A Flipped Classroom Model for Inquiry-Based Learning in Cyprus Primary Education Context

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Abstract

In this article, we present the outcomes of the pilot phase of a multi-case study being conducted in Cyprus. The study aims to develop and propose universal design principles of using a Flipped Classroom (FC) approach as a pedagogical structure of Inquiry-Based Learning (IBL) applicable across primary education context in Cyprus. The universal design principles refer to the general guidelines most primary teachers can follow when designing their lessons by integrating the two instructional models of FC and IBL, and to the specific pedagogical strategies teachers can use for different school subjects to motivate and improve their students' learning processes through Networked Lerning (NL) opportunities. Providing teachers with those principles (i.e. guidelines and strategies) is particularly important given the lack of instructional experiences of Cyprus primary school teachers in implementing a FC model in their classroom practices and a wide range of subject matters that those teachers need to teach. There has been a limited focus, in previous research concerning the FC model, on its effectiveness within the primary education context and also in relation to the NL technologies used. The pilot study aims to primarily address this research gap, develop the IB-FC model and present potential benefits of using the IB-FC model in primary school context. The learning process based on the IB-FC model includes pre-class, in-class and after-class activities. During the pre-class phase, students explore the learning content provided by the teacher at home and obtain an entrance ticket which is used during class time for the IBL facilitated by a series of classroom activities, which require the students to be creative and collaborative. Forums and other features of online learning platforms are utilized so as to promote NL through collaboration and communication. The after-class phase involves self-assessment procedures and the completion of an e-portfolio page. After the first pilot-nature of iteration of implementing the model, participant students' learning experiences and perceptions on this new learning scenario were collected through focus groups and reflection forums. Based on our findings from the pilot study, the IB-FC framework including important pedagogical principles and additional instructional tools have been developed and offered to seven primary school teachers in the current stage of our multi-case study, through which the framework will be further developed and refined.

Keywords

Flipped classroom, flipped learning, inquiry-based learning, primary education, technology-enhanced learning, universal principles, instructional tools

Introduction

The Flipped Classroom (FC) is one of the new and innovative pedagogical approaches in current literature concerning technology-enhance learning (e.g. Bergmann & Sams, 2012; Young, Hughes, Inzko, Oberdick, & Smail, 2011). The FC aims at leveraging students' personalized learning supported by different technological tools outside the classroom time, thus maximizing in-class time for student active engagement in social and collaborative learning (Mazur, Brown & Jacobsen, 2015). It is also referred to as *inverted classroom* (Gannod, Burge, & Helmick, 2008). It is the model where the traditional lecture materials are transferred outside the classrooms (in alternative formats, mainly video-tutorials, readings, screencasts), allowing in-class time to be used for collaborative Inquiry-Based Learning (IBL) activities (Bergmann, & Sams 2015; Love et. al., 2015; Ullman, 2013). In this study, the definition provided by the Flipped Learning Network (2014) is used, which refers to FC as 'a pedagogical approach in which direct instruction moves from the group learning space to the

individual learning space, and the resulting group space is transformed into a dynamic, interactive, learning environment' (p. 1). Such educational innovations have been taken up by an increasing number of educators aiming to improve learners' learning experiences and competences (Bergmann & Sams, 2012). The FC approach has received a growing research attention given the promising results of its implementations that showcase its capacity to enhance teaching practice while better supporting students' learning (Giannakos, Krogstie, & Chrisochoides, 2014).

Flipped classroom research- A challenge for primary education

Research implementing the FC approach, albeit its potentials, has exclusively focused on higher education context with a few exceptions (e.g. Hultén, & Larsson 2016; Kim, 2017). In addition, most of the studies on FC have either explored how experienced teachers/researchers implement FC in their classrooms or measured the effect of using this approach as compared to more traditional approaches (e.g. Herreid & Schiller, 2013; Teo, Tan, Yan, Teo, & Yeo, 2014). There has been few research that tries to understand the attractiveness or usefulness of the model from the perspectives of the students or the teachers using it. Therefore, the previous studies have not effectively provided pedagogical principles to guide the design, implementation and evaluation of the flipped classroom (Kim, Kim, Khera, & Getman, 2014) and thus have failed to promote its implementation at lower educational levels. Moreover, various unspecified limitations prevailing in the field of FC in primary education, and which focus on the young age of students and the need for well-developed self-regulation skills, have further limited related studies, questioning the effective implementation of the model. Various questions arise if we decide to criticize this assumption though: Is the young age of learners an actual limitation? Is FC only for grown-up students? What kind of a FC design could be applied to primary education and which could be the universal principles for an effective implementation? Which guidelines and professional development is necessary for primary school educators and what kind of a model can be developed?

Upon answering the above questions, we initially developed a pilot study so as to explore young students' experiences and reactions to this pedagogical approach, in combination with an IBL model. IBL refers to 'the process of posing questions, problems or issues, gathering information, thinking creatively about possibilities, becoming proficient in providing evidence, making decisions, justifying conclusions, and learning the ways of challenging, building upon and improving knowledge of the topic or field of study' (Friesen, 2013, p. 154). It therefore encourages students to explore, conjecture, discover, collaborate, and communicate (Laursen & Kogan, 2014; Savery & Duffy, 1996; Stephenson, 2012) by operating multiple perspectives (Short & Harste, 1996). IBL, as a common instructional model in primary education, has several limitations when implemented on its own (Capaldi, 2015). Flick, identifies that 'learning how to learn', essential in IBL, can be a very challenging task to master (Flick & Lederman, 2004) especially for low achievers and young learners who may have a limited pre-knowledge base and a lack of self-discipline. Moreover, during IBL, learning is student-centered and the teacher works only as a facilitator (Kim & Chin, 2011). Hence, teachers should spend a lot of preparation and planning time to meet students' needs during the implementation and also manage in-class time well to make sure content is fully covered. Assessment of students' work can also be very difficult as students can take their inquiries beyond the expected requirements. Rubrics are therefore essential for guidance. Beliefs, attitudes and worries over incorrect outcomes of experiments or activities may be additional internal problems during IBL (Magee & Flessner, 2012).

Despite some of the discussed pedagogical challenges associated with its actual implementations, implementing IBL enables radical, effective, changes in teachers' classroom practices from the traditional lectures to the empowerment of learners to lead autonomous learning, deeper understanding, critical thinking and investigation (Bergmann & Sams, 2008; FLN, 2014; Mazur et al., 2015). Such changes could happen in any subject matters if teachers were not restricted to the goals and content of the National Curriculum which cannot be easily covered within the constraints of classroom time with the students. One of the most promising ways to cover the required content and also benefit from IBL-based instruction may be the combination of this teaching method with the FC approach (Love et al., 2015) or the use of IBL features within a FC instruction (Chen & Chang, 2017; Huang & Lin, 2017; Çakiroglu & Özturk, 2017). One such example is Chen and Chang's (2017) research in higher education context using the SOP² model into the flipped classroom ("S": Self-study, "O": online group discussion, and "P2": Double-stage Presentations). Hence, we argue that one way to reduce pedagogical challenges emerged in the IBL classrooms and realize its full potential in actual pedagogical practices can be to combine IBL activities with the FL approach, so to support students' IBL both at home (pre-class and post-class activity) and at school (in-class activity). In particular, the effective use of communication and networking technologies can transform students' individual learning space at home into the social learning

space where they can also benefit from having Networked Learning (NL) opportunities with their peers before and after the class-time.

Therefore, this multiple case study aims to (a) address the current lack of evidence in relation to the effectiveness of the FC approach in K-12 contexts and the pedagogical challenges of implementing the FC approach in primary education as discussed above (b) explore the FC approach as an effective instructional structure for IBL, through which both teachers and learners can improve their practice (Rahman, Aris, Mohamed, & Mohd, 2014; Giannakos et al., 2014). Ultimate purpose of this study to develop the IB-FC model (a FC design model for IBL) and to propose the universal design principles of implementing that model, which can be easily adopted and used by primary school teachers and applicable across diverse subject matters that they have to teach. In this paper, we will report the preliminary findings of our case study with a particular focus on the effective use of social and communication technologies for outside classroom activities, which enable students to have meaningful NL experiences.

A case study

To address the challenge discussed in the previous section and to assess the potential effectiveness of the IB-FC model, a single case study of a pilot nature, was conducted in a Grade 5 (students aged 10-11) Geography class with 17 students, at a sub-urban public primary school in Cyprus. The school had no tradition in the implementation of TEL (Technology-Enhanced Learning) methodologies, although this particular group of students previously had a chance to work via a Moodle (a VLE-Virtual Learning Environment) and Mahara platform (an e-portfolio platform) since their teacher, the first author of this article, has been involved into various ICT (Information and Communication Technologies) projects in the current school year (2016-17). Due to a lack of technological facilities (e.g. computer lab) at school, students would bring their own device to school to work with and the teacher would implement blended learning methodologies (using electronic devices as well as pen and paper/books). This case study was implemented towards the end of the school year (June, 2017) so by then, these students had the chance to familiarize themselves with basic NL tools such as many online applications which enhanced networking, collaboration and digital skills.

The case study was designed using key research on FC in higher education settings, borrowing practicing frameworks and adapting them to primary education. Successful methods documented in the literature differentiated between time in and out of class. In-class activities usually range from knowledge building, to collaborative discussion, small group tutoring, hands-on and problem-solving projects/activities, skill practice, lab activities, speeches, conversation, exploring real problems, peer reviewing etc. (Bergman & Sams, 2008, 2012; Hamdam, McKnight, & Arfstrom, 2013; Project Tomorrow, 2013; Toto & Nguyen, 2009). Out of class activities concentrate on videos, presentations, forum-use, note taking tools and preparatory procedures, e.g. entrance tickets etc. (Hultén & Larsson, 2016).

The learning activities designed for this pilot, considering all of the above, are illustrated in detail in Table 1.

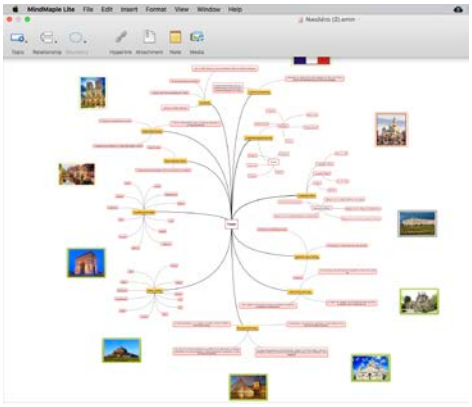
Table 1: Sequence of Learning Activities- Pilot Implementation of the IB-FC model

Learning Activity	Phase (Duration)	Technology
1.Study of content/resources- Use of tools and multimedia: Videotutorial/flip, Geography book, school Atlas, Google Earth, Youtube videos, tourist guides, online sources	**Pre-class Individual learning space (3 days)**	Mahara Google Earth Youtube Electronic maps
2. Preparation of mind-map (entrance ticket) Students have an example of a mind-map created on MindMaple and shared through the classroom Google Drive which shows the different parameters they can focus on whilst reading/studying the material given (e.g. tourism, industry, geophysical characteristics etc.). Students complete their own mind-map and share it through the class Drive before the lesson. This will be used for completing the inquiry-based tasks during class.	**Pre-class Individual learning space (30')**	Google Drive MindMaple

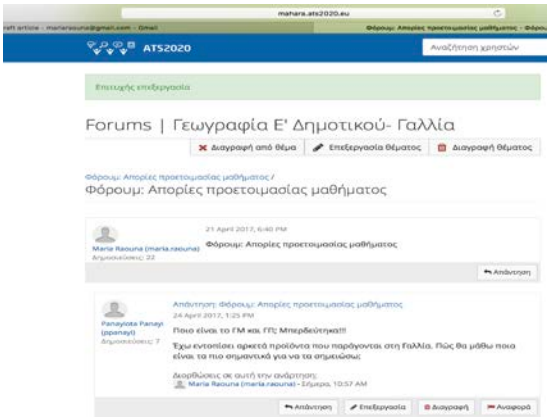
3. Posing questions/areas of exploration in the forum Students use the forum which is linked to the lesson on the Mahara platform to pose questions on the content they have studied and propose areas for further exploration during class time.	**Pre-class Individual learning space (30')**	Mahara forum
4. Use of entrance tickets to revise main points and information about France Students use their groups' flipcharts to fill-in the blanks on a France map and hence any queries on main geophysical characteristics are resolved	**In-class Group learning space** (10')	Drive
5. Forum replies and analysis The teacher answers any questions posed in the forum and guides the class towards identifying the parameters to be further explored by themselves using the internet to gather and analyze information.	**In-class Group learning space (20')**	Mahara forum
6. Problem solving project/IBL activities: Paris Marathon preparation Each group lives in a different country and aims to run in the Paris Marathon 2017. Therefore, some travelling preparation is needed, besides the daily exercise before the race. Students use a Google Slides presentation to complete the following tasks within it. (a) Use Google Earth to put a pin on your own country (different for each group) and a pin on Paris. Specify the orientation and embed a screenshot in your presentation (b) Calculate, using the Google Earth ruler, the distance (in km) you will have to travel in order to reach your destination. (c) Search and find what the weather would be like at this season in Paris, so as to pack the right clothes with you. Think about visiting other towns in France as well. How different the weather would be? Record that and consider it whilst packing-up. Talk about the different climatic zones across France and how these translate into weather differences (how and why?) (d) Create a list of monuments you would like to visit in your free time during the Paris Marathon. Use the internet to find the right information and explain your choice of monuments. Use pictures, videos and any other multimedia for presenting your answer. Take a note of the resources you have used. (e) Create a short video with your team of the most important documents using the online application *Animoto*. Post your video in the classroom blog (using the embed function). (f) Create an online research for the rest of the school, using Google Forms, regarding their choice of Paris monuments and post it on the classroom blog (in Blogger). Post it right after your *Animoto* so as to guide them. (g) Analyze the research results, using Google Sheets and create graphs. Post your analysis on the classroom blog. (h) Which are the local products you would buy for your mum and bring back home to her? Do a relevant research and make a list, giving reasons for your choice.	**In-class Group learning space** (6 periods, 40' each)	-Mahara -Moodle chat -Class Drive (Google slides) -Google Earth -Animoto -Google Forms -Blogger -Google Sheets
7. Final presentation of problem solution/results Students have a choice to use any tool that they are familiar with and believe is appropriate enough for presenting as a group all the relevant information they have gathered during activity 6.	**In-class activity Group Learning Space (4 periods, 40' each)**	Their own choice of tool: e.g. Blogger, Sway, Voki, Scratch etc.
8. Assessment Students use rubrics for individual self-assessment and complete their e-portfolio on Mahara. They then report to the forum their goals for the next lesson (everything they believe they should improve in, e.g. communication, collaboration, information literacy etc).	**After-class Individual learning space (1 hour)**	Google Sheets Mahara Moodle forum

The activities follow a sequence of pre-class to in-class and after-class session (i.e. from the individual to the group learning space and back to individual learning space), exploiting NL technologies such as Mahara, Moodle, Google Drive and online tools and applications, whereas in-class activities target to promote IBL methodology. Students had three days to study the content during pre-class (Activity 1), prepare the mind-map (Activity 2) which would serve as an entrance ticket to the lesson (Screenshot 1) and pose any questions/inquiries or suggestions regarding the learning process to be followed in class in the forum provided

(Screenshot 2). During the in-class activities, activities 4 and 5 were introductory to the lesson, focusing in analyzing and using the entrance ticket for revision and for answering the questions posed in the forum by the students during pre-class. The IBL tasks of activity 6 had taken six learning periods (40' each) to complete, during which students worked in groups of four. Four more learning periods (40' each) had been used for completing the creative activity (Activity 7), whereas the after-class activity involved assessment through the use of rubrics and the completion of the e-portfolio page, each student working approximately one hour alone.



Screenshot 1: Example of an entrance ticket



Screenshot 2: Pre-class forum (Mahara)

Results

At the end of the pilot implementation, focus groups (3 groups of 6-6-5 correspondingly) were used for discussing the IB-FC lesson, with an emphasis on perceived benefits and/or challenges and limitations. Individual written responses were also important as young students may feel more comfortable in expressing their views and experiences in writing, hence a reflection forum on Moodle had been used. Names had been erased and the same code for each participant used in both data collection tools applied (P1-P17).

Benefits

The six principles of NL (McConnell, 1999) had been used to analyze and categorize the data collected from the focus groups discussions and the student forum reflections. These are analyzed below:

(i) Openness in the educational process: The study of content before and after class–time extended learning beyond the classroom and within a more social context as expertise knowledge was also made available through the flips and the online material. This gave the students the confidence that '*we know what we are doing'* (P1). During class-time students had the chance to integrate new ideas into their learning, evident in the quote: '*Google Earth was hard but now it's easy. Actually, I will use it for all my Geography classes from now on…It's good to explore before the lesson. Makes you feel smart*!'

(ii) Self-determined learning: Students emphasized how they have been supported in gathering, critiquing and analyzing information on their own through the availability of multiple and varying sources of information they had to study at home, e.g. '*If I didn't understand one of them, I had a different source to look at. That made it easier to find the information*' (P8). Concept application later on in class, by using the entrance tickets, had been part of the benefits, as students learn to take responsibility of their own learning needs, whilst the availability of the forum '*…made it easier to pose question' (P2) and '…and use those questions for conducting a research later in class'* (P5).

(iii) A real purpose in the cooperative process: Students talked of how much they had enjoyed collaborating '*on something we had studied from before and prepared for it*' (P16), as the Moodle chat and forums made it easier as well. Google Drive also enhanced the creation of an interactive environment since '*…it* (Google Drive) *is like the wiki on Moodle, only you can edit same time with your partner*' (P8).

(iv) A supportive learning environment: 'What a great time we had…exploring new areas with the teacher being there when we needed her! I say we keep doing this!' (P2). Many of the students expressed their satisfaction of

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being able to discuss with their teacher in class any new ideas/concepts they had come across during research and in exploring new issues and concepts. Many misconceptions were able to be addressed as '*We were able to pose any kind of stupid question we thought we had…and our teacher was there!*' (P6), 'The time to do it in class was finally enough!' (P15).

(v) Collaborative assessment of learning: Self, peer and tutor assessment processes were made much easier. since '*…we could also pause and rewind the teacher to check on what we actually had to do and how*' (P10); 'Criteria rubrics were made available on Moodle and for every activity…'(P3). 'Reflection forums were hard to think about and write-up in the beginning' (P2) but students felt more prepared and skilled through practice.

(vi) Assesment and evaluation of the ongoing learning process: 'We worked together with the teacher, both in class and at home…the chat was there for guidance' (P5). This proved very useful since mutual agreement and acceptance on the learning process is valuable in choosing the right strategies which will lead to successful learning goals. Students had recorded their prior-knowledge before watching the flip and also set up their learning strategies in the forum which was made available before the lesson in class. This has assisted towards a better use of the entrance ticket, as student suggestions were considered, and also a more integrated way of working on the rest of the activities. Hence almost all activities ran smoothly, giving rise to the development of excellent e-portfolio pages, one of them gaining first placement national award at the E-Portfolio Competition organized by the Cyprus Pedagogical Institute.

Challenges/Limitations

During the pilot, students needed access to a device and an internet connection, both at school and at home. This did not pose any problem since the teacher was able to borrow devices to the students who did not own one (2 in total). The most challenging part though was the creation of the mind-map as some students expressed a feeling of discomfort with the software they had to use, whilst others found the missing parameters '*too hard to spot*' (P2). Other challenges involved the post-class task with the completion of the e-portfolio page. Some students said they didn't like the task and that '*it took too long to finish*' (P17). Overall, student perceptions had been very positive with minor exceptions, in cases where collaboration did not work optimally and in cases they faced a running problem with the software given for the activity, especially the students using tablets and not laptops, e.g. Google Earth, MindMaple.

Implications of the pilot study- Further research

Concentrating on the benefits of the FC methodology in the pilot study, in combination with the IBL activities, a draft framework for combining both models can take the form suggested in Figure 1. The four main categories of benefits identified through the focus groups discussions and student forum reflections guide the Group Learning Space activities focusing on: *1. How to begin/facilitate the lessons?; 2. What students do during the lessons?; 3. What students can do about the lessons?; 4. What students as a group do during the lessons?*. These are further analyzed to particular IBL activities (some of them already used in the pilot study), linked to the individual learning space created by the FC model.

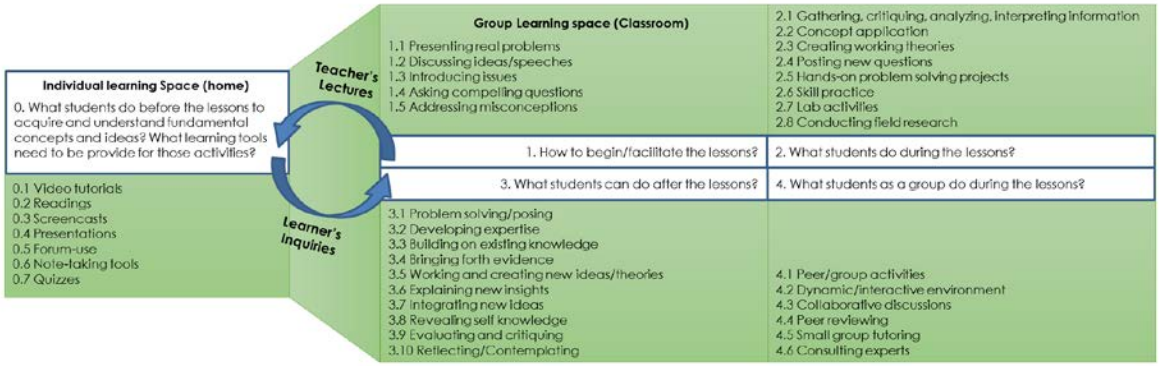

Figure 1: A visualization of the IB-FC framework

This draft framework has guided teachers in the current multi-case study and supported the important part of their professional development towards the initial write-up of the IB-FC instructional designs, in combination

with several instructional tools (e.g. orchestration routines, digital tools, IBL activities, entrance/exit tickets) developed for providing extra support to the teachers who may wish to implement the model in their classroom. These are made available on the Moodle platform (http://www.protyposxoleio.com) created for the actual research which will involve the implementation of the IB-FC framework in various grades of public primary schools in Cyprus during this school year (2017-18), aiming in exploring and establishing the universal principles for its effective implementation. Seven experienced primary school teachers in Cyprus had been selected which will all together constitute multiple case studies, in which they will design, implement, and reflect on the model together with their students and the parents. Classroom investigations and interviews will be the main data collection tools at the end of each learning cycle (3 in total), whereas data analysis in each stage will feed into revising and improving the framework and the instructional tools which guide the IB-FC instructional designs. Beyond these, narratives, reflections and insights of each educator (e.g. reflective diaries), as a preliminary lens to reflect on the instructional designs together with insights and reflections from the collaborative process followed for the development of learning designs (teacher and researcher collaboration), are highly significant. Furthermore, for every learning cycle, students and teachers will have to fill-in a self-assessment tool, whereas teachers will also complete an assessment rubric for each student. Personalized support given, eg. via mobile devices (Ogata et al., 2015; Yin et al., 2015), will also be reported and analyzed.

Discussion- Conclusion

While IBL and the FC are both newer innovations in teaching, both have dominated higher education settings (Capaldi, 2015; Love et al., 2015) with minimum research at lower levels of education. The pilot part of this research aimed at testing the potential of combining the two models in primary education in an attempt to see how the limitations of both can be overcome and their benefits exploited, thus answering two of the crucial questions: 'Is the young age of the learners an actual limitation?' and 'Is FC only for grown up students?'. IBL can indeed serve as a perfect instructional practice to use for the freed-up time arising from FC implementation with high school and university students (Love et al., 2015), but it seems from the pilot that this can also be true with the young learners as well. Encouraging collaboration and the communication of new knowledge learned from flips between learners features injecting IBL into FC and vice versa in the same mode as with older students, thus it helps to increase student confidence and minimize limitations such as lack of self-regulation skills and self-discipline. This has been feasible through the use of NL technologies, using Moodle as a Virtual Learning Environment (VLE) and exploiting the potentials of both internal and external online tools. Teachers can be guided in creating IB-FC instructional designs by trying to incorporate into those such NL technologies, features of the framework and guidelines provided by the instructional tools which have been developed through the study of previous implementation attempts in other settings. The planned multiple-case study research will provide valuable feedback in better answering the other two important questions raised above on which particular principles are vital for an effective implementation and what type of a professional development educators need for feeling comfortable and competent in applying the IB-FC model in primary education.

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