Design thinking in App inventor game design and development: A case study

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Abstract—Design thinking is considered as a creative, human-centric, participative, exploratory and problem-solving process that values different perspectives of a problem. In this study, we bring the design thinking in a curriculum framework of K-12 game creation by App Inventor which is currently popular block based programming environments for fostering Computational Thinking. In a case study on a middle-school students game creation course in Beijing, the students’ creative thinking process and computational thinking skill are investigated in order to understand perceptions of App Inventor and physics cognitive knowledge involved in the game creation. The future work is to construct a framework of integrating the Design Thinking for cultivating K-12 students’ computational thinking.

Keywords—Design Thinking; App Inventor; Game Creation; Computational Thinking

I. INTRODUCTION

A. Emergence of Design Thinking

In recent years, innovation has become a buzz-word that has spread into various areas of politics and business. Design thinking can be considered as a creative, human-centric, participative, exploratory and problem-solving process that values different perspectives of a problem[1][2][3]. Its origins have been traced back to the 1960s design methods movement, that shifted from a scientific investigative approach of ‘what is’, to a more creative exploration of ‘what ought to be’ [4]. Although design thinking has become an integral part of the design and engineering fields as well as business, it can also have a positive influence on 21st-century education across disciplines because it involves creative thinking in generating solutions for problems.

B. Programming for K-12

Computational thinking (CT) is a term coined by Wing[5] to describe a set of thinking skills, habits, and approaches that are integral to solving complex problems using a computer and widely applicable in the information society. There is growing consensus[6] that computational thinking is a fundamental skill that everyone needs to succeed in our complex and technological culture. Computer programming is an excellent way to develop computational thinking skills[7], because it involves the use of computer science concepts such as abstraction, debugging, remixing and iteration to solve problems[8][9][10]. In computer programming field, programming for K-12 can be traced to the 1960s when Logo programming was first introduced as a potential framework for teaching mathematics[11]. Nowadays, this is fuelled by the availability of easy-to-use visual programming languages such as Scratch[12], Toontalk[13], and Alice[14], etc. MIT App Inventor is currently one of the most popular block based programming environments. Researchers have used App Inventor in summer camps and other outreach activities for K12 students for several years now[15][16][17][18][19]. Meanwhile, App Inventor has also been effectively used for professional development workshops for K12 teachers[20][21], as well as introductory computing courses at the college level[22][23][24].

C. Research Purpose

This study aims to describe how to design effective framework for the App Inventor game creation course by combining the physics knowledge.

II. THEORETICAL FRAMEWORK

A. Key Elements for Design Thinking

Design thinking is considered emergent, to define and means different things to different people[25]. Approaches to delivering design thinking also vary in terminology and phases of execution. Three basic phases of the design described by[26][27][28][29] are analysis, synthesis, and evaluation.

B. Connected design thinking Encompassing the Entire

In our research, we adopted the Stanford d.school[30] process of design thinking which including empathize, define, ideate, prototype, and test. The design action plan is an iterative process, and each action phase should achieve some deliverable outcomes. In our research, students learn to adopt the design process for their product.

<table>
<thead>
<tr>
<th>Activities</th>
<th>deliverables</th>
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<tbody>
<tr>
<td>Empathize (understand our users)</td>
<td>User interview, Observation, Immersion</td>
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<tr>
<td>Define (define clear project objectives)</td>
<td>Workshops, Stakeholder Meetings</td>
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<tr>
<td>Ideate (explore ideas and solutions)</td>
<td>Ideation activities, brainstorming, mindmaps, sketching/drawing</td>
</tr>
<tr>
<td>Prototype (build and visualise ideas and solutions)</td>
<td>Space prototyping, physical prototyping, paper construction, wireframe building, storyboards, role-plays</td>
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C. Game creation

Game creation is suggested to provide greater student engagement and learning than game play [31], in supporting a constructivist approach in which the students learn how to synthesize information and express it, in the authoring of an original game. In a case study with grade 5 students using Scratch software, researchers found that the students could design games within a constructionist framework and that programming skill increase with increased design experience[32]. In our study, learners complete a digital game design and development by App Inventor.

III. METHODOLOGY

A. Setting and participants

The case setting was grade eight in a middle school of Beijing and there are 25 students which divided into five groups. Students worked in a project-based setting by researching physical topics and creating thematic games in collaboration with other students. The class was conducted in computer classroom that everyone has a computer. Students were allowed to use mobile devices, including laptop, tablet computer and mobile phone in the classroom, and the wireless network works in the classroom.

B. Course structure and activities

The Course consisted of four modules, lasting 1 week each. Participants were expected to expend 4 hours of effort in each module.

Module 1: Introduction to the Game creation and App Inventor. Designed to help participants learn about the potential of mobile apps in education, share one’s favorite game in the field of physics and discuss the key points and steps in game design. This module introduced participants to the five steps of the design action plan, and participants discuss the topic in groups.

Module 2: Game design. Participants empathize, define and ideate the topic through the design action plan. They need to do some activities, complete deliverable outcome, and draw the sketches of their game.

Module 3: Hands-on with App Inventor. Participants learned about basic components for building apps and built practice apps. During the process, the instructor provided suggestions and facilitated discussion on block programming.

Module 4: Design with App Inventor. Participants built one practice app, proposed an app of their own and built a working prototype or completed app.

In addition, participants continuously engaged in active app review–feedback process similar to that in module 2.

C. Data collection and analysis

This study adopted a mixed-method approach to collect and analyze the following data: student digital artifacts, classroom observations, survey and individual student interviews.

1) Pre & Post-test: All participants were required to independently complete the cognitive knowledge test of physics before and after the class.

2) Artifacts: Students designed and developed their games and the teacher collected their screencasts and documents. Games were played for general functionality and user interface, and were played and reviewed with each of the students.

3) Observations: The observation was recorded and focused on students’ behaviors, relationship dynamics in groups, student conversations, and other notable moments related to students’ learning.

4) Survey: In the final lesson of the course, all the group presented their game in the mobile, and take a questionair which include the course satisfaction, the interesting on programming, the understaning of game design and the self-efficacy.

5) Interview: The interviews contained open-ended questions in which students and the instructor were asked about their game creation experience, opinions about the design process and course. Students were asked to tell about their experience with questions: How do you feel about designing games? How do you think designing games help you learn? How do you feel that combine the physical knowledge to produce a game through the App Inventor? What is something new or creative that you have learned about design games? In designing and creating unique games, how does the process feel like?

IV. FINDINGS

A. Game creation and class engagement

Each group creates a game with the combination of physical knowledge, and these games are very creative and interesting. Students take the physics knowledge as the basic theory foundation of their games. Generally, the students worked on game creation and fully engaged in the game constructions. And the class is very lively and interesting.

B. Reflections on the course

Student interviews offered details on the creative work in the game design and development environment. The student’s words offer the insight into understanding how the student, in the creation of games, perceives the creative thinking process, “I learn to make simple mobile phone software; AI let me open the door to the game creation, and it also improves logical thinking, problem-solving competency; It is a meaningful thing that applying what I learn to solve problems in the APP design; The combination of AI and physics making the game looks true and feel fresh”.

C. Course Satisfaction

Items of the survey are about attitude on the instructional method and software application. It is found that most of the
students (more than 87%) strongly like the design thinking integrated into the course, and more than 67% to 80% strongly agree the learning strategies learned in the class would help them to learn better. Students suggested to design more interactive activities involved, and they are tired of the didactic-style teaching.

V. CONCLUSION

The current research employed design thinking to develop a framework of the App Inventor curriculum for game creation combining physical knowledge. The main contribution of the current research is manifold. First, the conceptual framework for effective teaching and learning for the App Inventor game creation curriculum. The teaching according to the conceptual framework improves the knowledge learning performance. Second, the class helps students feel connected, make learning more immersive, engaging, and relevant experience. Third, the game project with design thinking improves the students’ learner experience and learning performance. The limitation of this study is that it comprises the physical course, cannot draw on the full computational thinking context.

In the future, we may construct a framework of integrating the Design Thinking for cultivating K-12 students computational thinking. There are a number of future research tasks being considered in the agenda of this study. First, design and implement a K-12 programming curriculum constructed based on the framework. Second, design instruments to assess CT knowledge, skills, and perspectives of learners in the programming curriculum. Third, evaluate the design thinking framework is effective by evaluating the progression of learning outcomes of CT knowledge, skills, and perspectives which include computational identity and digital empowerment.

REFERENCES