Erasmus Plus Flipped Learning in Praxis (FLIP)
UK Case Study Report

Title: Effects and utility in applying the flipped learning concept to teaching and learning using technology-enhanced learning for inclusive special education

Authors: Dr. Sveta Mayer* (University College London – Institute of Education), Dr.Kaska Porayska Pomsta (University College London – Institute of Education), Matthew Unsworth (Barrow Hills School) and Ruth Humphrey (Barrow Hills School)

**Correspondance: Dr. Sveta Mayer. Dept. Learning and Leadership. University College London – Institute of Education. 20 Bedford Way. London. WC1H 0AL. Email: s.mayer@ucl.ac.uk*

Summary

The effects and utility of technology-enhanced learning as an intervention to support typical and atypical developing children's learning is becoming well researched. However, whilst the effects of technology-enhanced learning utilized by classroom teachers' as part of their repertoire for pedagogic design for typically developing children is increasing, the utility and effects within inclusive classrooms to support atypical developing children is underexplored.

To explore this an in-depth case study of one classroom teachers' use of technology-enhanced learning to design inclusive pedagogy for their KS2 science class and systematic observation and reflections of the learning experience of one child (Child 1) with special education needs was carried out taking a participatory approach. The researchers engaged with the classroom teacher as co-researcher to design and implement technology-enhanced learning by applying the flipped learning concept to support the classroom teacher in developing their pedagogy for technology-enhanced learning. Child 1's special education needs were identified by the SENDCo as: (a) attention (maintaining focus upon the task in hand), (b) ability to hold information in mind to successfully engage in learning activities (working memory) and (c) working independently as main areas of development. These abilities are required of learners engaging in technology-enhanced learning developed using the flipped learning concept.

Investigating the application of flipped learning concept in designing technology-enhanced learning utilized for inclusive education is therefore important because the concept advocates classroom teachers to develop pedagogy opportunities for flexible learning (F: Flexible learning) using multi-media technology to develop resources for students' learning of curriculum content anytime anywhere within and outside the classroom. Thus paving the way for teachers to engage students in more independent and peer group student-centred learning (Learner centred) with the intention of developing mastery learning (Intentional outcomes). The flipped learning concept also advocated professional collaboration between teachers (Professional collaboration) in developing their flipped learning pedagogy to support students.

Findings revealed a lot is required of classroom teacher and special education needs student in these respects. Issues of attentiveness and flexibility arose for the student as they experienced difficulties in moving from one learning activity to another. There was an increase in the need for personalised learning support from the classroom teacher to enable child to access technology-enhanced learning suggesting student may be experiencing issues with cognitive load. There was a small rise in student's emotional expression suggesting issues with emotional regulation and there were issues with engaging in independent or social peer group learning. It was of note to find that by engaging the whole class in technology-enhanced learning this freed up teacher time to devote to student with special education needs. This suggests that technology-enhanced learning designed using the flipped learning concept may readily engage typical learners but additional support is required for special education needs students with learning difficulties in area of attentiveness, behavioural regulation and metacognition.

The implications of this research are that findings suggest that for atypically developing children there may be learner specific issues in cognitive, emotional and social load when they experience learning through pedagogy applying the flipped learning concept to design technology-enhanced learning for the inclusive classroom. Experiences of cognitive, emotional and social load for typically developing children's learning within the flipped learning classroom is purported to as supporting learning because students have the opportunity to self-direct their learning, learn independently or within social groups and access learning anytime-anywhere (Abeysekera and Dawson, 2015; DeLozier and Rhodes, 2016). Given this understanding, findings from our study have identified some important implications for successful provision of special education within the inclusive classroom using the flipped learning concept.

This study reports on the finding from the UK case study as part of the Erasmus Plus funded Flipped Learning in Praxis project.

1. Introduction

The Erasmus Plus – Flipped Learning in Praxis project involved education practitioners from across Europe in applying the flipped learning concept as defined by Hamdan et al., (2013) to develop pedagogy for technology-enhanced learning within their classroom practice (Bermann and Sams, 2012). Schools from Iceland, Germany, Italy, Norway, Slovenia and UK were involved and supported by national partners within each country. The flipped learning concept enables classroom teachers to develop pedagogy opportunities for flexible learning (F: Flexible learning) using multi-media technology to develop resources for students' learning of curriculum content anytime anywhere within and outside the classroom. Thus paving the way for teachers to engage students in more independent and peer group student-centred learning (Learner centred) with the intention of developing mastery learning (Intentional outcomes). The flipped learning concept also advocated professional collaboration between teachers (Professional collaboration) in developing their flipped learning pedagogy to support students.

The main aim of the project is to learn more about how teachers apply the flipped learning concept to incorporate the use of multi-media technology into their teaching and learning to personalise learning and to determine what impact this has on student learning. To achieve this the project engaged national partners to collaborate with schools teachers to conduct case studies of teaching and learning applying the flipped learning concept within the respective schools' context (i.e. developing pedagogy for children in rural areas, children with special education needs or adults learning vocational skills). The outcomes from the project are to generate a comparative analysis across EU of teachers' 'best practice' in applying flipped learning concept to their practice and determining the impact this has on students' experience of learning.

2. UK Context:

In the UK the context was inclusive special education. The case study evaluation reported here illustrates teachers' and special education needs staffs' professional practices in developing pedagogy for technology-enhanced learning personalized for special education students in their class and how this impacted upon students' learning experiences. The aim of the UK case study was to support teachers and special education needs staff in applying the flipped learning concept to classroom practice and to evaluate the impact of this practice on special education students' curriculum learning and the development of personal skills in attentiveness and self-regulated behavior. Attentiveness (ability to pay attention) and self-regulated behavior (ability to control behavior) were selected as focus for evaluation because technology-enhanced learning advocates a dynamic and flexible nature of learning, including (i) independent and peer group work in the classroom or at home, (ii) face-to-face learning or learning mediated by technology and (iii) switching between different learning activities and modes of learning, (iv) learning individually or socially in peer groups. These aspects of technology-enhanced learning which may be difficult for children with special education needs if they have issues with attention, hyperactivity, independent learning and social interactions

Three schools were approached to join the UK case study and one school signed up. The case study school is an independent school for children aged 2-13. The school has pioneered cloud-based

facilities for teaching and learning within the whole school setting in the UK. It had at the year of starting this study fully implemented cloud-based teaching and learning. All practitioners and students have access to personal Samsung tablets with S-pen, teachers had access to Samsung TVs within their classrooms and home-school communication was accessed via Google. This made the school an ideal place within which to conduct this study and the school in turn would benefit from the professional development work included with the project (see section 3.3 below). The focus on evaluating the impact of classroom teachers' use of pedagogy for technology-enhanced learning on special education students' curriculum learning and the development of personal skills in attentiveness and self-regulated behavior was jointly agreed with the school.

3. Methods

The study was designed as a participative exploratory case study Conlon and Pain, 1996) undertaken over 2 years: Phase I - a pilot phase in year 1 and Phase 2- a teacher case study phase in year 2. Findings and conclusions from the teacher case study are presented in this report (see section 4 and 5).

3.1 Participants

The head teacher and a group of seven practitioners were involved in the study, undertaking roles in line with their professional responsibilities in school. The group of practitioners included the head of academic learning (responsible for teaching and learning), the information communication and technology officer (implementation of ICT and cloud-based technology), the special education needs and disabilities coordinator (special education support) and four classroom teachers (teaching children from 2-13 years).

Classroom teachers implementing the flipped learning concept to develop their pedagogy for technology-enhanced learning engaged all their classroom students. Within their class, teachers selected one or two students who had special education needs related to attention and self-regulation of behavior to focus their observations of impact upon. During Phase 1, the four classroom teachers involved six students (age range 4 years to 11 years) and during Phase 2, the classroom practitioner involved four low attaining students in sciences all aged 11 years. Of these four students, one student met all the criteria for sampling and inclusion for evaluation of impact (i.e. that student has special learning needs related to attention and self-regulated behavior and a complete set of data are gathered for the child (see section 3.4) Findings and conclusions related to this student will be reported (see section 4 and 5).

The head teacher and all seven practitioners took part in the Phase 1 pilot study and four practitioners took part in the Phase 2 teacher case study. The four practitioners were the head of academic learning, head of ICT, the special needs coordinator and one teacher, all worked together as a collaborative with work overseen by an acting head teacher.

3.2 Ethics

Ethical consent from practitioners, children and their parents was sought in collaboration with the head teacher and head of academic learning abiding by school policy and parental consent and following the BERA and BPS guidelines for ethical practice.

3.3 Engaging participants

The practitioner-practitioner and researcher-practitioner collaborations were undertaken through a series of workshops, individual tutorials, online communication via a project website and email. Practitioners were engaged in a series of six workshops during the Phase 1 pilot and explored: (i) developing technology-enhanced learning activities using the flipped learning concept (Hamdan, et. al., 2013), (ii) engaging in participatory action research with each other as a collaborative and with researchers (Conlon and Pain, 1996; McTaggart, 1991), (iii) considering constructivist learning theory to develop pedagogy for independent and peer group work (with teacher facilitation) (Shuell, 1988 and Weisberg, 2013), (iv) development of children's self-regulated behavior (executive functions) (Diamond, 2013) and developing learner profiles. In Phase 2 practitioners were engaged in one workshop to support them in developing a teacher case study drawing upon learning from Phase 1.

Individual tutorials, online communication via a project website and email was ongoing throughout the two phases.

Throughout the study the head teacher and group of practitioners were involved in co-designing their school-based work within the remit of their professional responsibilities (i.e. student assessment, classroom pedagogy, utilizing ICT or gaining parental consent). The researchers also co-designed with the head teacher and group the approach to the Phase 1 and 2 data collection tools to capture 'best practices' in teaching and learning using the flip learning concept for technology enhanced teaching and learning. This co-designing also informed the data collection and analysis tools for the across EU schools study.

3.4 Data Collection

The data gathered by classroom teachers within the collaborative group during Phase 1 and 2 was shared with researchers using a secure school website. In reviewing the data collected, a full data collection set has been gathered from the Phase 2 teacher case study collaborative detailing the application of flipped learning concept to develop pedagogy for technology-enhanced learning for inclusive education and assessing impact of this upon the learning experience of special education needs students. The classroom teacher involved in the Phase 2 teacher case study was a science teacher for students aged 11 years and developed technology-enhanced learning activities using flip learning concept to deliver the science topic reproduction to all students in their class.

3.4.1 Students' prior attainment

The classroom teacher assessed all the class students' prior knowledge and selected four students to focus upon and develop differentiated pedagogy for technology-enhanced learning for. All four had lower science attainment within the class, achieving 50% or below (grade D) in their end of year science exam the previous year. Within this sub-group, completed data sets from two students (Child 1 and 2) were shared with researcher.

Child 1, was a low science attainment student achieving 36% (grade D) in the end of previous year science exam. SENDCo assessment of Child 1 for special education needs identified (a) attention (maintaining focus upon the task in hand), (b) ability to hold information in mind to successfully engage in learning activities (working memory) and (c) working independently as main areas of development.

Child 2, was a low attainment student achieving 46% (grade D) in the end of previous year science exam. SENDCo assessment for special education needs identified (a) auditory processes in listening and (b) ability to hold information in mind to successfully engage in learning activities as main areas of development (working memory). Child 2 displayed no problems in being attentive and self-regulating their behavior when working independently or within a social setting as main areas of development.

Given the aim for this evaluation is to determine the potential impact of technology-enhanced pedagogic provision on the learning experience of special education needs learners with difficulties in attention and self-regulation of behavior, findings will be reported here for Child 1 as an illustrative personalized learner profile (see section 4). Child 1 is female and age 11 at time of this evaluation. Conclusions and implications for implementing technology-enhanced learning will be derived based on this individual case (see section 5 and 6).

3.4.2 Teachers 'best practice' in provisioning technology-enhanced teaching for children with special education needs

Data about classroom teachers' 'best practice' was gathered using online data collection tools co-designed with practitioners. These were: (i) a **personal online action research reflective log** for teachers to journal their professional experiences and insights as they developed their pedagogy for technology-enhanced learning and (ii) an **online teacher verbal report tool** to enable teachers' to peer reflect upon, discuss and share their professional practice and their pupils' learning experiences with their peers. The teacher verbal report included a short student verbal report tool for teachers to use to gain feedback from their students and include this as part of their peer reflection. In addition,

teachers video-taped their lessons to enable them to reflect upon their practices prompted by the videos when conducting the teacher verbal report. It transpired that the collaborative were unable engage in peer-reflection due to limited time. Instead the classroom teachers engaged in self-reflection of their own teaching practice and the learning experience of their target special education needs student.

In addition, the classroom teacher gathered data on: (i) SENDCo staff on assessment report of their target students' learning strengths and difficulties, (ii) their own teacher assessment of students academic learning needs based upon students prior learning, (iii) their lesson planning for incorporating pedagogy for technology-enhanced learning(by applying the flipped learning concept) and differentiating their teaching - drawing from the SENDCo staff assessment, (iv) their teacher lesson plans and activities for implementing flip learning concept within their classroom and differentiated activities for special education needs students, (v) students' progress in academic achievement before and after flipped learning lessons, (vi) teacher retrospective reflections on students' behavior during flip learning (verbal and non-verbal communication, emotional expression, flexibility in learning in different situations and social settings and personalized learning support needed). The head teacher also shared school data on students' cognitive ability and academic achievement in end of year school exam performance.

3.4.4 Assessment of special education needs students' executive function skills

The researchers also collected data of case study teachers' perspectives about their target students' classroom behavior before and after implementing the flipped learning concept within their class. This was used to independently verify the initial diagnostic assessments the teacher had made of their target students classroom behavior, which was based on their observations. The Behaviour Rating Inventory of Executive Function (BRIEF) psychometric test questionnaire was used. This test provides a norm-referenced assessment of students' executive function skills i.e. comparing teachers' perception with other teachers' perceptions of age-matched children, including children who have learning disabilities. The questions ask teachers to reflect upon their observations of students' classroom behavior. The questionnaire takes 10-15 mins to answer and determines teachers' perceptions of students' strengths and difficulties in (a) behavioral regulation - ability to remain attentive, self-regulate their emotions and to flexibly move freely from one learning activity to another and (b) metacognition - to independently start learning activities, to hold information in mind and follow instructions (working memory) and to self-monitor what they are doing and how well they are doing.

4. Findings

4.1 Classroom teachers' experiences

Analysis of classroom teachers' 'best practice' will be determined as part of the across school comparative analysis. The classroom teachers' reflection about their professional experience of applying the flipped learning concept to develop pedagogy for technology-enhanced learning for special education students in their class is presented.

In considering the dynamic nature of pedagogy for technology-enhanced learning i.e. engaging learners to different teaching and learning activities; face-to-face or technology-based learning modes; independent or peer group work and learning at school or at home, the classroom teachers considers the utility of this in providing opportunities for children to encounter learning in multiple contexts, from multiple perspectives and multiple representations. In this respect the classroom teacher reflected:

> *'I'm in high hopes that allowing children freedom to use the various ICT applications as they feel fit will give them the ability to learn in a way that best suit each individual.'* Classroom Teacher

In decision-making about how to apply the flipped learning concept to develop their pedagogy for technology-enhanced learning, the classroom teacher prioritised developing flipped learning experiences within the classroom first to enable students to become familiar with using the technology and how to learn independently on their own or in small peer groups (with teacher facilitation). This included making sure students felt safe learning using technology and that they could make decisions

about choosing between the different resources available to them. For example they could choose to work individually wearing headphones or collaborate with peers. As students became familiar with how to use the technology the classroom teacher developed opportunities for them to learn independently at home.
Below is an overview of how the classroom teacher utilized technology to assist them in provisioning science learning to their classroom and developing technology-enhanced learning resources for all learners in their classroom, including students with special education needs.

4.1.1 Teachers' use of technology to provision teaching for students

The classroom teacher utilized the Hapara Workspace (https://hapara.com) to establish a digital learning environment within which to (i) plan lessons, (ii) make available online learning activities differentiated for all learners (i.e. students who were high achieving and those with special education needs), (iii) share learning objectives and success in achieving these (i.e. through formative and summative assessment), (iv) provide access to all teaching and learning resources within school time and at home and (v) to provide a platform for students to submit their homework assignments. An additional valued feature of this environment is that students have access to their learning journey as they progress through science topics – meaning they can access all teaching and learning resources at anytime for revision. The classroom teacher reflected:

> *'Hapara workspace - allows me to share all course material and add 'what a good one looks like' - to offer children a model of what I had hoped to see from their work, using one of their cohorts work for this seems to gain greater effect.'* Classroom Teacher.

In general the classroom teacher gave the following insights about how they planned their practice for technology-enhanced pedagogy. At the beginning of topic students were given a digital overview (mind map) of the key areas of curriculum learning they were going to take. This enabled them to see and check progress as they moved through the curriculum topic. Whilst this was a visual aid the classroom teacher also proposed this would enable students to make conceptual links between the topic areas covered. The topic area was introduced by modeling mastery of learning e.g. using a short video (created by teacher or accessed via internet) followed by key information about the subject, a quiz to test and feedback to assess mastery. The class teacher also engaged students in discovery learning within small peer groups to introduce topics but found students were put into a position of risk as their learning and understanding was 'visible' to all class members. More teacher support was required to reassure students of the safe nature of the learning experience. Other useful resources for introducing topics but also to be used as references during and after topic for revision were online textbooks. These were accessed individually and offered a 'safer' starter for students. However, this kind of independent learning meant that there were risks of generating misunderstanding or misconceptions. The classroom teacher reflected:

> *'(Students) are all familiar with textbook resources and trust in the information they find from this source. You have to keep an eye though, if they come across a question where the answer is not immediately obvious on the page in the text, they will very quickly resolve to popping that question into google, instead of searching the text book for the answer. This is dangerous as the answer that pops up is usually at a higher level than they require at this stage and can therefore knock confidence.'* Classroom teacher.

Learning activities during the class time were prepared by teacher and introduced both verbally and with written guidelines about how to complete these. Students were given the choice to decide how they were going to present evidence of their learning and achievement of learning outcome using their tablet and pen devices e.g. complete prepare a written document, create a video about what they have learnt or take a photograph to capture their work. These examples of students learning outcomes were shared with the class as examples of peer learning. The teacher reflected this was a safe way of developing and modeling mastery learning and giving opportunities for students unsure about their learning to learn from their peers. The classroom teacher reflected:

> *'(By sharing examples of how they completed learning activities) the mistakes made, were … look(ed) at as a group by revisiting the (learning objective) and by using the screen mirroring*

facility available to us in the classroom. The children could then self assess their work.' Classroom teacher

By the end of topic the classroom teacher reflected they used more questioning techniques in class using both 'traditional' mode of question/answer face-to-face but engaging students to use their tablet and pens to respond. Student responses were screen linked to Samsung TV so class discussions could take place by viewing responses as they arose. Since students could erase their responses on the tablet at anytime they felt safe this exercise was a learning activity. As students gained confidence in their knowledge of the topic, the classroom teacher introduced online questioning using e.g. Socrative tool (http://www.socrative.com) where teacher sets the questions online and students respond online being able to view whole class responses prompts a discussion and reasoning for correct answers. This engages students to applying the new knowledge they have learnt during the topic and to consolidate this learning for themselves.

The classroom teacher also created a series of videos uploaded onto Youtube for students to access at anytime during the lesson and also afterwards for revision at home.

'Feedback from this sort of support material (teacher created videos) is excellent from parents, they are happier for their children to listen to (me) the teacher teaching the material rather than the excellent on-line videos available ... They say it is because they can believe that the videos that I have made are relevant to their child's learning for the syllabus but that they do not think the other video material is targeted at the common entrance objectives.' Classroom teacher.

Finally, in the ever-present risk that technology devices fail to function or internet access fails, the teacher advocated designing lesson activities as a series which include non-ICT activities to be utilized when needed.

4.1.2 Teachers' use of technology to develop learning resources for special education needs students

It was noted that students who were attaining lower academic success in science, be that due to special education needs or not were reluctant to explore the various facilities offered. Students who were attaining greater success in science tended to be more attracted to using ICT as a learning tool and to produce their class notes and homework assignments.

The classroom teacher also reflected that inclusive education i.e. integrating teaching of curriculum with support for developing special education needs students' personal learning skills was '*tricky*'. The classroom teacher observation and reflection of Child 1 academic and personal learning experiences through the topic delivery is provided below (see 4.2).

Finally the teacher recognised the importance of developing personal learning skills for achievement in curriculum learning in school but appreciated that the students were fortunate to be supported in this respect by colleagues within the SEND departments and parents at home. The role of students' parents to become involved in supporting students' development of personal skills was considered by the teacher to be a promising area for developing ICT resources to enable this.

4.2 Students' learning experiences

Analysis of impact upon Child 1 learning experience is presented below as a personalized learner profile. This profile incudes a summary of the classroom teachers' retrospective reflection of Child 1's academic and personal achievement. Academic progress in science learning is based upon pre-post assessment of end of year science exams and teacher science topic tests. Progress in development of personal learning skills in attentiveness and self-regulated behavior is based upon (a) classroom teachers' verbal report (see 4.2.3) and (b) researchers' assessment of classroom teachers' perceptions about the students' executive functions related to attentiveness and self-regulated behavior (see 4.2.4).

4.2.2 Academic Achievement:

Child 1 was a low science attainment student achieving 36% (grade D) in the end of previous year science exam. The classroom teachers' assessment of Child 1's knowledge of the science topic Reproduction before and after implementing the flipped learning concept to develop their learning activities found the student achieved 45% before and 75% after. In the end of year science exams Child 1 was assisted by a reader and scribe and attained 60% (grade C). Commenting upon Child 1's achievement in class the classroom teacher reflected:

> *'My target child one is extremely weak and we have considered giving her year 5 level work as a staff body before now. Any way her results were pleasantly surprising.'* Classroom Teacher

4.2.3 Personal Achievement

SENDCo assessment of Child 1 for special education needs identified attentiveness, ability to hold information in mind to successfully engage in learning activities and working independently as main areas of development. The classroom teacher provisioned for this in the delivery of science topic Reproduction and using the Teacher Verbal Report and videos of lessons reflected upon Child 1's learning behavior. The areas of improvements and limited/no improvements in Child 1's behavior for each of the behavior categories as perceived by the classroom teacher were:

- **Communication**

Child 1 improved somewhat in communicating their immediate and prior learning of science but made little improvement in independently requesting help on what to do next to complete a task. The classroom teachers' reflective comments were:

> *'(Child 1 is) shy to ask (for help) verbally. Will wait. In response to me encouraging her to communicate - will try but lacking confidence. Has the confidence to pop her hand up to answer (a question) if the whole class is questioned.'* Classroom teacher.

- **Emotional expression**

Child 1 improved a lot in their emotional expression of pride but displays they are worried or embarrassed. The classroom teachers' reflective comments were:

> *'(Child 1) seems proud and excited by her (learning activity). (They) wait for cues from peers (on what to do) and look to neighbor for cues – checking what peer is up to before committing (to work).'* Classroom teacher.

- **Flexibility**

Child 1 improved somewhat in maintaining communication but found it easier to do this 1:1 with the classroom teacher face-to-face. The child did improve communication with classroom teacher when engaged in technology-based learning activities. However they found it more difficult to communicate within a group when learning activities were within a social peer group were either face-to-face or mediated through technology. The child has improved somewhat in following instructions given by teacher or through technology about what to do to complete a task but finds it difficult to follow instructions from within group work. The child finds it difficult to engage within a social setting and maintain their attention or to engage in turn-taking with peers. The classroom teachers' reflective comments were:

> *'(Child 1) shows contentment whilst I use the screen to show films or display interactive media. Can find her way around the IT on her tablet, is capable of using s-note and opening up her e-book. Requires help when negotiating new IT tools such as quizlet. Has become an expert at copying from a peer without them being aware.'* Classroom teacher.

- **Learning Support**

The classroom teacher reflected upon the kinds of technology-enhanced learning activities Child 1 seemed to find helpful in improving their personal learning skills as flagged up by the SENDCo assessment (i.e. attentiveness, ability to hold information in mind to successfully engage in learning activities and working independently). The teacher reflected that learning support to help child maintain their attention by reminding them on what to do when introduced to a new learning activity

somewhat improved the child's ability to know what to do. However, the classroom teacher became aware Child 1 had not improved upon their ability to self-regulate their behavior and engage in independent learning. The teacher found they needed to provide learning support by giving the child positive verbal feedback, physically model ways the child could do an activity or show them other students work by screen mirroring to give examples of 'good work' to check own progress independently. The classroom teachers' reflective comments were:

> *'Providing a mind map has helped (child) to see where the learning needs to go. (Also) vocabulary lists, help sheets. Reading a question for them. Pointing at where they are within the mind map overview (helps). Asking her questions. (Child 1 also) has extra support lessons (outside of classroom) where she is recapping or pre-learning lesson material. The short films on Twig are used along with quizlet for learning new vocabulary.'* Classroom teacher.

4.2.4 Special education needs students' executive function skills

The Behaviour Rating Inventory of Executive Function (BRIEF) psychometric test questionnaire was administered to the classroom teacher in order to gain a norm-referenced appraisal of teachers' perception of Child 1's strengths and difficulties in executive function skills (i.e. comparing teachers perception with those of other teachers' perceptions of age-matched children, including children who have learning disabilities). Pre-post tests were administered to teachers at the time of starting delivery of the science curriculum topic and again at the end of topic. The assessments spanned across one calendar month.

Findings indicated that based on teachers' perception of child's behavior in the classroom, Child 1 exhibited difficulties in executive function skills related to behavioural regulation – in particular ability to maintain attention while move flexibly from one learning activity to another. This corroborates teachers' observations of Child 1 (see 4.2.3. personal achievement –flexibility). Child 1's strengths in behavioural regulation were their ability to inhibit responses to distraction or act impulsively and to positively maintain regulation of their emotions. By the end of topic delivery, post-test revealed Child 1 was perceived to have less of a problem with flexibility with a 14% increase in function– however students' scores remained high indicating their difficulties were still within the range for special education needs provision. Interestingly post-test assessment for emotional regulation indicated the child's emotional regulation was decreased by 14% suggesting the child was perceived by teacher to have more problems in this respect. This corroborates their reflections from observing Child 1 (see 4.2.3 – emotional expression). There was no change in Child 1's ability to inhibit their behavior in situations of distraction or curb any impulsive actions.

The BRIEF test also provides assessment of children's metacognitive ability, i.e. child's ability to function independently when starting learning activities, to plan and organize their work, to hold information in mind and follow instructions (working memory) and to self-monitor what they are doing and how well they are doing. Findings from pre-test indicated that the teacher perceived Child 1 to have difficulties in executive function skills related to metacognition – in particular their inability to start working on and maintain attentiveness to a learning activity. This is corroborated by the high level of support required by Child 1 to help them get started with their work but also to guide them on what to pay attention to in order to complete the activity (see 4.2.3. – learning support). By post-test, the classroom teacher perceptions indicated some improvement in this area (10%) however students' scores remained high indicating their difficulties were still within the range for special education needs provision.

Teacher perceptions of Child 1's working memory (i.e. ability to hold information in mind and follow instructions while learning) indicated functional problems in this respect. This is corroborated by teachers' observation and reflection that Child 1 requires a lot of learning support to secure the student's attention because they are not engaged and to maintain attention to consolidate their learning, this because the student is unable to work independently. By post-test this had decreased somewhat (11%) but students' scores remained high indicating their difficulties were still within the range for special education needs provision.

Finally, the BRIEF test provides an assessment of students' metacognitive abilities to plan and organise and monitor their progress within the current time or anticipant what they need to plan and organise for the future. These abilities relates to not only planning, organising and monitoring materials/resources but also to their writing and oral communication of their understanding of subject knowledge. The classroom teacher perceived Child 1 to have difficulties in planning, organising and monitoring themselves but this was not for material things, which suggests the child may have difficulties in communication through oral and written work. This is corroborated by teacher observation and reflection that Child 1 has difficulties with verbal and non-verbal communication, engaging in rules and processed required of the learning activity and monitoring their learning, especially within the social group setting (see 4.2.3 – flexibility).

5. Conclusions and Implications

In undertaking work on this project, the head- teacher and seven practitioners (head of academic learning, head of ICT, the special needs coordinator and four teachers) were engaged in working together as a collaborative to develop their pedagogy for technology-enhanced learning utilizing the flipped learning concept to underpin this. Commitment to conducting the more rigorous evidence-based teacher case study during year 2 was overseen by an acting head teacher and undertaken by four practitioners (head of academic learning, head of ICT, the special needs coordinator and one teacher) who worked together as a collaborative. The conclusions and implications from this study about the impact of technology-enhanced learning on special education students' curriculum learning and the development of personal skills in attentiveness and self-regulated behavior is based upon the teacher case study classroom teachers' evidence-based practice.

5.1 Promoting diverse use of technology and digital media for learning within school time and at home

This aspect of flipped learning concept is advocated as flexible learning which means the students experience dynamic learning through teachers' use of: different teaching and learning activities; face-to-face or technology-based learning modes; independent or peer group work and learning at school or at home. This flexibility may be experienced as a stimulating yet chaotic learning environment by students but students with special education needs may have difficulties with this flexibility. This is illustrated in this study and suggests that for special education needs students, careful management of classroom resources, learning activities and switching between different modes of learning need to be provisioned by classroom teachers. In addition, development of students' skills in self-regulation of behavior, in particular flexibility, needs to be provisioned for by not only classroom teachers for curriculum learning but also through provision offered by special education staff.

5.2 Encouraging student-centred learning through independent and peer group work within the classroom

Although it was found in this study that the case study student with special education needs did experience difficulty accessing learning through independent and peer group work it was interesting to find that they were receiving personalized support from the classroom teacher because the teachers' time has been freed up from supporting whole class: by virtue of the technology-based independent and group work set for non-special education needs students. This suggests implementing technology-enhanced learning within the inclusive classroom context has potential for increased teacher-to-special needs student contact time. Such time was being devoted to special education needs students' curriculum learning and thereby increasing potential for success in academic achievement.

5.3 Fostering students use of technology for mastery learning

Through teacher observation and reflection it was found that special education needs students experienced difficulties with independent and peer group learning and switching between different modes of learning. However, these children benefitted from the availability of teacher generated videos and access to online learning apps at anytime within the classroom and at home to help student review the curriculum content covered by teachers in class, practice their knowledge of content and

prepare for the next class. Provisioning for this was time expensive on part of teachers however teachers developed invaluable curriculum learning resources for not only special education needs students by also non-special education needs students. In addition, such resources may be utilized by students in other classrooms and new students in years to come making development cost-effective in time.

5.4 Empowering practitioners to engage in professional collaboration to develop technology-enhanced learning for special education needs students

In undertaking working on this project the head- teacher and seven practitioners (head of academic learning, head of ICT, the special needs coordinator and four teachers) were engaged in working together as a collaborative to develop their pedagogy for technology-enhanced learning utilizing the flipped learning concept to underpin this. Practitioners' feedback to researchers conveyed they experienced difficulties in balancing their work on teaching and learning and collaborating with each other and the researchers on the project. Practitioners conveyed collaborations with each other and researchers during year 1 when workshops were being run was manageable and helpful for their professional development in developing pedagogy for technology-enhanced learning and raising their awareness of the special education needs of students in their class. However, they found it difficult to find time to engage in peer-dialogue to reflect upon their 'best practice' and share data/information about their practice with researchers. It may be that practitioners may become empowered to be involved in school-based projects such as this one, if the work they undertook was aligned to their professional development targets or they can seek accreditation for their work. The latter is appealing to teachers but the fees costs are often too high for them to consider this a serious option.

Overall, conclusions and implications for teaching and learning within an inclusive classroom context from this study as presented above are based upon finding from this case study in relation to applying the flipped learning concept to develop pedagogy for technology-enhanced learning for special education needs students within inclusive classroom contexts.

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