An Overview of Computing Pedagogy Using the Flipped Classroom Model in Malaysian Education

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Abstract—**In the 21st Century, many researchers realized the importance of computing and suggested developments in learning computing. Therefore, there is a need to design a new 'integrated pedagogy' for learning computing to align with the Malaysian Education Blueprint. This will produce future generations that are well-equipped in terms of knowledge and skills. This paper aims to identify computing pedagogy using the Flipped Classroom Model (FCM) in the Malaysian Education setting because the FCM transforms traditional teaching and learning and maximizes the use of technology. Literature reviews and interviews with three Computing teachers were carried out to obtain opinions on using the FCM. The literature reviews and teachers' responses identified that the FCM will benefit the students and teachers. The overall findings suggested that the FCM may be implemented in Computing subjects and taking into considerations other factors like students' motivation, for active learning or teacher-centered perceptions in implementing FCM.**

Keywords—computing education, computer science education, ICT education, computing pedagogy, flipped classroom

I. INTRODUCTION

The role of computing has been growing significantly in this 21st century. Computing subjects like Information Communications Technology (ICT) and Computer Science has been gradually included in Malaysian primary and secondary school curriculums [1]-[6]. There is a need for educators and students to enhance their Computing skill so that they can be more informative, creative and innovative which is in line with 21st Century teaching and learning. Ang et al. [7] pointed out that one of the major challenges is educators need to provide opportunities for students to use computer technology and develop their potential in using technology. It is desirable to begin learning Computing in schools as 21st Century students now will simply absorb knowledge and adapt themselves with the latest technology. Early exposure permits them to adapt easily so that when they enter higher institutions or during employment, they are well prepared.

The goals and basis of Ministry of Education Malaysia which is align with Malaysia Education Blueprint is to produce future generations that are excellent in terms of knowledge and skills, especially in Science, technology and Computing which requires higher order thinking skills, ability to communicate effectively in different languages and have positive personality traits so that it will contribute to the welfare of the country, family and individual [8]. In recent years, technology advances very fast and has affected the growth in learning Computing. The computing elements do evolve quickly as well. Most parents could not help their children in this subject as they may

not have been exposed to computing in their education. There is a need in keeping the state of learning and yet coping with the advancement of technology. In recent years, there have been changes in the Malaysian curriculum. In year 2017, the ICT subject was excluded from the Malaysian secondary schools' curriculum which was included during year 2006 [2] and added in primary schools' curriculum. ICT subjects have been added in Malaysia Curriculum for Primary 4 in year 2014 as the first batch [5]-[6]. As for Malaysian Secondary School, Computer Science subject has been added into Malaysian secondary schools' curriculum in year 2017. Whereas, ICT and Computer Science subjects were added into the primary and secondary curriculum much earlier for countries like UK and US [8]. There is a need for students to learn about the fundamentals of browsing the internet, managing emails, word processing, creating spreadsheets, building databases, image editing, multimedia presentation, video editing, animation, control stimulation, networking and programming at an earlier age. It is not easy to master all these Computing skills. Every student may have different learning abilities and may be exposed to computing at different ages depending on the facilities that they have at schools.

As mention earlier, Computer Science was introduced into Malaysian Secondary schools in the year 2017. The aim of the Education Ministry is to train the students to be future creators of technologies (Computer Scientist) instead of just users of technologies (ICT users). Fig. 1 shows students' progression pathway ten years ago which is in 2006 and Fig. 2 shows recent students' progression pathway in 2017. It could be seen clearer the students' learning shift by comparing the figures. In summary, it could be said that primary school students now (year 2017) are learning what secondary students used to learn in year 2006, and secondary students now (year 2017) are learning what college/university students used to learn in year 2006 [3]-[4]. The future pathway of current year 2017 secondary school students is unknown when they enter college or university.
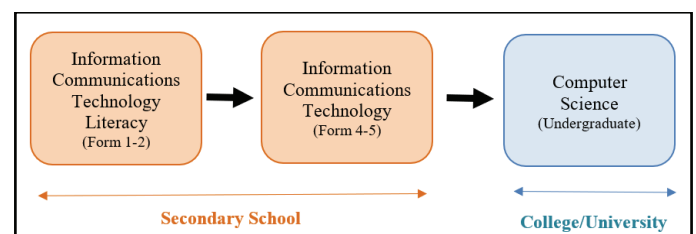

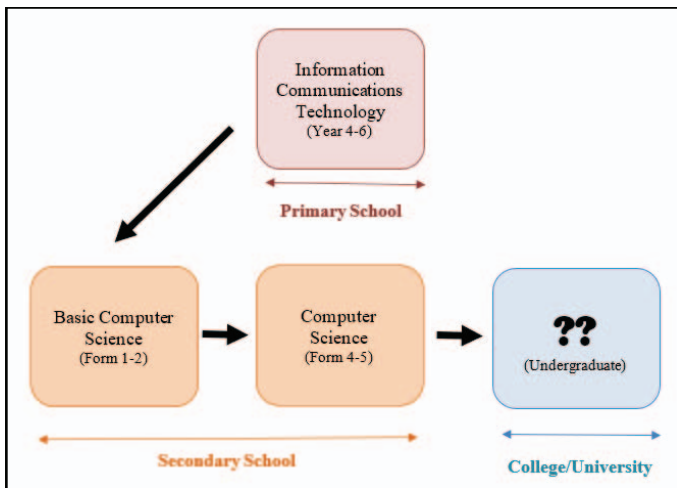Fig. 1.   Students' Progressive Pathway in the year 2006

Fig. 2.   Students' Progressive Pathway in the year 2017

II.   LITERATURE REVIEW

Watkins and Mortimore [9] states that the models of pedagogy held by academics and researchers have become more complex over time in a review of research literature on pedagogy; for example, incorporating our understanding of cognition and meta-cognition in recent developments. Many researchers have also suggested that developments in ICT (Computing) provides very different learning opportunities. An assumption here is that the use of Computing is changing the pedagogical roles of teachers, and an evoking interest for using Computing in schools as a catalyst to transform the teaching and learning process [10]. Therefore, it is important for the students to learn ICT and a need to design a new 'integrated pedagogy' [11].

Flipped Classroom Model (FCM) classrooms invert traditional teaching methods, delivering lectures online outside of class and moving "homework" into the classroom. Many factors influenced the creation and adoption of the FCM into teaching pedagogy. However, two specific innovators that played a key role. In 2007, teacher Jonathan Bergman and Aaron Sams discovered software to record Powerpoint presentation at Woodland Park High School. Their live lectures were recorded and posted online to students who missed class. The online lectures started spreading. Bergman and Sams were asked to speak about their methods to teachers around the country. Teachers began using online video lectures and video podcasts to teach students outside class, reserving class time for concept mastery exercises and collaborative work [12]. This paper uses FCM because the popularity of FCM has increase dramatically in recent years and it transforms the traditional teaching and learning maximizing the use of technology.

III.   OBJECTIVES

The main aim of this paper is to identify the Computing pedagogy of FCM in the Malaysia Education Setting. This leads to the following questions :

- What are the current practices in the Computing subject?
- What are the constraints in learning Computing subject?

- Do the flipped classroom features help to solve the constraints and help in promoting students' learning in Computing subject?

IV.   METHODOLOGY

Literature reviews and interviews which involves three computing teachers were done to obtain opinions on using FCM and understand the current computing subject environment.

A.   Literature reviews

A list of 7 articles related to FCM in Secondary School. The articles selected are all research based papers, as opposed to conceptual papers that evaluate the effects of FCM. FCM has only been introduced by Bergmann in 2012. So the articles are all very recent from 2013 to 2018. The following key words were used to search for related publications: "Flipped Classroom Model" and "secondary school". The search conducted via IEEExplore, Springer and Taylor & Francis. A review of more than 50 scholarly papers, only 8 candidate papers were selected after applying the inclusion and exclusion criteria that considered relevant to the study: the studies concern specific IEEExplore, Springer and Taylor & Francis, the studies must be recent published between 2013 onwards and the studies must mention the Flipped Classroom Model used by the educators to support secondary school students' learning. After being analyzed, it is summarized in Table I in section V.

B.   Interview

In order to support the findings of literature reviews, a preliminary study was done to identify the Computing pedagogy of FCM in Malaysian education setting. Three Computing secondary teachers from different parts of Johor Bahru district were interviewed. Their average years in teaching roles are about 3-5 years.

The interview questions by Snowden [13] are used and modify according to the needs of the research objectives. The questions of the interview are divided in four categories which are: 1) Computing subject; 2) Video Lectures; 3) Computing topics, software and skills and; 4) FCM.

Part 1 questions are about current practices in Computing subject. Part 2 questions are about the current usage of videos for teaching and learning and opinions on the effectiveness of watching video lectures. Part 3 questions are about the Computing topics, software usage and skills needed for Computing subjects. Lastly, Part 4 questions are about opinion towards implementing the FCM in Computing subjects. The results and findings are analyzed in the next section.

V.   RESULTS AND FINDINGS

The literature reviews and teachers' responses reviews that the FCM will benefits the students and teachers. The following are the results and findings.

A.   A meta-analysis literature reviews

We can draw a conclusion referring to Table I that many researchers have tried implementing the FCM in various disciplines and the outcomes have been positive. Only a few

negative results emerge from the flipped classroom model. According to the Malaysian Blueprint, it has been emphasized of the importance of ICT (Computing) for this generation [8]. However, not much research was done using FCM in Malaysian secondary school education setting especially on Computing subjects. Therefore, there should be more research carried out on Computing subject in Malaysian secondary school education settings using FCM.

TABLE I.   ARTICLES ON FCM COMPARING SCOPE AND DISCIPLINE

Authors (Year)	Discipline	Country Implemented	Findings
Esperanza et al. [14] (2016)	Algebra	USA	**Positive Effects :** - the evaluation of FCM showed positive towards student perceptions. - a significant positive change in students' confidence and enjoyment of mathematics.
Tomory and Watson [15] (2015)	Advance Science	USA	**Positive Effects :** - FCM may be the solution for creating both academically challenging courses and increasing inquiry in science classrooms. **Negative Effects :** - lower income students may lack the appropriate resources
Olakanmi [16] (2017)	Chemistry	Africa	**Positive Effects :** - Both quantitative and qualitative findings reveal that the students responded favorably to FCM and experienced a positive increase in their attitudes towards chemistry compared to the traditional classroom experience.
Lee and Lai [17] (2017)	3D Modeling	Hong Kong	**Positive Effects :** - students are inclined to accept the FCM. Conclude that it is possible to improve students' higher-order thinking capability using the flipped classroom approach to teaching.
Bergmann and Sam [18] (2013)	Mathematics	USA	**Positive Effects :** - Students' Perception Survey = 87 percent of parents and 95 percent said that they preferred flipped learning to the traditional lecture format.
Education [19] (2013)	English, Mathematics, Science, Social Studies	USA	**Positive Effects :** - Test scores, graduation rates, and college attendance have increased. - student engagement has improved dramatically, and discipline problems have declined. - the pass rate increased,
Wong and Chu [20] (2014)	English	Hong Kong	representing an increase of 9 to 19 percentage points across the subjects. **Positive Effects :** -Students' Perceptions Survey (Likert scale - 5 point): ~ 10 positive statements of new Model. All means effectiveness higher than 3. ~ 4 positive statements of students' engagement. All means effectiveness higher than 3.
Lee [21] (2018)	English, Korean	South Korea	**Positive Effects :** - Transformation into a more equal and democratic classroom - restoration of enjoyment in learning and teaching - improvement of self-confidence - inspiration for the learning and teaching community

Besides that, Wong and Chu [20] states that implementation of flipped classroom should be implemented for a longer period (may be a year) to obtain accurate analysis as most are implemented in short courses or only for a semester. A new model could also be developed referring to the existing methodologies. New ways to reduce preparation time for the flipped classroom because video making or editing may be very time consuming [22]. Therefore, these will be taken into consideration in future research.

B. Interviews of Computing Teachers

The data gained from the interviews are analyzed and could be categorized into three major themes and sub-themes as shown in Fig. 3.
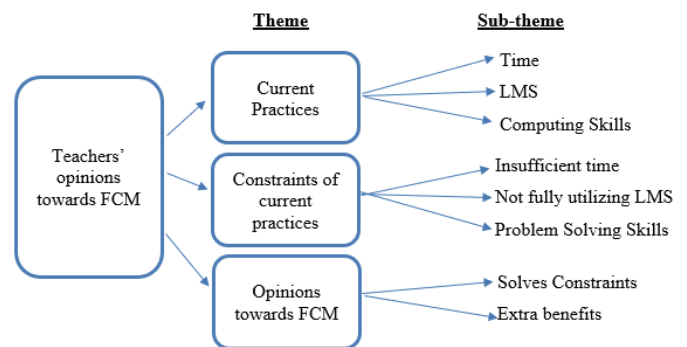

Fig. 3.   Interview themes

1) Current practices of Computing subjects

The current Computing classes are 4 times, twice or once a week in secondary schools. Total hours per week is either 1 hour 40 minutes, 1 hour 45 minutes or 2 hours. The LMS (Learning Management System) used in government schools is Frog VLE (Virtual Learning Environment). The Computing or ICT skills that students need to learn and enhance are Problem Solving Skill, Creativity Skill, Critical Thinking Skill,

Communication Skill, Information Management Skill, Logical Thinking Skill, Manipulation Skill, Reasoning Skill, Decision-making Skill, Metacognition Skill and Innovative Skill.

Most teachers do use videos for their lessons. Videos are mostly downloaded from YouTube. They seldom create their own videos as it quite time consuming. The teachers do not have problems using videos in their lessons as videos attracts the students' attention and helped them to understand and remember better compared to only other traditional methods of teaching. This allows students to not only listen but also visually relate to what they are learning. In practice, teachers give more explanations, extra exercises and class discussions to help students in areas where they are weak.

2) Opinion of constraints in teaching Computing subject

There are some interview questions of the part 2 and part 3 as mention in section IV (B) defines that constraints in teaching Computing subject. The following are the concluded findings.

All three teachers mentioned that they have insufficient time to conduct their lessons to cover all the syllabus of the subject. The weekly periods for teaching and learning are insufficient as students need more time to digest the information taught by the teachers before implementing it in their assignments, projects or homework.

The LMS system (Frog VLE) is not utilized by all government schools because computers and internet connection in school are too slow to access the LMS system. Most schools have netbooks which are not as useful as laptops. Only schools with good funding and good ICT infrastructures utilize LMS in their teaching and learning.

Subject topics that teachers find most difficult to teach are networking and programming. Computer application that students are weak in are Adobe Photoshop (image editing), MS Access (database management) and Visual Basic (Information System) which involves logical, programming, critical, creative, mantic thinking skill required for problem solving skills. In summary, there are three main computing skills which are Creativity Skill, Problem Solving Skill and Critical Thinking as reviewed in Ang et al. [23]. The teachers were asked to confirm the skills needed in the syllabus for each topic. The importance of Problem Solving Skill is clearly shown because all topics need Problem Solving skill as shown in Table II for Secondary ICT and Computer Science subjects.

TABLE II.   COMPUTING SKILLS BASED ON SECONDARY SCHOOL TOPICS

Topics	Subject*	S1*	S2*	S3*
Information and Communication Technology and Society	ICT		✓	✓
Computer Systems	ICT		✓	
Computer Network and Communication	ICT		✓	
Multimedia	ICT	✓	✓	✓
Programming	ICT	✓	✓	✓
Information Systems	ICT	✓	✓	
Basic Concepts of Computational Thinking	BCS		✓	
Data Representation	BCS		✓	
Algorithm	BCS		✓	✓
Command Code	BCS		✓	
Programming	CS	✓	✓	✓
Database	CS	✓	✓	
Human Interaction and Computer	CS		✓	

* S1=Creative Thinking Skill, S2=Problem Solving Skill, S3=Critical Thinking Skill, ICT=Information Communication Technology, BCS=Basic Computer Science, SC=Computer Science.

3) Opinion toward FCM

After explanation about the Flipped Classroom Model to the teachers, they all agree that the Flipped Classroom Model will benefits the students and teachers.

"The FCM will bring benefits to the student as it is in line with the interests of 21st century students and gadgets supporting the 21st-century class." (Teacher 1)

"The FCM is definitely better that the traditional teaching and learning method as it fully utilized our time at home and in class." (Teacher 2)

"I guess the FCM may be the solution in solving the constraints of current practices in teaching Computing subject." (Teacher 3)

As teachers have insufficient time in class lessons to finish the entire syllabus, they had to rush through the lessons. The students are not given sufficient time to practice and master computing skill. With flipped classrooms, students are able to watch, digest and construct their own knowledge at their own pace as different students have different ability levels to digest before implementing their knowledge in their assignments. Students will have ample time to ask their teachers more questions during class time while doing their assignments as most problems will only occur when dealing with the assignments practically. Teachers suggest that peer collaborative learning may help in their knowledge construction. Discussions may be done before and after class via online/LMS system.

VI. DISCUSSION

FCM solves the time insufficiency by using out of class time where students can watch video lectures at home and they have more time to do their exercises or assignments in school. They may also grab the opportunity to discuss their answers or solve difficulties in completing their assignments with peers and teacher instead of listening to lectures in class time.

Computer and internet connection in school are too slow to access to the LMS system. Students can solve this problem by accessing faster internet at their homes or places with internet connections and using their own laptop or mobile devices. Another alternative is to have the LMS system in mobile apps as most students have their own smartphone in general instead of desktop computers, notebook, tablet PC or other devices. For example, Wu, Zhou and Luo [24] reveals that smartphone users in a rural area are respectively more than 80% compared to desktop computers (about 50%) and other electronic devices (less than 35%).

The following Table III summarized the whole paper and concludes that FCM has the potential to solve all the current practices constraints.

TABLE III.   SUMMARY OF COMPUTING SUBJECT CONSTRAINTS

Teachers' opinions towards FCM		
Current Practices	*Constraints of current practices*	*Does FCM solves constraints?*
1 hour 45 minutes to 2 hours	Insufficient time to cover syllabus	Yes.
Frog VLE	Not fully utilized.	Yes.
Computing skills	Too many skills to be mastered by students.	Yes.

VII. CONCLUSION

This paper posited that the FCM framework has its potential in solving all the constraints of current teaching and learning practices for Computing subjects Malaysian secondary school settings. FCM suits the interests of 21st century students compare to the traditional methods of teaching. Although the literature reviews and the findings of the preliminary study proven that FCM has its potential, the strategy of defining the best framework for FCM remains unanswered and deserves further study. Therefore, there should be more research to be done for implementing the FCM especially on Computing subjects in Malaysian secondary school education setting taking in considerations of other factors like students' motivation, for active learning or teacher-centered perceptions in implementing FCM.

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