Research in Learning Technology
Vol. 28, 2020

ASSOCIATION FOR LEARNING TECHNOLOGY ALT

ORIGINAL RESEARCH ARTICLE

A flipped classroom model for inquiry-based learning in primary education context

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Received: 17 June 2019; Revised: 29 March 2020; Accepted: 5 May 2020; Published: 9 July 2020

A multi-case study will be presented in this publication which aimed to address an important gap in the current literature concerning the effective implementation of a flipped classroom (FC) model in a particular educational setting. There has been limited research focusing on utilising a FC model within the primary education context despite its potential benefits for young students, such as facilitating student-centred inquiry-based learning (IBL) and developing their higher order cognitive skills. This multi-case study has been drawn from authors' collaborative action research project with other teacher participants, during which the authors explored the effective ways in which a FC model can be utilised to promote students' IBL in primary school settings. The authors first develop an inquiry-based flipped classroom (IB-FC) model and applied the model into five primary schools in Cyprus for a school year (2017–2018). A total number of five teachers, 77 students and 48 of their parents were invited to participate in the project. A large volume of qualitative data was collected mainly through classroom observations and interviews. Data analysis of teachers', students' and parents' experiences and perceptions led to the development of seven universal design principles. These principles can be used to support primary school teachers' attempts to design effective instructions using the IB-FC model.

Keywords: flipped classroom; inquiry-based learning; primary education; universal design principles

Introduction and literature review

Over the past decades, education standards have stressed the value of student-centred learning in which students are responsible of their own learning and they are actively involved in higher order cognitive tasks (Hannafin and Land 1997; Shea *et al*. 2012). A flipped classroom (FC) model has attempted to achieve these standards by allocating more class time for student-centred learning activities and by leveraging accessibility and use of advanced technologies to support a blended learning approach. The FC model is 'a pedagogical model 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' (Flipped Learning Network 2014). That is, the FC model offers students access to online video lectures

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Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287

and tutorials (i.e. flips) prior to in-class sessions, so that they are prepared to take part in more interactive, collaborative and higher order cognitive activities such as research, debates, problem-solving and discussions (i.e. inquiry-based learning [IBL]) (Bergmann, Overmyer, and Wilie 2012; Davies, Dean, and Ball 2013; Fulton 2012; Hughes 2012; Lage, Platt, and Treglia 2000; Talbert 2012; Zappe *et al*. 2009).

Students benefit from the pre-class exposure to content and outside classroom events because they can effectively distribute their time and independently pace their learning through online options given to meet their individual learning needs, cognitive abilities and prior knowledge. During in-class sessions, students have a range of opportunities to engage with IBL activities, mainly through actively participating in group work, rather than passively listening to the teacher (i.e. lecturing). Teachers, in turn, spend most of their in-class time for facilitating student-centred learning and monitoring student performance and progress and providing adaptive and instant feedback to individual students or to student groups accordingly (Fulton 2012; Herreid and Schiller 2013; Hughes 2012).

Flipped classroom

There has been growing research attention to utilising the FC model, grounded on its pedagogical potential to enrich teaching and learning activities, promote better pedagogical outcomes (Giannakos, Krogstie, and Chrisochoides 2014) and improve overall learners' experiences and competencies (Bergmann and Sams 2012). Although some researchers (e.g. Rutherfoord and Rutherfoord 2000; Tenneson and McGlasson 2006) have argued that the FC model is neither a new nor an innovative pedagogical approach – given that teachers have always used pre-class learning materials such as readings or pre-quizzes to better prepare their students for in-class lessons – the FC model has gained a fast-growing attention in current technology-enhanced learning (TEL) contexts (Strayer 2012).

TEL research concerning the implementation of the FC model has exclusively focused on higher education contexts with minor exceptions (see Hultén and Larsson 2016; Kim and Chin 2011). When it comes to primary education contexts, there have been general concerns about the feasibility of the FC practices due to a lack of self-regulation skills among primary school students at a relatively young age. Moreover, most FC studies have focused on comparing the FC model with more traditional pedagogical approaches with an educator's perspective (Herreid and Schiller 2013; Teo *et al*. 2014) and only a few have more clearly examined students' perceptions of the usefulness and attractiveness of the model. Students' experiences during the three phases of an FC model (i.e. pre-class, in-class and after-class phases), which could effectively inform the effective design, implementation and evaluation of FC practices, are rarely available, thus necessary in primary education context in particular (Kim and Chin 2011). Therefore, there has been a limited understanding of the effectiveness of the FC implementation, particularly in primary education settings.

Inquiry-based learning

IBL can be defined as

> 'the process of posing questions, problems or issues, gathering information, thinking creatively about possibilities, becoming proficient in providing

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> 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).

IBL, therefore, encourages students to explore, discover, collaborate and communicate with their peers (Laursen and Kogan 2014; Stephenson 2012) by operating multiple perspectives (Short and Harste 1996). However, it has been reported as a rather challenging task to implement effective IBL activities in primary education contexts (Capaldi 2015), given that the necessary higher order skills as missing.

Similar to the concerns about the feasibility of the effective implementation of the FC model in primary education settings, young students are often perceived being incapable or less capable to complete meaningful IBL activities without direct, on-going teacher interventions (Kim and Chin 2011). This can be proved very challenging especially for those low achievers who do not possess a required level of prior knowledge (Flick and Lederman 2004). Previous researchers also observed the negative attitudes towards and worries about their potential failures in their IBL learning processes (e.g. wrong results of experiments; unexpected difficulties) among many primary school students (Magee and Flessner 2012). Despite those suggested limitations and obstacles, however, there are a good number of pedagogical benefits of successful IBL, including the development of in-depth understandings, autonomous learning abilities and critical thinking skills (Çakıroğlu and Öztürk 2017; Mazur, Brown, and Jacobsen 2015), promoted if in-class time is saved through an FC approach.

Inquiry-based flipped classroom model

This article suggests that such a positive pedagogical transformation, from traditional lecture-based instruction to student-centred IBL, can be made possible in primary education settings by utilising the FC model in the IBL design and implementation, that is, more practically speaking, by freeing up classroom time for more guided IBL activities (Çakıroğlu and Öztürk 2017; Chen and Chang 2017; Huang and Lin 2017; Love *et al*. 2015). Such an attempt to integrate the FC model and IBL has been lacking in the primary education contexts despite the potential to address the perceived limitations and challenges reported by the previous studies as discussed above.

This study, therefore, aims to address those pedagogical concerns that arise from both FC- and IBL-oriented primary education contexts by exploring the pedagogical possibilities for utilising the FC model to enhance the quality of IBL design. That is, this research addresses the identified gaps in the current literature: (1) a lack of understandings about teachers', students' and parents' lived experiences and perceptions of the implementation of the FC model in K-12 education and (2) an absent of a systematic pedagogical and research attempt to combine the two models of IBL and FC which may effectively assist teachers in developing effective instruction in K-12 education and further enhance students' learning experiences (Giannakos, Krogstie, and Chrisochoides 2014; Rahman *et al*. 2014).

Thus, the authors first developed a theory-informed instructional model, inquiry-based flipped classroom (IB-FC) model (Figure 1), based on their literature review results and a series of small-scale pilot studies (Loizou-Raouna and Lee 2018a) in the first author's own teaching contexts. This model has been then used, in the present multi-case study, to design and develop a number of IB-FC cases, situated across five

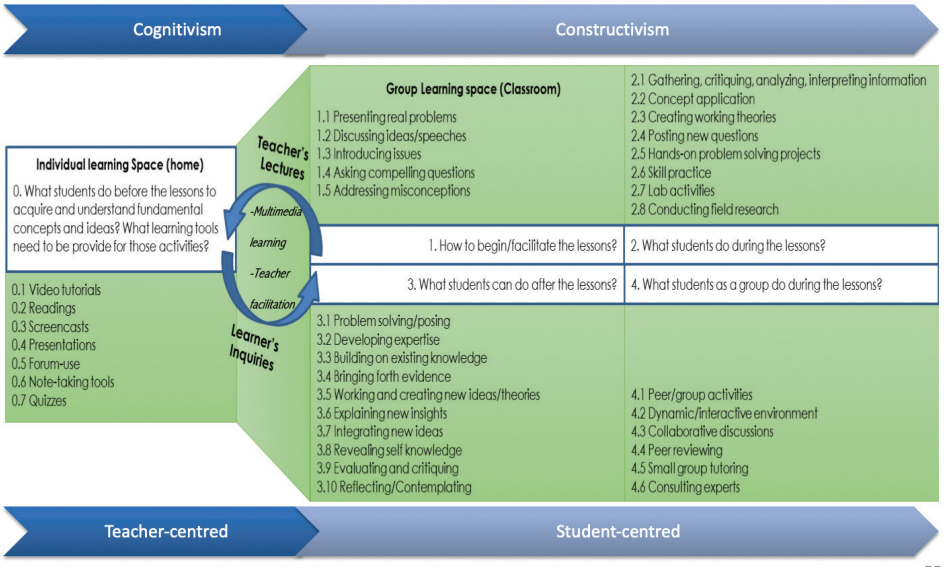

Figure 1. IB-FC model.

primary schools in Cyprus. The model distinguishes between the individual and group learning space, assisted through the use of multimedia and screencasting technologies. Teachers' lectures in the form of the flips given (e.g. video-tutorials, readings, and so on) and learner's inquiries which arise through the entrance ticket completion serve as the link between learning at home and in the classroom. At the group learning space, IBL activities are grouped into four sectors: (1) how to begin/facilitate the lesson; (2) what students do during the lessons; (3) what do students do after the lessons and (4) what students as a group do during the lessons.

This multi-case study, drawn from authors' collaborative action research project with five primary school teachers in Cyprus, focuses on supporting primary school teachers' attempt to implement the IB-FC model in their classroom contexts by developing and providing universal design principles that can be used to guide the teachers' practice. This investigation has been guided by the following research questions:

RQ1: What are the experiences of teachers, students and parents in different IB-FCs in Cyprus primary school context?

RQ2: What are the overall perceptions of teachers, students and parents on implementing the IB-FC model in different subject matters in Cyprus primary school context (i.e. benefits, challenges and limitations of the model implementation)?

RQ3: What are the universal design principles for effective implementation of the IB-FC model in Cyprus primary school context across different subject matters?

Research methodology and implementation

The research was carried out in five different classes, in five different public primary schools in Cyprus, that is, working with students aged between 8 and 11 years old. Figure 2 illustrates the basic information about the five different classes (CS1–CS5), including the drop-out case.

Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287

Case Study	School profile		Students' profile			Teacher profile			
	Urban-Rural	*Total # students*	*Grade*	*# students in class*	*ICT competency*	*Age/ Gender*	*Years of teaching experience*	*Education*	*ICT competency*
CS1 Tesa's classroom	Rural	30	3 & 4 (mixed)	10	Basic*-Good	37 /F	15	BA Primary Education MA ICT & Education	Very good
CS2 Rosemary's classroom	Urban	280	3	19	Basic*	41/F	18	BA Primary Education. MA ICT & Education	Excellent
CS3 James' classroom	Urban	115	6	8	Basic*	40/M	15	BA Primary Education. BA Sociology. MA Educational Leadership	Very good
CS4 Ben's classroom	Urban	298	6	23	Good	41/M	18	BA Primary Education MA Curriculum & Instruction. PhD Information & Communication Systems	Excellent
CS5 Mary's classroom	Suburban	202	6	17	Very good (pilot CS)	37/F	15	BA Primary Education. MA ICT & Education. PhD candidate: E-Research and TEL	Excellent

Figure 2. Participants' profile (school, student and teacher).

'Six sources of evidence' (Yin 2009, p. 101) for qualitative studies were used for data collection. The collected dataset includes a mixture of primary data and secondary data: (1) pedagogical documents: IB-FC design reports and lesson plans; (2) archival records: for example, educational policy (MOEC 2019); (3) teacher interviews and student focus groups; (4) parents' survey; (5) classroom observations and (6) researchers' fieldnotes including reflections and insights.

Nvivo, as a qualitative research software, assisted the researchers in managing all the different data collected, walking through the themes, nodes, patterns, flowcharts and key issues arising, presented in the results section. After all stages of analysis, the themes regarding teacher, student and parent experiences (research question 1) were grouped as pre-class, in-class and after-class, whereas teacher, student and parent perceptions (research question 2) were grouped into benefits and challenges with limitations. Universal principles (research question 3) which arise from the theme analysis are discussed right after.

According to the research framework, different IB-FC tools were developed which aimed to guide the teachers towards the design of the IB-FC lessons, uploaded on the Moodle platform developed for this research (which can be found here: http://www.protyposxoleio.com). These include suggestions for the various stages of implementation, as well as suggestions on the orchestration routines and digital tools which could be used.

A simple lesson template was developed (Figure 3) with all the steps of the IB-FC design (introductory in-class, pre-class, in-class, after-class), important notes for the teachers and the research framework. The aim of the template was to assist the teachers in their initial development of the IB-FC lessons, making sure they follow the correct structure which they could gradually evolve themselves. Further examples of flips were also given to teachers for preparing their own.

Ethical approval for undertaking this research was granted initially from Lancaster University, allowing for the high-risk research because the students who took part were aged 8–12 years. Given that the research was carried out in public primary schools in Cyprus, ethical approval was also granted from Cyprus Ministry of Education and Culture and the Cyprus Centre of Educational Research and Evaluation.

Template for lesson designs

This is a template to guide you through the design of the IB-FC lessons. You can refer to the IB-FC tools uploaded on Moodle for further guidance.

A. Introductory in-class session (10')-

- Attract students' attention. Set the scene for the resources and content given for study at home.

B. Pre-class, i.e. at home ("day- work", do not use the word '*homework*')

- Video/flip (5'-10')* and/or presentation and other sources/notes for reading/studying.
- Optional: Upload further sources on Moodle or simply print up a short notes sheet with a quick response (QR) code on the top. Forum on Moodle for note taking, summarizing, writing up the learning goal, answering questions**, suggestions for in-class activities (e.g. What do you think we should process further?), share of entrance tickets etc.
- Teacher help: Available online chat for questions (optional/preset time)
- Assessment: Entrance ticket, e.g. quizzes, mind maps, worksheets, polling system*** (to be uploaded on Moodle).

C. In-class

- Lecture (5-10'): answering questions, looking at forums, notes, filling-in the gaps, clear misconceptions.
- Inquiry-based learning: guided and independent practice e.g. students research and create content using entrance ticket and other sources (upload on Moodle or Drive or e-portfolio).
- Identify which students need help
- Review questions
- Exit ticket or Assessment/self-assessment/peer-assessment: survey, worksheet, rubrics etc.
- Closing lecture (5-10')

D. After class

- Ask them to re-watch the video or a new flip in closing the lesson at home. /
- Completion of e-portfolio: prepare the final page or the e-portfolio with their reflection on the unit, incorporating learning evidence.

Figure 3. Initial IB-FC lesson template.

Research results

Rosemary, Tesa, Ben, James and *Mary* are the teacher pseudonyms which will be used in the presentation of results, whereas S1.#–S5.# (S1.#: Students in case study 1, etc.) and P# symbols will refer to student and parent participants, respectively.

Overview

Normal practice in CS1–CS4 settings had been traditional, with minor use of technology; hence, IB-FC implementation was at a lower rate, implemented mainly in the main subjects of Greek Language and Mathematics. In CS5, a 'Bring Your Own

Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287

Device' initiative was already followed for 2 years and therefore it had been easier for the teacher and the students to switch to an IB-FC model and exploit its potentials and limitations in all school subjects. Implementation was also easier and more common in the upper primary classes, CS3–CS5.

Teacher, student and parent experiences

Pre-class experiences

Flips

Teachers recognised that it is of great significance to have a flip which would substitute 'what I would otherwise lecture the students about anyway' (Mary), and that 'The flips should have a "value-added" to the learning process' (Ben). All student participants were excited with the video-tutorials as they all recalled that the best time they had was when they watched the videos at home, especially the ones with completely unknown content, for example, 'I liked videos that were showing things I didn't know before' (S1.5). Teachers preferred to use ready-made videos as flips embedded on Moodle for various reasons. One of the teachers, *Ben*, specifically said that it is very easy for him to find ready-made videos and spend less time preparing for the lesson. Parents also found it 'very interesting', with only a few (n = 9 out of 48) pointing out the fact that their children are sometimes busy enough with other homework so they felt tired and pressured to watch the flips. Most teachers agreed that there were times that they have chosen to give out flips in other formats, other than video (e.g. presentations, online content).

Entrance ticket

The term '*entrance ticket'* refers to the activities the students had to complete after watching/studying the flip/flips given at home. These activities are assigned together with the flips to make sure the students actually watch/study them and are well prepared. Teachers admitted that the flips gave them a chance to assign activities as homework/entrance ticket which they would otherwise not give out '…because for being able to do it they must have had access to what I'm telling them in class which is what the flip does now for me…' (James). Concerning students, most of them in *Tesa*'s and *Ben*'s classroom mentioned that it was a bit demanding for them to complete the entrance ticket. 'We were writing answers and a lot of things' (S1.5), especially when they should answer questions (S4.20, S4.23), or create something on their own, without the presence of the teacher. Teachers claimed that their choice in preparing particular entrance tickets always had to do with the age of the students, the lesson goals and the available Moodle activities/tools (e.g. chats, wikis, quizzes, forums).

Time

The length of the video or flips in other formats was also critical. Teachers acknowledged the value of short videos/flips, for example:

> 'I was trying to find short ones [videos], 5–10 minutes, but even the longer ones when I couldn't edit them and make them shorter, I suggested to the students to watch let's say from the 5th till the 12th minute'. (Ben)

Teachers also preferred to use short activities as entrance tickets, ranging from multiple-choice questions created with the equivalent Moodle tool to using a Moodle forum for posting short answers, '…taking no more than 20 minutes' (Tesa). Students also never liked complicated assignments, neither the parents some of whom claimed that: 'We do not have all the time this requires' (P15).

Supports

Parents: Teachers would guide the parents in how to help their children at home through parent–teacher meetings at school. It was also done periodically in person later during the model's implementation, responding to particular parents' requests. What actually happened at home was that some of the students, as they reported, asked their parents (both or one of them) for help (n = 12 out of 77), for example, 'My mum knows what I am doing, my dad doesn't know' (S2.14). The fact that some parents cannot help their children due to their incompetence in the use of Information and Communication Technologies (ICT) was also evident in the students' interviews. However, most of the parents' responses and experiences (n = 35 out of 48) have been positive indeed, despite the challenges. Parents (n = 39 out of 48) generally spoke of how they liked the fact that they have participated in the research, especially at the later stages of the model's implementation.

Teachers: Almost all students (n = 71 out of 77) said that they got some kind of support they might have needed from their teacher while completing their entrance ticket. *James*', *Ben*'s and *Mary*'s students even had the opportunity to personally contact them during afternoon hours, either through Moodle, Viber, SMS or through a phone call. Teachers would check on the entrance tickets before the in-class session and provide feedback, either during the same afternoon, giving time for correction of errors, or during the night before coming to the class where errors would be corrected by students the day after.

In-class experiences

Less engaged and management

When students do not watch the videos at home and do not complete their entrance ticket, this is seen as a 'crisis' situation in the FC model because the teacher cannot proceed to the in-class activities. Indeed, students' lack of responsibility and 'feeling lazy' (Ben) was the main implementation problem teachers had to deal with. Teachers talked of how impossible it was to move on to the IBL activities in class whenever they would realise that only a few students have watched the flips and completed the entrance tickets (or completed it in a haste), occurring mostly in *Rosemary*'s and *Ben*'s classrooms.

How would teachers deal with the less-engaged? The teachers would sometimes play the video again in class for everyone to watch it again; at other times they would ask the students to watch it on their own in class (using their headphones). *Rosemary* also suggested the creation of an in-flip station in class, whereas teachers also agreed that if the students use the same device, both at school and at home, they are more likely to work more efficiently during pre-class.

Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287

IBL activities

The activities in the class were inquiry-based 'engaging and very interesting to the students' (Mary) just like what the IB-FC model encompasses. These activities were the 'extension' of the flip/flips the students had to watch at home. 'Going beyond the book' (James) had been the purpose of every IBL activity as teachers noted and those should have been fun, interesting and engaging to the students.

Figures 4–6 show the kind of IBL activities completed during class time in the Greek Language lesson, Mathematics and in all other Social Studies and Sciences, as these have been drawn from the Lesson Plan Analysis (Note: CS = Case study).

Teachers' experiences in creating IBL activities mostly focused in how Moodle tools have been used because 'they (Moodle forums) had been very easy to use' (Rosemary), especially in the Greek language lesson, given that some activities were not clearly IBL, for example, Drill and Practice in Maths. Teachers specifically mentioned

Figure 4. Types of IBL activities used in the Greek lesson (CS1–CS5).

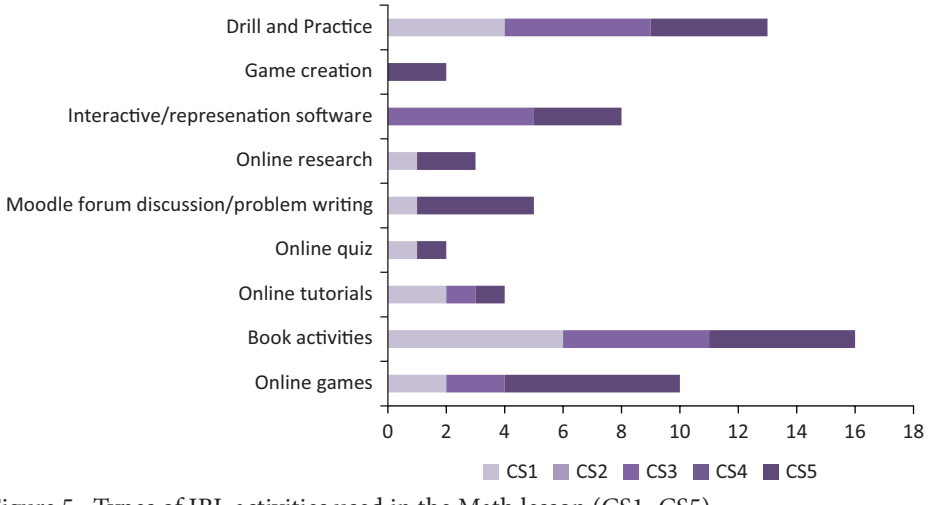

Figure 5. Types of IBL activities used in the Math lesson (CS1–CS5).

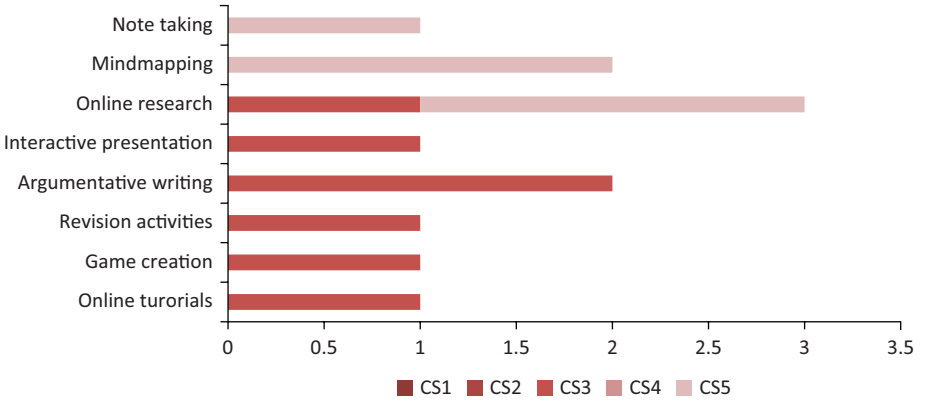

Figure 6. Types of IBL activities used in the Social Studies lessons and Science (CS1–CS5).

how forums were useful for asking their students to answer questions, post comments on flips, give feedback to their peers or post the outcomes of individual or group research any time during the learning process.

Students witnessed using Moodle chats '…for discussing a topic at home or in class' (S5.6) usually in groups so as to avoid too many lines. However, the most effective activities for the upper primary students (CS3–CS5), as their teachers claimed regarding their own experience, had been the online research following a flip. Most students preferred working in groups because they could combine their personal input from the flips they have watched at home and complete in-class activities more easily.

After-class (IB-FCs evaluation)

Most of the students reported that it is easier for them now (i.e. through the IB-FC model) to complete their after-class work/extra activities because they have the pre-class videos (flips) available, for example, 'Because our teacher will not upload or ask something we don't know' (S5.1). Portfolio development had been the after-class challenge for the students in *Mary*'s classroom, using Mahara platform, because none of them liked the process because it was very demanding, for example, 'I didn't like the portfolios. It was a lot of work for us' (S5.10). Nevertheless, the important thing is that most of them enjoyed its development (n = 15 out of 17 CS5).

Computer or online assessment methods, either through Moodle or through other online tools would work for the students. Observation notes strongly emphasise how students got more excited with online assessment versus a hard copy, achieving high scores, for example, 'We liked it better. And let's say it was more pleasant/joyful because we were feeling different from the other classrooms' (S4.19).

Teachers, student and parent perceptions

Benefits

The flips and work at home

Overall, students preferred this new way of learning over their traditional class as they value the videos more than the books (n = 72 out 77), for example, 'It was better

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than having a book. The video is better'. (S4.18); students also mentioned that they could watch them as many times at it was necessary to be able to complete their work (entrance ticket). Some of the teachers stressed the fact that students could create their own digital work (*Mary's and Ben's classroom*) or e-portfolios (*Mary's classroom*) with the information they would gather, related to the flip.

Student interest, engagement and participation in class

James' and *Mary*'s students (n = 25) reported how easy everything was as they had teachers' support in class. Teachers also thought of this new methodology as an approach to attract students' attention and elevate motivation and participation because they are asked to function just like in their everyday life: use of visual aspects and access to electronic devices. Many students (n = 28) even said that they would like to work in this way in all subjects. Parents also agreed that students' engagement was highly encouraged. Among the benefits parents wrote was the chance of developing students' critical thinking through interesting and innovative activities.

Personalised learning and differentiation

'As teachers, we have long strived to maintain what is called "personalised learning" and "differentiation". It's a huge challenge, somehow I feel made more possible with this methodology' (Mary). Savings in class time also offered teachers the opportunity to work more closely with the students who needed further guidance and assistance with the new and more complicated concepts introduced.

Challenges and limitations

Age and skills of students

The young age of the students and their limited ICT skills posed challenges and set limitations during implementation, especially at the early stages. Overall planned IBL activities did not always work as expected, especially with the lower primary students (*Tesa's and Rosemary's classrooms*), either because they would not all watch the flips or understand them well or because they both lacked ICT and IBL skills required. Shared class accounts were created to overcome some of these challenges.

Unsuccessful activities

Long flips and pre-class activities (entrance tickets) were disliked by all students who would prefer shorter and less-complicated work. The same applied for parents who sometimes neither had the skills nor had time to offer guidance to their children. This sometimes led to unfinished work, misconceptions and students' disinterest.

Technical challenges

Although most of the students confirmed that they enjoyed their work at home and denied having device or connectivity problems, Internet safety had been an issue for a few parents (n = 9 out of 48). Teachers also agreed that there was no particular device

problem in class. However, students who brought in their laptops (*Ben* and *Mary*) worked better than the ones working on tablets because they avoided compatibility problems with some of the software. This is one of the reasons that *Mary* used a 'Bring Your Own Device' programme. However, periodic problems with Internet connectivity in the class had been the main challenge reported.

Parents' concerns

Many parents (n = 25 out of 48) underlined that the weakest part of the programme was their children spending too many hours on the computer/device, increasing their total screen-time. They associated this with the possible development of eye problems because they believe that '…the students are trapped with the computer' (P10).

Discussion: Universal design principles

The study and analysis of the teachers', students' and parents' experiences and perceptions have given rise to particular practical suggestions for teachers, discussed here. These were further coded and defined as IB-FC universal design principles, while some of them were validated through past theories and research on FC design principles in higher education (Brame 2013; Chen and Chang 2017; Kim 2016; Kim *et al*. 2014). Below the seven universal design principles (UDP1–UDP7) this study proposes are presented.

UDP1: Structure and flexibility

Structure

During the preparation of the IB-FC lesson designs, educators should initially follow particular design steps, such as the ones given in the IB-FC lesson template in Table 1, which would ensure a clearly defined structure both for them and their young students. The use of Virtual Learning Environments (VLE) tools indeed assisted towards well-structured IB-FC lessons, whereas teacher support through a variety of synchronous and asynchronous tools is important.

Moreover, the structure can be achieved when orchestration routines are adopted. This means that educators should provide all the necessary instructions for the students to be able to find their way out on their own and achieve higher orders of cognitive work, as Lankford 2013, and Zainuddin and Halili (2016) have also proposed. The main examples arising from RQ1 and RQ2 analysis are as follows: (1) creation of common classroom accounts; (2) monitoring of activity timings; (3) provision of devices for all; (4) sequencing of activities and provision of 'extension' activities; (5) organisation of in-flip stations; (6) structuring through a VLE and (7) classroom management, for example, rewarding/marking system.

Flexibility

The model should be used selectively during design and flexibly during implementation. Parents noted that there should be a combination with traditional teaching (e.g. P28). If the model is universally implemented, it would also translate into a huge

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workload for the teacher in preparing all the flips (Lage, Platt, and Treglia 2000) because primary school teachers teach almost all subjects to their classroom students and do not specialise in one (as opposed to secondary and higher education settings).

UDP2: Simplicity and accessibility

Simple and universally accessible technologies should be used (Internet connection, devices and software). Students should be able to use them and the teachers should feel confident to solve technical issues. The first step towards deciding on the adoption of an IB-FC model implementation altogether, or on the lesson designs, is to have good Internet connectivity, both in class and at home. Indeed, access to networked and school technology by students is one of the challenges of the FC approach (Ullman 2013). During the research, teachers preferred using mobile devices in class and not in the computer lab because 'that provided flexibility' (James). Maintaining a 1:1 student–device ratio in class was easy but not always necessary. A 1:2 ratio works best with the young students, whereas the adoption of a 'Bring-Your-Own-Device' initiative seemed to solve many device problems for *Ben* and *Mary.*

UDP3: Interconnectivity and community

Interconnectivity

IBL activities which clearly connect the individual learning space with the group learning space should be chosen. Students should be able to make the connection (Hamdan *et al*. 2013). Depending on the content and length of the video, students should watch it more than once and as many times it is needed. The flips should also contain the right amount of new knowledge for the students and have a value-added, similarly emphasised by Kong and Song (2015). Overall, students in the research proposed a simple note-taking strategy to deal with the new information.

Community

IB-FC implementation in primary education needs the building of a young learners' community, developed through multiple means of communication between all, with clearly defined and well-structured guidance and support. Parents and students highly emphasised that they should also be able to personally contact the teacher in a synchronous or asynchronous way (communication tools) at any time during the learning process, especially during their work at home.

Teachers should circulate around the classroom and support students, providing facilitation for building a learning community. This clearly refers to Kim's *et al*. (2014) *social presence* principle.

UDP4: Differentiation and personalisation

An opportunity should be given for all students to gain basic understanding and exposure to content prior to class. The very nature of the FC approach provides flips at the individual learning space so that students can watch them as many times they need to understand the content, promoting differentiated instruction and personalised

high-order in-class learning (Yarbro *et al*. 2014). Students have recognised that they do not all share the same skills, abilities or prior knowledge, for example, '…we are all different' (S4.1).

UDP5: Development and progression

Activities which gradually promote IBL and transversal skills should be offered, that is, teachers should spend time to help lower primary students gradually attain IBL skills. 'Learning how to learn' is a difficult task for young students to master (Flick and Lederman 2004). As many planned IBL activities did not work best in Tesa's and Rosemary's classrooms, it is important that teachers spend time during the first months of implementation into building IBL skills, assigning easier and simpler tasks and guiding the students through it (Kim and Chin 2011). For the upper primary students, it had been easier to promote IBL skills and teachers have really worked with their students on different IBL activities.

UDP6: Motivation and engagement

One of the key principles of IB-FC implementation is how teachers offer motivation and an incentive to students to prepare for class so as to avoid disengagement and in-class revision problems (Cole, Martin, and Dennis 2004). This had been again one of the four design principles suggested by Brame (2013). Participant teachers dealt with disengaged students by creating in-flip stations, playing the video-tutorial in class and explaining content, either on a personal or on a whole-class level. This should help develop both intrinsic and extrinsic motivation (Abeysekeraa and Dawson 2015).

UDP7: Assessment and evaluation

A mechanism to assess student understanding and address misconceptions at every stage of the learning process should be created (prompt and adaptive feedback). Educators need to make sure that they give opportunities/time for review and correction of errors after peer/teacher/self-review. Students understand what is needed to be done because the instructor evaluates and gives feedback throughout the learning process (pre-class, in-class, after-class), overcoming deficiencies in learning (Kim *et al*. 2014).

Conclusion

This research aimed to study actual IB-FC implementation in primary school settings. It was found that teachers, students and parents had mostly positive experiences and perceptions. Overall students were satisfied with the FC activities, all enjoyed the flips and many agreed that the class time interaction through the IBL activities was key to their understanding. Students and teachers perceived that the FC activities were more interesting, motivating and engaging, especially with the use of technology, than a traditional class. Teachers have enjoyed the design and implementation process and they were willing to offer all the support and guidance the students needed throughout the learning process. Teachers collaborated well with the parents who appreciated the effort and were also willing, happy and supportive towards their children.

Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287

These findings are in line with many other previous studies, as this has been emphasised in the discussion of the universal design principles arising from the research.

Contrary though to many previously published studies, the present study is distinctive in the following two ways. Firstly, it tested the feasibility of implementing a FC in a primary school context in Cyprus, through an action research methodology within multiple case studies. A majority of previous studies did not explicate any specific conceptual framework to help instructors design their FC s at any level of education (Bishop and Verleger 2013; Giannakos, Krogstie, and Chrisochoides 2014), not even the few studies which exist in primary education (Aidinopoulou and Sampson 2017; Gough *et al*. 2017; Hultén and Larsson 2016; Kostaris *et al*. 2017). Moreover, it is the first time the FC model has been implemented at any level within the educational context of Cyprus (Loizou-Raouna and Lee 2018b). The current research proposed and tested the implementation of a combination of FC with IBL to address the limitations and challenges of both methodologies and help educators, students and parents *enjoy* the benefits of both.

All in all, the present study proposed universal design principles based on the practical implementation suggestions arising from students', teacher's and parents' experiences and perceptions as well as relevant literature. Further research could concentrate on investigating the implementation of a new IB-FC model based on these principles, in K-12 education, testing their effectiveness and further benefits and challenges arising.

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Citation: Research in Learning Technology 2020, **28**: 2287 - http://dx.doi.org/10.25304/rlt.v28.2287