

Evaluation of the effectiveness of the app on improving student learning

To assess the effectiveness of the app on improving student learning, (1) students' scores in the first and final attempts of the same games will be compared and (2) a summative student survey will be conducted at the end of Phases IV and IV to evaluate the usefulness and influence of the app quantitatively from the user's point-of-view. For the teaching effectiveness, in Phases V and VII, a qualitative survey will be carried out in which teachers of the courses involved will be required to comment on the impact of the app on their teaching and report any action plans formulated based on the student performance report from the app data. The resultant data and conclusions will then be reported to the Curriculum Committee of Biology Programme for further discussion.

Result from Student Survey

Result of student survey on effectiveness of Bio-mining in facilitating learning on Biology essential terminologies is shown in Appendix I.

Over 60% of students agreed that playing Bio-Mining was a fun experience and with Bio-Mining they could learn and memorize the terminologies effectively. More than half of students agreed that getting instant feedbacks enhanced awareness about one's learning progress, and with Bio-Mining they were more engaged and motivated to learn terminologies (Graph I). Less than 15% of students had opposite views on the above points about the effectiveness of Bio-Mining. Given that learning terminologies is regarded as a nerve-racking and unappealing task, we conclude that Bio-Mining allows considerable percentage of students to learn terminologies with fun, can engage and motivate them to learn the terminologies effectively outside class, and also enhance their self-awareness on the learning progress. This is supported by the fact that over 60% of students spent more than 30 minutes in playing Bio-Mining and over half of these students in fact spent more than 1 hour on the mobile app (Graph IV). Effectiveness of Bio-mining in facilitating learning on terminologies varied among different courses (Graph II). It was most effective in Biodiversity Laboratory II and least effective in Biodiversity Laboratory I, despite the similar nature of two courses (Graph II). This can be explained by the number of relevant minigames and thus the freedom of choice: only 4 for Biodiversity Lab I while 8 for Biodiversity Lab II.

Less than 10% of students liked to share their achievement of Bio-mining through facebook, the common social media, while 70% of students disliked doing so. More than 40% of students enjoyed being a member of the learning community constructed by Bio-Mining with around 20% of students held an opposite view (Graph I). The possible explanation is that students might feel uneasy to share their academic performance through facebook which is usually used for sharing their social life and personal emotions. Yet, they felt being a member of a learning community as most of classmates were playing the same games and they could learn their own ranks among the players. We conclude that for some extent, Bio-Mining can help the isolated learners to form a learning community for Biology which may deepen their motivation in learning biology.

Analysis of Data extracted from the data extraction tool

By comparing the best record and the first record of individual students (Appendix II, Graph V), students made great improvement during the process of game playing. This shows that Bio-Mining is an effective learning tool for active players.

Data analysis also revealed some user behaviours of CUHK students which may be also useful for other mobile game-based learning (Appendix II).

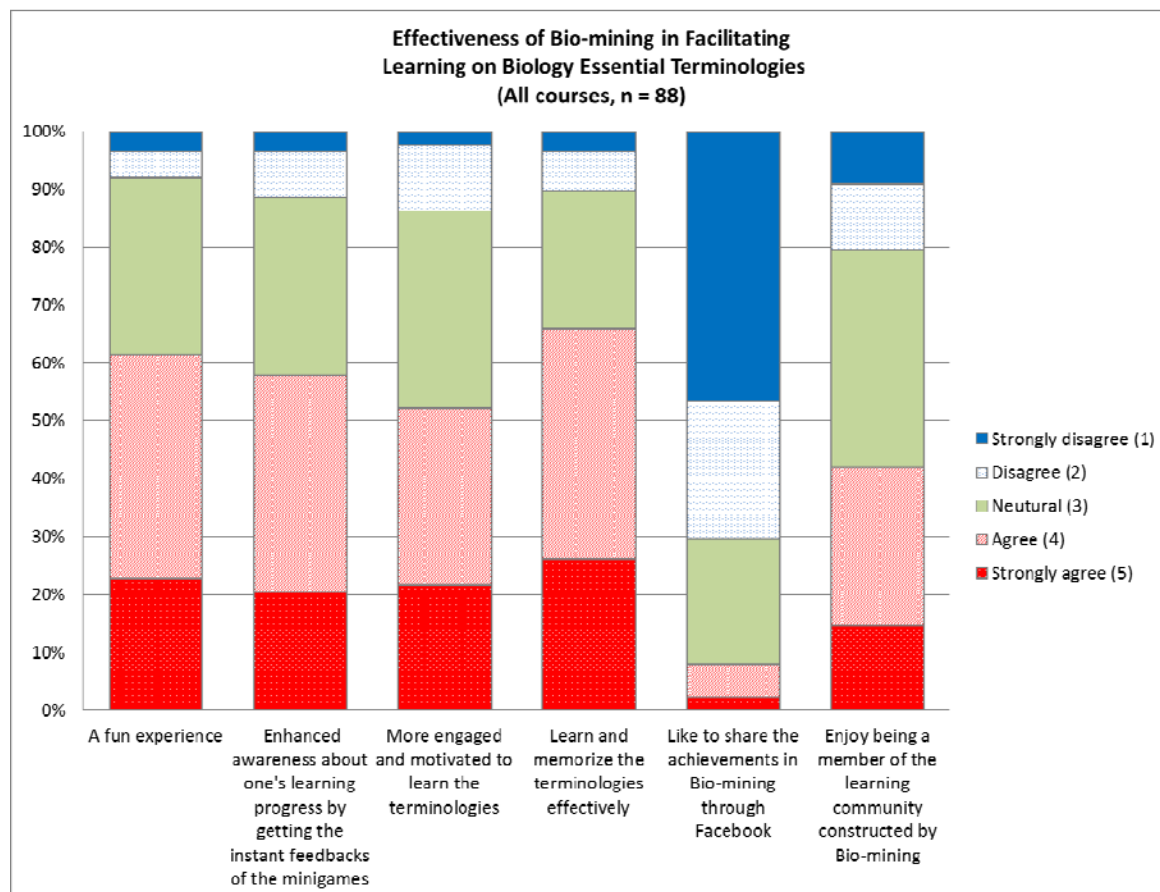
A relative high frequency of login was found during 12:00NN to 23:59PM (Graph VI). The wide time window could be explained by the high flexibility provided by three platforms (android, iOS and web browser) so that the users can play the game at any time and any location. The high penetration of mobile phone usage as reflected by the fact over 84% CUHK users accessed the app through mobile-phone platforms alone as reflected by Table IV highlights the significance of developing mobile-phone compatible platform for e-learning in the future in CUHK.

Some other useful facts have been obtained: the average duration of login of CUHK users was 30 minutes (Table II) and the average number of mini-games per login session was 11 (Table III). No significant difference is found between male and female.

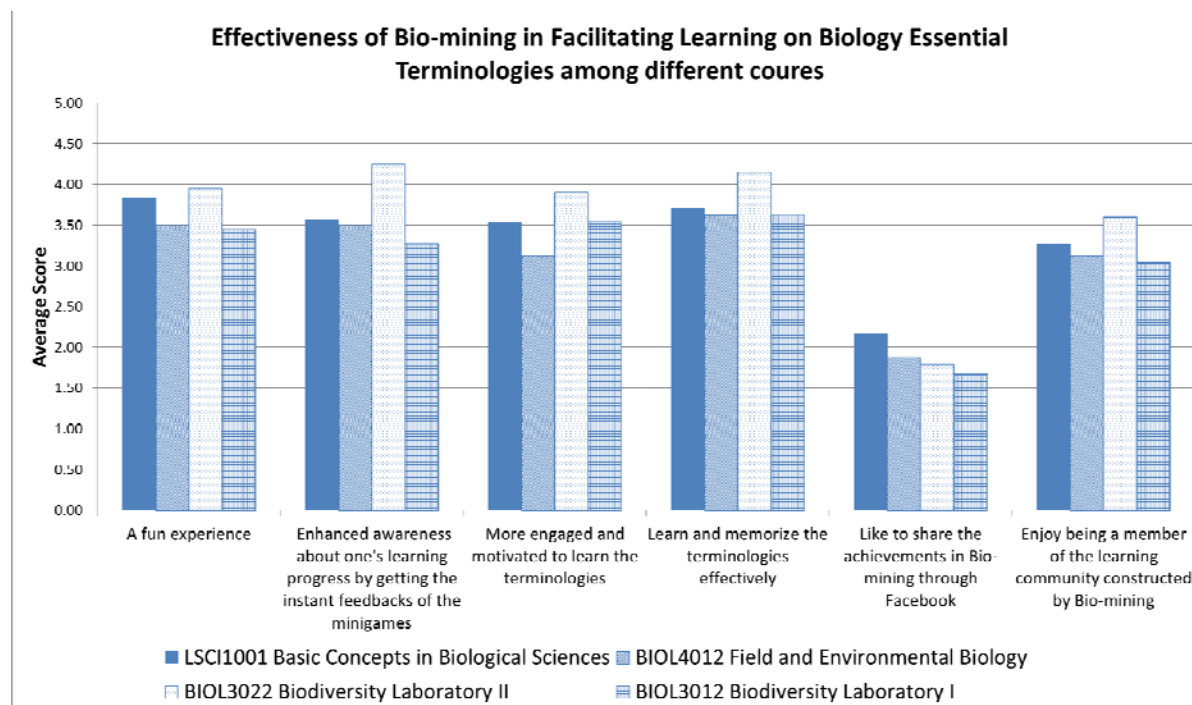
Teachers' opinions on Bio Mining

- In general, teachers agreed that Bio Mining can make learning terminologies more fun and effective.
- It was observed that only those students who really interested on biology or intended to get better grades would play the game when it was given on a voluntary basis (Teacher of LSCI1001).
- It was observed that in biodiversity lab courses, Bio Mining might help students spot out the key terminologies in the course learning materials (Teacher of BIOL3012 and BIOL3022).
- It is apparent that the app helps the identification and familiarization of the species living in different habitats and therefore facilitates the learning process. Students did like the design of the game, as well as the interface design and how the specimens are displaced. It seemed that some students using phones with smaller panels did find the graphics to be too small, and in some cases on the loading of the images could be slower than expected. In the coming year improvements could be focus on the improvement in the size and resolution of the images hoping to enhance the recognition of the species concerned (Teacher of BIOL4012)

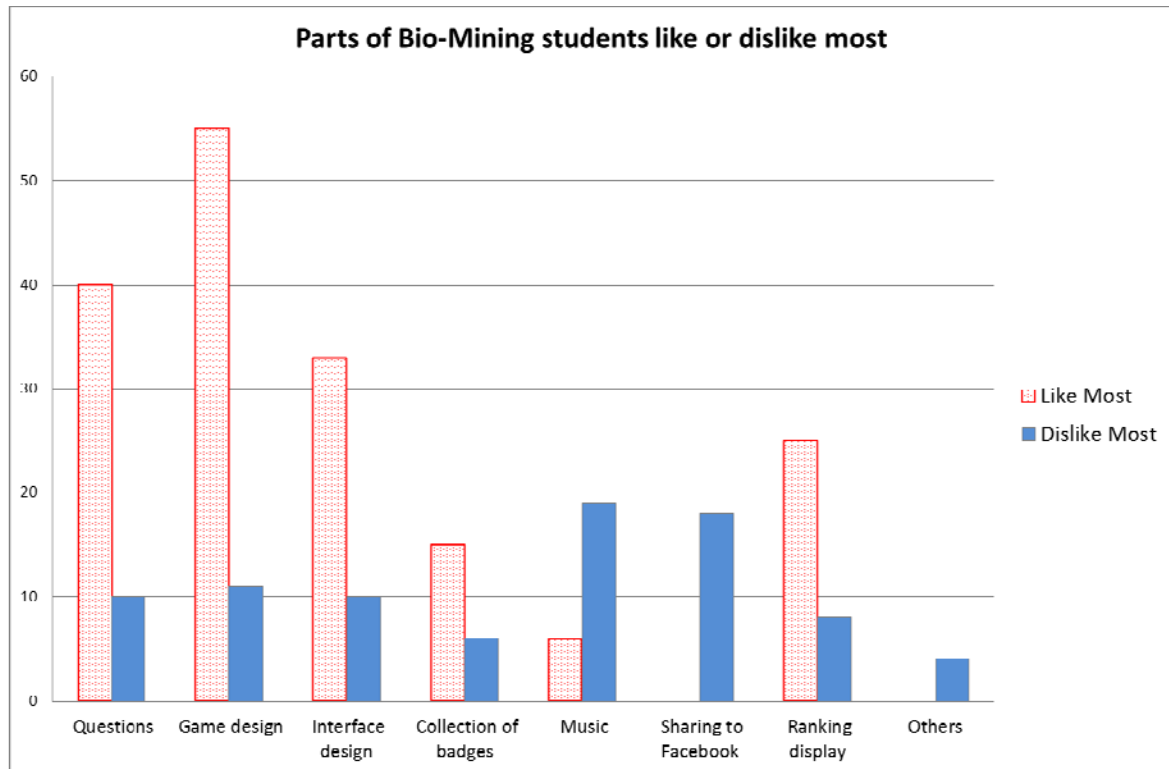
Appendix 1: Result of Student Survey



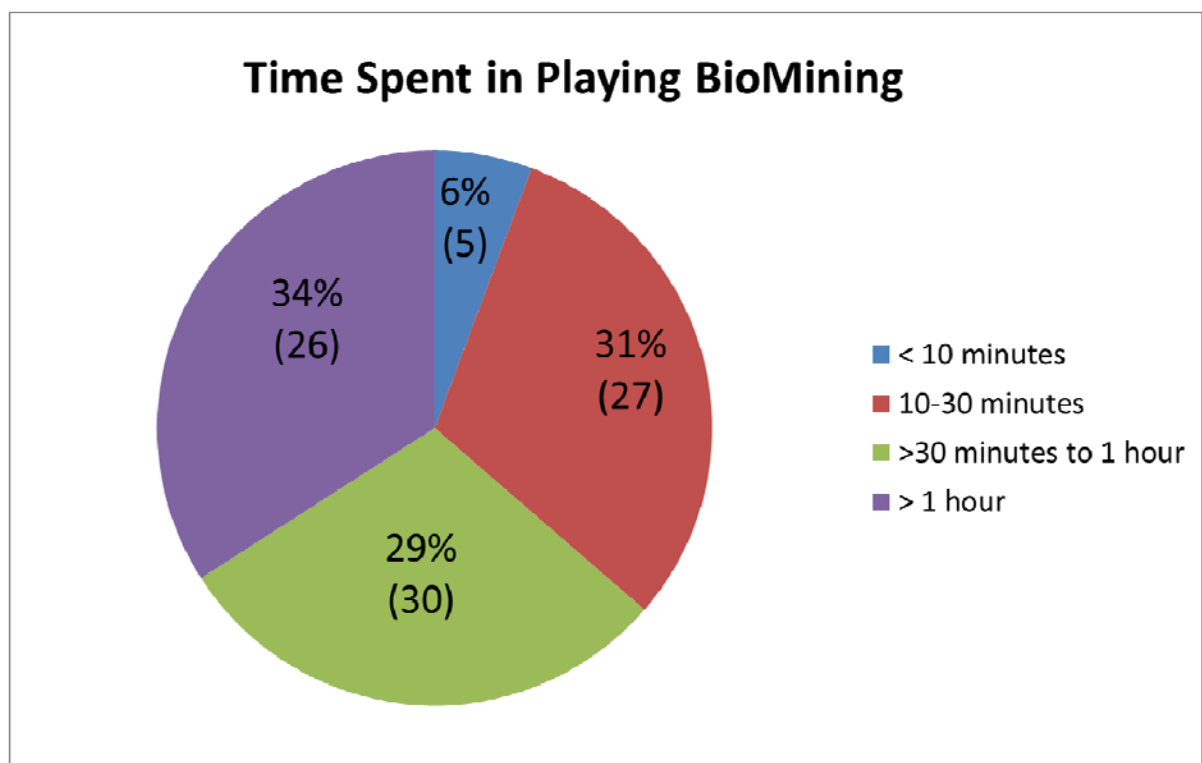
Graph I. Effectiveness of Bio-mining in Facilitating Learning on Biology Essential Terminologies



Graph II. Effectiveness of Bio-mining in Facilitating Learning on Biology Essential Terminologies among different courses (using a five-level Likert scale).



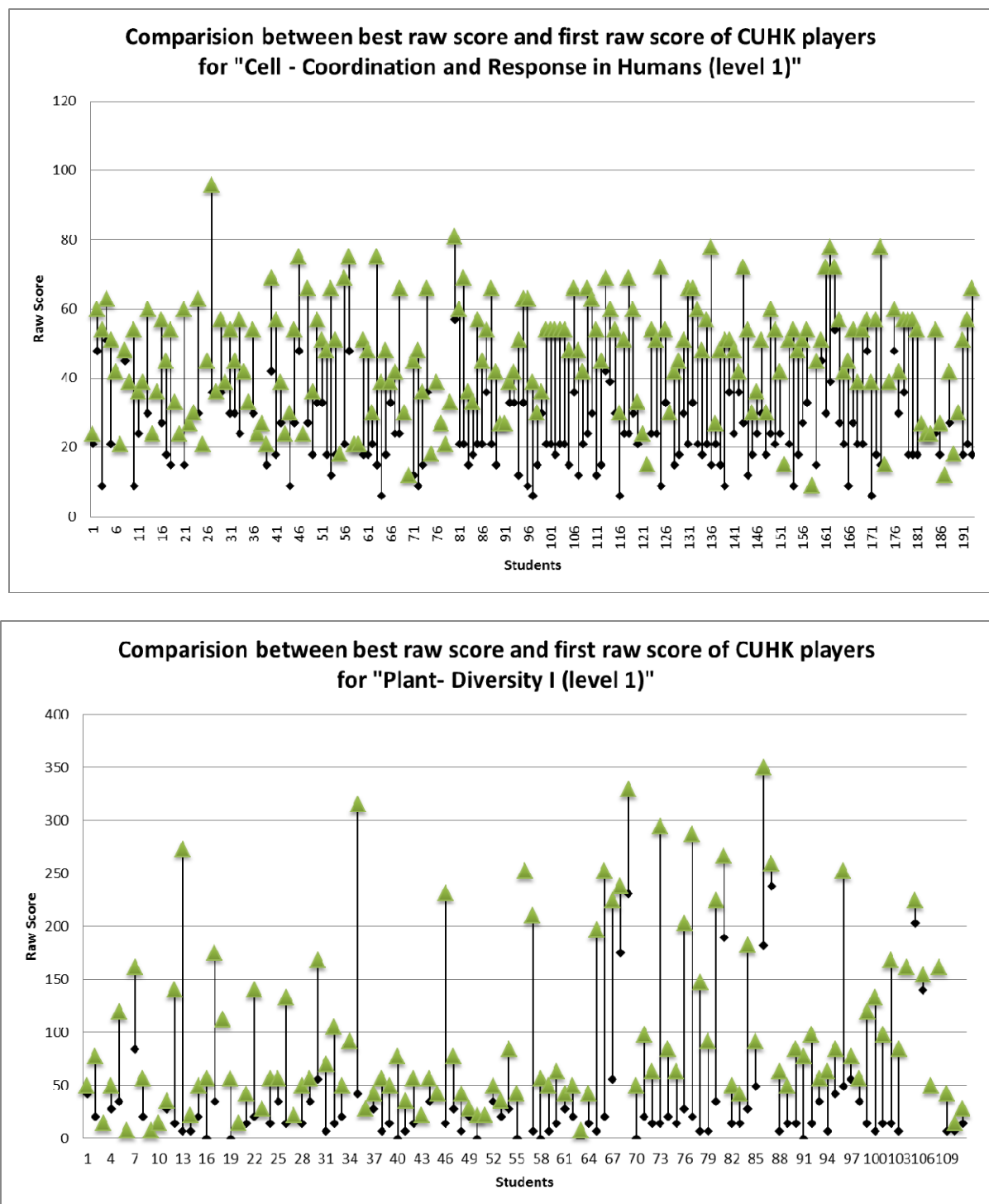
Graph III. Parts of Bio-Mining students like or dislike most (n = 88)



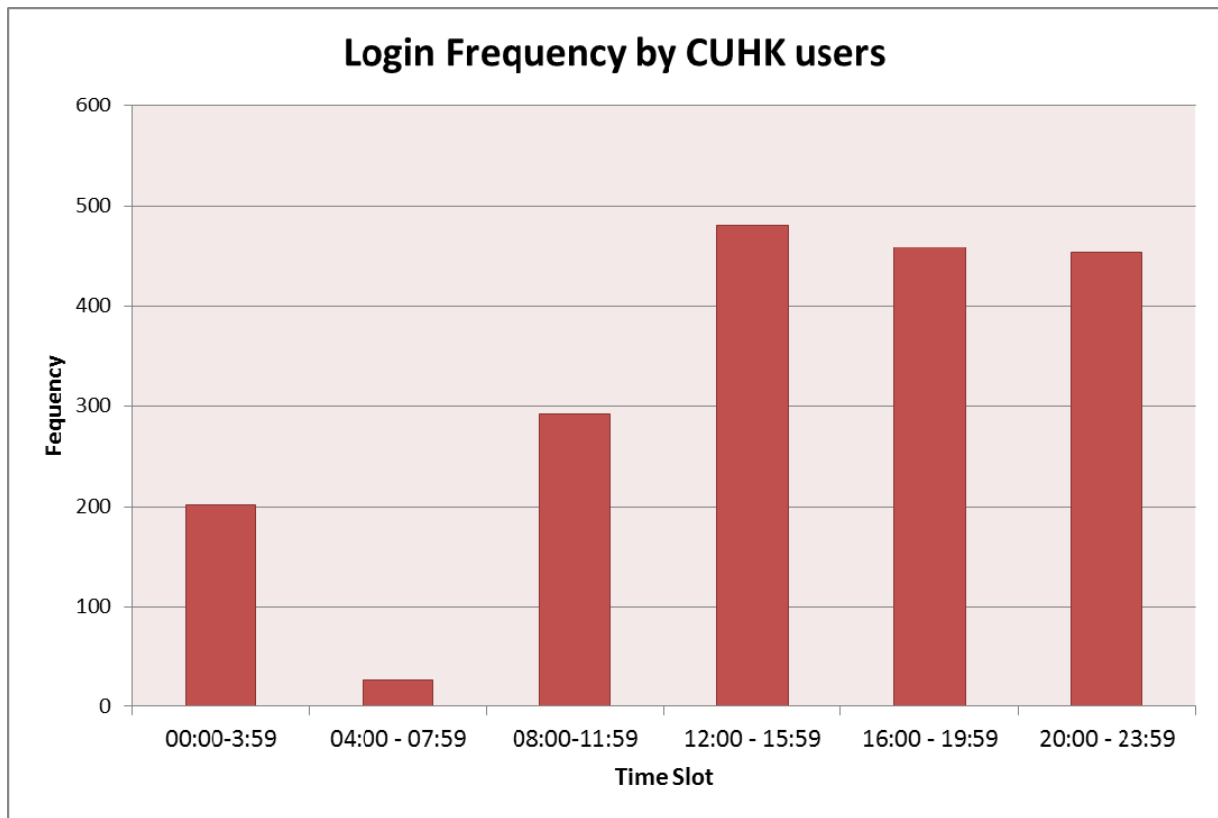
Graph IV. Time spent in playing Bio Mining (n=88)

Table I. Suggestions to improve Bio-mining given by students

Course	Period	Suggestions to improve Bio-mining
BIOL3012 Biodiversity Laboratory I	2014-15	Add some videos watching instead of games.
		Useless
		Question bank should be expanded because same questions appeared quite frequently.
		I hope to play offline
	2015-16	It will be appreciated that if there are more questions, so that the same question will not appear again and again
		Biomining needs players to wipe the screen to reveal the photo. I think this is very unnecessary and disturbing.
		Also, I think students can memorize the terminology very easily, I think the questions should better be MC, asking about the properties of the plants.
		I really appreciate that a game app is made for us, but there are rooms for improvement for this app. Thank you for your effort!
		More pictures can be provided
		the questions are almost the same for all levels
		one game design (wipe the block): the area that we are allowed to wipe away is too small, sometimes i am not able to guess the object with such a small area. Instead, it's better to allow us to wipe away the whole area, (with there is already a time limit)
		Cherry, Thank you for your effort in helping us to learn more in these courses and I enjoy your lessons and lab a lot! Someone who really loves Biology:)
BIOL3022 Biodiversity Laboratory II	2014-15	have completely no idea how the "challenge others" works =.=
		-off line available
		-more variety of the question bank is needed especially the intermediate and advance levels
	2015-16	Personally I think a more "boring" game design can be more effective for Biology student to memorize the terminology. For example, just showing the photo and then having us to spell the word, instead of having us to swipe the screen for the photo and then spell out the word.
		Can include more terms in some of the sections, e.g. inflorescence More questions are needed because they frequently repeat.
BIOL4012 Field and Environmental Biology	2014-15	Make the buttons larger, always fail to touch, the words and picture are too small (im using moible with small screen!!!) , the sharking of the plants part seems useless, un-responsive!!!! The picture are not clear. Bugs always happen! Question too repetitive! For the spelling question, I can guess the answer easily without wipe the window clear to see the picture.
LSC1001 Basic Concepts in Biological Sciences	2014-15	quite funny
		Some games are useless long just to get a short answer
		Questions are too easy and repeats again and again
		It would be better to include more questions.
		can't re-login after logged out
		The pace of the game is so fast (the timer) that I can't learn effectively based on the flash of the game...I have to do cross-reference with the lecture notes, wiki and textbooks to help me. The administrator can give it a pause and request the players to press for next question when the players answer a question correctly. Hope this can help you!! Good luck
		On android 5.0 the game would not be installed. The responsiveness on iOS was also slow.



Graph V. Comparison between best raw score and first raw score of CUHK players for “Cell - Coordination and Response in Humans (level 1)” “Diversity I (level 1)”. Triangle represents the best score of the student while diamond represents the first score of the same student.



Graph VI. Login frequency of CUHK users of Bio-Mining

Table II. Duration of Login of CUHK users

Role	Gender	Min	Max	Average
CUHK	All	00h : 00m : 01s	5d 11h : 03m : 08s	00h : 30m : 16s
	Male	00h : 00m : 02s	1d 07h : 00m : 35s	00h : 27m : 38s
	Female	00h : 00m : 01s	5d 11h : 03m : 08s	00h : 32m : 55s

Table III. Game per session of CUHK users

Role	Gender	Min	Max	Average
CUHK	All	1	108	10.998
	Male	1	78	10.199
	Female	1	108	11.777

Table IV Analysis of Platform usage of CUHK users

Platform	Role	Gender	Times	%
Android Only	CUHK	All	245	70.81%
		Male	131	
		Female	114	
IOS Only	CUHK	All	0	0%
		Male	0	
		Female	0	
Web Browser Only	CUHK	All	0	0%
		Male	0	
		Female	0	
Both Android And IOS	CUHK	All	83	23.99%
		Male	44	
		Female	39	
Both Web Browser And Mobile apps	CUHK	All	18	5.20%
		Male	11	
		Female	7	