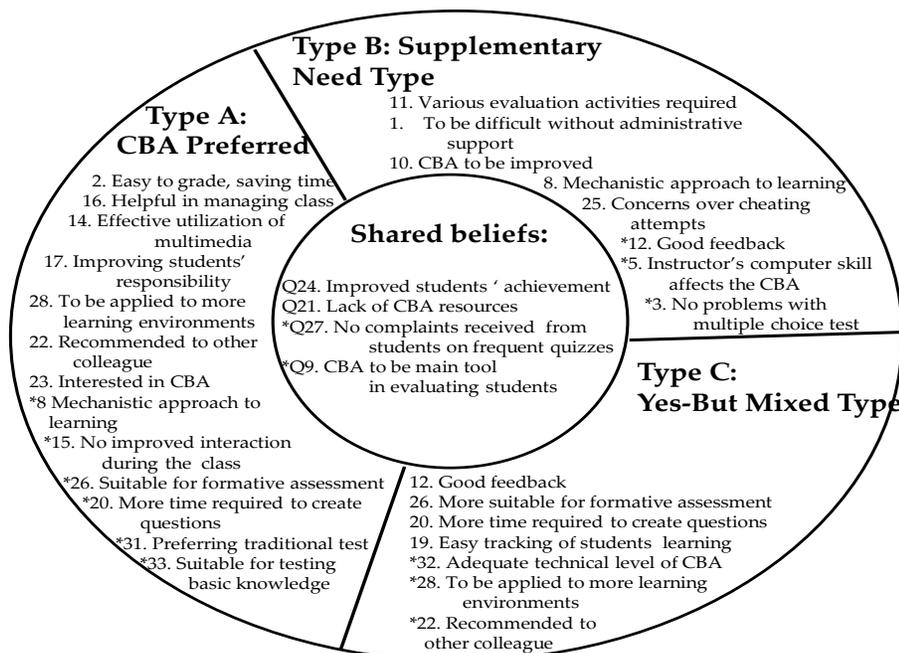   environments
*22. Recommended to
    other colleague

Figure 2. Perspectives of the three types on CBA (Instructors' typology)

Qualitatively excellent e-feedback has replaced the ineffective CBA feedback nowadays (Yorke, 2003); nevertheless in this study, both instructors and students were convinced of the need to improve CBA feedback. In-depth interviews for this study showed that the negative response toward feedback mostly resulted from insufficient feedback on short or long essay CBA tests. Instructors felt the difficulty in providing meaningful feedback on screen because they faced large numbers of students or practical constraints such as time and workload.

This result may be due to Korea's circumstance and cultural characteristics in education combined with the significance of grades and fierce competition. However, this may become an indicator for the perception and attitude of Blackboard users, for current CBA and blended courses. CBA has reached its particular purposes; however, it is being judged as inadequate for a complete, thorough system. In order to effectively apply CBA to a learning environment, the advantages and disadvantages of CBA, and the perception and attitude of users should be thoroughly investigated, and the purpose of evaluation and its cost-effectiveness should be considered prior to applying CBA.

The result of this study proposes the following technological and pedagogical perspective to faculty, schools, and practitioners. First, the instructors should propose a CBA containing high quality feedback based on students' need in order to maximize its benefits. To do this, the instructors can have access to various CBA resources including questions banks and more technical and administrative support. Second, the result of the present study for investigating the perceptional typology of both instructors and students showed that a complete replacement of CBA or its suitability for summative assessment seemed to take more required time. Instead, a strategy that allows students to move on to the next step is proposed with the application of high quality formative assessment. Third, a more intense academic burden was found in students enrolled in CBA or online courses at a regular university. The instructors should avoid giving too much work to students compared to a traditional class when designing the classes. Lastly, CBA that induces autonomous learning is very suitable for self-regulated learners who rarely depend on instructors (Zimmerman & Schunk, 2001). The present study suggests that provisions or solutions for unmotivated or untalented students are essentially needed.

Acknowledgements

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