Strategies in Designing a Media Computing Course to Provide a Discovery-Enriched Curriculum to Students with Diverse Technical Background

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Abstract. In this paper, we share our experience in designing a media computing course that aims to teach creative media students who had a diverse technical background. We describe several strategies in the course design and delivery that is aligned with our discovery enriched curriculum. Firstly, we designed the learning materials with visual content that is related to students' real life to stimulate their interest. Secondly, we catered for students' diverse background by designing learning tasks with different levels of difficulty. We also offered different means of help to the students in case they faced any problems. Our design of the learning and assessment tasks encouraged students to make self-discovery and innovation. An empirical study is conducted by analyzing the relationship between several factors for a selected group of students. The relationship between the students' homework grade and their attendance in the laboratory illustrates a positive trend, showing that students who attended our laboratory more often got better scores in the homework. Moreover, the relationship between students' homework grade and their quiz grade also illustrates a positive trend, showing that the design of our laboratory tasks was well aligned with the quiz assessments to help students master the concepts in this course such that we can adjust our focus to put more emphasis on certain topics based on the strength and weakness demonstrated by the students in the homework.

Keywords: Discovery enriched curriculum · Diverse background · Discovery and innovation · Experience sharing

1 Introduction

City University of Hong Kong has been adopting a discovery enriched curriculum (DEC) in developing teaching and learning activities since 2012. With DEC in mind, we would like our students to be able to make original discovery. The slogan of our university is Discover&Innovate@CityU® which clearly aligns with our university mission to nurture and develop the talents of students and to create applicable knowledge in order to support

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social and economic advancement. There are three key aspects that we would like our students to develop: attitude, ability and accomplishment. Our students have received a number of awards and generated some intellectual properties as a result of the DEC introduction (http://www.cityu.edu.hk/provost/dec/DEC_awards.htm).

In this paper, we shared our experience in devising strategies to deliver a discovery enriched curriculum in a media computing course. This course includes some programming elements for students to implement some media effects. It was found that a student's motivation and willingness to participate in learning activities is a major determining factor in his/her academic success [1]. As a result, we described how we designed our learning tasks to stimulate students' interest to keep them engaged in class. In fact, Regueras *et al.* examined students' motivation in learning programming in a competitive learning environment [2]. The e-learning communities have explored different aspects of teaching programming. Vesin *et al.* modeled the learners with a programming tutor system [3]. Watson *et al.* proposed to make use of concept visualization together with corrective feedback for students to learn programming in a game-like setting [4]. Hwang *et al.* focused on students' collaborative learning of programming through a web-based system [5]. Choy et al. proposed an automatic assessment system for correcting programming assignments [6]. A virtual education system with a lot of visual content has been implemented to teach C programming [7]. In our previous work [8], we have shared our experience in teaching webpage programming course by including a number of interesting demonstration webpages to be shown to the students in the lectures to ignite students' passion for knowledge and motivate them to come to the lectures. In this paper, we shared our experience in teaching another course on media computing to students with diverse technical background.

This paper is organized as follows. In Sect. 2, we will introduce our course and state our strategies in designing this course to align with our discovery enriched curriculum. In Sect. 3, we include an empirical study to analyze different factors in evaluating some aspects on the design of our course. The conclusion and future work are described in Sect. 4.

2 Course Design and Delivery

In this paper, we would like to share our experience in designing a course that was taken by first year students. It is an introduction course about media computing offered by the Department of Computer Science. On the other hand, this course is offered to our students studying in creative media so many of them do not have strong technical background. It is thus a challenge to design this course to stimulate students' interest and to suit students with diverse background such that students are able to implement some media computing techniques through writing some simple programs. We have developed several strategies towards achieving this goal and they are described in the following subsections.

2.1 Designing Visual Content Related to Real-Life Examples

The course spans a duration of 13 weeks. Every week there are 2 hours of lecture and 2 hours of laboratory. The assessment tasks consisted of 2 individual homework, 1 quiz

and 1 group project. Most of our course is focused on two media types: image and audio. We designed the course content to include examples that are closely related to students' real life in order to provide them better motivation to learn about the subject.

For images, we provided HTML5 code to illustrate image manipulation techniques such as color-to-gray conversion, brightness adjustment, flipping and rotation, etc. HTML5 was used because students had already learnt it in the previous semester on web programming. Many students already had experience with Photoshop to manipulate images. In this course we would like to show students how some of these functions can be implemented in practice. In the first homework, students were asked to implement some image effects. They were asked to work with the portrait images containing their own faces since nowadays many students like to take selfies and apply various image effects with their mobile phones. By asking them to work with their own photos, we would like to motivate students to work on the homework to implement the image effects by themselves and get more attached to the interesting results. For example, one of the homework tasks is to identify the centerline of the face region and then flipping the left part of the face horizontally and pasting it to the right part of the face to construct a symmetric face as shown in Fig. 1.

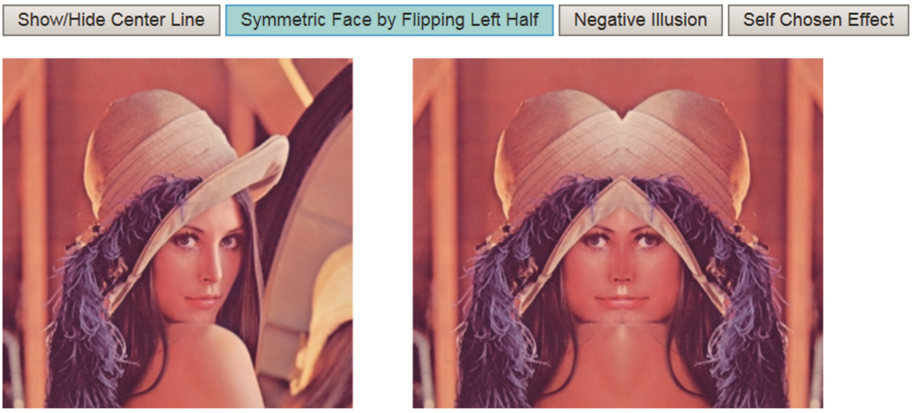

Fig. 1. One of the first homework tasks to construct a symmetric face.

For audio, we used Web Audio API to demonstrate the implementation of various sound effects because it is easy to load an audio file and do some low-level processing by manipulating individual audio samples. With Web Audio API, some javascript code was shown to the students to illustrate how simple audio processing can be implemented such as changing loudness, changing playback speed, fade in/out etc. In one of the laboratory, the tasks were designed to let students simulate a touch tone keypad. First a graphical interface of a mobile phone illustrated in Fig. 2 was provided to the students. They were then guided to implement the touch tone for each key by applying dual-tone multi-frequency signaling, i.e., generating two sinusoids of specific frequencies corresponding to each key. In this way, they were able to create the touch tones similar to the real-life case as if they are pressing a key in their touch tone phone. These touch tones together with dial tone, ring tone and busy tone are introduced in the laboratory such that students can implement these familiar sounds on their own.

Fig. 2. Graphical interface of the second homework to work with touch tones.

2.2 Catering for Students with Diverse Background

As mentioned before, the students in this course were in their first year with diverse technical background. Prior to entering university, some students already had taken some courses in multimedia and programming. On the other hand, some students may have taken information and communication technology while other students had only taken art subjects without any previous experience on computer related subjects. Given the diverse background of students, it is a challenge to design the course content regarding the level of difficulty. If the course content is too difficult, then students with little technical background would not be able to catch up. On the other hand, if the course content is too easy, then students with strong technical background would feel too bored.

The laboratory tasks were designed to cater for students with diverse background. They consist of basic tasks that are relatively easy as well as some more challenging tasks that are optional. During the laboratory, students were given time to solve each basic task. The lab tutor would walk through the solution of the basic task with the students after a while. Students who finished the basic tasks early were asked to carry on to work on the next tasks and continued to do the optional tasks if they finished all the basic tasks. In this way, all students can make accomplishments to a level depending on their abilities. For example, during one of the laboratories, students were asked to add rectangular borders on an image to create the collage effect. The basic task assumes that the rectangular borders are upright so that they do not need to consider rotation (Fig. 3 left) while the optional task asks students to come up with the rotated rectangular borders which correspond to a much more challenging task (Fig. 3 right).

On the other hand, the homework was designed to be an extension of the laboratory tasks. As a result, students who had attended the laboratory sessions should be able to complete the basic tasks of the homework by putting together what they had done from the laboratory. In other words, the laboratory was a preparation step towards other assessment tasks such as homework and quiz.

Fig. 3. Outcome from a basic task (left) and an optional task (right) in one laboratory.

2.3 Offering Different Means to Help Students

It is inevitable that students may have questions about the course work. As a result, it is important to provide support to help students in this case. In this course, different means of help were available to support the students. During the laboratory sessions, the lab tutor and the teaching assistant would go around the class to check with the students if they had any problems and answer their questions. Students were asked to form groups during the laboratory to solve problems and work on the project. The classroom where the laboratory was held has chairs equipped with wheels that facilitate students moving them around to form groups quickly. In this setting, students could also get help from their peers which is preferred by most students. During the classes, the instructor also kept reminding the students that they could contact him after class in case they had any questions. The course webpage also includes a discussion board feature where students could post questions for the instructor to answer. In the second homework, one question is posed as follows:

Whenever you have problems in your program, you may have asked your classmate(s). In addition to this option, do you know that there are also other options, for example,

- *Check and post your questions on the discussion board in the Canvas course page?*
- *Ask the instructor/tutor/teaching assistant during or after class?*
- *Schedule an appointment with the instructor and ask him questions and the instructor will be very happy to help you?*
- *Review the related materials from CS1303 which you should have learnt?*

The above question aims to remind students about their options for seeking help in case they face problems in this course.

2.4 Encouraging Students to Discover and Innovate

The slogan of our university is to Discover and Innovate, which indicates what we would like our students to achieve. In the design of this course, students were encouraged to make discovery on their own and be innovative. Near the end of each laboratory session, each group was given some time for them to discuss about issues related to what they had learnt in that class and then they would give a presentation in front of the class. Students were also asked to provide self-reflections about what they had learnt in each homework. For the project, each group is required to describe what the group members have learnt and discovered throughout this project. They were asked to demonstrate their critical thinking by considering various issues such that what problems or challenges they had encountered, how they overcame the difficulties, how they made adjustments and derived the solution, what kind of learning experience they would like to share, etc. From these self-reflections, students can realize better what they have discovered through different learning tasks. For example, one student wrote about her discovery from the first homework: "*I think this homework is the advance level of all lab exercise. I can modify the code which we learned during the lesson. But I try to find another ways to finish the coding. For example, I use the if-else statement instead of Boolean statement to show center line.*"

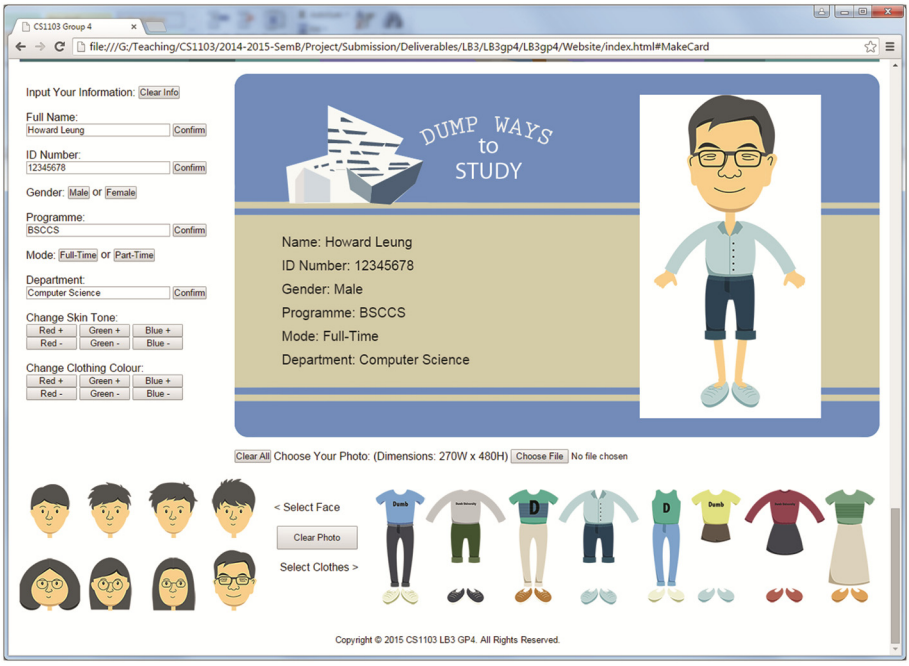

Fig. 4. A group project in the form of a webpage demonstrating creativity.

In each homework, students were asked to come up with their own creative effects. There was a lot of freedom in this task. Some students explored on their own to create

interesting media effects. Those students could not come up with novel ideas still could finish this part by putting together the effects that they had learnt in the class. For the project, each group was asked to include any innovative ideas or creative aspects that the group has put into this project. In particular, they were asked to state how their work is different from existing similar webpages/products/platforms and emphasize about the novel aspects of their work. For example, one project group has come up with a creative idea and applied the media computing techniques to implement a webpage that lets the user to have a student card like layout with customized photos and text as illustrated in Fig. 4.

3 Empirical Study

In the course described in this paper, the students were divided into 7 laboratory sessions which are co-taught by 3 lab tutors, with the first author being one of them. The first author has selected two laboratory sessions that were taught by himself for the empirical study reported here. Altogether there were 53 students in these 2 sessions. As mentioned previously, these students had diverse technical background as some of them had taken multimedia and programming subjects before whereas some other students may not have taken science subjects during their senior secondary school. In this study, we mainly examine 3 factors: (1) students' attendance rate during the laboratory sessions; (2) their homework grade; and (3) their quiz grade.

3.1 Relationship Between Attendance Rate and Homework Grade

Attendance is taken during each laboratory session. In this study we counted how many times the students were present during Week 4–11 since the laboratory tasks during these 8 weeks were highly related to the 2 homework. On the other hand, we added the grades of the 2 homework for each student. We would like to examine the relationship between these 2 factors in order to determine whether the design of our laboratory tasks could actually help students complete a higher percentage of the homework and thus achieve a better grade. The relationship between these 2 factors is plotted and shown in Fig. 5. In Fig. 5, the x-axis indicates 4 homework grade categories: [0,15], [15-20], [20,25], [25,30]. Note that each of the two homework carries a maximum of 15 marks thus the sum of the two homework grade has a maximum of 30. Under each of these grade categories, we take the average attendance among students from Week 4–11 (thus a maximum of 8) and show it in the y-axis. It can be observed in Fig. 5 that there is a clear increasing trend showing a positive correlation between these 2 factors. The result shows that in general as students attended more laboratory sessions, they had better performance in their homework. A possible explanation of this trend is that our laboratory task design was effective that it was guiding students to accomplish their homework. One may also argue that better students may attend the classes more often and they may do well in the homework simply because they are better students. We agree that this is true for some students who were already good, on the other hand, we also observed that many students who attended the classes had weak technical background thus it is still

beneficial for students to attend the laboratory and get better grade. However, we also believe that we should not force students' attendance by imposing any absence penalty. This is because we believe that although it is important for students to attend classes so that they can learn better, it is also as important for students to learn to be responsible for their own choices and actions. This is the attitude that we would like to train our students in addition to their ability and accomplishment.

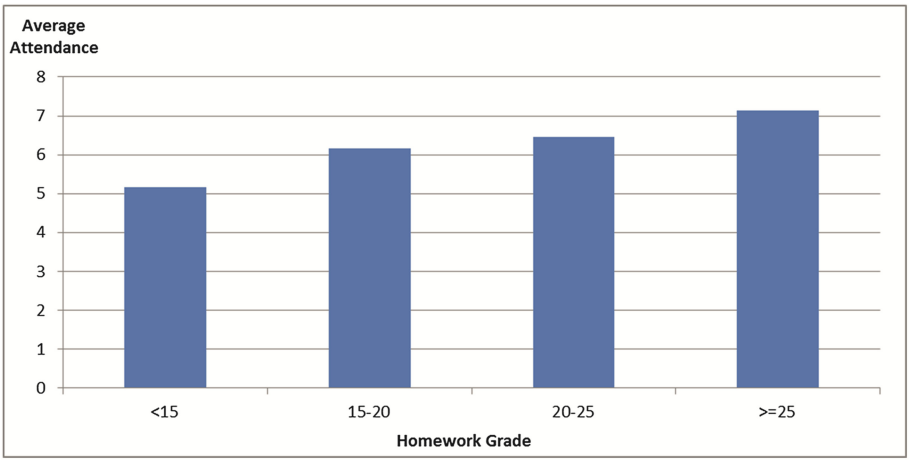

Fig. 5. Relationship between students' homework grade and average attendance during Week 4–11

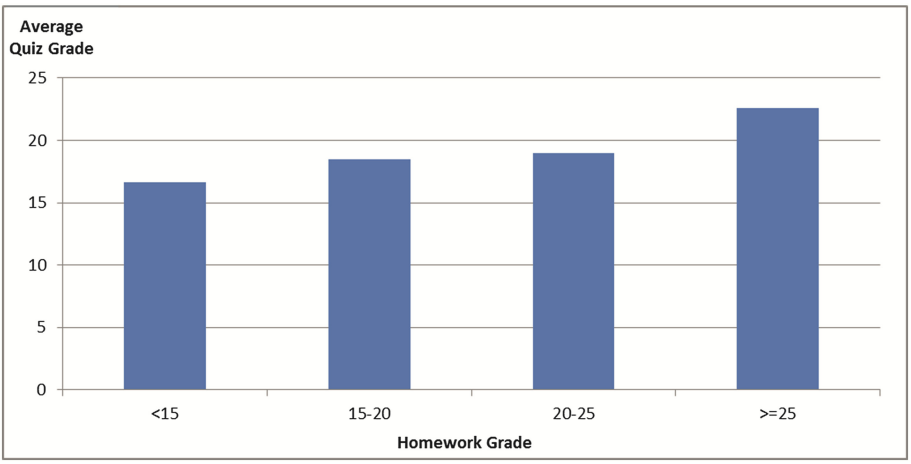

Fig. 6. Relationship between students' homework grade and average quiz grade

3.2 Relationship Between Homework Grade and Quiz Grade

At the end of the semester, the students were given a quiz to test their concepts. The quiz consists of 60 multiple choice questions and students had 1.5 hours to work on it. Each question carries 0.5 mark thus the maximum grade of the quiz is 30 marks. The relationship between the homework grade and the quiz grade is examined to determine if the homework tasks helped students understand the concepts covered by this course. The relationship between these 2 factors is shown in Fig. 6. In Fig. 6, the *x*-axis is the same as the one in Fig. 5, i.e., the 4 homework grade categories. Under each homework grade category, the quiz grade for those students is averaged and shown in the *y*-axis. It can be observed in Fig. 6 that there is a positive relationship between the homework grade and the quiz grade, meaning that in general students who got better scores in the homework also performed better in the quiz. The result illustrates that the design of our homework tasks was well aligned with the assessment tasks from the quiz. The homework scores can thus be considered as good continuous assessment indicators to predict the students' performance at the end of the course such that we can adjust the focus to put more emphasis on the concepts with which the students are weak. This will help students accomplish more at the end of the course and enhance their learning experience.

4 Conclusion and Future Work

In this paper, we have shared our experience in designing a media computing course that aims to teach creative media students who had a diverse technical background. We have shown several strategies in the course design and delivery that is aligned with our discovery enriched curriculum. Firstly, we designed the learning materials with visual content that is related to students' real-life to stimulate their interest. Secondly, we catered for students' diverse background by designing learning tasks with different levels of difficulty. We also offered different means of help to the students in case they faced any problems. Our design of the learning and assessment tasks encouraged students to make self-discovery and innovation. We have made an empirical study by analyzing the relationship between several factors in a focus group. The relationship between the students' homework grade and their attendance in the laboratory illustrates a positive trend, showing that students who attended our laboratory more often got better scores in the homework. Moreover, the relationship between students' homework grade and their quiz grade also illustrates a positive trend, suggesting that the design of our laboratory tasks was well aligned with the quiz assessments to help students better master the concepts in this course. We could thus look at the strength and weakness demonstrated by the students in the homework tasks and adjust our subsequent teaching focus to help students make better accomplishments.

One problem that we observed in teaching this course was that some students did not want to take this course but felt that they were forced to take it because it is a compulsory course. As a result, they were not too motivated to learn despite our efforts in designing this course with a lot of interesting content. In the future, we can work with

the program leaders to see if we can devise a better way to deliver the message to the students that this course is a fundamental step in their programme and it is crucial for students to learn the programming techniques so that they can handle the courses in their senior years. On the other hand, we will keep an open mind about how to adopt other strategies in this course and explore other factors to enhance the learning experience of the students while following a discovery-enriched curriculum.

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