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# A Cloud-based Awareness Classroom Learning Activity Portfolio System Based on iBeacon for Flipped Classroom

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**Abstract:** The paper presents a cloud service system that builds students' awareness classroom activity portfolio. Here the system is call a classroom learning activity portfolio (CLAP) system. It utilizes iBeacon devices, a kind of wireless devices to connect without human intervention, as awareness functions in the learning environment construction. Also, it develops APPs for mobile devices to get students' classroom activity portfolio, and then to keep them in the cloud server of the system. Additionally, Apps offers web links for learning. There are several types of students' classroom activity portfolio including log data of recording students enter/leave classroom, responses to pushing information once students entered classroom, and distances from students' position (seat) in classroom to teacher' presentation location (for example, the front desk of the classroom). The CLAP system can offer analysis results of the classroom activity portfolio. Hence, it can help students who can readily send their records or responses on class in classroom. Moreover, they do not require in typing many data (for example, long URLs) for interacting with the portfolio collection system. Furthermore, the system can assist teachers in collecting students' classroom activity portfolio, and then to have analysis results of the portfolio. For instance, teachers can get the result that students entered classroom but they send less or no feedback in classroom to the cloud server. Experimental results demonstrate the CLAP system has high learning interests while applying it in flipped-classroom learning.

**Keywords:** iBeacon, Flipped Classroom, Bluetooth4.0, Classroom Learning, Classroom Activity Portfolio.

## 1. Introduction

Recently, e-Learning is becoming popular in our life. More and more courses are teaching over Internet via asynchronous and synchronous learning manners so as to enhance learning performance. However, how to increase high interaction among teachers and students during e-Learning is still a critical research topic. Therefore, it is an emerging popular issue to develop appropriate information technology for classroom learning (c-Learning) and then to blend c-Learning with e-Learning such that learning performance can be further promoted (Domingo & Gargante, 2016; Volk et al., 2017; López, 2010).

Nowadays, mobile devices (like smart phones and tablets) are widely used in our life (Moreira et al., 2016). Especially, how to increase high interactions for c-Learning via integrating wireless sensor technology with mobile devices in constructing awareness learning environments is an important research issue. Here the paper first presents the design of a learning awareness environment (LAE) based on wireless sensor technology, and then proposes the CLAP system based on the LAE, which provides functions to collect students' learning activity portfolio in traditional classroom via Apps, and also offers analysis results for these portfolios. According to the results, teachers can quickly figure out students' learning performance for teaching contents students studied so that they may adjust their teaching strategy or method.

The CLAP system is able to support the so-call flipped classroom, a pedagogical strategy, when it is applied in learning in traditional classrooms. In this flipped-classroom instruction model, students study instructional contents (almost online video materials) outside of classroom. Hence teachers have more time to discuss with students on class for the instructional contents inside of classroom. Accordingly, a key issue is to develop information technology to promote high interaction while involving flipped classroom inside of classroom. The proposed system can aid the flipped-classroom instruction model. For example, the system offers teachers a function to post students' questions for readings or instructional contents teachers assign before class time. Once students entered classroom, APPs automatically get/display students' questions the system pushes. Then, students are encouraged to send responses with respect to the pushing information (students' questions) to the CLAP system. This way is capable of increasing more interaction between teachers and students in classroom.

In the paper, the CLAP system builds a LAE using iBeacon devices as wireless sensor facilities. Also, it offers APPs for mobile devices to acquire students' classroom activity portfolio containing several types of students' classroom activity portfolio: records that students enter/leave classroom, responses to pushing information once students entered classroom, and distances from students' seat to teacher' presentation location (for example, the front desk of the classroom). The CLAP system also can offer analysis results of the classroom activity portfolio. Finally, the paper presents evaluation results of using the CLAP system for flipped classroom instruction in classroom via a questionnaire survey for the learning interests scale. The results show that the CLAP system helps students to have high learning interests.

The remainder of this paper is organized as follows. Section 2 briefly reviews related flipped classroom and iBeacon. Section 3 describes the CLAP system. Section 4 shows the experimental results. Conclusions are drawn in Section 5.

## 2. Literature Review

### *2.1. Flipped Classroom*

Nowadays, flipped classroom is a widespread pedagogical strategy, which is learner-centered instead of teacher-centered. Learning is not limited in classroom, on the other hand, it can be extended to outside of classroom. Due to learning on-line teaching materials outside of classroom, learning inside classroom time can be used more efficiently (Gilboy, Heinerichs, & Pazzaglia, 2015). For example, student can share or discuss their thoughts that not learning in the class with others via teachers' guidance (Diller, 2015). This makes short and rigid class time for learning to be more effective and efficient. That is, it has more time for discussions or other activities in class time (Obradovich, Canuel, & Duffy, 2015). Moreover, studying outside classroom learning results in that students evaluate their study situation by themselves. That is, if students deem that they still need more time to further study teaching materials, they can repeatedly study these materials through outside classroom learning (Evseeva & Solozhenko, 2015).

### *2.2. iBeacon*

Apple iBeacon is a protocol for connecting wireless devices without human intervention, which provides location service and pushing notification. Apple iBeacon adopts Bluetooth Low Energy (BLE) technology broadcasting near field signal (about 100 meters) within an interval area. Many smart mobile devices were added iBeacon functionality in their operation system. Hence the smart mobile device plays a role as a reader device, which either scans for nearby iBeacons devices or connects to such iBeacon devices to retrieve or exchange information (Radhakrishnan, Misra, Balan, & Lee, 2015). Many iBeacon-based applications taking smart mobile devices as readers were proposed, for instance, indoor location tracking (Chen, Zhu, Jiang, & Soh, 2015). Some attributes iBeacon devices offers, for instances, UUID, RSSI, TX Power, Major, and Minor, can be used in device identification and distance estimation. UUID is employed to differentiate a large group of related iBeacon devices. One important feature of using iBeacon devices is to calculate distance from an iBeacon device to smart mobile devices by getting iBeacon's RSSI attribute (signal strength). TX Power is exploited to compute proximity (distance) between iBeacon devices and smart mobile devices. Major and Minor are employed in distinguishing a smaller subset of iBeacon devices and identifying individual iBeacon devices in the subset, respectively.

## 3. System Description

### *3.1. Building a LAE in classroom*

Figure 1 shows the design concept of building a LAE in a traditional classroom. The LAE contains iBeacon devices inside classroom, students' smart mobile devices installed APPs, a cloud server, a database server, and wireless network utility. The CLAP system collects students' classroom learning activity portfolios via APPs. Once APPs query iBeacon devices, the target iBeacon device send the corresponding action to APPs. Subsequently, APPs automatically display pushing information to students due to pushing information being get from the cloud server. Therefore, students can response these information via sending their responses to the cloud server. Meanwhile, APPs automatically send proximity distance between students' locations and iBeacon devices to the cloud server by connecting to wireless sensing technology. The pushing information teachers create in the paper consists of bulletins, key points of courses, students' questions for studying teaching contents outside classroom, and supplementary teaching materials. The pushing information can be made before class or in-class time.

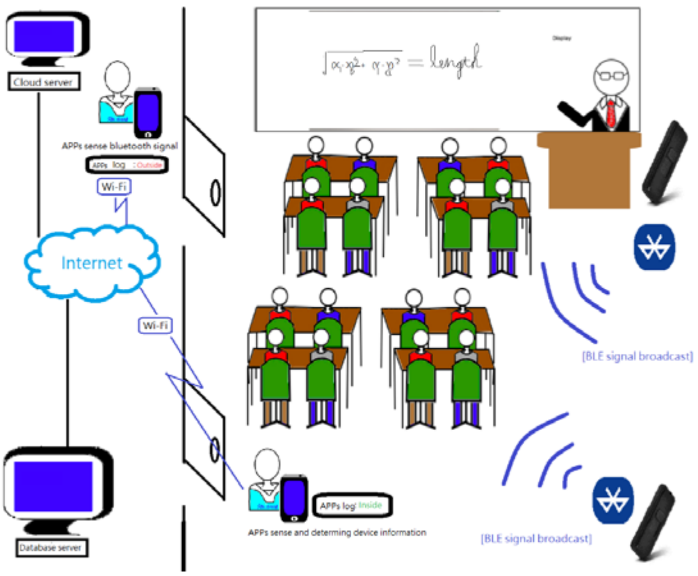


Figure 1. The design concept of building a LAE in traditional classroom.

### *3.2. The CLAP System Structure*

Figure 2 displays the structure of the CLAP system, which consists of three main components: teachers' web APPs (implemented by Responsive Web Design, RWD), students' mobile devices with APPs, and cloud services. The system offers teachers pushing information management and query learning performance which can be obtained by calculating students' learning activity portfolio in classroom. Students' mobile devices can automatically read iBeacon's BLE signal, and APPs in mobile devices can get related location information for iBeacon devices, and send the location information to the cloud server. Meanwhile, APPs trigger the corresponding action which was set up in the cloud server. Subsequently, APPs exhibit pushing information for students, and then students send responses for pushing information to the cloud server. Several data for students' learning activity portfolio in classroom are kept in database server, which include pushing information, responses for pushing information, location information, log of entering/leaving classroom, distance from lectern, etc.

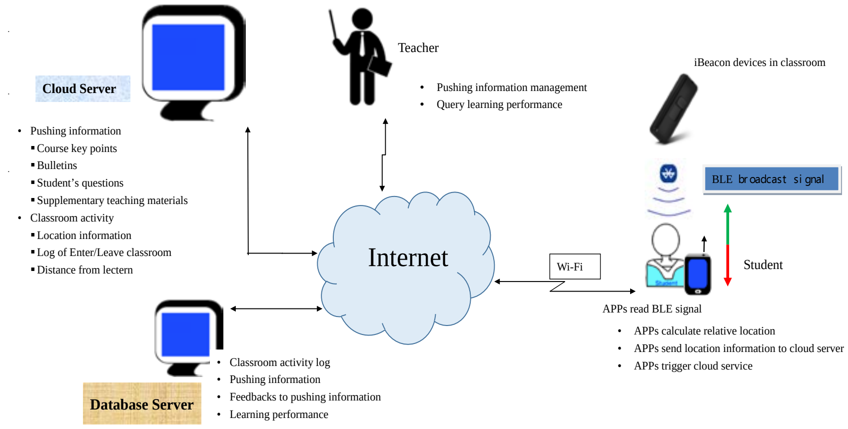


Figure 2. The structure of the CLAP system.

## 3.3. *A flipped-classroom learning process using the CLAP system*

The CLAP system can be used to support c-Learning in traditional classrooms while applying flipped classroom for learning in traditional classrooms. The CLAP system can help teachers and students to have high-interaction learning activity on class time in classroom. Figure 3 draws the process of using the CLAP system to collect students' awareness classroom activity portfolios. First, teachers manage push information, for example, creating students' questions for reading on-line teaching materials. Then, students' mobile devices automatically sense iBeacon devices when students enter classroom on class time. APPs in mobile devices send log data of entering classroom and trigger corresponding cloud services. For instance, APPs display students' questions teachers create before class time. Subsequently, students can send responses for pushing information to the cloud server. This way of sending what kinds of responses can be used to measure students' level to learn on class time.

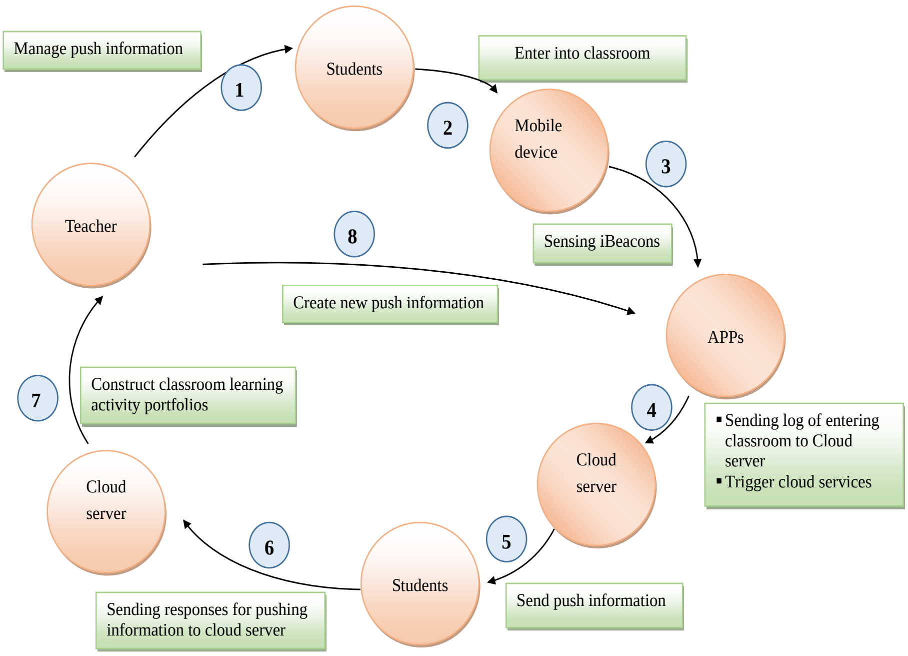


Figure 3. The process of using the CLAP system to collect students' awareness classroom activity portfolios.

In Figure 3, the process of using the CLAP system to collect students' awareness classroom activity portfolios is briefly described as follows. Suppose students had finished to study on-line teaching materials and teachers also got their questions from learning management systems or other learning platforms.

- Step 1. Teacher creates pushing information before class time.
- Step 2. Students' smart mobile devices get ready before entering classroom.
- Step 3. Students' smart mobile devices automatically query iBeacon devices in classroom while entering classroom.
- Step 4. Once iBeacon device is read, APPs get position information for target iBeacon devices. Apps send students' position information to the cloud server, and also trigger corresponding cloud services which are specified in advance associated with iBeacon devices.
- Step 5. The corresponding cloud services is to push information to Apps.
- Step 6. Students utilize APPs to send responses for these pushing information to the cloud server. Some students may do nothing for the pushing information.
- Step 7. The cloud server collect records sent by APPs, which including students enter/leave classroom, responses to pushing information once students entered classroom, and distances from students' seat to teacher' presentation location (for example, the front desk of the classroom. It construct these types of records to form students' classroom activity portfolios. Subsequently, it also can offer analysis results of the classroom activity portfolios when teachers query the results.
- Step 8. Teachers may create or update pushing information on class time for interacting with students. The system can perform high interaction on class time due to having time limits for sending responses for pushing information. The process is repeated starting Step 3 until students leave classroom or class closed.

## 4. Evaluation Results

Thirty-nine students (29 males and 10 females) participated in the experiment, who are in a university of science and technology in the middle of Taiwan. They have smart phones with Android system. In the experiment, only Android version of APPs is developed. Student survey of using the CLAP system for the class, “Business Data Communications” adopting flipped-classroom pedagogical design. These students receive the use of the CLAP system and the process of classroom activity mentioned in Subsection 3.3., as shown in Figure 3. The students voluntarily answer the questionnaire. The questionnaire has 11 items for learning interests. The items (questions) of learning interests were reedited according to (Hwang & Chang 2011) such as “In the Business Data Communications class use CLAP system APPs are fun”. The questionnaire is written in Chinese. The questionnaire adopts five-point Likert scale. Each item has five options, from 1 “strongly disagree” to 5 “strongly agree.” The higher score means the higher perception of effectiveness for the case of exploiting the CLAP system. The validity of the items is gained by two experts who major in information management. Figure 4 shows descriptive statistics were used to summarize all variables (questions) for learning interests.

Figure 5(a)-(d) illustrate the editing for the contents for four kinds of pushing information, bulletins, course key points, students’ questions, and supplementary teaching materials, respectively. Figure 4(a) displays APPs in smart mobile device offers login function to identify legal users. Figure 5(b) displays in getting students’ locations via smart mobile devices. Once iBeacon devices are read, APPs display signal status for location information on screen of students’ mobile devices. Figure6 (c) shows log data for student’s position information exhibited in Figure 6(b), which are kept in the cloud server. Figure 6 illustrate that student’s APPs display three kinds of responses for four sorts of pushing information. Figure 7 (a)-(d) exhibit four operating screens for four sorts of pushing information, bulletins, course key points, students’ questions, and supplementary teaching materials, respectively. Figure 8 (a)-(d) show detailed results of students’ responses for four sorts of pushing information, bulletins, course key points, students’ questions, and supplementary teaching materials, respectively. Figure 9 presents summary results of three choices each student chooses for four kinds of pushing information.

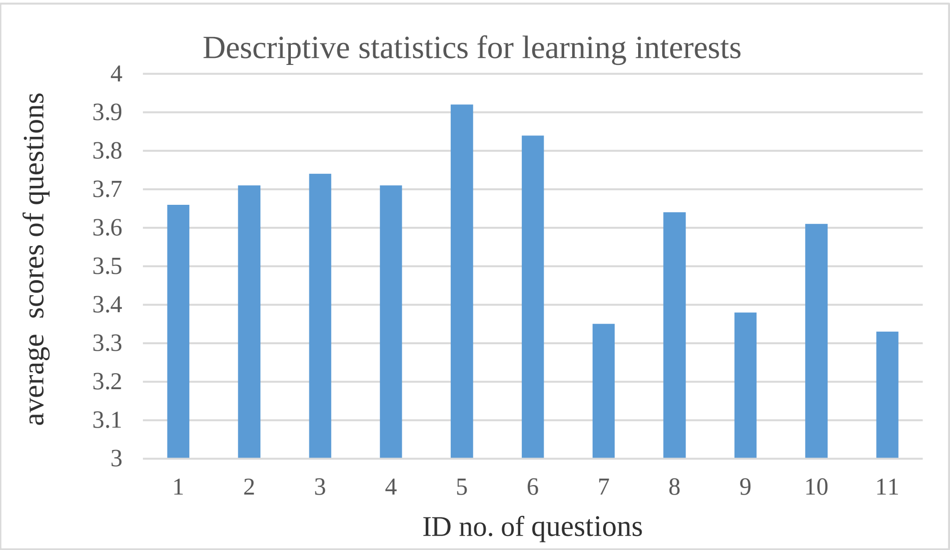


Figure 8. Results in terms of descriptive statistics to summarize all questions for learning interests.

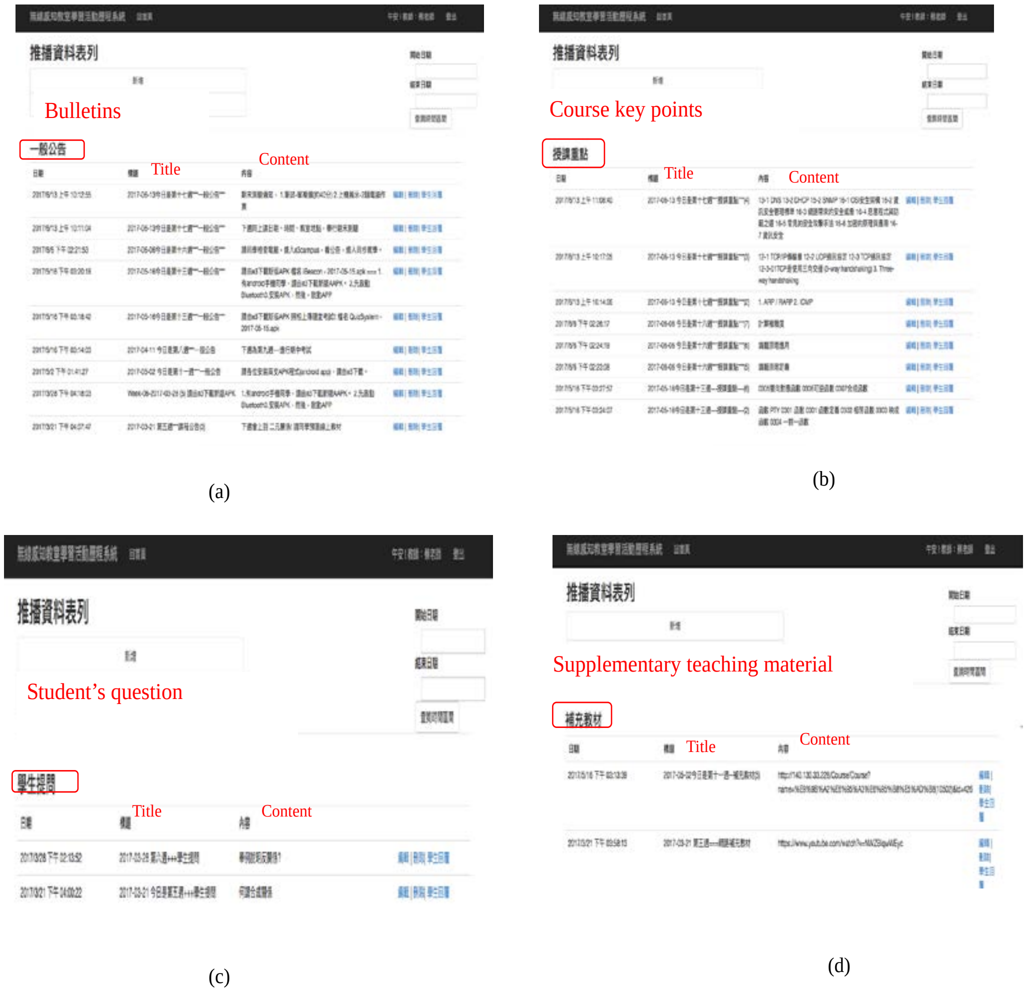


Figure 5. (a) - (d) illustrate the editing for the contents for four kinds of pushing information, bulletins, course key points, students’ questions, and supplementary teaching materials, respectively.

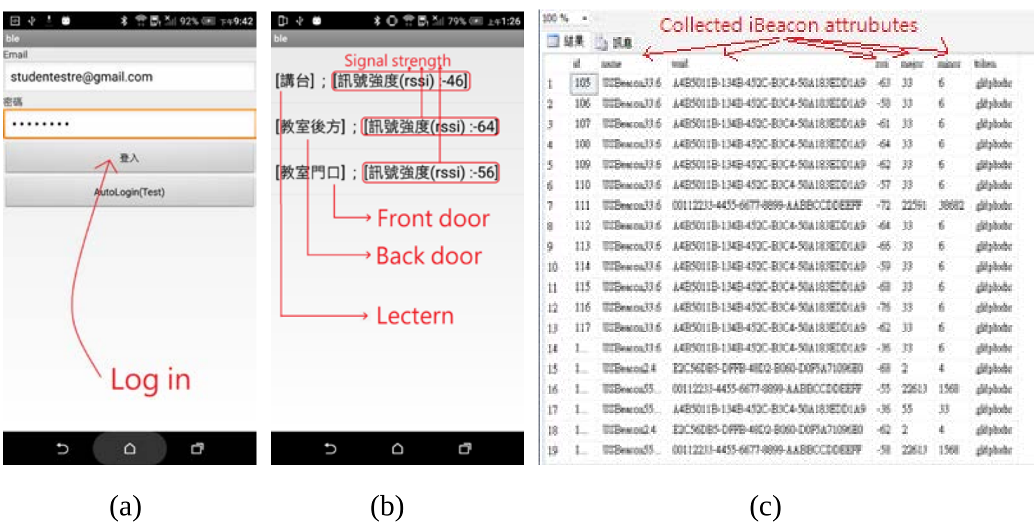


Figure 9. (a) Mobile device APPs login interface; (b) iBeacon devices are first read and then APPs display signal status for location information on screen of students’ mobile devices; (c) log data for student’s position information exhibited in (b), which are kept in the cloud server.


Figure 10. Student's APPs display three kinds of responses for four sorts of pushing information. (a) - (d) are four operating screens for four sorts of pushing information, bulletins, course key points, students' questions, and supplementary teaching materials, respectively.


Figure 8. (a) - (d) show detailed results of students' responses for four sorts of pushing information, bulletins, course key points, students' questions, and supplementary teaching materials, respectively.

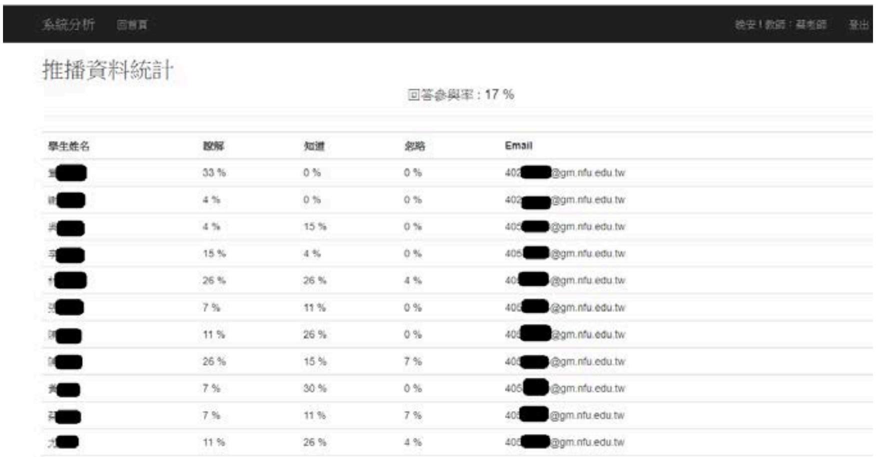


Figure 9. Summary results of three choices students' send for four kinds of pushing information.

## 5. Conclusions

The paper has proposed a cloud service system, the CLAP system, for students' awareness classroom activity portfolio. The paper also builds a LAE using iBeacon devices in the design of wireless awareness functions. In the LAE, the CLAP system develops APPs for smart mobile devices for collecting data to construct students' classroom activity portfolios. There are several types of students' classroom activity portfolio, including records that students enter/leave classroom, responses to pushing information once students entered classroom, and distances from students' seat to teacher' presentation location (for example, the front desk of the classroom). It also offers analysis results of the classroom activity portfolio. Hence, it can benefit students who can readily send their records or responses on class in classroom learning. Moreover, they do not require to type many data (for example, long URL) for interacting with the portfolio collection system. Furthermore, the system can assist teacher in collecting students' classroom activity portfolio, and then to have analysis results of the portfolio. For instance, teachers can get the result that students entered classroom but they send less or no feedback in classroom to the system. Descriptive statistics were used to summarize all variables for learning interests. Evaluation results show that the CLAP system benefits students for learning interests.

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## References

Bergmann, J., & Sams, A. (2012). Before you flip, consider this. Phi Delta Kappan, 94(2), 25-25.

Chen, Z., Zhu, Q., Jiang, H., & Soh, Y. C. (2015, June). Indoor localization using smartphone sensors and iBeacons. In Industrial Electronics and Applications (ICIEA), 2015 IEEE 10th Conference on (pp. 1723-1728).

Diller, D. (2015). TF6 Implementation of the Flipped Classroom Model Using VirtualACEP to Teach a Cardiology Curriculum to Emergency Medicine Residents. Annals of Emergency Medicine, 66(4), S157-S158.

Evseeva, A., & Solozhenko, A. (2015). Use of flipped classroom technology in language learning. Procedia-Social and Behavioral Sciences, 206, 205-209.

Gilboy, M. B., Heinerichs, S., & Pazzaglia, G. (2015). Enhancing student engagement using the flipped classroom. Journal of nutrition education and behavior, 47(1), 109-114.

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. Computers & Education, 56(4), 1023-1031.

Obradovich, A., Canuel, R., & Duffy, E. P. (2015). A survey of online library tutorials: guiding instructional video creation to use in flipped classrooms. The Journal of Academic Librarianship, 41(6), 751-757.

Radhakrishnan, M., Misra, A., Balan, R. K., & Lee, Y. (2015, October). Smartphones and ble services: Empirical insights. In Mobile Ad Hoc and Sensor Systems (MASS), 2015 IEEE 12th International Conference on (pp. 226-234).

Domingo, M. G., & Gargante, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. Computers in Human Behavior, 56, 21-28.

Volk, M., Cotič, M., Zajc, M., & Starčič, A. I. (2017). Tablet-based cross-curricular maths vs. traditional maths classroom practice for higher-order learning outcomes. Computers & Education, 114, 1-23.

López, O. S. (2010). The digital learning classroom: Improving English language learners’ academic success in mathematics and reading using interactive whiteboard technology. Computers & Education, 54(4), 901-915.

Moreira, F., Ferreira, M. J., Santos, C. P., & Durão, N. (2016). Evolution and use of mobile devices in higher education: A case study in Portuguese Higher Education Institutions between 2009/2010 and 2014/2015. Telematics and Informatics, 34(6), 838-852.