D5.3 – Report and findings from experimental pilot in the United Kingdom

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Document Author/s: Thomas Hughes-Roberts, Andy Burton, Dominic Marinovs, Jamie Tinney
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LIST OF ABREVIATIONS

NOLB	No One Left Behind
WP	Work Package
PMLD	Profound and Multiple Disabilities
PMD	Project Management Dashboard

EXECUTIVE SUMMARY

This document reports on the UK pilots as part of the No One Left Behind Project (NOLB). The UK focussed on the impact of the project learners at risk of exclusion to their individual learning needs; for example, cognitive disabilities. Through participation in this project, an approach to utilising digital Game Making within classroom teaching has been developed utilising the mobile platform applications Pocket Code and Create@School. This approach utilised game templates that could be downloaded by teachers and students and "populated" with subject relevant learning material in the form of game assets. Through this process knowledge acquisition is encouraged through careful consideration of what game assets should be added and how they would work as part of the game as a whole. This flexible approach allows for adaptable teaching to take place based on the individual needs of the learners in question. Learners with low levels of cognitive ability can focus on asset creation and simply "plug and play" from the game templates provided while more able learners can further adapt the game itself through the utilisation of coding concepts.

This approach and the application itself was implemented within four participating schools over a three-phase period consisting of a feasibility trial and two subsequent cycles of full testing. Sessions were observed to measure the in-class impact of the intervention. To facilitate this, a bespoke observation tool was developed using an interval sampling technique. This allowed for the observation and coding of sampled teacher and student behaviour to measure both instances of engagement within sessions and instances of collaboration between learners. The majority of intervention session were observed using this tool as well as a number of control groups for each class involved to serve as a basis for comparison. Further to this observation tool, the UK also implemented qualitative data gathering techniques using teacher interviews. This approach was necessary as the cognitive ability of the learners focussed on here prevented self-reporting from them.

Results demonstrate a positive impact from the project on the learners involved. Every class except one involved in cycle 2 of the project held an improvement in engagement which is statistically significant when compared to the control sessions suggesting the intervention provided students with a more focussed learning experience. From the observation tool, there was no statistically significant difference in instances of collaboration among students suggesting the intervention provide a learning experience that is as collaborative as other teaching techniques. However, teacher feedback suggested that the quality of collaboration was much improved in the participants in the trial suggesting intervention sessions fostered a more inclusive learning environment within the classroom.

1 INTRODUCTION

This document reports on the impact Pocket Code, and later Create@School, had within the classroom with particular focus on learners with diagnosed individual needs and their inclusion in the educational process. Therefore, the primary means of assessment was derived from classroom observations of learning and teacher feedback; as our target learners would have difficulty self-reporting. Teachers played a pivotal role in assessing the impact the project had on learners given their knowledge of the students and their daily engagement with learning. Given the complexity of learners dealt with in our pilots, the UK focussed on engagement and collaboration as key indicators of inclusive teaching practice delivered through Pocket Code based sessions.

The remainder of this report is structured as follows:

Section 2 provides an overview of the participating schools, the students within them and the lessons being delivered as part of the trial. Following this an overview of the lesson plans produced for our students is detailed. These lesson plans and the associated game templates provide a flexible and accessible teaching aid tailored to the needs of our target participants. Due to the range of complex needs and variation of those needs across the sample gathered, a suitable range of plans and templates was developed; this process is detailed in this report.

Section 3 provides an overview of the UK piloting plan in relation to the tasks present within the Gantt chart set-out at the start of the project.

Section 4 provides details of how the piloting was assessed and the resulting data from this assessment. Specifically, a bespoke in class observation tool was developed which can be applied during a teaching session. This tool gathered information dealing with teacher behaviour, learner behaviour and general engagement levels of the students. Furthermore, a series of qualitative feedback sessions with teachers was implemented to guide the evaluation of the project. In Cycle 1 these interviews were unstructured in their approach. A structured interview was then implemented within the evaluation protocols for cycle 2.

Section 5 concludes the report and summarises the findings from the piloting that took place in the UK. Overall, the UK reports a positive impact of introducing Game Making through the use of Pocket Code and Create@School applications. We observed increases in engagement in learners participating the project and teachers reported improvements in the quality of learning for at risk groups of students.

2 THE CHARACTERIZATION OF THE PILOT

2.1 *The participant schools, teachers and students*

The table below shows the participating schools, year groups, and subject/themes and identifies which cycle these groups collaborated within.

UK PILOTS	Course	Age	Subject	Students	Cycle
Sneinton St. Stephens	Victorian Britain Ancient Greece	Yr 5	Topic: History	30	1
Sneinton St. Stephens	Anglo-Saxons	Yr 6	Topic: History	30	2 (same group as cycle1 yr 5 above)
Sneinton St. Stephens	Victorian Britain Space	Yr 5	Topic: History and Science	30	2
Sneinton St. Stephens	Ancient Greece Food from around the world	Yr 4	Topic: History and Geography	30	2
Oak Field	Work and Life skills	Yr 10 / 11	Work and life skills, PSD, IT	8	1
Oak Field	Work and Life skills	Yr 10 / 11	Work and life skills, literacy, IT	12	2
Oak Field	Work and Life skills	Sixth Form	Work and life skills, PSD, IT	5	2
Christ the King	Religious and spiritual experience	Yr 9	RE	26	1
Christ the King	Respiration, Electricity and magnetism	Yr 8	Science	13	1
Christ the King	Atoms, elements and compounds, Energy	Yr 8	Science	27	2
St. Peter CofE	Life cycles	Yr 5	Geography	23	2
			TOTAL		

2.2 *Co-participative development of Create@School*

Our objective was to identify a set of common processes and timings that are needed in order to have pilots working and running with Pocket Code (and subsequently Create@School) integrated in classes during the two cycles of innovation in order to set a teachers' framework that allows improving the students' meaningful learning, engagement and social inclusion.

In (Annex 8) we show four examples of lesson plans used in the pilots of NOLB. These plans (Lesson plans A to C) demonstrate how the planning process has been informed by learning hierarchies and by identifying the ability levels of the pupils to scaffold their development in using Create@School. The highlighted sections show how programming instructions (in this case using the 'broadcasting' block instruction)

builds learning from simply recognising and adding the instruction (Lesson Plan A), to a higher level of cognitive learning in which pupils demonstrate their understanding of the 'broadcasting' instruction to create this more advanced section of the program (Lesson Plan B).

In the Annex 3 (Lesson Plan C), we show how learning hierarchies have been identified as well as the ability level of the target pupils. The highlighted sections show how the game-making framework may work in practice (in this case using the 'Diffusion' game shown the game templates).

Using the overview of the game-orientated Pocket Code technical modules as a guide (see D1.2 Functional Conceptual Framework); we can see that it falls into an action genre game (template). The Create@School features include the identified common elements and functions in game design, and it follows the academic resources. The subject is Science and the resource is appropriate for the Respiration System topic.

Lesson plan C introduces the learning objectives, linking with the learning hierarchy, whilst allowing the pupils to develop a subject-related 'game' using a scoring component. During the lesson plenary, the Diffusion game is downloaded, played and analysed allowing the pupils to discover, at their own pace, what other functions could be included and how to design their own inclusive games. Annex 4 shows the Medium term plan for this topic, including how 'diffusion' is covered in the lessons.

The first innovation cycle started with the parallel development of the transference of game mechanics and dynamics to the Pocket Code platform and generation of templates/modules for customisation into the curriculum topics. With close work with schools/teachers to situate transferred technologies and metrics one project by academic topic was fully developed and tested for usability and the application of Pocket Code; while this cycle will allow pilot sites to gather the needed information, all templates/modules necessary for the "Game-based Teacher`s Framework". This followed on into the 2nd cycle developing the stages required to initiate Create@School, and the teacher training guide was designed and the metrics defined, selected and refined.

By allowing children with special needs to develop their own games, NOLB, through Pocket Code, also aimed at developing special requirements and accessibility features in programming to meet the needs of children with physical and cognitive difficulties. A severe problem for accessibility is that developers may not have the ability to effectively implement accessibility or personalisation. Modules could be added to Pocket Code, presenting them with personalisation and thus building the mental foundation required to pursue accessibility.

For example, in chapter 2.3, templates to support the creation of games have been devised. These are to be completed by the end of the modules. These resources can be downloaded and used as a reference, or adapted during the game design process to help the pupils develop good design principles. Alongside these, guides have been created to breakdown the code and MDA (mechanics, dynamics and aesthetics) of the templates.

These resources show, how assets and materials are used during the teaching-learning process, and how they enable teachers to develop games within their subject using a range of pedagogies and styles of learning behaviours.

2.3 *Programs statistics*

The four example templates in figure 3 are included with the Create@School app. These are intended to support students during the game design process, to help them to develop good design principles. This is ensured by utilising the provided framework and templates within the current modules and training guides. The modules comprise programs which require game design development, and it is the pupils' task to expand and populate them with appropriate content (the *enhancements by users'* section within the template examples in figure 3). This scaffolds the pupils' game design processes and allows them to focus on the game development.

These templates were enhanced using object grouping and scenes to make them more concise and to support the pupils more effectively. The game genres used were created as they were identified as offering potentially useful models for gameplay and as supporting the project's definition of a common game structure. They provide links with videogames found in the commercial entertainment marketplace (such as a vertical platformer template which works in a similar fashion to the videogame 'Doodle jump'). We have found that these links to familiar games and gameplay styles have engaged the pupils to a greater degree. Appropriate academic subject content has therefore been used within these tempolates. This has helped provide greater accessibility to coding and game development, as well as the curricula objectives being met. The development of these game based methods are shown below.

2.3.1 Game-based Methods

Within the NOLB Innovation Cycles, a key element of the project was to integrate the methodologies and materials used in commercial games into the classroom. These games-based approaches linked with the curricular content to help reach the learning objectives and to increase empowerment and meaningful learning in pupils, whilst using the language and practice of game development.

The aims of these games-based methods are to co-exist other teaching approaches to enable the the teacher to scaffold the learning experiences with the Create@School tool. Through the pilots, various methodologies of use of game-based teaching methods were trialled, these included:

1. **Starter/Plenary mini-games**

   - Pre-existing programs with some adaptation for basic learning of coding skills – to build knowledge and create challenge.
   - Teacher provides subject orientated questions for pupils to answer through their coding knowledge.

2. **Full games (subject-based)**

   - Examples of games to be used & re-used.
     Provide the building blocks of knowledge and the related rational thinking of the themes approached in their academic subjects.
   - Playable though limited in adaptation (though may apply to certain individuals). High engagement/collaboration expected.
   - Playing games: Games already developed in Pocket Code that approach knowledge of the theme in the subject to be instructed could be used to understand the rational of problems or issues approached. This games embed school-like exercises in a computer game environment, with images and themes that relate to the students' preferences or likes,

allowing children to see how solutions or knowledge relate to the academic subject being instructed.

3. De-bug activities

- Simple mini-games (subject-based) with an intentional fault within the code. Pupils can begin to use their basic design skills to fix/debug the game
- Linking with the subject content, the de-bug program could "fix" a process in a literal sense.

4. Component Mini-games

- Programs which focus on introducing and applying game mechanics and design elements into the curriculum
- Game-based approaches with curriculum content to reach the learning objectives

5. Module output pupil created game (game template modules)

- The module's outcome is that the pupils (using Pocket Code) will be able to make (or adapt) digital games, as outputs that demonstrate their learning.
- The genre will be pre-selected, the pupils will be able to create their own content and use game elements previously applied.
- Pupils will need to plan and design their games (using story boards etc) before applying this to Pocket Code.
- Developing games: Within the 'playful learning' approach, Pocket Code allows children to develop their own games within their curricula lessons, using their perspective, rational and logic, as well as their preferred assets (thematic images, sounds, etc.). Thus students create their own learning material under Pocket Code game projects.

By creating and modifying games, the students developed and discovered the rules or logic of the knowledge to be acquired by themselves. The game's objective is the academic goal pursued, but also supports other skills such as computational thinking, problem solving, etc.

Currently the following programs have been created for use with school classes in the NOLB feasibility study/pilots. Some links are complete 'gamified' programs to play; already developed to approach knowledge of the theme in the subject. Others are useful game components, or debug activities focused on the 'playful learning' approach, allowing children to develop their own games within their curricula lessons:

Austria:

- General game template demonstrating the shape of a game (Akademisches)
  https://share.catrob.at/pocketcode/program/4943 (German)
  https://share.catrob.at/pocketcode/program/4854 (English)
- Skill game template
  https://share.catrob.at/pocketcode/program/4759
- Skill game "flappy" object
  https://share.catrob.at/pocketcode/program/4758

- Music game template (BORG Birkfeld)
  https://share.catrob.at/pocketcode/program/4921
- Computing Quiz template (BORG Birkfeld)
  https://share.catrob.at/pocketcode/program/4808
- Shooter template (GIBS)
  https://share.catrob.at/pocketcode/program/4771
- Story telling/Quiz template (GIBS)
  https://share.catrob.at/pocketcode/program/4800
- Educational (Physics: fluid density) template
  https://share.catrob.at/pocketcode/program/4661
- General object steering template (gamepad)
  https://share.catrob.at/pocketcode/program/4762
- Physics template (5th Grade)
  https://share.catrob.at/pocketcode/program/6857
- Physics template (2nd grade)
  https://share.catrob.at/pocketcode/program/9931

Spain

Official NOLB Spain account:
  https://share.catrob.at/pocketcode/profile/3620
GloriaUPM Pocket Code account:
  https://share.catrob.at/pocketcode/profile/2244
Teacher accounts: Ubeda –
  https://share.catrob.at/pocketcode/profile/3602 3 Eso (13-14 yrs old)
  https://share.catrob.at/pocketcode/profile/3612 2 Eso (12-13 yrs old)
Teacher accounts: Puerto de Santa Maria -
  https://share.catrob.at/pocketcode/profile/3615 4 Eso (14-15 yrs old)
  https://share.catrob.at/pocketcode/profile/3616 3 Eso (13-14 yrs old)
  https://share.catrob.at/pocketcode/profile/3617 2 Eso (12-13 yrs old)
- Educational (Maths: system of equation)
  https://share.catrob.at/pocketcode/program/3381 (Spanish)
- Quiz game template https://share.catrob.at/pocketcode/program/5149
  (Spanish)
- Educational (Maths: prime numbers)
  https://share.catrob.at/pocketcode/program/4553 (Spanish)
- Educational (Maths: trigonometry)
  https://share.catrob.at/pocketcode/program/3554 (Spanish)
- Educational (biology) https://share.catrob.at/pocketcode/program/3378
  (Spanish)
- Educational (History: prehistory)
  https://share.catrob.at/pocketcode/program/3571 (Spanish)
- Educational (Mathematics: equations)
  https://share.catrob.at/pocketcode/program/3376 (Spanish)
- Educational (Science) https://share.catrob.at/pocketcode/program/2662
  (Spanish)
- Quiz game template https://share.catrob.at/pocketcode/program/5128
  (Spanish)
- Educational (Mathematics)
  https://share.catrob.at/pocketcode/program/5261 (multi-language)
- Educational (Mathematics: prime numbers)
  https://share.catrob.at/pocketcode/program/5236 (Spanish)
- Educational (Mathematics: trigonometry)
  https://share.catrob.at/pocketcode/program/5238 (Spanish)
- Educational (Mathematics: fractions)
  https://share.catrob.at/pocketcode/program/5234

UK

- Broadcast template
  https://share.catrob.at/pocketcode/program/11863 (UK)
- Educational (Science: broadcast template)
  https://share.catrob.at/pocketcode/program/5370 (UK)
- Educational (History: broadcast template)
  https://share.catrob.at/pocketcode/program/5403 (UK)
- First interactive program template – (Example; the Victorians – History Year 5):
  https://share.catrob.at/pocketcode/program/5395 (UK)
- First interactive program template
  https://share.catrob.at/pocketcode/program/5395 (UK)
- Variable template
  https://share.catrob.at/pocketcode/program/11864 (UK)
- Educational (History: variable template)
  https://share.catrob.at/pocketcode/program/5397 (UK)
- Educational (Science: Variable template)
  https://share.catrob.at/pocketcode/program/5398 (UK)
- Educational (RE: variable template)
  https://share.catrob.at/pocketcode/program/5759 (UK)
- General inventory template
  https://share.catrob.at/pocketcode/program/5399 (UK)
- Game mechanic: Scores program template
  https://share.catrob.at/pocketcode/program/6967 (UK)
- How to fix: sound repeating program template
  https://share.catrob.at/pocketcode/program/5402 (UK)
- Class starter – Correct or Incorrect - Broadcasting
  https://share.catrob.at/pocketcode/program/11992 (UK)
- Class starter – Correct or Incorrect – Changing looks
  https://share.catrob.at/pocketcode/program/11993 (UK)

  Game mechanic: Timer templates -
  https://share.catrob.at/pocketcode/program/5404 (UK)
  https://share.catrob.at/pocketcode/program/5405 (UK)
  https://share.catrob.at/pocketcode/program/5406 (UK)

- 2-player synchronous game: Aerobic Vs Anaerobic (science; year 8)
  https://share.catrob.at/pocketcode/program/5411 (UK)
- Inventions (History; year 5)
  https://share.catrob.at/pocketcode/program/11908 (UK)
- Church denominations
  https://share.catrob.at/pocketcode/program/12703 (UK)
- Highscore template
  https://share.catrob.at/pocketcode/program/8161 (UK)
  2 player highscore template
  https://share.catrob.at/pocketcode/program/8498 (UK)
- Scoreboard template player 1
  https://share.catrob.at/pocketcode/program/8514 (UK)
- Scoreboard template player 2
  https://share.catrob.at/pocketcode/program/8515 (UK)
- Café ordering simulator
  https://share.catrob.at/pocketcode/program/9994 (UK)

- Circuit symbol debug
  https://share.catrob.at/pocketcode/program/10146 (UK)
- Ancient Greek Olympic debug
  https://share.catrob.at/pocketcode/program/8797 (UK)
- Stewardship debug
  https://share.catrob.at/pocketcode/program/11179 (UK)
- Mini-game: Negative or positive charge
  https://share.catrob.at/pocketcode/program/9361 (UK)
- Sequencing *looks* activities: Making a sandwich
  https://share.catrob.at/pocketcode/program/9713 (UK)
- Seven-day creation
  https://share.catrob.at/pocketcode/program/9714 (UK)
- The big bang theory
  https://share.catrob.at/pocketcode/program/10312 (UK)
- Evolution
  https://share.catrob.at/pocketcode/program/10313 (UK)
- Washing hands
  https://share.catrob.at/pocketcode/program/10609 (UK)
- Good morning! Extra – sequencing mini-game
  https://share.catrob.at/pocketcode/program/11142 (UK)
- Moving backgrounds – Ancient Greek Olympics
  https://share.catrob.at/pocketcode/program/11386 (UK)
- Bingo caller/card
- Template caller: https://share.catrob.at/pocketcode/program/12117
- Template card: https://share.catrob.at/pocketcode/program/12118
  Ancient Greek Olympics:
- Caller: https://share.catrob.at/pocketcode/program/8705 (UK)
- Card: https://share.catrob.at/pocketcode/program/9937 (UK)
  Health and hygiene:
- Caller: https://share.catrob.at/pocketcode/program/12123 (UK)
- Card: https://share.catrob.at/pocketcode/program/10608 (UK)
  Morning routine
- Caller: https://share.catrob.at/pocketcode/program/12124 (UK)
- Card: https://share.catrob.at/pocketcode/program/11304 (UK)
  Snacks and lunchtime
- Caller: https://share.catrob.at/pocketcode/program/11321 (UK)
- Card: https://share.catrob.at/pocketcode/program/11313 (UK)
  Religion and Science
- Caller: https://share.catrob.at/pocketcode/program/11442 (UK)
- Card: https://share.catrob.at/pocketcode/program/11443 (UK)
  Electricity (electrical circuits)
- Caller: https://share.catrob.at/pocketcode/program/12125 (UK)
- Card: https://share.catrob.at/pocketcode/program/11609 (UK)
  Victorian Britain
- Caller: https://share.catrob.at/pocketcode/program/11904 (UK)
- Card: https://share.catrob.at/pocketcode/program/11903 (UK)
  Items in a church
- Caller: https://share.catrob.at/pocketcode/program/12912 (UK)
- Card: https://share.catrob.at/pocketcode/program/12911 (UK)
  Respiration
- Caller: https://share.catrob.at/pocketcode/program/12915 (UK)
- Card: https://share.catrob.at/pocketcode/program/12914 (UK)

2.4 *Game Templates*

To begin the game-making process, we look to the curriculum adaptation and planning process, notably, the class objectives; what are the objectives of the class within this subject? (The "what" of learning).

When discussing the priorities within the topic the themes were broad with several areas to prioritise. In the Planning process, we would then; look at the defined timeline for the expected outcomes, the pupils' skill level on Create@School and what training might be required so that the students' learning experience is planned.

To transfer the concept of games to Create@School, the project's definition of a 'ceremony' provides a link to how to structure the game. Initially it is useful to have a game genre to work with as a foundation as different ways to present and play with the content. This may change through the process, since the genre classifications are unfixed and diverse, but it will help define:

- what game design elements are necessary to effectively create the chosen genre;
- what the interface is capable of;
- will the theme 'fit' into the genre classification (or the genre fit into the theme);
- whether the students will be engaged with this genre.

For example, if we select a 'quiz game' as the type/genre of the game, the mode of play in a social context would be predominantly as a single player though to build the 'ceremony' aspect of play, we could include leader/score boards so that the game could be passed around peer to peer. So, for changing the topic's learning objectives into something that appears like a game, we can add a new experience by for example adding or modifying/editing:

- a new context (backgrounds, new story end, narrative, etc.);
- a set of graphics assets (images, music, backgrounds, etc.) or improve aesthetics;
- a set of game mechanics (change the goal of the game) or change the dynamics including rewards mechanism.

By changing or adding different context, game assets and intentions, or additional game mechanics, the player adapts, customizes and creates diversity with the dynamics and aesthetics of the games, generating fun and engaging experiences.

By using the game design elements children, teachers and any game-maker can build and remix games to create new ones. The templates allow editing an existing design, enabling, allowing personalisation of backgrounds, landscapes, characters, the creation of new challenging levels, as well as changing the difficulty of a game.

The following figure shows a selection of the first game templates that adhere to different shapes of games and are available in Create@School.
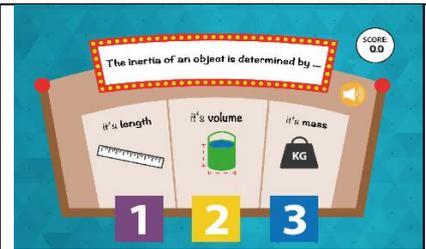
Create@School game created:		Quiz
ID: 9992		
Description:		Question/answer with text and images (audio). Provide content per the questions.
Gameplay:		Tap on one of the answers (1, 2 or 3). After answering the question, you get additional content. Switch to the next question by tapping.
Enhancements by users:		Add looks and more questions.
Learning goal:		Define questions to a certain subject/topic.
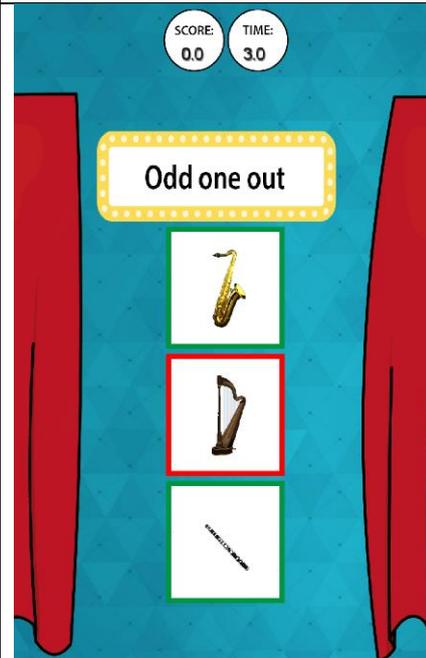
Create@School game created:	Puzzle
ID: 10148	
Description:	Odd one out, skill game.
Gameplay:	Tap on the curtains to open them. Tap on the one icon that does not fit with the others (odd one out). Attention: Time is running out – you only have 3 seconds to choose, or your score will decrease!
Enhancements by users:	Add looks and adjust the code.
Learning goal:	Logic challenge. Learn about a topic.

Create@School game created:	Adventure
ID: 9995	

Description:	Storytelling with linear choices.
Gameplay:	Listen to a question and decide "Yes" or "No". It is a linear game so one question will also lead you to the end of the game.
Enhancements by users:	Add content and sound files. Define more levels.
Learning goal:	For retelling a book. E.g. Help the characters to escape to a safe place (refugee stories) or answer subject related questions during the adventure.

Create@School game created:	Action
ID: 9997	

Description:	Tap on screen and get points per the asked question. Attention: Objects can also reduce the score.
Gameplay:	Tap on correct objects. The correct/incorrect objects depend on the question. The HUD-elements also include a timer with 30 seconds, a high score display and your current score.
Enhancements by users:	Add correct and incorrect objects. Define an overall question.
Learning goal:	Learn about a certain topic e.g. deoxygenated and oxygenated blood cells by tapping on the objects.

Figure 1: The first four NOLB Game Templates in the Create@School app

3 THE UK PILOT'S PLAN

The UK Pilot was implemented as per the plans laid out in D5.2 "Plan for the No One Left Behind small scale pilots' validation". The GANTT was set out as represented in Figure 2 with the first cycle of piloting running from months 9-22, and the second cycle running from month 21-30. Three schools were initially used, a primary, a secondary and a special education school. This was increased to utilise a fourth school (another primary) in the second cycle to reach the required numbers for student involvement.

3.1 *Progress of the performed work*

The piloting progressed as set out in the Gantt chart, see Figure 2. The description of the first task the "Setting-up" was included in Deliverable 5.2. The remaining tasks were completed according to schedule.

Teacher Training:
Teachers were trained by means of introductory hands-on sessions where they followed a set of tasks with a trainer to build a program. These sessions took place both as group training when possible (at Game City, Nottingham) and in school based meeting sessions. Continued training occurred in pilot sessions as they were all led by a pocket code expert trainer. By these means the teachers built upon their knowledge of Pocket Code/ Create@School in every lesson in class.

Students Training:
Prior to the onset of each class's pilots, the students were introduced to pocket code using a one off session where the students were guided through an info-board production task. During this task the students created a short program to tell a little about themselves using drawing, photos, audio, text and animation. This task was not linked to curriculum materials and as such was purely intended as an introduction to Pocket Code.

Development of Pedagogical Teaching Content:
The Pocket Code expert, running the training sessions, liaised closely with the class teachers at each school in order to be able to develop and deliver relevant course material via the pocket code lessons. Teachers provided their lesson plans, and the pocket code expert developed resources which could be used to integrate with this material via the game-making mechanisms.

The first piloting cycle:

The first cycle of piloting occurred using the developed pedagogic content and with the joint aims of honing the evaluation and assessment methodology at the same time as identifying the methods which work best in the classroom to integrate the new technology. The sessions were led by the Pocket Code expert, with support from the class teacher and any TA's present. One researcher was also present with the primary purpose of using and testing the observation protocols which had been developed and which are described thoroughly in part 4 of this document. The researcher was also available to assist with technological issues that may arise from time to time, including login issues, networking issues, screencasting issues, general crashes etc. The observer also observed any technological failures, bugs, glitches etc to enable reporting back to developers for debugging of the software.

The second piloting cycle:

The during the second piloting cycle, the use of Create@School was introduced. This required setup of the tablets with usernames and passwords for each individual student. In the second cycle, 3 classes were used in Sneinton St Stephen's school, one each from years 4, 5 and 6. A new year 8 science class was used in Christ The King Catholic School, as the other classes had progressed to year 9 and as such were beginning their GCSE curricula and no longer available for the experiment. Two classes were used in the special school, a Year 10 group, and a year12/13 group. A new school was introduced, Ruddington St Peter's CofE Junior School, where the year 5 ICT class was introduced.

The finalised observation protocol from the initial phase was utilised throughout the second phase for both intervention (with tablet and Creat@School) sessions, and control (no tablets) sessions. This protocol is described fully in section 4.

In section 4 we describe in detail the outcomes from the pilot, and the barriers experienced. Recommendations are made in the conclusion.

■ Cycle times (preparatory, 1st innovative and 2nd innovative) in which the project is divided
■ Overall process, as explained in subsections 3.X
■ Sub-processes or tasks belonging to the overall process

	JAN M1	FEB M2	MAR M3	APR M4	MAY M5	JUN M6	JUL M7	AUG M8	SEPT M9	OCT M10	NOV M11	DIC M12	JAN M13	FEB M14	MAR M15	APR M16	MAY M17	JUN M18	JUL M19	AUG M20	SEPT M21	OCT M22	NOV M23	DIC M24	JAN M25	FEB M26	MAR M27	APR M28	MAY M29	JUN M30
Preparatory Cycle																														
1st Innovative Cycle																														
2nd Innovative Cycle																														
Setting-up																														
Device definition and logistics																														
Schools agreement																														
Subjects contents required																														
Pocket Code approach																														
Development of basics Pocket Code tutorials																														
Development of advanced Pocket Code tutorials according to schools CVs																														
Development of Pedagogical Teaching content																														
Courses evaluation																														
Contents definition																														
Detection of interests and expectations																														
Modules 1st cycle. 1.1 - 1.4																														
Modules 2nd cycle. 2.1 - 2.9																														
Teachers' Training																														
Basic Pocket Code tutorials																														
Advanced Pocket Code tutorials																														
Students' training																														
Basic Pocket Code tutorials																														
Advanced Pocket Code tutorials																														
Evaluation phase																														
Definition of the pilots' experimental design objective																														
Design of the experimental program																														
Measurement and verification																														
Interval Observation Instruction and Coding Sheet																														
Follow-up running pilot																														

Figure 2: No One Left Behind pilots' Gantt chart

4 RESULTS OF THE CREATE@SCHOOL EVALUATION

To assess the impact of Create@School, the UK pilots were concerned with evaluating the added value the intervention provided when compared to typical classroom sessions. To this end, each session was observed to identify changes in teaching practice and student behavioural changes relating to session engagement and collaboration. Furthermore, teacher feedback on impact was sought to fully evaluate the pilot.

Engagement and collaboration are seen as suitable indicators of inclusive teaching practice for the target audience within this study; that is, learners with a range of potentially complex individual needs that can be a barrier to education. Should a whole class maintain an average level of increased engagement due to the teaching practice then a reasonable assumption can be made that the class is persisting with their learning. Furthermore, should participants who traditionally struggle to engage reject the teaching and learning practice then a possible influence may be held over the entire class's general level of engagement. Put simply, should a whole class maintain a higher level of engagement then there is an increased chance of more students having been included within the learning process. Indeed, engagement for the target groups is described as the single best indicator of learning (Iovannone, 2003). The role of collaboration in inclusive teaching is self-evident – if there is an increase in instances of learners working together then participants can be said to be included in learning alongside their peers.

As the target groups within the UK consist of a wide range of abilities, with some students with profound and multiple disabilities, gaining direct feedback from learners regarding the use of the app was difficult to achieve using measures that could be consistently applied across the whole set of learners in our study. As such, the challenge within our pilots was to utilise direct classroom observations and teacher feedback to evaluate the impact of the app and the pedagogy derived from it. However, should students consistently engage with the application such that it is at least as engaging as traditional teaching methods then the application can be said to be usable. Due to the range of cognitive disabilities in our target groups, should the application not be usable there will be little to no engagement.

4.1 *Methodology*

Evaluation was conducted through both qualitative and quantitative measures. Qualitative measures include teacher feedback through focus groups and interviews and in-class observation notes. Quantitative measures include in-class observations utilising two formally defined protocols. Each approach is described over the following two sections.

4.1.1 Observation Protocol

The observations conducted as part of pilot impact evaluations utilised a formal, quantitative data gathering process. An overview of an observed session is detailed across two stages detailing the behaviours exhibited by both teachers and students with the aim of noting down the teaching activities taking place and their relation to learner engagement and collaboration; this is similar to the STROBE classroom observation tool (O'Malley et al., 2003; Kelly et al., 2005). Each stage of this data collection process is detailed in the following section of this document.

Observed intervention sessions are therefore compared to a suitable control group to ascertain if there is any statistically significant difference. In this case, suitable controls are taken to mean observations of the same class within a comparable, typical teaching session of similar learning content.

4.1.2 Observation Protocol – Stage 1

Target behaviour is captured over fixed intervals (Alessi, 1980); a single session is split into 5-minute intervals, the first stage is completed at the start of each interval and deals with detailing the characteristics of the teaching session observed across three categories: structure, teaching activity, and general engagement.

Structure: This deals with how the class has been organised for the teaching session; i.e. is the whole class treated as one or has it been separated in to smaller groups etc. The following codes should be used:

Table 1 – Observation: Class Structure

Code	Structure
1	Entire Class
2	Sub Groups
3	Other

Activity: This deals with the nature of the learning scenario currently being taught and utilises the following codes:

Table 2 – Observation: Teaching Activity

Code	Activity
1	Instructional
2	Procedural
4	Inquisitorial
3	Other

Task Assessment: This deals with a quick assessment of the proportion of the class that is on task from the following codes:

Table 3 – Observation: Task Assessment

Code	Task Assessment
1	Half or less
2	More than half
3	Almost all
4	All

4.1.3 Observation Protocol – Stage 2

Stage 2 deals individual participant (teacher and student) behavioural observations. In this phase, the observer notes down what the teacher is doing and then proceeds to sample 4 learners within the classroom; a different learner is chosen each observation until the whole class has been observed, the process then begins again if there is time left in the session.

For each individual observation (of the teacher and sampled learners) a 20 second window is used to record the observable behaviour. A momentary sampling technique is utilised whereby a behaviour observed at the end of the 20 second window is recorded.

The following serve as the code for teacher behaviour:

Table 4 – Observation: Teacher Behaviour

Code	Teacher Behaviour
1	Talking to entire class while all the students are passive receivers.
2	Starting a discussion with the whole class or talking through a learning activity that students should be following step-by-step.
3	Starting or conducting a discussion with groups.
4	Monitoring groups of students (as they work independently).
5	Monitoring the entire class (as they work independently).
6	Asking class or individuals to show their work (during or at the end of sessions).

The following details the codes for the learner behaviours:

Table 5 – Observation: Learner Behaviour

Code	Learner Behaviour
1	Off-task – engaged with another behaviour.
2	Off-task – disruptive to peer or peers.
3	Reading, writing, typing, listening – could be following the session but difficult to determine, could be waiting for the next instruction.
4	Following along with instructor or with learning material – e.g. off slides, from a book, in response to a request for help etc.
5	Receiving personal tutoring or interacting with teacher; demonstrating work to them etc.
6	Demonstrating work to another student. Receiving demonstration from a peer.
7	Working with another student or groups of peers to solve problems.
8	Wanting to participate/speak/demonstrate (arm raised) or actively participating - answering questions or demonstrating work to the class.

Any time remaining in the 5-minute observation interval is utilised to record any qualitative notes regarding the session; this includes interface issues and bug reports for the Create@School interface. A full observation protocol document can be found in Annex 1.

4.1.4 Teacher Feedback

Further to direct session observations, teacher feedback was sought using focus groups, interviews and, to a lesser extent, teacher diaries. During cycle 1 this process of gathering feedback was informal, taking place during project meetings and using un-structured e-sources (i.e. teacher's diary). A formal method was then introduced in cycle 2 to examine the teacher perceptions of impact during the study; there follows a list of questions guiding this interview (the full protocol is included as annex 2):

1. Can you summarise how Create@School is currently/has been used in your classroom?

2. How would you assess the impact it has had on the students learning experience?

3. Have you noticed any changes in the way the students learn within sessions driven by Create@School?

4. Have you noticed any changes in student attitudes within sessions driven by Create@School?

5. Have you observed any changes from the previous two points within other sessions since taking part in Create@School sessions?

6. Can you give any examples of particular students that have particularly reacted to Create@School sessions?
   Interviewer note: positively or negatively if requiring some prompts but avoid leading questions.

7. Would you feel confident employing Create@School driven sessions in the future, without the support of the NOLB project team?

8. If so, where do you see yourself using Create@School in the future?

9. Can you give an overview of how you might introduce it?
   Interviewer note: subject area, general outline of sessions – why was this example chosen could be an interesting area to explore if possible.

10. If not (from question 6), what support do you think you would require to become comfortable working with Create@School independently?

11. Is there anything else that would make the introduction of Create@School long term difficult?

4.2 *Impact of Create@School in UK Pilots – Cycle 1*

4.2.1 *Feasibility trial – Identified usability Issues and Initial Feedback*

Prior to the formal piloting beginning a brief feasibility trial was implemented in order to assess both the intended approach to using the application and any potential usability issues that arise from the application's use. This latter point is important given our target participants will have a mix of individual needs including those with Profound and Multiple Learning Disabilities (PMLD).

Trials took place in two classes within two schools; The first a mainstream school for primary education containing a mix of typically developing students and those with individual learning needs; the second a special school supporting students with PMLD, a subset of learners that exhibit a wide range of individual needs and where learning goals vary widely.

A further school was also involved in this stage but due to the frequency of trials and the initial approach taken quantitative data is not in a form that would provide useful analysis. A review took place with this school to determine changes to be made to ensure successful implementation of the project in cycle 2; qualitative data is reported on in section 4.2.10.

Each school was provided with tablets pre-loaded with Pocket Code. Tablets were numbered and individually assigned to learners to utilise throughout the trial; hence within each session each learner worked on their own tablet to tackle the tasks at hand.

A class of 30 in the primary school and a class of 12 students from the special school took part in the feasibility trial; within this first feasibility trial, no control condition is utilised.

The purpose of this initial trial was three-fold:

- to evaluate the suitability of game making tools in special education;
- to assess the potential impact of game making tools in special education and develop suitable tools for measuring that impact;

- to determine the usability requirements and challenges game making tools face with the target participants.

The trial consisted of two sessions, each an hour in length and took place over the course of a typical classroom session. Standard session topic, learning objectives and content were converted into a game making session aimed at achieving the same outcomes. Content used in the primary education school dealt with the Roman history topic, and in the special school, key life skills lessons were adapted.

The sessions varied in length having to fill the time provided within a typical teaching slot in the school day. While a rigorous lesson plan was produced, at this stage of the trial no pre-made content was produced for the coding elements of Pocket Code itself meaning participants would be starting the lesson with a blank template in Pocket Code.

Sessions were delivered by a Pocket Code specialist in conjunction with the usual class teacher. Furthermore, within the special school, teaching assistants were present as usual.

The impact of the feasibility sessions was measured through the following means:

- qualitative observations during sessions to assess interaction with Pocket Code; an observer attended each session taking general notes.
- teacher and teaching assistant feedback following the sessions through un-structured interviews and focus groups.

4.2.2 Usability Issues – Feasibility Trial

The use of programming in game making holds significant challenges which must be overcome if it is to be a tool utilised in everyday teaching; particularly in special education. Teachers within our trial held concern that their students spent time learning to code with the Pocket Code bricks rather than learning the subject knowledge the lesson should be delivering.

"The students did not have the ability to remember what we did last session; we had to revisit what the bricks do so we could carry on".

"Between sessions they couldn't remember how to use Pocket Code… some cannot recall the correct ordering or what individual blocks do".

This would perhaps suggest that a number of participants within our sample struggled with the abstract ideas of programming inhibiting its use as a tool for learning. This suggests a need for careful adaptation of the User Interface (UI) to enable those with cognitive disability to tackle the concepts found within programming (and to an extent game making). Further to this, teachers stated students with Special Education Needs and Disabilities (SENDs) need software adaptations, for example:

"There are too many categories [of bricks] within each script type; our students need less choice".

Again, it would appear that participants with cognitive disability find it difficult to tackle the higher-level concepts that the bricks represent and the range of options available to these participants further hinders their ability to understand and apply the functionality offered. A solution could be found through personalisation of the Pocket Code environment through User Profiles where, based on the cognitive needs of the learner, only certain categories and their bricks are available until understanding has been demonstrated. Indeed, Werner et al. (2014) suggest four levels of computational thinking related to the concepts of programming which can be used to evaluate understanding.

Identifying the computational concept each brick represents is a further challenge to these student's due to the vocabulary and labelling used within the environment:

"The wording to describe the blocks is not appropriate for our learners".

The use of words such as "forever" (to describe a loop) or "broadcast" (send parameters between objects) do not aid learners with cognitive disability in grasping the concept the brick represented preventing the application of that brick within a game. Teachers within the special school, where this observation was most prevalent, suggest that their students' reading ability was at a level where it is difficult for them to simply understand the words, and as such, the concepts the words represent leading to their application in game making being next to impossible when the students are introduced to Pocket Code.

However, interviews with teachers suggested replacing the text with symbols (e.g. Makaton) for their students as utilised in other learning material across this schools. This would enable the students with PMLD to begin to grasp the concepts represented by the bricks. However, the programming may require cognitive skills that some of these participants do not yet have and, therefore, they must still be able to engage with the session without being limited by the learning tool. As suggested in the pedagogy examination, this could include the use of pre-built game templates. The students would then be expected to create assets related to the subject being taught and to perform only minor changes to the coding blocks. Indeed, student responses in the observations highlight the enjoyment gained from creating digital artefacts/assets for the games. These changes are highlighted in the development of our lesson plans and pre-made game templates.

Discussed thus far is the impact cognitive disability has on learners with PMLD whilst engaging with game making as a learning tool. However, various issues with physical disability were identified which were often unique to subsets of participants; understandable, given the heterogeneous nature of classroom education. For example, some students found the text too small in formula editors, the use of colour in labelling the bricks confusing and the interaction when placing a brick difficult where a drag and drop would be easier than the currently implemented user interface. Whilst these usability issues are common, the range of issues observed across individual participants in our study highlighted the need for personalisation within the technology intervention in order to achieve a more inclusive learning experience. This can be achieved through the development of pre-made templates to an extent and this is reflected in the pre-made templates utilised in later cycles in the pilots.

4.2.3 Observations – Cycle 1

Two schools, as described in table 1, took part in first iteration of testing for the project and held accompanying controls: Sneinton St. Stephens Primary School (SSS) and Oak Field Sports College (OF). The former provides mainstream education with classes containing a mix of typically developing learners and those with noted individual needs. The latter provides special education for learners with PMLD.

The following table summarises the statistics from the first cycle of the intervention detailing the number of discrete observations for both the intervention sessions and the control sessions.

Table 6 - Cycle 1 Overview

	SSS	OF
Intervention Sessions	8	4
Intervention Intervals	100	55

Intervention student observations	500	220
Control Sessions	2	5
Control Intervals	24	60
Control student observations	120	300

Note, control sessions for OF school consisted of a separate but similarly developing class engaging with the sessions the intervention group normally would have while the control for SSS school consisted of the same class of learners in other lessons with similar learning outcomes and activities.

4.2.4 Cycle 1 – Engagement

To evaluate engagement, the observed codes recorded from Table 5 were re-coded to one of two classifications: 1 or 2 recoded as not-engaged, any other code can be said to be engaged.

Table 7 provides a summary of the engagement statistics for the two schools in cycle 1:

Table 7 - Cycle 1 Engagement

	Intervention		Control		Chi-Square Value
	Engaged	Not-engaged	Engaged	Not-engaged	
SSS School	86.7%	13.3%	81.5%	18.5%	P = 0.201
OF School	91.3%	8.7%	78.3%	21.7%	P < 0.001

Table 7 illustrates that a higher percentage of engaged scores were recorded for both schools when examining the whole dataset; i.e. all intervention session data compared to all control session data. However, this was only a statistically significant difference for the Oak Field school. This would suggest that the introduction of the intervention technology was at a least as engaging as traditional teaching methods and, in some cases, can provide a more engaging learning experience for some students. These results will be explored further through the qualitative data obtained.

Sneinton St Stephens - Engagement

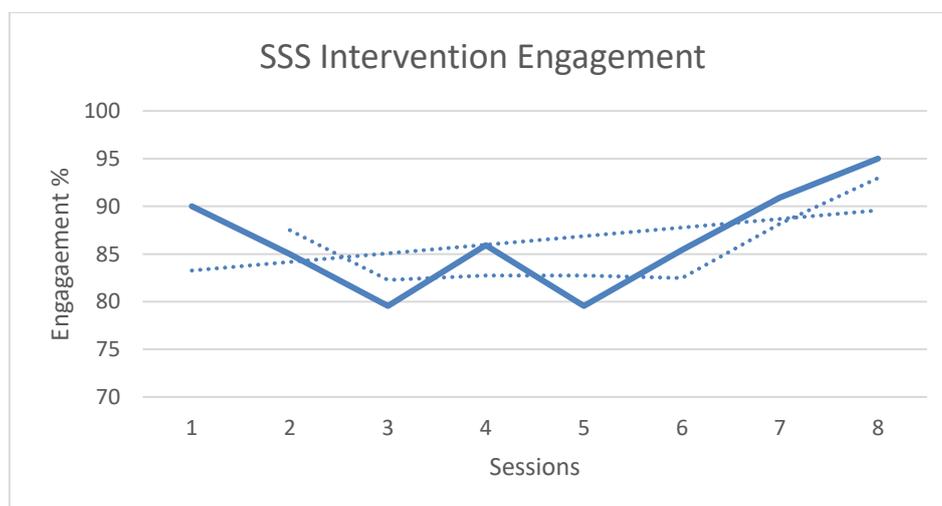Engagement across each session is summarised in figure 2:

Figure 3 - SSS per Session Engagement

Interestingly, figure 2 would suggest that engagement started high in the first session, perhaps due to the novelty of the learning method and the initial excitement over using game making in the classroom for the first time. Following this initial session, general engagement appears to dip and this trend continues for several sessions. This could suggest that, following the initial novelty of game making, students perhaps struggled with the new concepts introduced thus affecting their session engagement. However, following session 5 engagement appears to be an upward trend as exhibited by a 95% engagement observation in session 8. Again, this may suggest that, having acclimatised to the new concepts, students were then able to fully engage with game making as a classroom activity. This upward trend would suggest also that any initial engagement observed as a result of novelty may also translate into more persistent engagement that is the product of the strengths inherent in game making as a teaching tool. An increased number of observed sessions would be required to ascertain if this trend is a persistent increase in engagement.

Engagement – OF

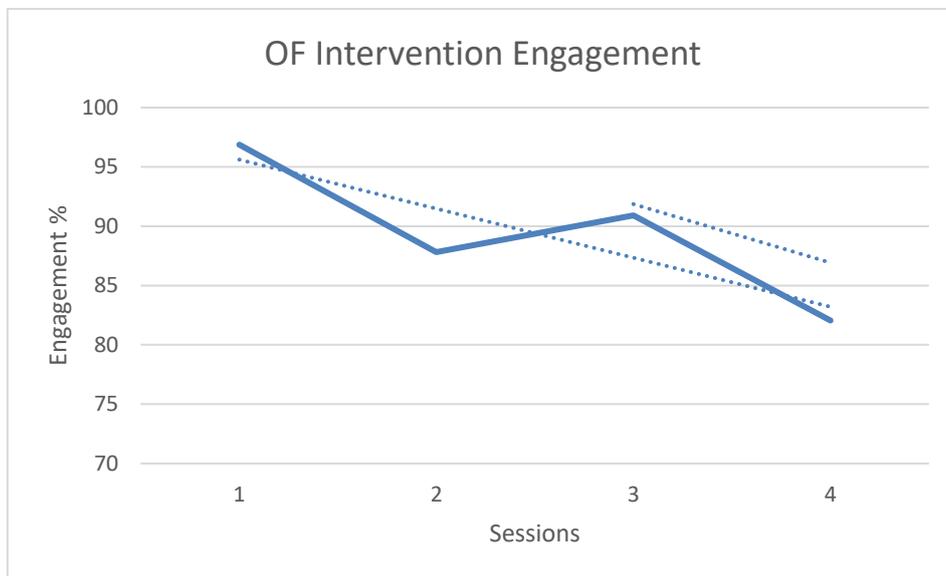Figure 3 provides an overview of engagement with the OF school:

Figure 4 - OF per Session Engagement

Interestingly, unlike SSS School the trend within OF appears to be on a downward trajectory when looking at engagement across each session; however, there are clearly fewer sessions to examine here and at the point the cycle finished in the OF school is around the session where engagement began to increase in SSS.

For comparison, figure 5 provides an overview of the control session engagement scores:
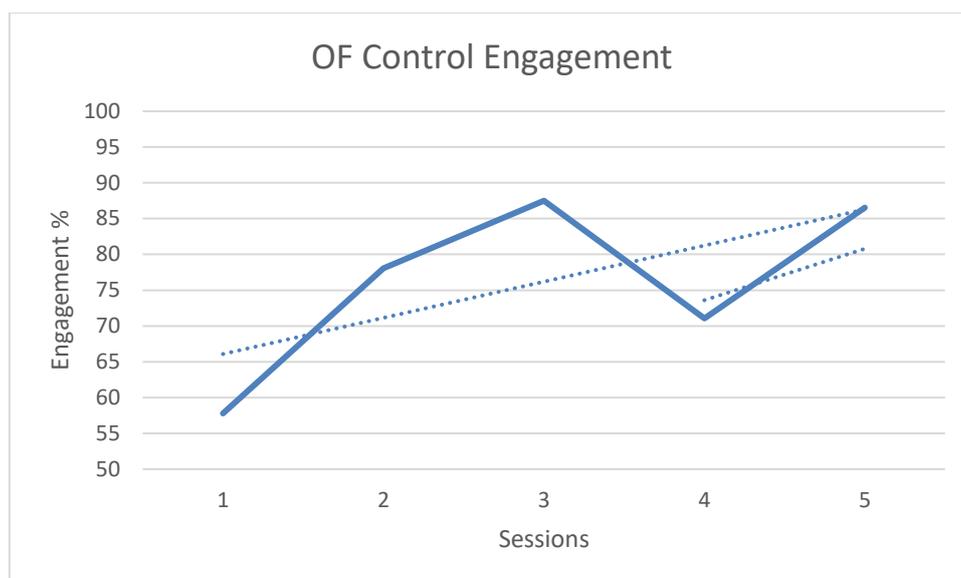
Figure 5 - OF per session control engagement

It is noticeable from the figure 4 that engagement appears more inconsistent across each session with a sub 60% figure at the start of the observations. However, this may be an outlier and an increase in the number of controls would ascertain if this is a consistent finding.

4.2.5 Cycle 1 – Collaboration

To evaluate collaboration, the observed codes from Table 5 were again recoded – an observed behaviour classified using code 7 or 8 can be re-classed as collaborative behaviour and all others as non-collaborative. A summary of this when looking at all intervention session and control session observations is provided in Table 9:

Table 8 – Cycle 1 Collaboration

	Intervention		Control		Chi-Square Value
	Collab'	Not-Collab'	Collab'	Not-Collab'	
SSS School	12.8%	87.2%	6.5%	93.5%	P = 0.093
OF School	12.6%	87.4%	6.2%	93.8%	P = 0.021

Again, a higher percentage of collaborative behaviour was observed in both schools compared to the control sessions and, as with engagement, this was a statistically significant difference for the Oak Field school only. This would suggest that the intervention and teaching sessions that employ it can produce a more collaborative learning environment in some cases and therefore, potentially a more inclusive one.

It is worth noting that instances of collaboration will be more heavily influenced by the session being delivered; e.g. should a session template contain a segment dedicated to group work instances of collaboration will naturally be higher in that session. As such, a per session breakdown is not applicable for examining collaboration in greater detail. Where the control groups are concerned, efforts were made to ensure comparable sessions formed the focus of observations; i.e. containing similar teaching delivery methods as the intervention sessions.

4.2.6 Cycle 1 – Computational Thinking

Further to the above-mentioned methods of measuring engagement and collaboration within the SSS School, a computational test was administered before and after the cycle. This test consisted of a compilation (total of 10) of computational puzzles, challenging various aspects of computational thinking. This was administered by the teacher who spoke out the questions, displaying the pictures required for the tests on the projector. Answers to each question were provided through multiple choice. The exact same 10 questions were delivered pre and post cycle. These tests were deemed to be too advanced for students at the OF school and, due to complications in the cycle could not be delivered in the CtK school. A copy of these tests is provided in the annex.

An overview of these results is provided in table 10.

Table 9 - Computational Tests Overview

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Cycle	29	1.00	9.00	5.1379	1.95894
Post-Cycle	29	1.00	10.00	6.2069	2.17747
Valid N (listwise)	29				

There appears to be a slight average increase on the total score obtained by a group in the post-cycle test; this is a statistically significant increase (Wilcoxon p=0.009). However, these results should be considered within the limitations of the method applied. That is, it is difficult to isolate the direct cause of the increase in computational thinking given that Pocket Code sessions were not the only learning the students engaged in over the 8-week period. This period would also have included maths and IT sessions which also contribute to computational thinking. Furthermore, several students (a third of the group) either performed the same or worse than they did at the start of the cycle bringing into question the validity of the method applied. Given this, the use of the tool was not continued into cycle 2.

4.2.7 Cycle 1 – Other Observations

Further to engagement and collaboration, the observation protocol also sought to understand the way in which Create@School is deployed in a teaching session compared to other, traditional sessions; e.g. does the use of this intervention naturally lend itself well to specific teaching methods?

The intervention sessions in both schools, for example, displayed more instructional teaching practice compared to their controls (both chi-square p<0.0001) as illustrated in the following figures:
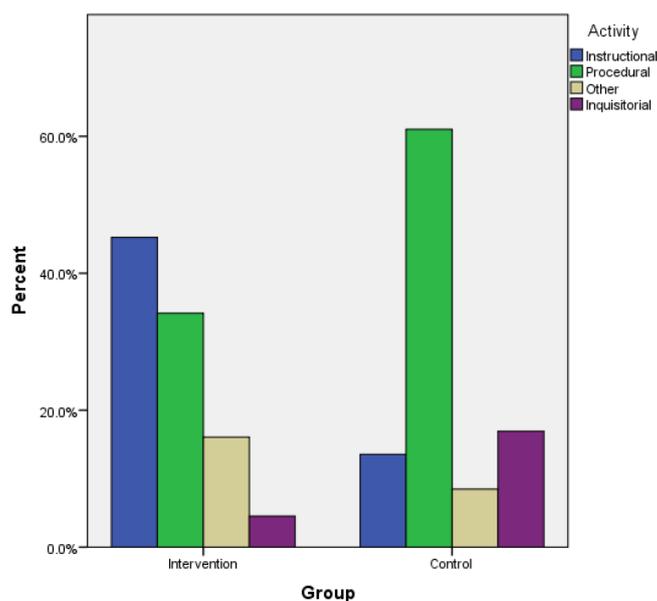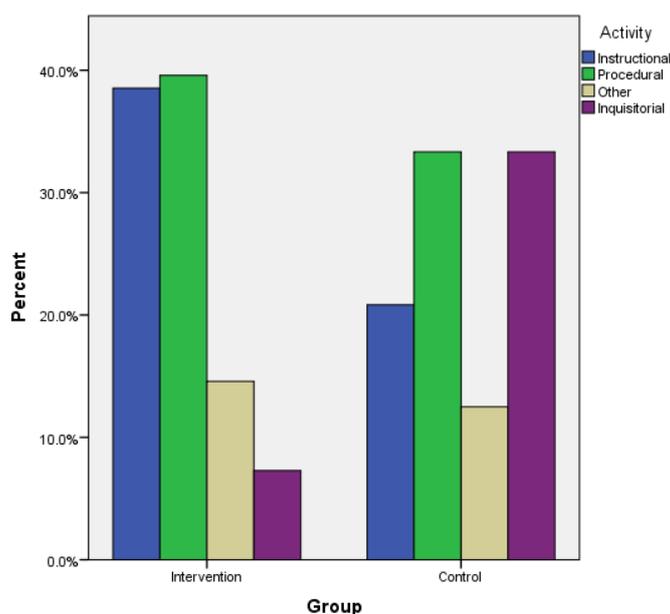
Figure 6 - SSS teaching activity

Figure 7 - OF Teaching Activity

The similar approach across the two schools suggests an emerging consistency of practice for the deployment of Pocket Code based sessions despite the differences between the two schools and their related student cohorts.

Similarly, observed teacher behaviour within the SSS control sessions held significantly more whole class monitoring (Chi-Square, $p<0.001$) where students were given a task and left to work on it with relative independence. A similar finding is present within the data gathered from the participating special school; however, the intervention sessions there also held significantly more individual and group based tuition which is perhaps to be expected given the much smaller class size and presence of teaching assistants.

4.2.8 Cycle 1 – Qualitative Feedback: OF and SSS

The introduction of Pocket Code within the primary school appeared to be mainly positive with teachers noting fewer instances of disruptive behaviour occurring which would

typically require their removal from the class; "they don't want to risk not being in the class when using the tablets". Furthermore, individual students appeared to react differently to the teaching medium compared to how they usually would; "one student, who usually gets very upset when making mistakes, seemed much more willing to have a go and experiment with the code". This was also noted about a number of students in the class throughout the cycle; in the teacher diary – "This was particularly evident with [student name] who is unable to focus for longer than a few minutes in most lessons. Throughout this whole lesson he was engaged in what he was doing, taking his time and making sure it was of a good standard which is something he can struggle to do at times in class". This would appear to be a strength of the medium, allowing learners to test their ideas and analyse the immediate results – "sessions allowed the children to further investigate pocket code and allowed them to use trial and error to solve problems". This also seems to be something which is being transferred into other sessions: "The children are becoming more and more confident with taking risks and having a go at aspects of the lessons they are not 100% sure on".

The more able students, having picked up the initial concepts earlier in the sessions, were observed helping less able students; the teacher is developing this finding so that these students could become "digital leaders" as per similar schemes present in the school; from the teacher diary – "The class seemed to rely on each other's skills and used their peers to help them if they were stuck. Teamwork is something which the class on the whole struggle with so it was nice to see them using each other's work in a positive way" and "during the sessions this week I noticed teamwork between members of the class, which is something this class struggle with on a whole. Children who were progressing well used their initiative and went around the class to help members of the class which were struggling". Interestingly, the teacher suggested that the increase of instances of teamwork was being transferred into other sessions – "the children are meeting their aims at the moment and the teamwork they have shown as a class is starting to now be used in other lessons. This is being modelled well during these sessions and recently we have started to see this behaviour in both English and Maths lessons.".

The participating teacher within SSS noted that knowledge (following session 5) retention between sessions was surprisingly robust allowing further sessions to run smoothly. This is in keeping with the measurers of engagement found in figure 3; from the teacher's diary – "The children have started the sessions more settled this term and this may be due to the familiarity they now have with pocket code".

Within the school focussing on students with PMLD teachers commented that the students appeared engaged, despite their low literacy levels which was identified as a potential barrier to Pocket Code use prior to the research. Participants appeared "calmer" (teaching assistant) in comparison to typical classroom sessions. Furthermore, there appeared to be obvious pride in the work achieved with participants exchanging tablets with each other to demonstrate their work. Participants "particularly enjoyed using the camera and paint program to create assets to use in the game" (teacher). This highlights that participants with SEND, who may struggle with more complex coding tasks, can still engage with Create@School based sessions through asset creation thus providing some degree of ownership over the work produced.

From this brief and informal observation and feedback opportunity Pocket Code as an everyday teaching tool could provide a potentially engaging and collaborative learning experience. However, aspects of the delivery required some alteration. For example, starting with a blank template for program creation led to an increased amount of time working on the basics of program development rather than the intended subject matter. Teachers expressed concern that students were spending too much time learning programming rather than the curriculum material required. In response to this, lesson templates have since been integrated with pre-made game templates which can be downloaded and altered to fit a session. For example, a generic quiz game template can

be adapted within the classroom with subject matter images, questions, answers and feedback.

4.2.9 Cycle 1 – Initial Qualitative Feedback: CtK

Initial results within the CtK school were not initially positive. A qualitative feedback session was held with the students to ascertain what could be changed regarding the delivery of the application with a view to making alterations in cycle 2. The following represent comments in which five or more students agreed:

"Too confusing – everything – the bricks, the way the bricks had to be ordered, the way it was taught"

This is in-line with other usability issues identified and as such alterations were made to the use of game making templates and teacher training material as well as the material provided to the students.

"Felt purposeless. Perhaps it would be better with a bigger project, i.e. over more curriculum time."

Alterations made for cycle 2 included going into this school earlier and dealing with a smaller subset of learners prior to introducing Pocket Code to the full class. This allows for tweaks to learning material, production of "digital leaders" from those who engage earlier with the application and the ability to focus on a larger project and curriculum material.

"In some lessons, we spent more time fixing things [technical problems] rather than being taught" and "Often by the end of the lesson problems were still being sorted out".

Teaching material was continually developed to ensure that the technical requirements of programming do not hinder the acquisition of subject knowledge. The development of frameworks and templates played a key role in addressing this issue.

"Repetitive – wanted a faster pace, more challenge. Some would have like something harder" and "didn't make a game that was fun – needs to be more game focus and more fun".

This feedback highlights the importance that while game templates can tackle a barrier to inclusion in learning it must not prevent more capable students from getting the most out of the session that they can.

4.3 *Impact of Create@School in UK Pilots – Cycle 2*

Cycle 2 of the No One Left Behind pilots ran in a fashion similar to the above but with the following alterations:

- An increased number of intervention sessions within each participating school.
- An increased number of participating schools (see table 1).
- Control sessions consistently changed to use the same group of participants as in the intervention sessions; this allowed direct comparison with behaviour in typical (non-Create@School) teaching sessions.
- The qualitative data collection tool was used to collect formal teacher feedback from across participating schools.

4.3.1 Observations – Cycle 2

Cycle 2 of piloting added further pilot classes to the round of testing. Within the mainstream primary school, a further two classes took part: a year 4 class and a year 5 class. The year 6 class continued their involvement in the project within their new school year group. The special school now included their year 10 and 12 groups of learners; again, these students exhibited profound and multiple learning disabilities. The secondary school included a year 8 class; piloting here was split into two parts with a smaller group taking part in the first stage to refine teaching content and then being introduced the whole class. Finally, a new primary school also volunteered to take part; this mainstream school also contained a mix of typically developing learners and those with noted individual needs.

Table 10 provides an overview of all observed sessions, both intervention and control in cycle 2 of this pilot study.

Table 10 - Cycle 2 Observation Overview

	SSS Yr 4	SSS Yr 5	SSS Yr 6	OF Yr 10	OF Yr 12	CtK Yr 8*	StP Yr 5
Intervention Sessions	8	8	5	7	8	7	5
Intervention Intervals	131	122	54	75	100	63	58
Intervention student observations	486	447	235	269	357	242	204
Control Sessions	2	1	2	2	2	2	1
Control Intervals	28	16	24	24	18	23	13
Control student observations	109	64	120	86	72	92	52

*Note, full sample only

4.3.2 Cycle 2 – Engagement

As per cycle 1 observational data was recoded to give a general overview of engagement or non-engagement for each behaviour observed. An overview of comparisons to control data is provided in table 11.

Table 11 - Cycle 2 Engagement Overview

	Intervention		Control		Chi-Square Value
	Engaged	Not-engaged	Engaged	Not-engaged	
OF Year 10	80.3%	19.7%	72.1%	27.9%	P=0.108
OF Year 12	89.6%	10.4%	75%	25%	P=0.001
CtK Year 8	82.2%	17.8%	70%	30%	P=0.015
SSS Year 4	90.1%	9.9%	73.2%	26.8%	P<0.0001
SSS Year 5	87.5%	12.5%	78.1%	21.9%	P=0.042
SSS Year 6*	95.1%	4.9%	81.5%	18.5%	P<0.0001
StP	93.6%	6.4%	82.7%	17.3%	P=0.012

*Note, same group as cycle one and therefore have pre-exposure to the intervention.

Engagement across all pilot sites is higher in our intervention sessions in comparison to the control. In all but one pilot site this increase in engagement is statistically significant according the Chi-square test for association.

Engagement – OF Year 10

Figure 7 provides an overview of the per session engagement, trend and moving averages for the observed intervention sessions.
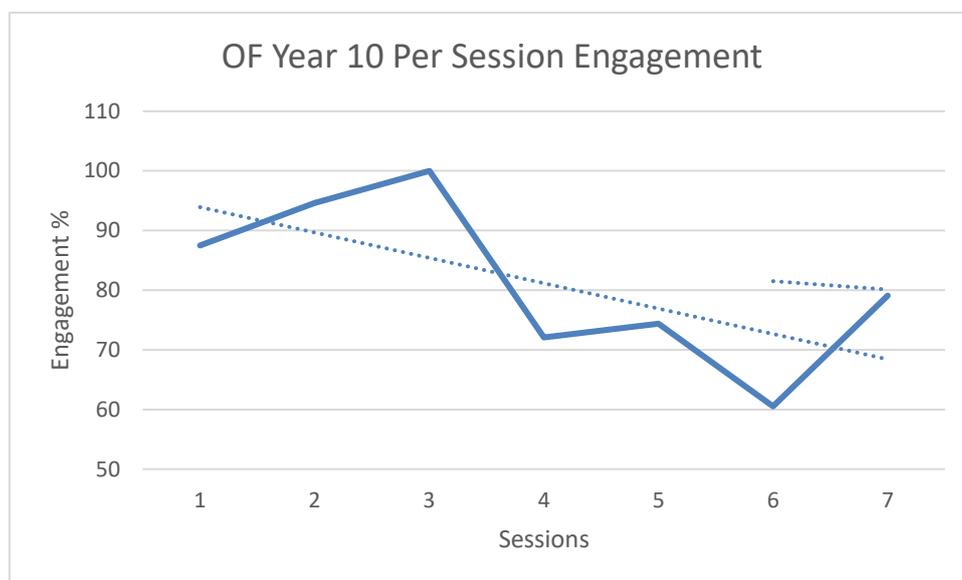

Figure 8 - OFS Year 10 Engagement

Again, this is the only pilot site in the second cycle of intervention testing that did not hold a statistically significant difference in the level of engagement compared to the control. The range of variability in engagement across the observed sessions may account for the lack of a statistically significant difference in comparison to the control.
The trend line demonstrates a sharply decreasing decline in engagement over the course of the session; however, again, this could be due to the range and complexity of the individual needs present in this participant sample.

Engagement - OF Year 12

Figure 8 provides an overview of engagement across all intervention sessions conducted in the other pilot group in the OF school.
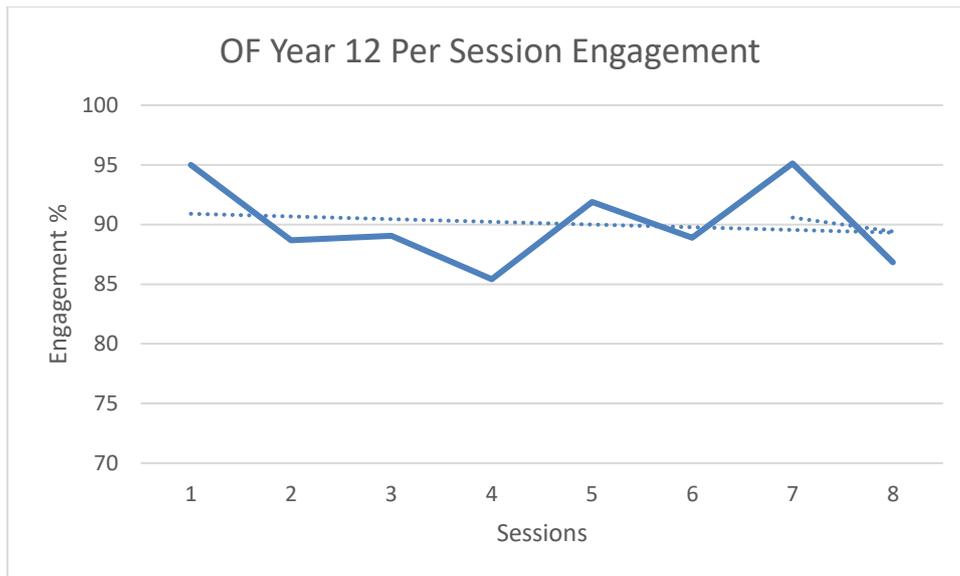
Figure 9 - OF Year 12 Engagement

This suggests a more consistent level of engagement across the intervention sessions for this group with a trend line that suggests a slight downward trajectory but is otherwise fairly level; perhaps to be expected given that engagement across these session is increased with statistical significance when compared to the control. Furthermore, this increase in apparent consistency demonstrates the variability among learners when considered across different groups even when taken within the same pilot centre.

Engagement – SSS Year 4

All three pilot sites within the SSS primary school held a statistically significant increase in engagement when compared the control. The year 4 group engagement over the course of intervention sessions is detailed in figure 9.
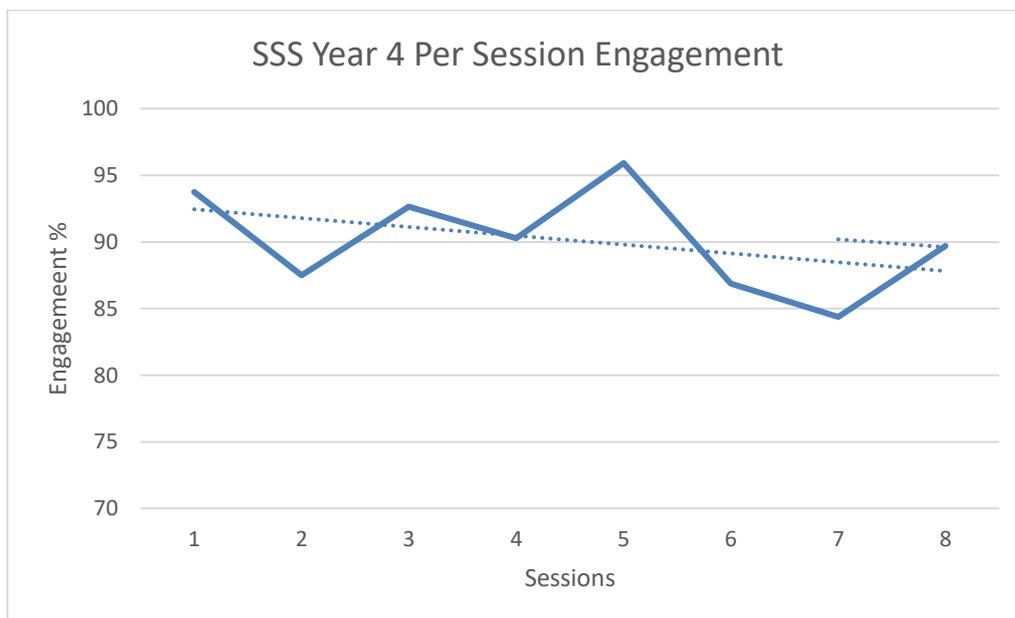

Figure 10 - SSS Year 4 Engagement

This group saw a relatively consistent level of engagement across the sessions of between 85-95% although there is a noticeable downward trend over the full course of the treatment.

Engagement – SSS Year 5

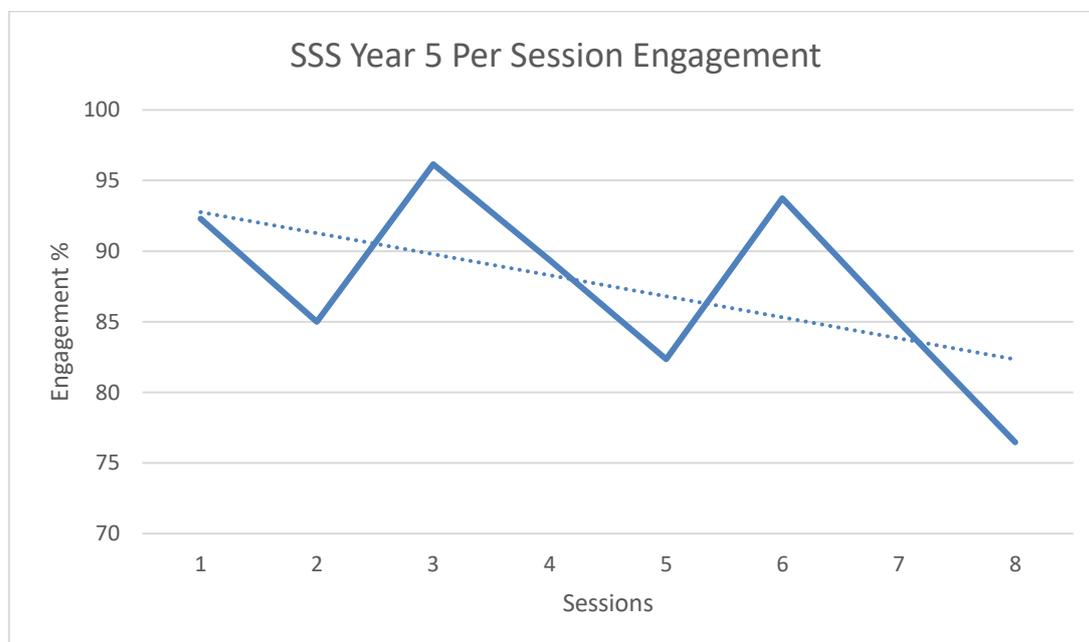For the year 5 group, figure 10 provides an overview.

Figure 11 - SSS Year 5 Engagement

Again, a downward trend is observed; however, the sessions appear to fluctuate between around 85-95% engagement with the final session appearing to be something of an outlier. Indeed, interestingly, this session appears to hold more observations of open class monitoring with regard to the teacher behaviour leading to a perhaps less structured portion of the session. This would suggest that the use of Create@School allows a more structured teaching session which leads to increases in engagement but unstructured, open work sessions can quickly lead to students going off-task without specific teacher guidance.

Engagement – SSS Year 6

Finally, the year 6 group engagement overview is provided in figure 11. Note, this group was continuing with the study as the former year 5 group from cycle 1 and as such already had significant exposure to the intervention.
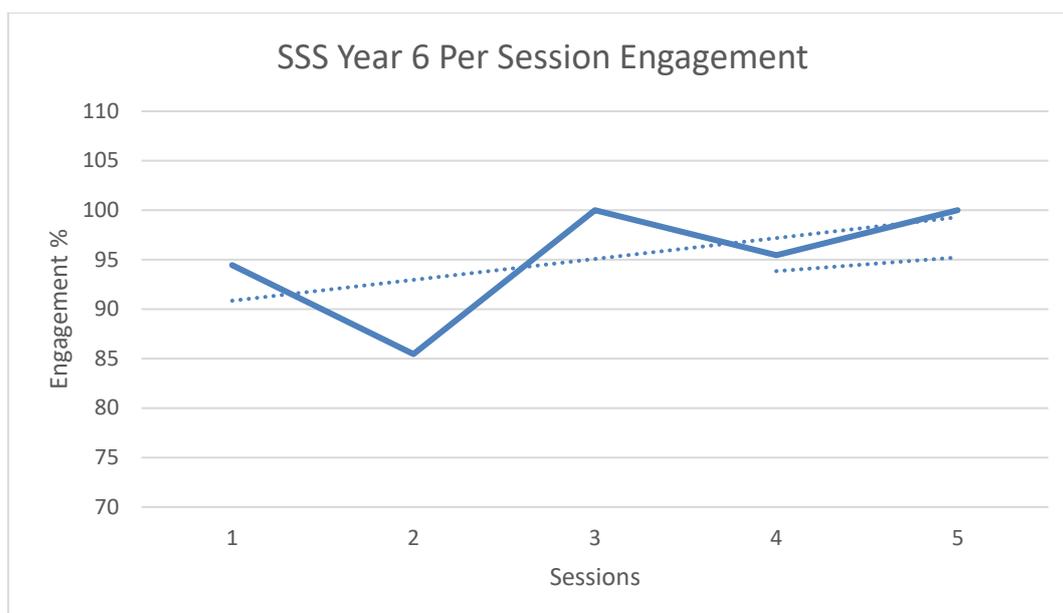
Figure 12 - SSS Year 6 Engagement

Interestingly, this group held the highest per session engagement, albeit over fewer cycle 2 sessions. Furthermore, the trendline suggests a clear and consistent level of engagement, particularly when considered with groups examined thus far. Recall, from cycle 1 that this group saw a dip in engagement prior to a rise by the end of the trial, teachers suggested this could be due to the students getting used to the intervention and the technical requirements of it. This, and the downward trends in other groups, may suggest that a period of adjustment to the intervention is expected and could then lead to consistently high engagement when part of the usual teaching toolkit. This group would therefore further suggest that prolonged use of the teaching intervention leads to consistently high levels of engagement within the classroom.

Engagement – CtK Year 8

The following two figures provide an overview of engagement with the CtK Year 8 class. Figure 13 charts the per session engagement of the smaller group participating in the study prior to the interventions use in the full class, illustrated in figure 13. This approach was taken in order to tailor the use of Create@School to the specific needs of secondary education.
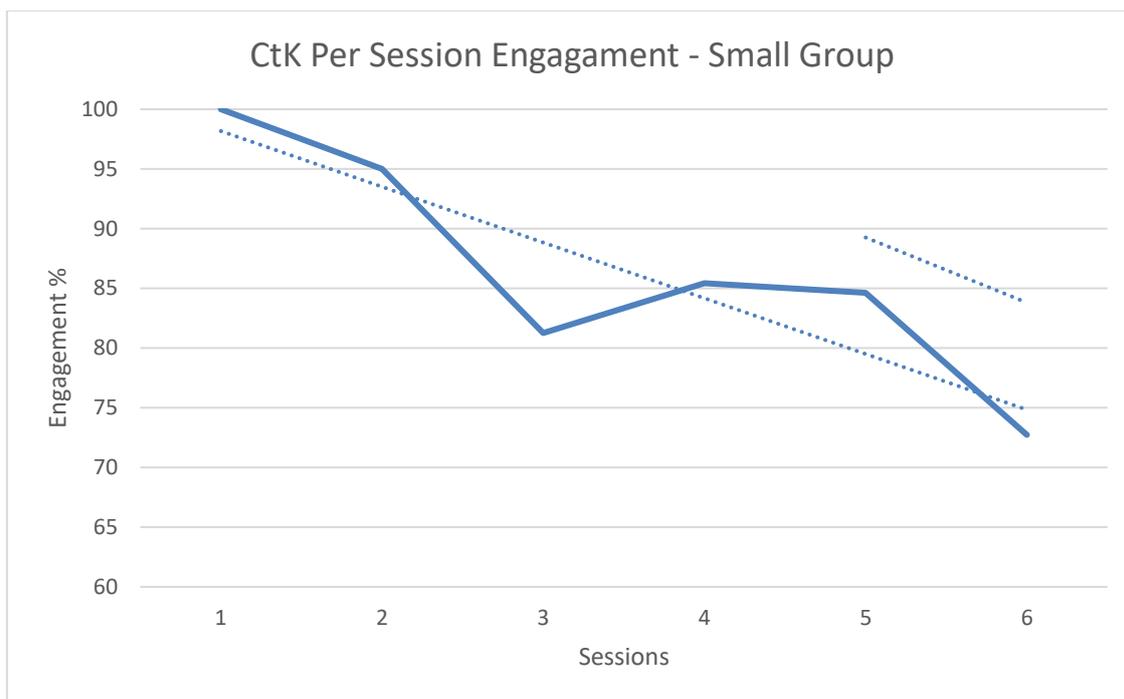
Figure 13 - CtK Year 8 Engagement (small sample)

Note, the clear downward trend in engagement, although this is from a high first session starting point. As mentioned previously this could be due to the novelty of the intervention leading to high initial engagement but lessening as the technical requirements require concerted effort to learn. We might, therefore, expect to see engagement rise as the whole class is introduced to the intervention. It may also be due to the transition across the sessions from a dictative coding learning style in the introductory lessons, to a more free and experimental learning style towards the end of the trial. Initial lessons served to introduce the mechanics of use of Create@School, whereas once this was achieved, the students were left to edit elements of the code more freely with an experimental rather than guided lesson format.
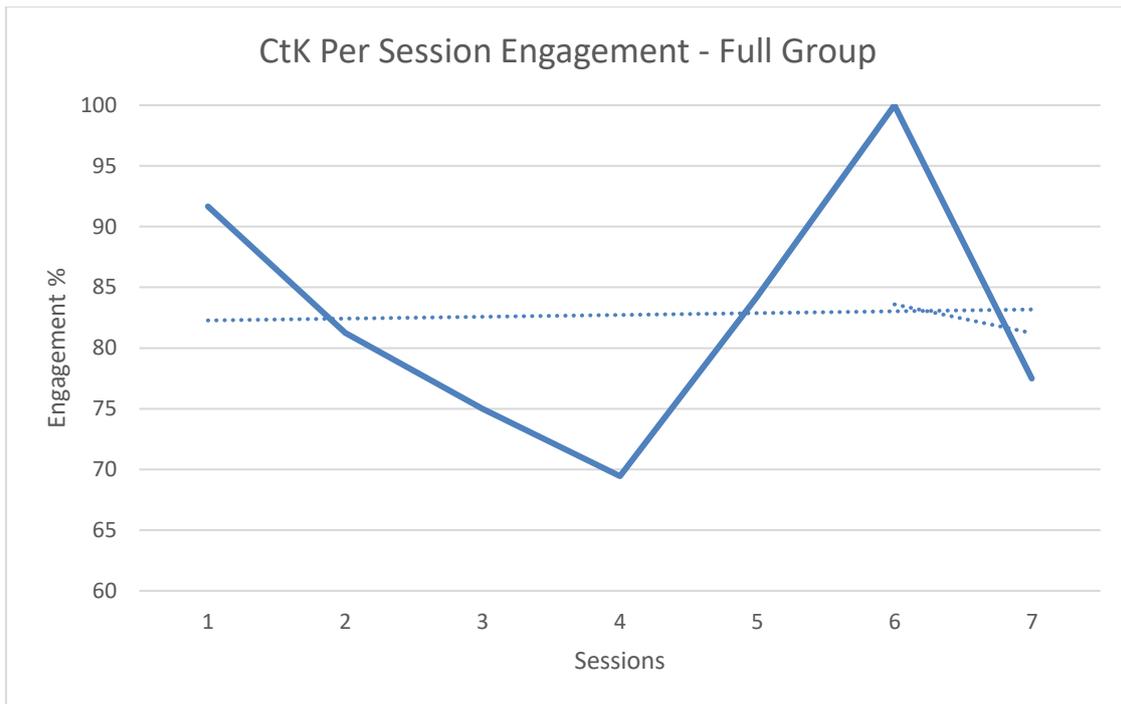
Figure 14 - CtK Year 8 Engagement (Full Sample)

The full class per session engagement would appear to confirm this as a decline in engagement is observed but then begins to increase following session 4 and the cycles as a whole demonstrates a slight upward trend in overall engagement. The final session does dip below 80% engagement; however, as per the previous pilot school this session's structure is also open with whole class monitoring being the most observed teacher behaviour (incidentally as does session 4).

Engagement – StP Primary School

The final pilot group, from the StP primary school, took part in five intervention sessions over the course of cycle 2. An overview is provided in figure 14.
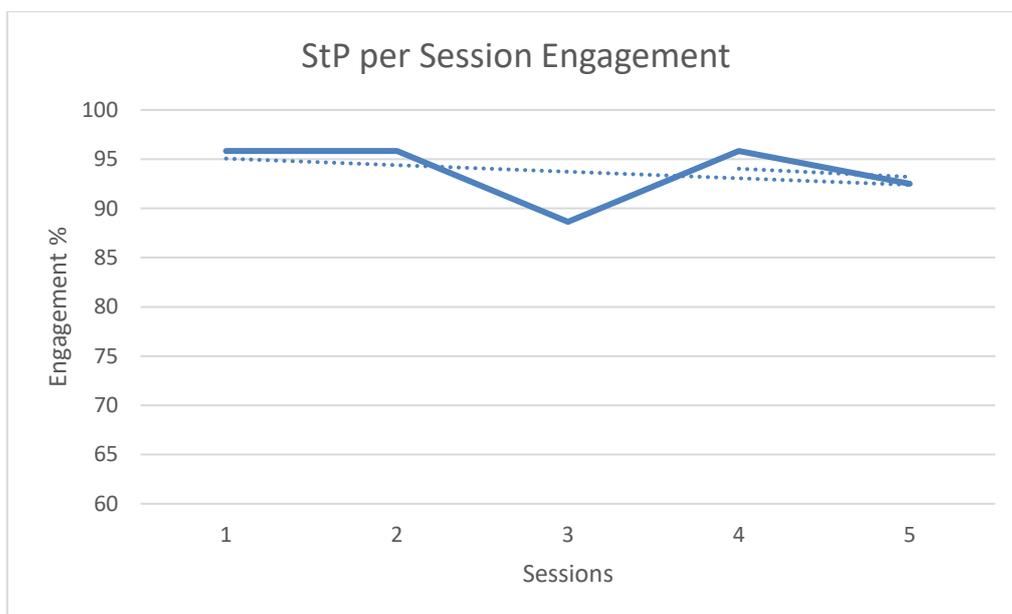

Figure 15 - StP Engagement

This group saw a high level of engagement throughout their sessions as shown in the relatively flat trendline. However, there are fewer sessions in this site than conducted in others and this high engagement may be due to an initial "novelty period" as seen within some of the other UK pilot sites.

4.3.3 Cycle 2 – Collaboration

Again, as per cycle 1, observed student behaviours can be recoded to isolate only those that represent some form of collaborative behaviour. This is summarised for the pilot sites in table 12. It is worth noting that collaborative behaviour is perhaps more reliant on the make-up of the session as opposed to the intervention itself; i.e. if no group tasks are incorporated then collaborative behaviour is not likely. However, in the more able schools, and in particular those that operate some form of formal peer mentoring, the use of the intervention may lead to increased instances of peer support within the sessions.

Table 12 - Collaboration Overview – Cycle 2

	Intervention		Control		Chi-Square Value
	Collab'	Not-Collab'	Collab'	Not-Collab'	
OF Year 10	4.1%	95.9%	3.5%	95.6%	P=0.794
OF Year 12	9.8%	90.2%	0%	100%	P=0.006
CtK Year 8	16.9%	83.1%	0%	100%	P<0.0001
SSS Year 4	14.3%	85.7%	13.4%	86.6%	P=0.794
SSS Year 5	16.6%	83.4%	20.3%	79.7%	P=0.454
SSS Year 6*	11.9%	88.1%	6.5%	93.5%	P=0.151
StP	21.1%	78.9%	21.2%	78.8%	P=0.991

Results here suggest that, in general, the intervention does not produce more naturally occurring collaborative behaviour. Only one pilot group exhibited statistically significant difference compared to its control and the remainder no clear difference. From this sample, we can conclude the Create@School sessions were at least as collaborative as traditional teaching methods and may lead to increases under certain conditions.

Furthermore, while this method will capture overt instances of collaboration it will not identify the kind of peer interactions being observed. For example, instances of learner satisfaction, increases empathetic support between peers and effects outside of the classroom will not be identified through this observation and sampling method. This could be a focus of further studies.

4.3.4 Cycle 2 – Qualitative Feedback

Three in depth interviews were conducted with teachers from Sneinton St. Stephens primary school, Christ the King Secondary School and Oak Field School & Sports College. Three teachers took part in a focus group interview within SSS, one teacher in an interview within Oak Field and two teachers in a focus group interview in CtK. The full transcripts for the interviews can be found in the annex. The following provides a thematic analysis on the interview data providing the key emerging themes behind the use of game making in the classroom and its impact on the learners therein.

A summary of the identified themes for discussion is provided in table 13.

Table 13 - Thematic Overview

Themes	Description
Engagement	Dealing with the level of learner engagement/focus within classroom sessions and in other sessions as a result of the project.
Inclusive Classroom/Collaboration	Dealing with the degree to which the class as a whole provides an inclusive environment for learning through improved peer interactions.
Inclusive Classroom/Individual Learning	Dealing with changes to individual participants that enable them to better engage with their learning within the classroom or beyond.
Knowledge and Skill acquisition	Dealing with the ways in which Create@School enabled or perhaps improved a learner's ability to gain new subject knowledge or skills.
Persistence of Leaning	Dealing with the degree to which participants practice independent and continue effort following error or lack of perceived progression.
Accessibility	Dealing with the ways in which Create@School overcomes issues with usability and accessibility
Barriers	Dealing with the potential issues preventing the long-term use of Create@School within everyday teaching and learning.

Theme 1 – Engagement

Engagement appeared high, from the teacher's perspective, within the primary school with students settling into the lesson quickly and easily as time in the project went on:

"They are very engaged in it aren't they. They are desperate to get the tablets out and do work on them" [SSS, S2].

"… it is a more engaging task. They are more willing... they really want to achieve during the lesson, and their attitude switched to: "I want to do well in this" [SSS, S1].

Similar perceptions of engagement were commented on in OF where engagement is often very difficult to achieve within sessions and can be a learning objective in and of itself:

"They are all really keen. Sometimes we have to say, "put your iPads on the table and listen a minute", because they all want to get on with it. But it's really lovely to see though, because in other sessions, I'm going "come on, let's get on with our work"" [OF].

Within the secondary school, however, engagement was more dependent on the learning task being focussed on through Create@School:

"There are a couple of games they've done, that I think are pretty good, that show a decent understanding. It all depends on the topic, because some topics are easier to do than others. For example, I did a biology topic about adaptation and variation… that was quite easy. They went around taking photos of different things about them. At the moment, we're doing stuff about physics, and it's quite hard to give them something to do … Depends on what games you are making" [CtK, C1].

"whilst [to C1] reinforced the idea... it did have impact, I think the students were engaged with the use of the tablets and the use of the programme itself" [CtK, C2].

This would suggest that, in order to focus on knowledge acquisition, the cognitive elements of coding and therefore game making have to be limited and instead the focus placed on asset creation in relation to learning material as suggested in the feasibility trial and cycle 1.

Engagement also appeared to depend on the kind of game being made within the session; those that quite clearly implement traditional game mechanics appeared more successful in engendering excitement than those that were more static in the final product:

"There was a game where you had to bounce from level to level, which was pretty good because it actually felt like a game, which is what they wanted. Whereas they've had other ones where they've just had to add photos to a slideshow kind of thing. I think there were less into that because it felt less like a game, more like a piece of work" [CtK, C1].

Theme 2 – Inclusive Classroom/Collaboration

Create@School lessons appeared to foster a more inclusive classroom when in use with instances of learners not only collaborating on their work but also demonstrating pride and satisfaction in what they have created. They appeared keen to share this with others:

"I think it is really good in showcasing their work, because they want to show each other what they know" [SSS, S1].

"And they tend to go to each other before they go to the adults in the room. To try problem solving and debug their program" [SSS, S1].

Similarly, within OF, the student who is perhaps at a higher cognitive level than his peers in the classroom often finished set work, requiring more to be allocated. However, the teachers noted that the student was beginning to go around the class and help others:

"Today I was getting him to explain to the other students how to do something so that he wasn't on his other games, so that he was doing something productive in the session" [OF].

Furthermore, interaction between students appeared to improve outside of sessions to include those who were not involved with the project:

"The person that was in our session and the person who hadn't… interacting a bit. One of them showing the other how to do it" [OF].

Within the secondary school teachers noted a "calmer" room in comparison to what they are used to in other teaching sessions:

"When I have been into those sessions, I think the students…. the group that you teach, there are quite a lot of energy. They are quite energetic students. I'm not saying that they are really badly behaved, but they are quite loud. Whenever I go when they are using the tablets, the atmosphere seems calm … when they've got the tablets in their hand, they are pretty easier to control" [CtK, C1].

This point is reinforced by teacher C2:

"They are not causing distractions … I think it does support behaviour for learning" [CtK, C2]

Theme 3 - Inclusive Classroom/Individual Learning

As well as apparent impact at a classroom level, teachers noted that the project appeared to impact a number of students on an individual level which included their general attitude and the approach to learning. A number of these students held individual learning needs so the impact the project had on them surprised the teachers within this study. Within SSS for example a number of students are highlighted to provide examples:

"[Name redacted], he tends to struggle to hold his attention in a lot of lessons. But this is something he has really excelled at" [SSS, S1].

"I barely get him to do any work, yet he will sit there, and won't get out his seat. And that is the thing with him, he'll constantly get out his seat looking for distractions. Yeah, he's just sat there focused, getting on and actually he's one of the lowest abilities in the class and yet he's still doing the things" [SSS, S2]

And following on from this in other classes the change is not apparent for other teachers with similar session types, suggesting that the change in this student's demeaner is due to Create@School specifically:

"That's not just the tablet, that must be Create@School, because we tried him with typing on the tablet and other work on the tablet which didn't go particularly well. So it is a lot because of Create@School that he's doing during those lessons" [SSS, S1].
S3 provides a further example from their class where the student change enabled them to be a more participative learner with the whole class:

"… he excels in these lessons. It is so nice for him, because quite a lot of lessons he is the one having lots of extra support, needing extra adult help, and he is able to help others in that lesson because it is really logical, it's really problem solving" [SSS, S3].

While, there is some suggestion in the secondary school that the application and sessions introduced increase creativity in some of the learners.

"There are some other kids, enjoyed... they preferred being creative with it … There has been some quite funny, creative ways that came through" [CtK, CS].

Furthermore, within the OF, teachers found that the exact same learning outcomes had a different effect on some students highlighted the engagement engendered in certain learners through Create@School:

"I've noticed that with [student 1], where sometimes we played bingo as a paper version one lesson. Because I was interested to see what would happen if he had a paper version then actually had a go of the gardening bingo to do with our session. And the paper he found really difficult. He was not engaged and finding it quite tricky to look and decide what it is exactly he was doing. Then we put an iPad [sic] in front of him, he was really engaged at looking at the board and waiting and really engaged by what's happening and he was matching it straight away" [OF].

As we have touched on elsewhere the driving factor behind positive impact within this study, particularly for learners with PMLD, appears to be gaining ownership of their work which can also bring about changes in their learning:

"Sometimes, because the ownership is on them... they've got their own iPad [sic], they've got their own games, they've got to add a sound. It was nice that [student 2] used his own voice to add a bit of... I know it would be difficult for us to understand what he was saying, but to have that confidence to actually record a sound. I was shocked … And that

is something we often struggle to get him to say a lot. So, it was quite nice to hear some of them actually using their own voices for things like that" [OF].

Theme 4 – Knowledge and Skill acquisition

Theme 4 deals with what learners acquire through the use of Create@school based teaching. Teachers appear positive that the application provides an extra means of supporting learning and getting subject knowledge across. Within SSS, for example, teachers reported that the application actually allowed greater focus on the subject material:

"… what's great about that from a teaching point of view is that you have got all the right subject matter in there. You are actually showing that a lot more than you might in a writing task" [SSS, S1].

Other teachers expanded that achievement is encouraged and of a higher quality due to the more advanced cognitive working added by Create@School:

"I think actually they are taking coding to an incredibly advanced level, aren't they. Some of the things they are doing are well beyond what ever I'd expected them to do in primary school" [SSS, S1].

"… what is covering that objective is about twenty times lower what you [teacher] are doing in the sessions" [SSS, S2].
Here the teacher believed that the learning objectives being achieved through the Create@School sessions are far above the level currently being tackled in the equivalent maths and IT sessions with regard to coding. Despite the higher level the students, across all year groups, appear to achieve their objectives with more ease and with more interest than in others:

"They prefer going into the game, changing several elements, than putting in a tiny bit of code making a turtle walk round a path - that's not interesting" [SSS, S1] – referring to the methods being utilised to teach programming in other sessions.

Furthermore, learners within the secondary school appeared to make strong strides in the programming capabilities as opposed to subject knowledge acquired suggesting Create@school can aid cognitive development in the long-term:

"So some of the programming skills - I have been impressed by" [CtK, S1].

Furthermore, teachers have been impressed by the apparent level of computational thinking developed in learners that otherwise struggle with their learning:

"... these students are generally quite weak academically, yet they have a certain degree of computational thinking or creativity where they can just do things so quickly" [CtK, S2].

However, there is concern at the higher levels of learning that the subject knowledge acquisition is not as high as it could be compared to a lesson that focuses on that knowledge:

"But that is more they've learned how to programme more than they have Science, I'd say" [CtK, S1].

Within the Special School, Oakfield, the sessions provided a useful means of consolidating learning through application:

"It is real application of some of the other skills we have to teach through the week like maths or whatever else" [OF].

This consolidation of learning has been noticeable when compared to students who have not taken part in the trial but share other classes together:

"where the 4 students have consolidated their learning [from the trial], they've come back to the following session probably remembering a bit more that the other students do, because they've always had two sessions" [OF].

Theme 5 – Persistence of Learning

Teachers reported some increases in independent learning for participants in the project, some of which surprised the teachers based on the students involved; specifically students became comfortable making mistakes and learning through a more experiential approach:

"They have got to the stage where they can do things now without being told how to do something. They are really good at experimenting" [SSS, S3]

"There is a deep problem-solving element, isn't there? I had towards the end of last year with the current year 6 and actually come up with problems, and a lot of them were playing around with code to see if they could work it out, where usually it's "I'm stuck, I gonna sit here!" I'm amazed with their problem solving" [SSS, S1].

Teachers within OF were surprised by the how quickly the students have adapted to Create@School and how quickly they have fostered a higher degree of independent learning that is not typical in these learners:

"in general, really positive. They are all excited for the session. I am so impressed now, we barely need to do anything. They can download their own programmes, and do their own 'broadcasting message' thing which is what we have been practising. We have barely had to support … I am so impressed with that, because in a lot of the other sessions we do, I'm having to support P-level students heavily" [OF].

Students appeared to develop novel ways of achieving in their sessions finding adaptive learning techniques through the application and bank of resources they have access to:

"... so some of them have downloaded other games, taken stuff of those games and put it onto their own. Which I thought was quite a good thing to do. So, to download something like sound bites from different games and putting them onto it, which I was surprised by" [CtK, C1].

Theme 6 – Accessibility

The use of Create@School appeared to provide adaptive means of overcoming usability issues present in other forms of classroom teaching; some examples are provided by teachers:

"And it doesn't require handwriting which is a thing he really struggles. It is nice to see him grow in confidence because of that" [SSS, S3].

Interestingly, while the impact on a number of students has been positive there remains a few that cannot access the aspects of learning that perhaps require higher levels of cognition. However, as we observed in the feasibility trial and cycle 1, asset creation and learning through developing artefacts still provided a pathway to engaging with the session:

"… I think she has found it really difficult. I'm sure she enjoys it, but is not able to access it, apart from the drawings, she really likes the drawing. She can't access the steps in the way the other children can" [SSS, S2].

Furthermore, colour coding appears to be important in reducing student barriers to access:

"things like you know when you get to this screen here [shows tablet] having different colours, because sometimes if you could say "click on the purple 'explore button'" it is easier than saying "click on 'explore'" because a lot of them can't read" [OF].

Theme 7 – Barriers to long-term use

The main barrier to utilising Create@School outside of the scope of the project stems from confidence of use and being provided enough time to gain a sufficient level of confidence through experience:

"With enough time sitting there figuring it out, I probably could do, but we have limited time for that. So, yeah, I probably wouldn't be up and running" [SSS, S2].
"The main barrier is the staff's confidence, especially TAs (teaching assistants) using IT" [OF].

"I think when I've been talking to certain teachers about it, they've said they need help accessing their emails at times. And there are still a lot of people out there who aren't maybe quite up to date with using tablets and things like that" [SSS, S1].
Teachers within the secondary school agree that more support may be required to train them further on the use of Create@School as well as time needed to become comfortable with it:

"Whilst I would say that I am digitally literate, when it comes to using specific programming tools I just get lost in the ether. It can become quite frustrating" [CtK, C2].
They suggest a layered approach to providing training material to teachers to improve the likelihood of further use post project:

"… but you could have almost like a complete beginner's, an intermediate and an advanced level use. I think you'd have to build a programme based on that where you would have an initial two-hour training stage …" [CtK, C2].

Indeed, a number of teachers agree that should teaching material support be provided through a range of pre-made game templates then this would provide a means of utilising the application in the future:

"There are other games that other people have made. It would just be about having a look to see if you could find if there is relevant things. As far as what we do in sessions, I would feel confident" [OF].

"If there were basic programmes to start with, and then it was a case of adding on to it, I think I could manage that" [SSS, S2].

"If for … the sci-fi adventure if the basic template was there, it was just going in, there were the lesson plans, training to follow. That we could have a quick scan over, that would be ideal" [SSS, S1].

"Yes, you would could almost do with like a catalogue of simple programmes, and three or four different ideas of activities that could accompany those, and actually you would probably be okay" [SSS, S1].

Through an iterative co-development of the pedagogical approach such templates provided a means of implementing Create@School within pilot sites that were initially difficult to reach:

"… was started to roll out the idea of building basic programmes - or get them to build basic programmes or games that were linked with the teaching, and get the students actually were then using the games and the platform and things they were creating" [CtK, C2]

And following on:

" … set up the programmes, so that the stuff the kids did were basically add-ons or added their own photos to it or adding their own levels to it, or whatever, like their own points scoring" [CtK, C1].

There was some concern that the amount of coding and therefore, coding knowledge required would get in the way of subject knowledge acquisition:

"I would feel that at the moment, that the coding element would get in the way of other things, we would end up a spending a lot of time on the nitty-gritty how to make something happen" [SSS, S3].

Teachers within the secondary school suggest that the kind of teaching required within this level of learning makes such interventions difficult compared to a primary school:

"In a primary school, you probably get half the afternoon doing tablets" [CtK, C1]

Following on:

"yeah, [in secondary] you have this one hour lesson. Some teachers only see a group twice across a fortnight - and [having] one of those lessons taken out straight away. If you have any technical issues, you lose half of your curriculum time … [in primary] you have a bit more time. You know the students. You are with them all the time. You can oversee the use of them a bit more effectively" [CtK, C2].

This would suggest that some areas of learning may be more appropriate for long term use and the nature of secondary education itself within the UK is a potential barrier. The increased contact time, looser learning objective and more open nature of learning in primary education appears to provide a better platform for application integration than elsewhere.

Conclusions

Teachers appeared positive with regard to the impact Create@School made in their classes through the project. From their perspective, students were engaged with the sessions; this engagement appeared to depend on the learning goal being aimed at and the mechanisms in place to achieve that goal. For example, sessions with clear learning outcomes and with a near final game template appeared easier for students to engage with through the creation of artefacts for the games being created. However, sessions without these clear goals, perhaps with more complex subject matter at their core, appeared to provide a less successful learning experience. Sessions within the secondary school held more variability in perceptions of positive impact held by teachers. This would suggest that the application is well suited to more open learning and perhaps would be better suited to less cognitively challenging learning. Although, further development of the pedagogy through game templates may address this.

Students appeared to increase their propensity for independent learning seeming to be more willing to take risks and learn through trial and error. This positive outcome suggests that the application could provide a powerful means of encouraging confidence in learning; an important outcome for at risk groups of students.

Finally, barriers to the long-term utilisation of Create@School following on from the project's conclusion mainly deal with teacher confidence in using the application and successfully coding with limited support. The importance of a wide and varied bank of templates was highlighted as an important resource for teachers to use in the future of their classroom delivery. The structure and signposting of this material must be clear in the level it is aimed at in order to be of use.

4.3.5 Behavioural Measures

To provide comprehensive feedback to teachers, behaviour was frequently recorded for a subset of students to trial the potential impact behavioural measures may have. Examples of the behavioural measures implemented through interaction tracking are provided in this section.

Specifically, behavioural measures are broken down into the following areas and the interactions within Create@School that define them:

- Confidence:
  - Event creation, e.g., create program, object, look, sound and copy actions
- Creativity:
  - Look & Feel Customisation/Aesthetics, e.g., Create your own resources (Pocket Paint, Camera, Recorder)
- Effort/dedicated time:
  - Time in Web View
  - Time spent with playing / testing the game
- Interest
  - Event creation
  - Look & Feel, Customisation/Aesthetics
  - Time in Web View
  - Time spent on research/tutorials (help function in Create@School)
- Persistence:
  - Event deletion, e.g., delete program, object, look, brick
  - Time in web-view
  - Time spent in Pocket Paint
  - Time spent with playing / testing the game
- Positive affect
  - Look & Feel, Customisation/Aesthetics
- Self-efficiency:
  - Absolute time spent in Create@School
- Self-engagement (over average in positive affect)
  - Look & Feel, Customisation/Aesthetics
  - Time spent in Pocket Paint
- Usage of Create@School
  - Coding Skills
    - use simple bricks (e.g., simple loops, show/hide, position bricks)
    - use of advanced bricks (collision, physics bricks)
    - usage of variables, lists, broadcast messages
    - merge programs
    - use templates

Within the UK, classes within the OF school were tracked between the dates of October 2016 to April 2017 providing Behavioural data for 7 students. While this does not give a basis for comparison, as no other school was involved at this stage, the data as presented gives a good indicator of behavioural tracking in the future.
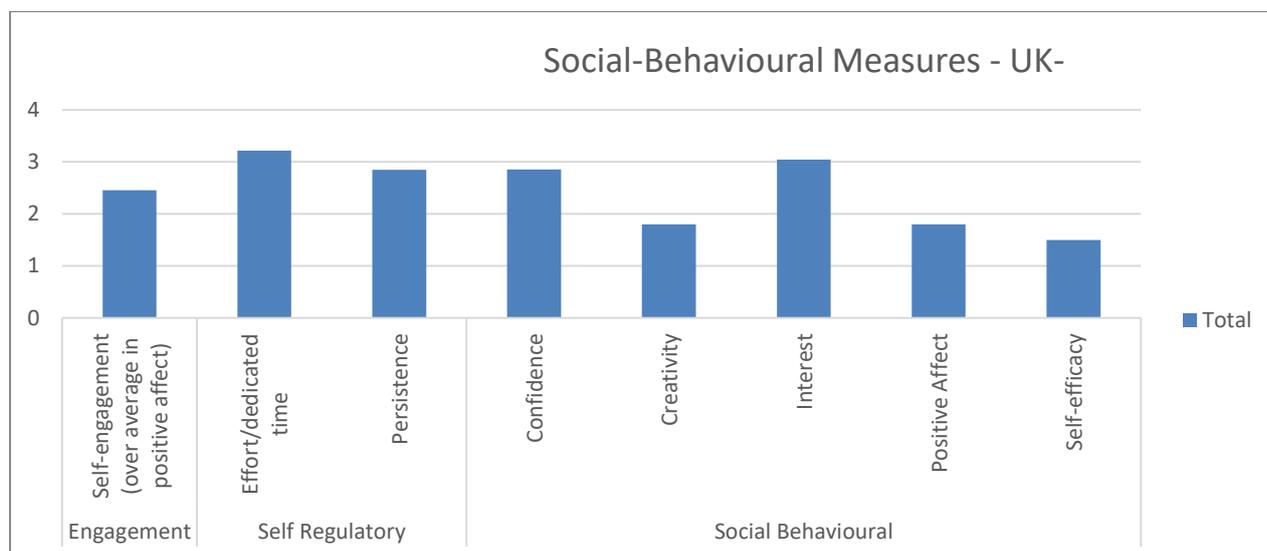

Figure 16 - Behavioural Measures, whole class

Figure 15 provides an overview of the whole class engaged with cycle 2 assessed using the behavioural measures; with a rating out of 4 for each outcome. From this, for example, we see that measures for creativity, positive effect and self-efficacy are the lowest for the group. This is perhaps to be expected given the range of PMLD's exhibited by this cohort of students and these learning areas are typical of the wider population this sample is taken from. Interest and effort, however, is higher compared to the other categories which is a positive outcome for the intervention; often, when dealing with students with PMLD, encouraging engagement and therefore interest is a challenge in and of itself.

These categories presented in figures 15 can, as mentioned, be broken down into the events that contribute to them according to the PMD. An example of this for the whole class we have data for in the UK is provided in figure 16.

Each of these can be further broken down to make comparisons between individual learners, allowing teachers to assess progress on both a class level and a discrete learner level.

Figures 17and 18 provides an example of one students profile within our sample group.
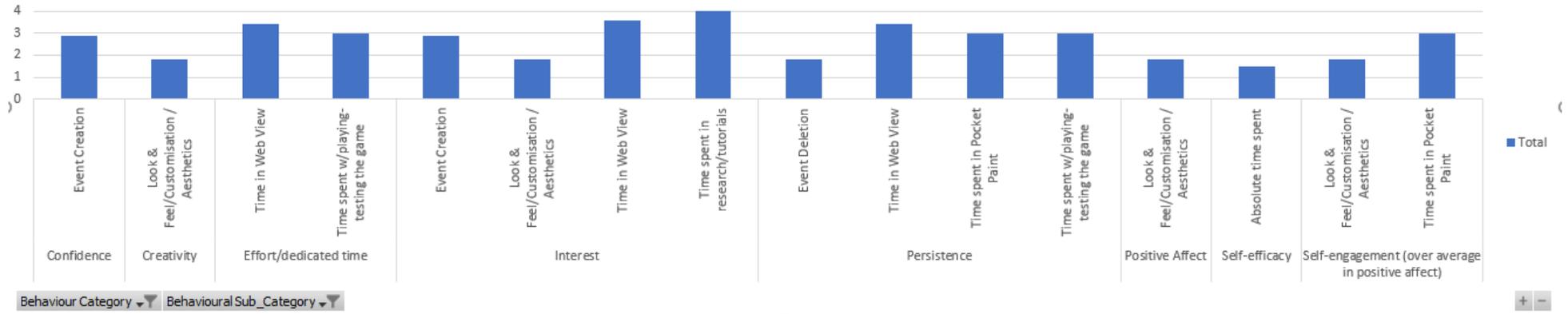
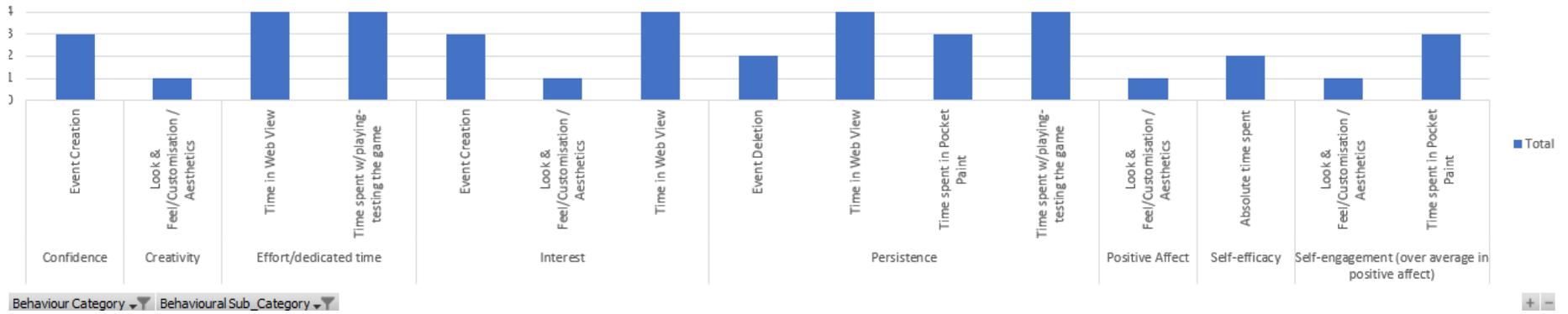Figure 17 - Behavioural Measures – Sub Categories, whole class

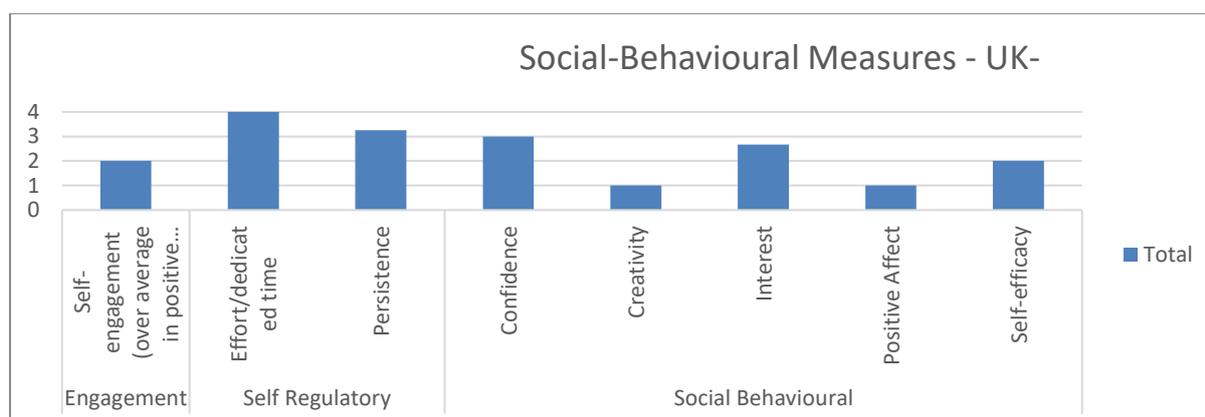Figure 18 - Behavioural Measures – Sub-Categories, nuoff0013

Figure 19 - Behavioural Measures, nuoff0013

From this we can see that this learner spent significant time in the web view of the application and therefore rates highly in effort and dedicated time towards this project. However, little time is spent developing the look, aesthetics and generally customising the project. This sub-category feeds into the general rating of creativity and therefore this measure is low for this learner. These results are in-line with the class as a whole and are to be expected for the learners within this sample.

4.3.6 Related Studies

Education has long sought to tap into the mass appeal of games to promote learning, and research suggests that they can provide a powerful means of teaching. Hainey et al. (2016) examined the use of games based learning (GBL) in primary education, finding its application across a wide range of subject areas and learning outcomes. Hainey built on work by Connelly et al. (2012), which found that playing games impacts across a range of areas including engagement, cognitive ability and, most commonly, knowledge acquisition and content understanding.

GBL has the power to simulate real world complexity and make learning more connected to what students would expect to find outside the classroom setting (Spires et al., 2011). Furthermore, video games can be used as therapeutic treatments for autism spectrum disorder (Malinverni et al. 2016), and have potential to be effective in engaging learners with special education needs due, in part, to games being ubiquitous to children's leisure environment (Griffiths, 2002). Indeed, Buckland et al. (2013) found that a serious game can provide a positive experience and an effective means of learning material. Furthermore, studies also suggest that playful learning through computer games can stimulate the intrinsic motivation to learn (Garris, Ahlers, & Driskell, 2002).

Game making can potentially provide a flexible means of learning; from its application to learning complex systems through the development of equivalent simulations, to simple artefact development that will hold some purpose in a larger system. It is suggested, for example, that knowledge creation can emerge through the construction of artefacts in a playful learning environment (PLE) via the co-creation of games (Kangas 2009; Singer, Golinkoff, & Hirsh-Pasek, 2006). Here, 68 students (aged 7-12) were asked to co-create "what-if" game worlds in a week-long experiment. The approach included phases utilising media creation to collaboratively develop assets for use in the physical outdoors game. Findings suggested such an approach could be beneficial in encouraging creativity across curricular topics and fostered a child-centred approach to learning.

This flexibility is easily transferable to digital game creation through platforms such as Scratch. In a series of sessions over 21-days, Baytak and Land (2011), utilised Scratch within a fifth-grade (ages 10-11) classroom focussing on the process of asset creation. Results suggest that the creation of artefacts promoted scientific knowledge while making programming knowledge "need-to-know" in the achievement of goals. This highlights the potential of such platforms to offer an inclusive learning environment; Maloney et al. (2008), for example, found that the use of Scratch was effective in increasing engagement in programming for urban youth, citing the benefits of a simplified, multimedia based approach.

Game making can be adjusted to suit increased learner capabilities and to achieve more ambitious learning outcomes. Fesskis et al. (2013) suggest that Scratch could improve problem solving skills in children; their study suggested an improved enjoyment in the learning process but without a comparative traditional teaching session to verify the finding. Ke (2013) noted that game design and creation through Scratch increased positive dispositions towards mathematics in a study involving 64 participants over 6 weeks (two 1-hour sessions per week). Kalelioglu and Gulbahar (2014) also examined the effect of utilising Scratch programming as a means of improving problem solving skills. However, in their short-term study no statistical increase was observed.

Furthermore, Denner et al. (2011) proposed that the creation of games in the classroom can improve the understanding of computational problems, particularly in female learners who may experience a lack of inclusion in such teaching sessions. While results suggest the games created only had moderate levels of complexity with regard to computational concepts, there is a suggestion that such approaches may support the development of computational thinking (Wing, 2006; Kafai et al., 2014).

5 CONCLUSIONS

This report has outlined the approach taken within the UK pilots and the way in which this approach has developed over time. Through the use of game templates these pilots have evaluated a flexible teaching approach utilising game making with students who have a range of individual needs from complex to typically developing. This approach was evaluated using two main methods of quantitative observation in session and qualitative interviews with teacher post trial. Positive findings can be summarised as follows:

- Engagement within Create@School session was improved compared to traditional teaching methods with statistical significance.
- Collaboration held higher instances in terms of percentage difference but this difference was not statistically significant suggesting Create@School sessions are as collaborative as traditional teaching sessions.
- Teacher reported a range of positive outcomes from the project including: increases in the quality of engagement in learners, increases in the range of methods utilised to acquire knowledge and skills, improvements in learner attitude that appears to create a more inclusive learning experience within the classroom and improvements in learner's willingness to work independently leading to potential increases in the persistence of learning.

However, teachers also suggest that there must be a consistent and well formatted resource to enable the applications to be used long-term post project. This resource is already available through other project deliverables and teachers are keen to utilise this further within their own teaching in the future.

The following outline recommendations for further work from both a project and academic perspective:

- While statistically significant difference in behaviour were observed, this measure is a simple binary description of engagement and does not speak of the quality of that engagement. Teachers did provide some more detailed qualitative feedback on the learner's progress. However, further studies should look to examine quality of learning through further measures. For example, instances of learner satisfaction, changes to processes of creation, instance of support provided to them and in depth evaluations of peer interaction would provide interesting areas of further work.
- Furthermore, a number of teachers commented on the surprising improvements in cognitive skills such as coding and problem solving. Such concepts would be difficult to measure with rigour as they would require isolating from other areas that could impact them. However, over a longitudinal study further work could seek to address this by examining improvements in cognition through achievement.
- Further integration of the Project Management Dashboard would also provide interesting data regarding this last point; perhaps implementing some form of Halstead metrics to examine the complexity of work produced over time or analysing difference in work produced independently from formal sessions.

To summarise within the UK, the project has demonstrated positive impact on the learning experience for participants involved. Teachers have been favourable of its development and implementation with some keen to integrate Create@school into projects of their own in future. The project has provided an in depth and varied range of teaching tools and provided the field with novel means of implementing digital game making in the classroom as well as offering ways forward for further research.

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7 ANNEXES

7.1 *Protocols Used*

7.1.1 *Annex 1 – Observation Protocol*

Observation Protocol – Stage 1

The first stage should be completed at the start of each observation interval and deals with whole detailing the characteristics of the teaching session observed. While this should be done at the start of each interval it may be that some observations here are relatively static; i.e. the structure of the class may not change across the interval observations.

The following details each area of data collection and summarises the codes to be used on the accompanying data collection sheet.

Structure: This deals with how the class has been organised for the teaching session; i.e. is the whole class treated as one or has it been separated in to smaller groups etc. The following codes should be used:

Code	Structure
1	Entire Class
2	Sub Groups
3	Other

Activity: This deals with the nature of the learning scenario currently being taught and utilises the following codes:

Code	Activity
1	Instructional
2	Procedural
4	Inquisitorial
3	Other

Task Assessment: This deals with a quick assessment of the proportion of the class that is on task from the following codes:

Code	Task Assessment
1	Half or less
2	More than half
3	Almost all
4	All

Observation Protocol – Stage 2

Stage 2 deals with the observations that are taken during the sample process following recording data in the previous table. In this phase the observer notes down what the teacher is doing and then proceeds to sample 4 learners within the classroom – these should be chosen at random; however, with the small class size the NOLB project is dealing with, every learner will be sampled multiple times.

For each individual observation (of the teacher and sampled learners) a 20 second window is used to record the observable behaviour. For this we have three options with regard to determining if an observable behaviour is taking place:

- Partial interval sampling – the behaviour can take place at any period of the 20 second interval. Note, this requires very obvious pre-determined behaviours to be the point of the study; i.e. walking, running etc. As such it may not be appropriate here.

- Momentary interval sampling – record the behaviour observed at a pre-determined time, say at the end of the interval. Taking such an approach would perhaps be better suited to a 10 second rather than 20 interval.

- Whole interval sampling – the behaviour must be observed for the whole of the interval; i.e. engagement must be true for the whole 20 seconds for that to be coded. Again, the 20 second interval could be reduced to avoid under reporting behaviour.

We will be utilising a momentary sampling technique with a behaviour recorded at the end of the interval.

The following serve as the code for teacher behaviour:

Code	Teacher Behaviour
1	Talking to entire class while all the students are passive receivers.
2	Starting a discussion with the whole class or talking through a learning activity that students should be following step-by-step.
3	Starting or conducting a discussion with groups.
4	Monitoring groups of students (as they work independently).
5	Monitoring the entire class (as they work independently).
6	Asking class or individuals to show their work (during or at the end of sessions).

The following details the codes for the learner behaviours:

Code	Learner Behaviour
1	Off-task – engaged with another behaviour.
2	Off-task – disruptive to peer or peers.
3	Reading, writing, typing, listening – could be following the session but difficult to determine, could be waiting for the next instruction.
4	Following along with instructor or with learning material – e.g. off slides, from a book, in response to a request for help etc.
5	Receiving personal tutoring or interacting with teacher; demonstrating work to them etc.
6	Demonstrating work to another student. Receiving demonstration from a peer.
7	Working with another student or groups of peers to solve problems.
8	Wanting to participate/speak/demonstrate (arm raised) or actively participating - answering questions or demonstrating work to the class.

Following the interval observations there should be time left in the 5-minute cycle. This time should be spent counting instances of student – student collaboration (specifically Assistance and Demonstration) and instances where the teacher warns a student or the whole class (it should be possible to log almost all reprimands, not just those after the sampling period).

NOLB Observation Record

School: **Year Group:**   **Observed By:**   **Intervention/Control**
(delete one)
Date: **Time:**   **Number of Students:**
Staff: **Subject:**   **Coding target:**

Timings. Allows linkage to tracked data	Refer to the accompanying sheet for the behaviours and their associated codes. Each interval below should last 5 minutes.				Individual learner samples. For each cycle determine what the teacher is doing and code the appropriate behaviour for each student. Note: Code the behaviour at the end of the 20-second observation.					Interactions. **Assist** & **Demo**: Student-student collaboration. **Warn**: Teacher reprimands an individual or the whole class		
Time at start	Interval	Structure	Activity	Task	Teacher	Learner 1	Learner 2	Learner 3	Learner 4	Assist	Demo	Warn
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
	11											
	12											
	13											
	14											
	15											
	16											
	17											
	18											
	19											
	20											

Additional info:

Session details and notes:

Session outline:

Interval	Activity description
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

7.1.2 Annex 2 – Teacher Interview protocol

Teacher Interviews
Following completion of a significant amount of intervention sessions, the following interview protocol was implemented to explore teacher perceptions and progress within the project.

Overview of Teacher Interview Questions
Semi-structured – interesting points should be explored further but without too much deviation from the script.
Profile Information
Participant role:
Time in the role:
Level taught:

1. Can you summarise how Create@School is currently/has been used in your classroom?

2. How would you assess the impact it has had on the students learning experience?

3. Have you noticed any changes in the way the students learn within sessions driven by Create@School?

4. Have you noticed any changes in student attitudes within sessions driven by Create@School?

5. Have you observed any changes from the previous two points within other sessions since taking part in Create@School sessions?

6. Can you give any examples of particular students that have particularly reacted to Create@School sessions?
   Interviewer note: positively or negatively if requiring some prompts but avoid leading questions.

7. Would you feel confident employing Create@School driven sessions in the future, without the support of the NOLB project team?

8. If so, where do you see yourself using Create@School in the future?

9. Can you give an overview of how you might introduce it?
   Interviewer note: subject area, general outline of sessions – why was this example chosen could be an interesting area to explore if possible.

10. If not (from question 6), what support do you think you would require to become comfortable working with Create@School independently?

11. Is there anything else that would make the introduction of Create@School long term difficult?

7.2 *Annex 3 – Computational Thinking Tests*

1 Ice Cream

At the Games ice cream parlour the scoops of ice cream are stacked onto the cone in the exact order in which you ask for them.

What choice to you make to get the ice cream shown in the picture:

A. Chocolate, Smurf and Strawberry

B. Strawberry, Smurf and Chocolate

C. Chocolate, Strawberry and Smurf

D. Strawberry, Chocolate and Smurf

Chocolate

Smurf

Strawberry

2 Magical Bracelet

A princess has a magical bracelet that looks like this:

When she stores her bracelets in her drawer she first opens them.

Which of the four bracelets in her drawer is the magical one:

A	
B	
C	
D	

3 Only Nine Keys

Daniel is sending text messages from his old phone.

For every letter he has to press the proper key once, twice, three or four times, followed by a short pause.

In order to type 'C' he has to press the number 2 key three times because 'C' is the third letter written on this key.

In order to type 'HIM' he has to press the number 4 key twice, followed by the number 4 key 3 times and finally the number 6 key once.

Daniel presses exactly six times to enter the name of a friend.

What is the name of his friend?

    A. Miram

    B. Iris

    C. Emma

    D. Ina

4 Watering Flowers

The diagram shows how a watering system is connected.

The system consists of tubes and valves. Open and closed valves are shown in the diagram by the direction of the switch.

Water only flows through open valves.

Which of the flowers (if any) will receive water when the valves are in the positions shown?

    A. A

    B. B

    C. C

    D. None
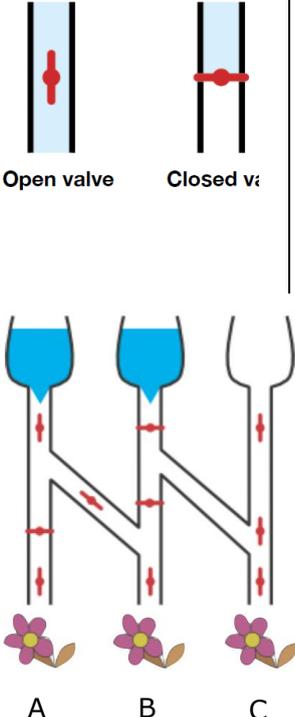
5 Tic-Tac-Toe

You are playing a game of tic-tac-toe with your friend. First your friend has to place an 'O', then you place your 'X'. You continue taking turns in this way. The player who places their three marks in a horizontal, vertical or diagonal line wins.

It is your turn to put an 'X' in the grid below:

Which position do you place your 'X' so that you have the best chance of winning?

A. 1

B. 2

C. 3

D. 4
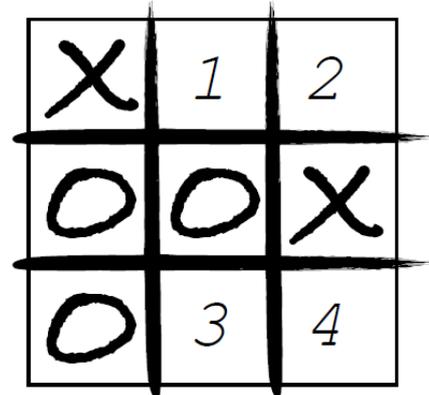
7.3 *Annex 4 – Extra Statistics*

All P-Values reported in this section are from Chi-Square tests for association unless otherwise stated.

Cycle 2

Teacher Behaviour - SSS Yr 4

The following breakdown is for the intervention groups only.

Teacher Behaviour
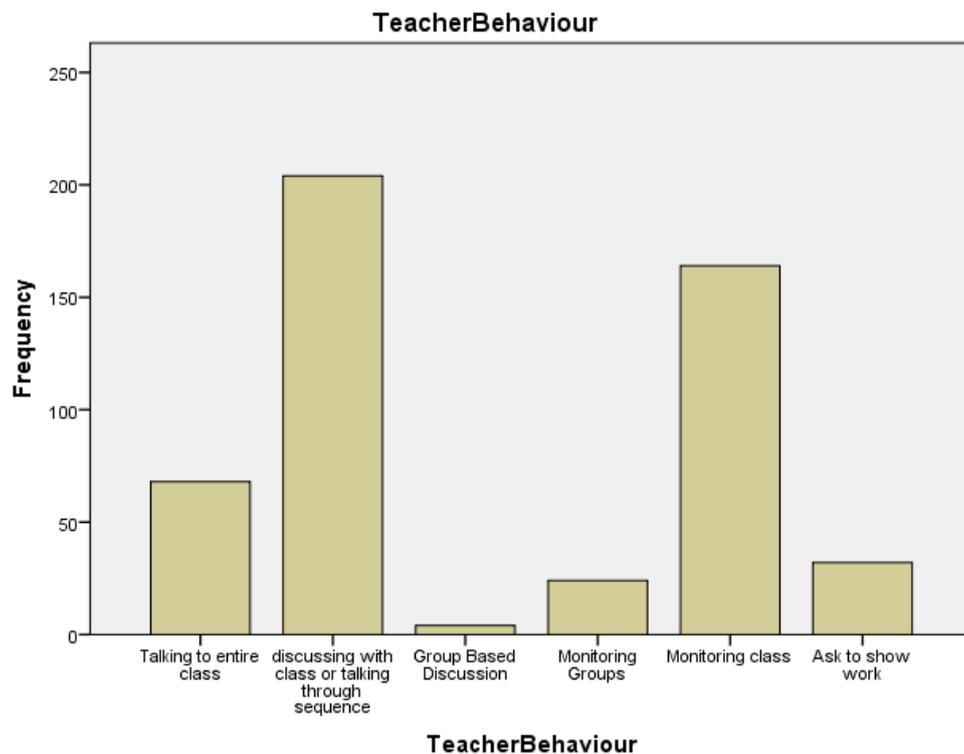
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	68	13.0	13.7	13.7
	discussing with class or talking through sequence	204	38.9	41.1	54.8
	Group Based Discussion	4	.8	.8	55.6
	Monitoring Groups	24	4.6	4.8	60.5
	Monitoring class	164	31.3	33.1	93.5
	Ask to show work	32	6.1	6.5	100.0
	Total	496	94.7	100.0	
Missing	System	28	5.3		
Total		524	100.0		

Significant difference compared to the control (p<0.0001) with increases in instructional teaching (talking to entire class and walking through steps) within the intervention sessions.
General Engagement – SSS Yr 4
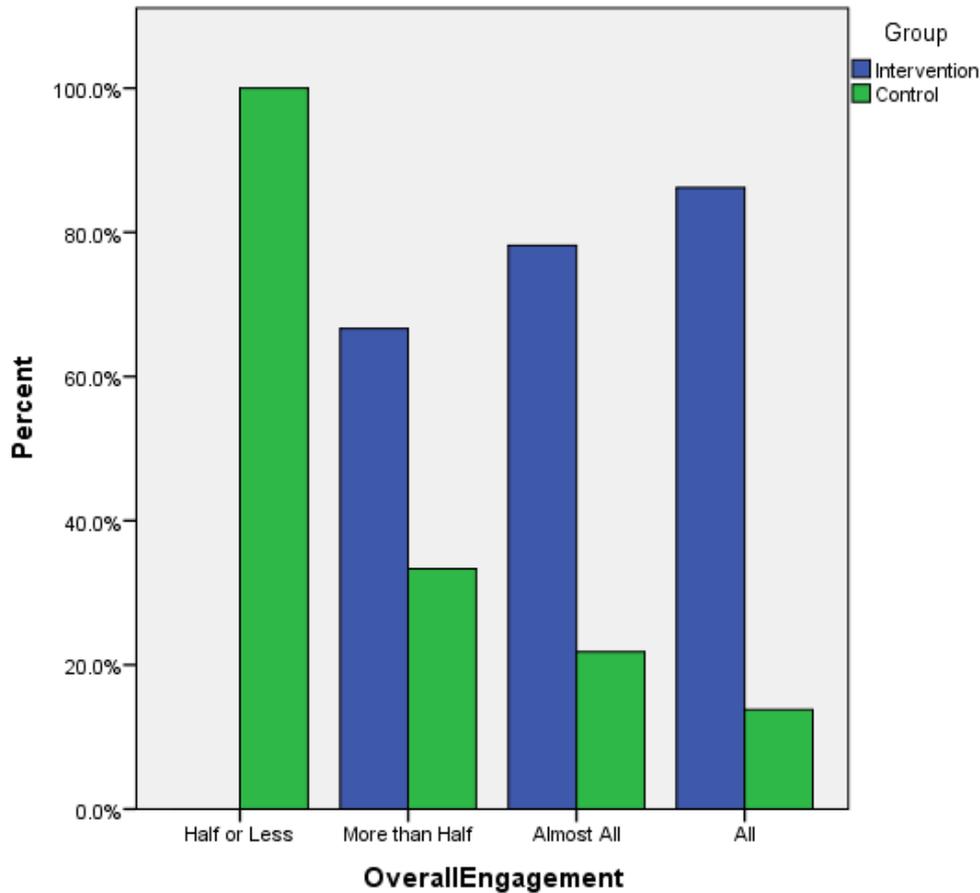
Significant difference compared to the control (p<0.0001) with increases the number of higher levels of engagement observed as demonstrated in the above bar chart.

Detailed student behaviour – SSS Yr 4
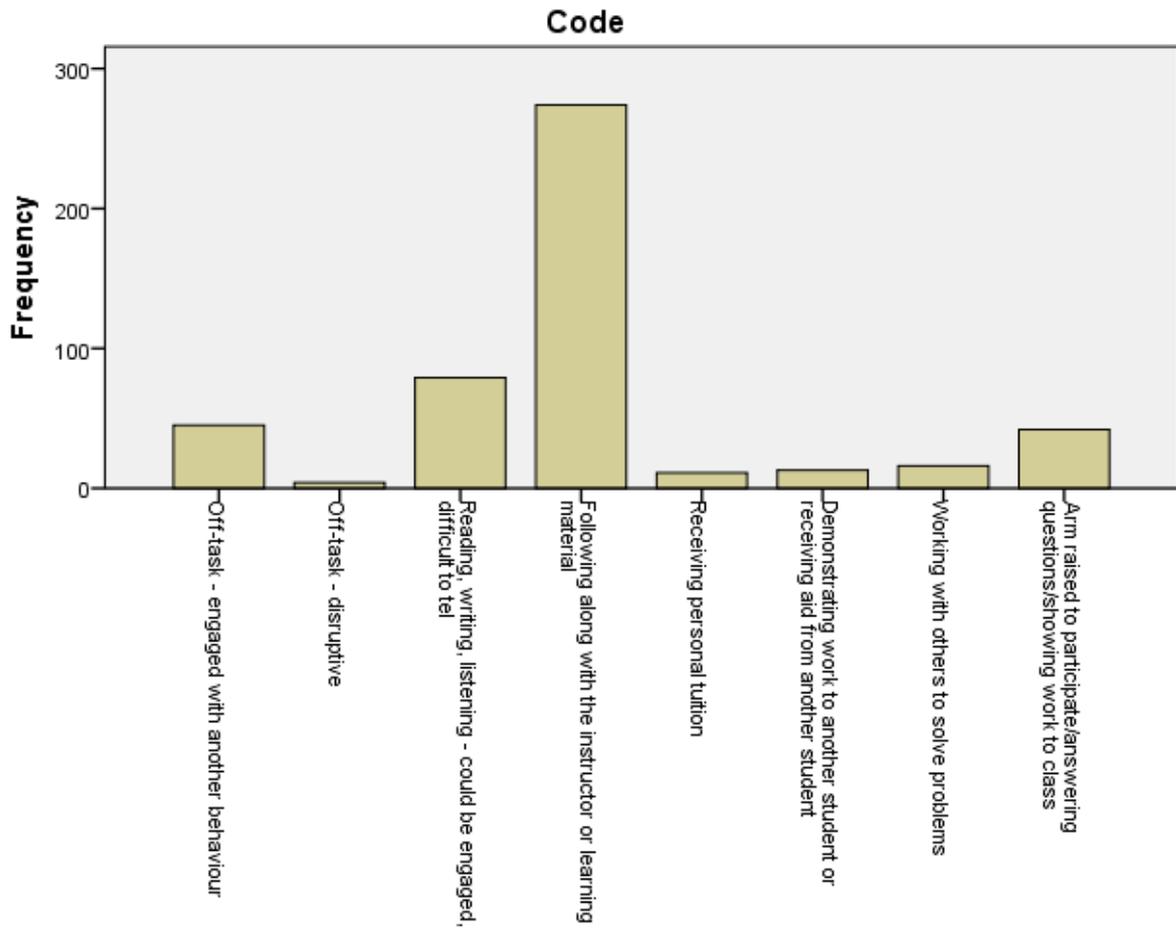
	Code				
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Off-task - engaged with another behaviour	45	8.6	9.3	9.3
	Off-task - disruptive	4	.8	.8	10.1
	Reading, writing, listening - could be engaged, difficult to tell	79	15.1	16.3	26.4
	Following along with the instructor or learning material	274	52.3	56.6	83.1
	Receiving personal tuition	11	2.1	2.3	85.3
	Demonstrating work to another student or receiving aid from another student	13	2.5	2.7	88.0

	Working with others to solve problems	16	3.1	3.3	91.3
	Arm raised to participate/answering questions/showing work to class	42	8.0	8.7	100.0
	Total	484	92.4	100.0	
Missing	System	40	7.6		
Total		524	100.0		

A Chi-Square test for association suggests several significant relationships; e.g. within the intervention groups higher instances non-engaged behaviour occurred during group based monitoring. Furthermore, when the teacher is monitoring the class there are higher number of working with others (p<.0001).
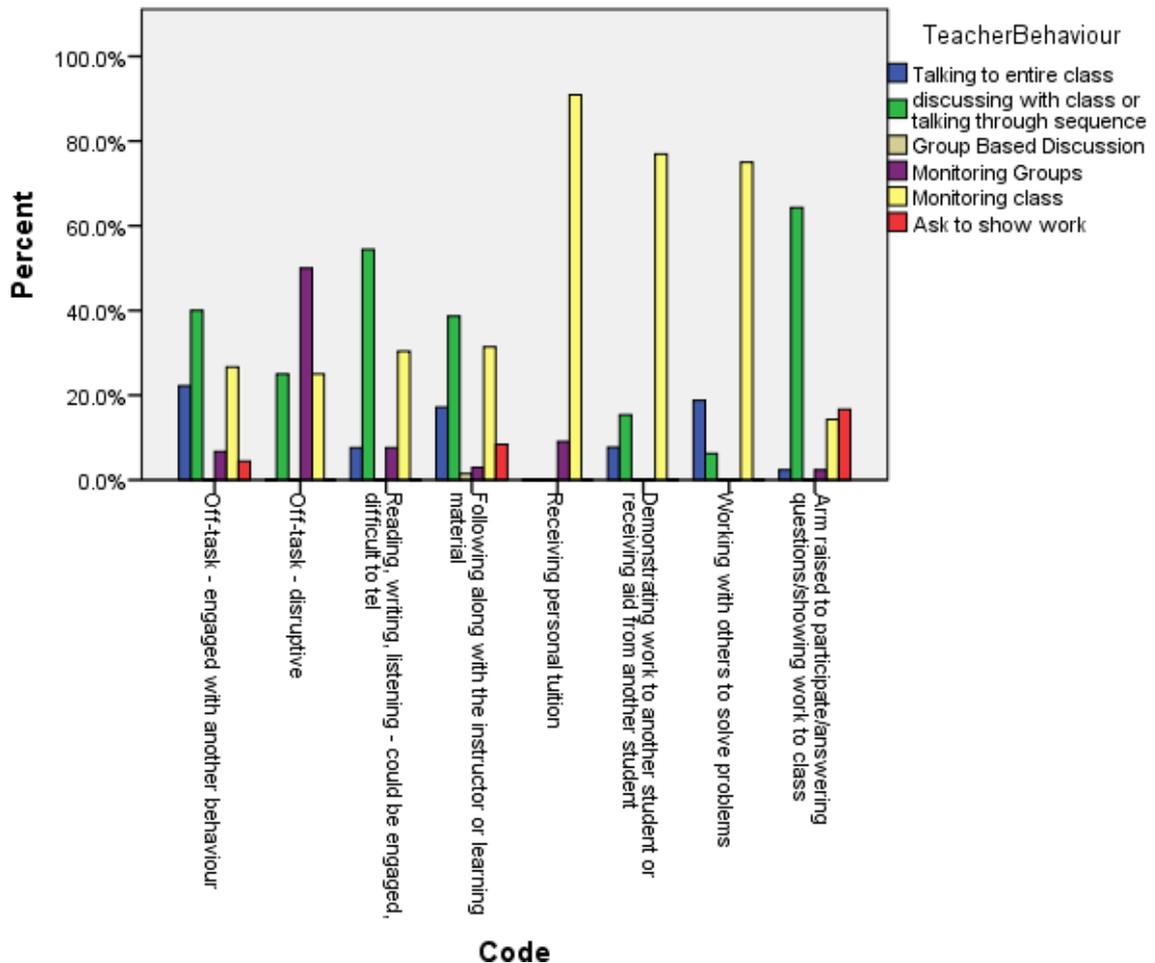
Teacher Behaviour – SSS Yr 5

TeacherBehaviour

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	72	14.8	15.3	15.3
	discussing with class or talking through sequence	176	36.1	37.3	52.5
	Monitoring Groups	12	2.5	2.5	55.1
	Monitoring class	184	37.7	39.0	94.1
	Ask to show work	28	5.7	5.9	100.0
	Total	472	96.7	100.0	
Missing	System	16	3.3		
Total		488	100.0		
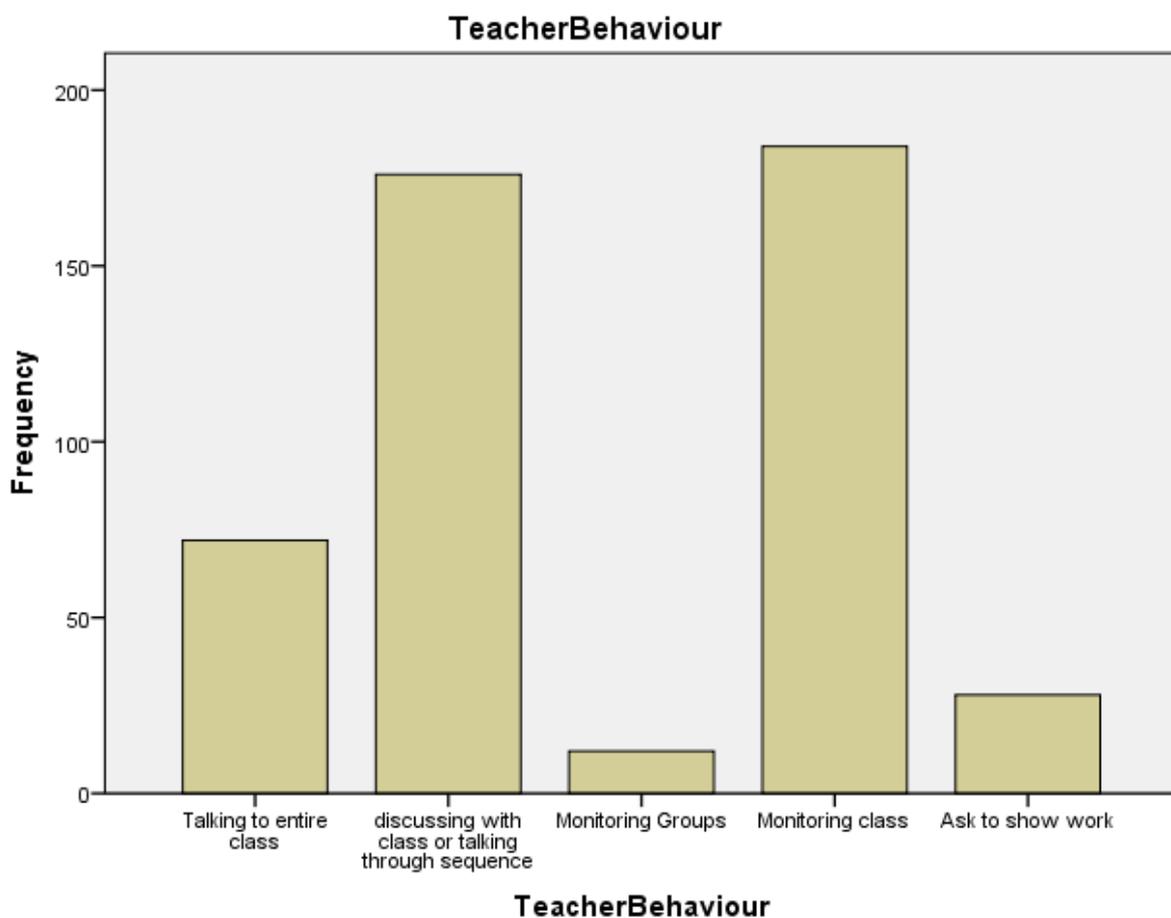
Again, significant difference when compared to the control ($p < 0.0001$) with a range of teaching methods applied within the intervention sessions with relatively few in the control.
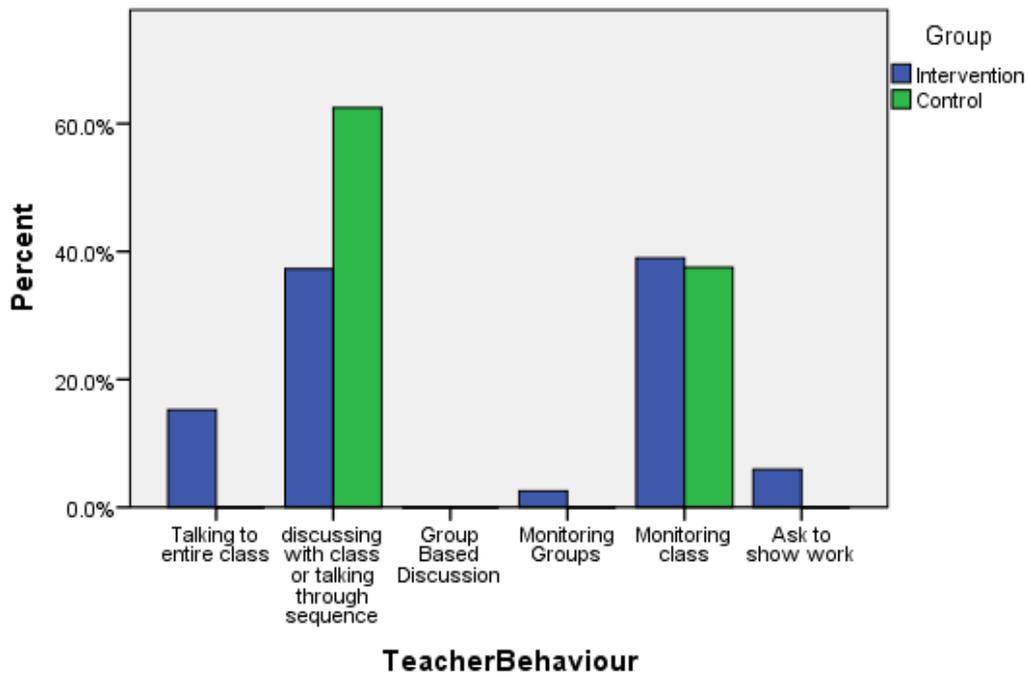
Detailed Learner Behaviour – SSS Yr 5
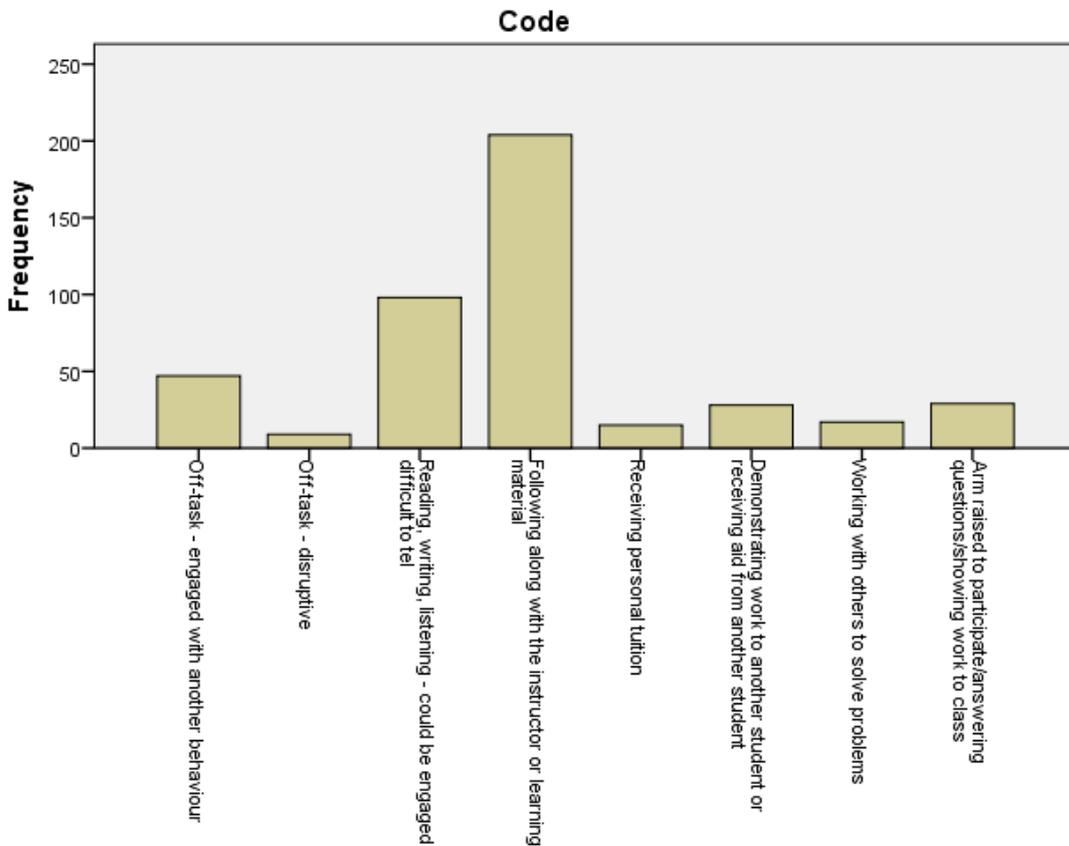
Again, similar spread of learner behaviours as seen in the year 4 group. Statistically significant relationships with teacher behaviour also found.
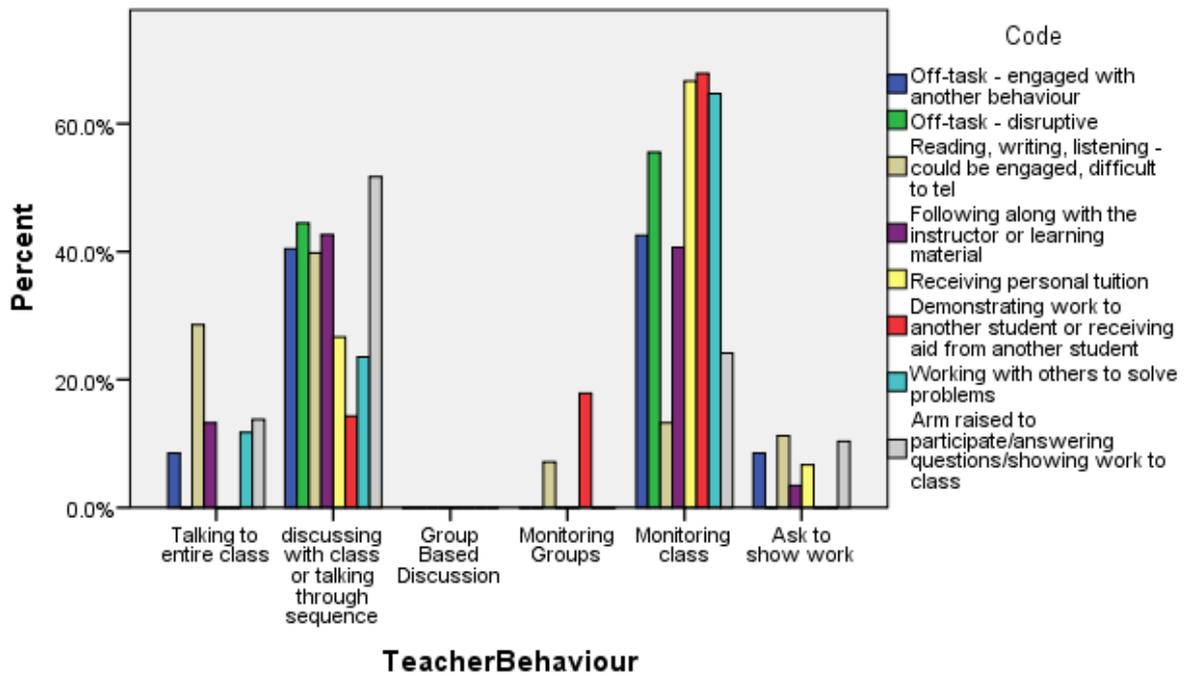
There are increases in demonstrating work to another student while the teacher is monitoring the class (perhaps overseeing an open session of work. This does appear to have the caveat that it also increases instances of unengaged behaviour however.
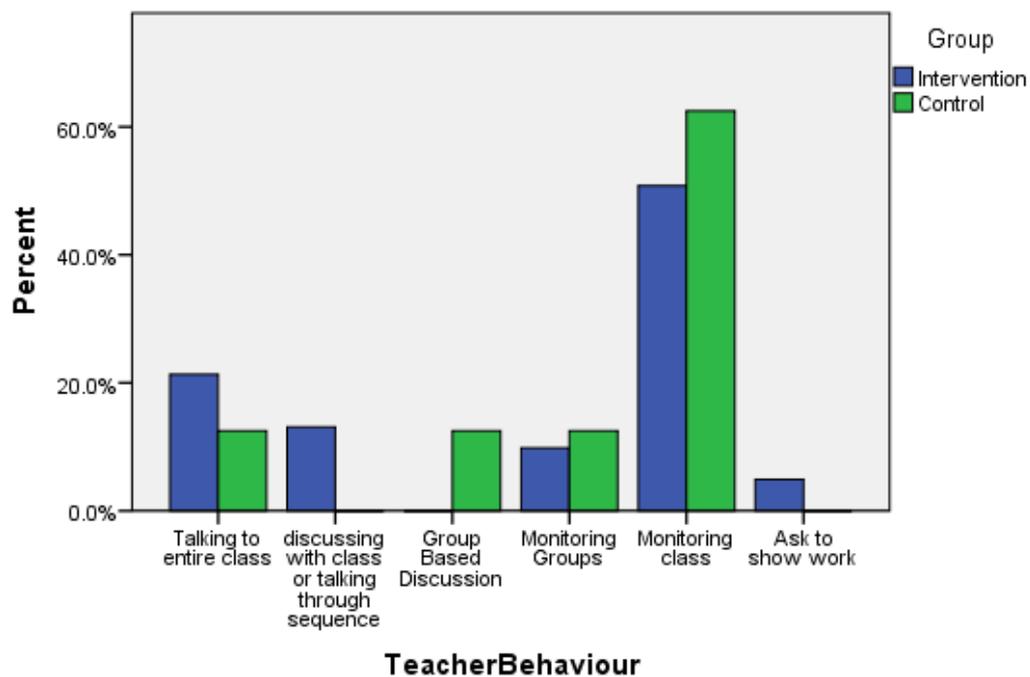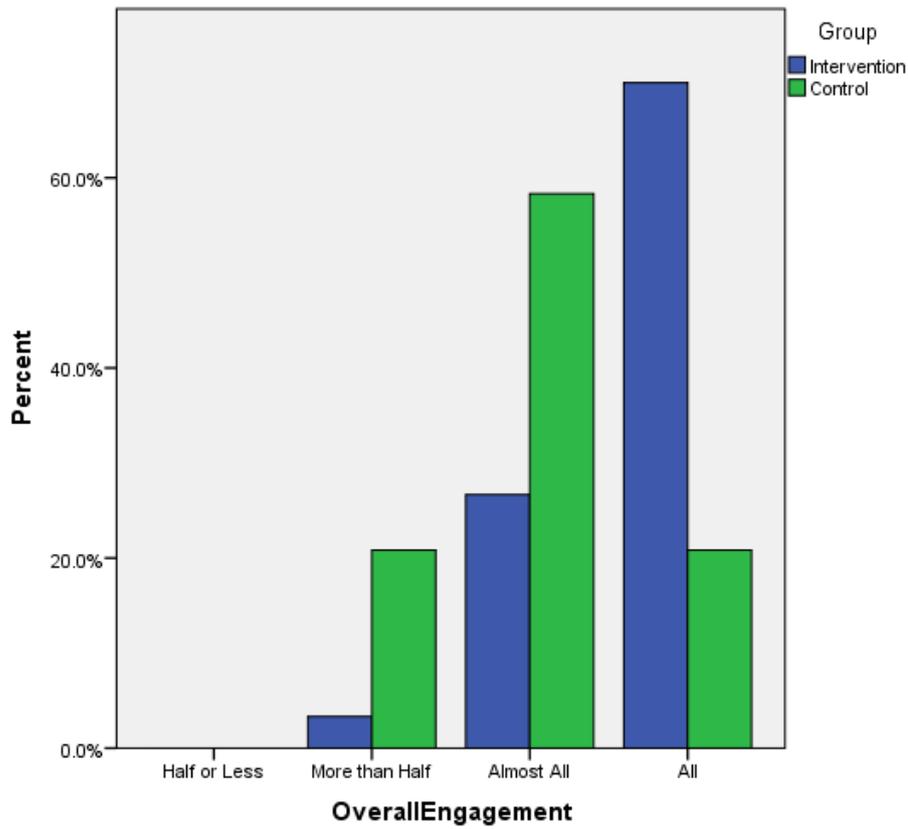
Teacher Behaviour - SSS Yr 6
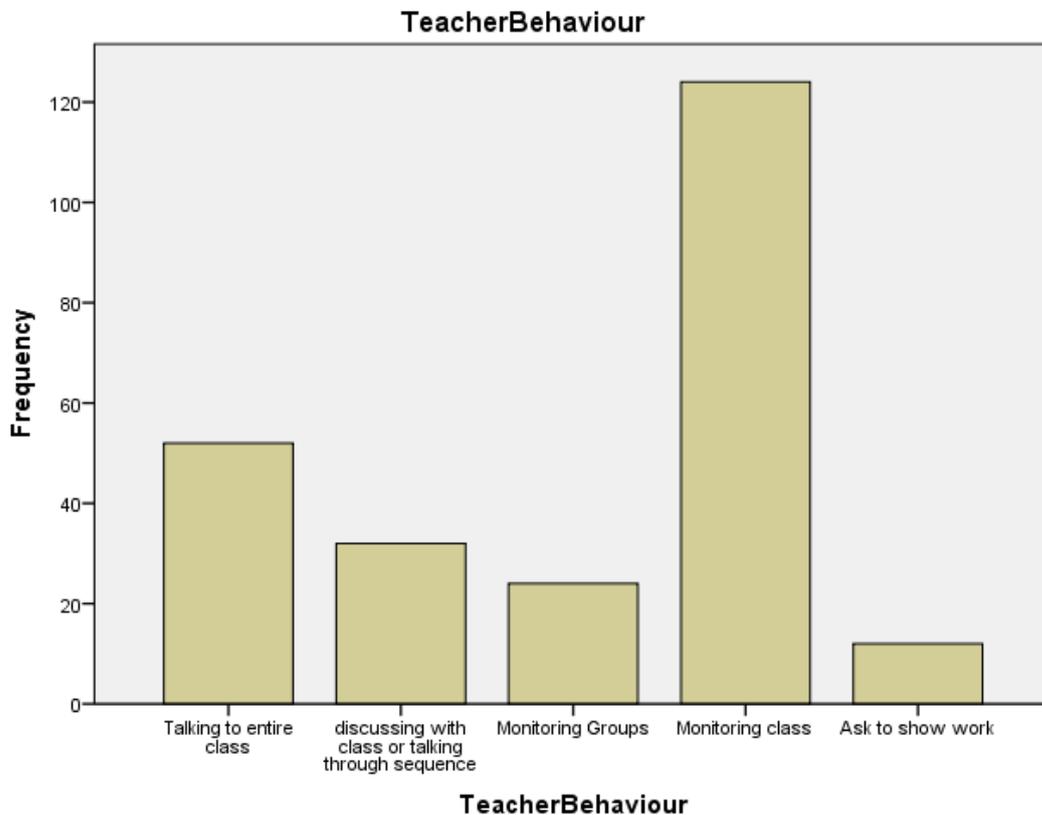
TeacherBehaviour

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	52	20.3	21.3	21.3
	discussing with class or talking through sequence	32	12.5	13.1	34.4
	Monitoring Groups	24	9.4	9.8	44.3
	Monitoring class	124	48.4	50.8	95.1
	Ask to show work	12	4.7	4.9	100.0
	Total	244	95.3	100.0	
Missing	System	12	4.7		
Total		256	100.0		

Statistically significant associations between the sessions (p<0.0001).

Overall Engagement – Yr 6

Statistically significant difference when compared to the control (p<0.0001) with more instances of "Whole class engaged" in the intervention sessions.

Detailed Learner Behaviour SSS Yr 6

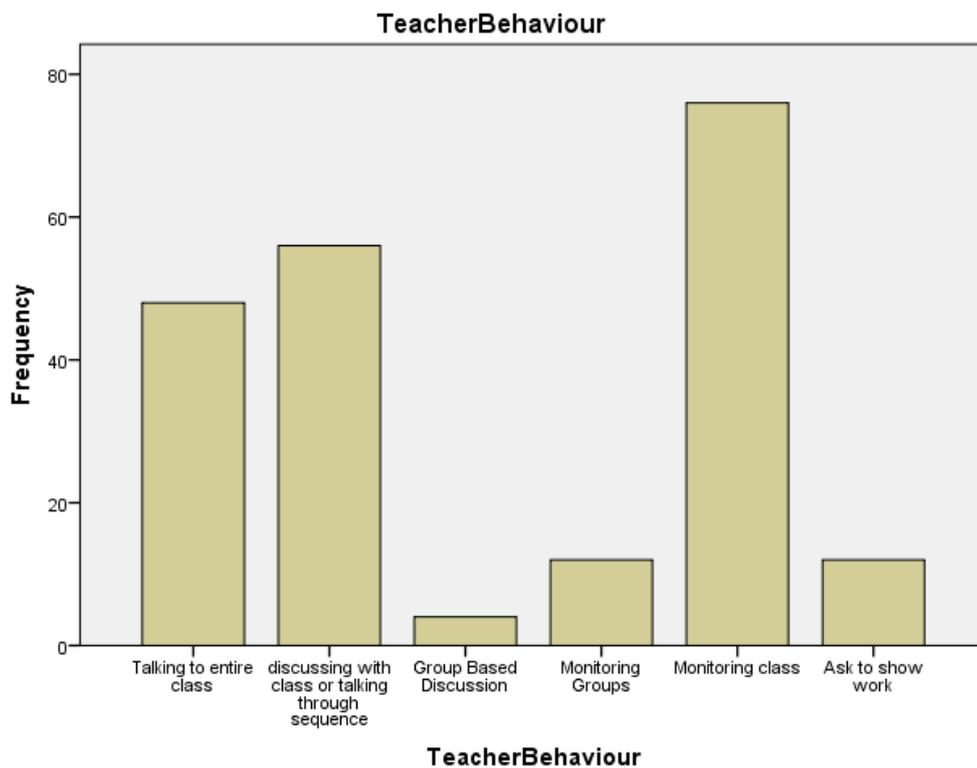Similar spread as seen in other groups for detailed learner behaviour.
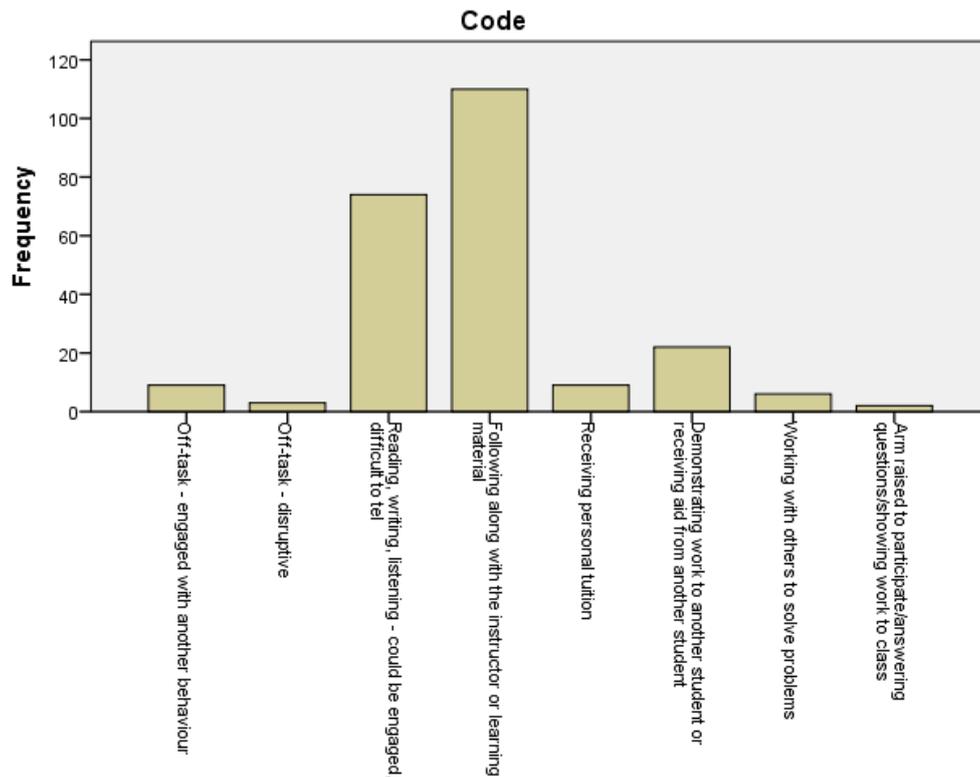
Again, with statistically significant associations compared to teacher behaviour that verify observations made in other groups.
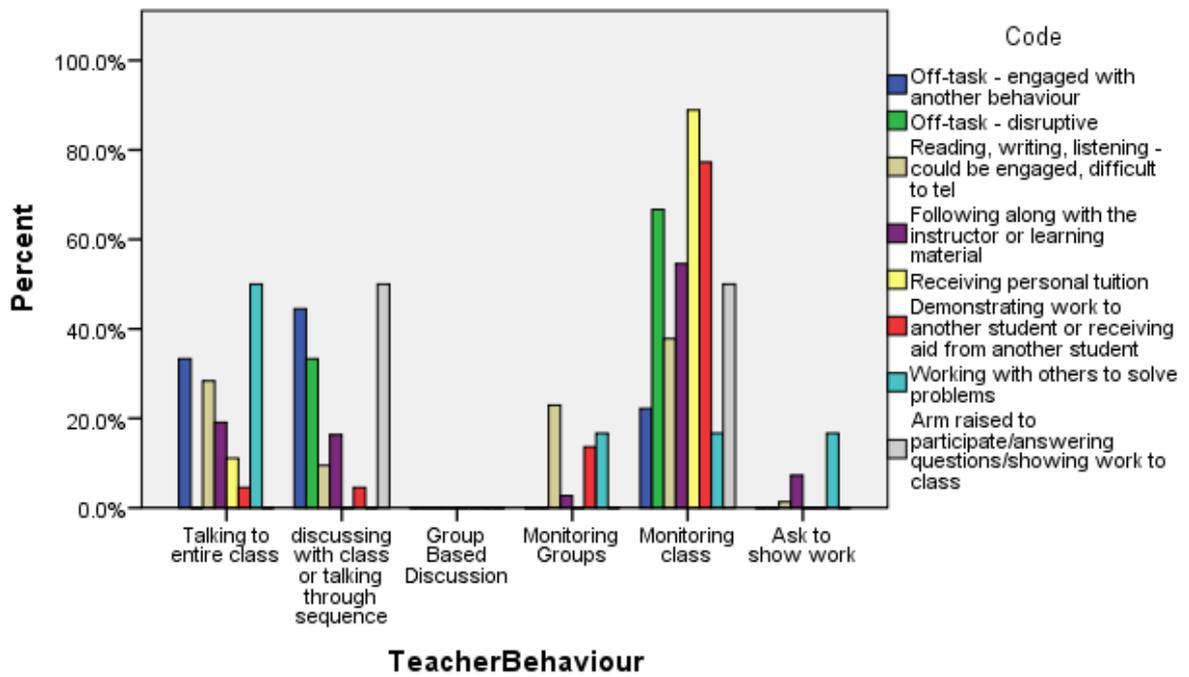
Teacher Behaviour - StP

Relatively similar spread of teacher behaviour in this school as we have seen this far.

Teacher Behaviour

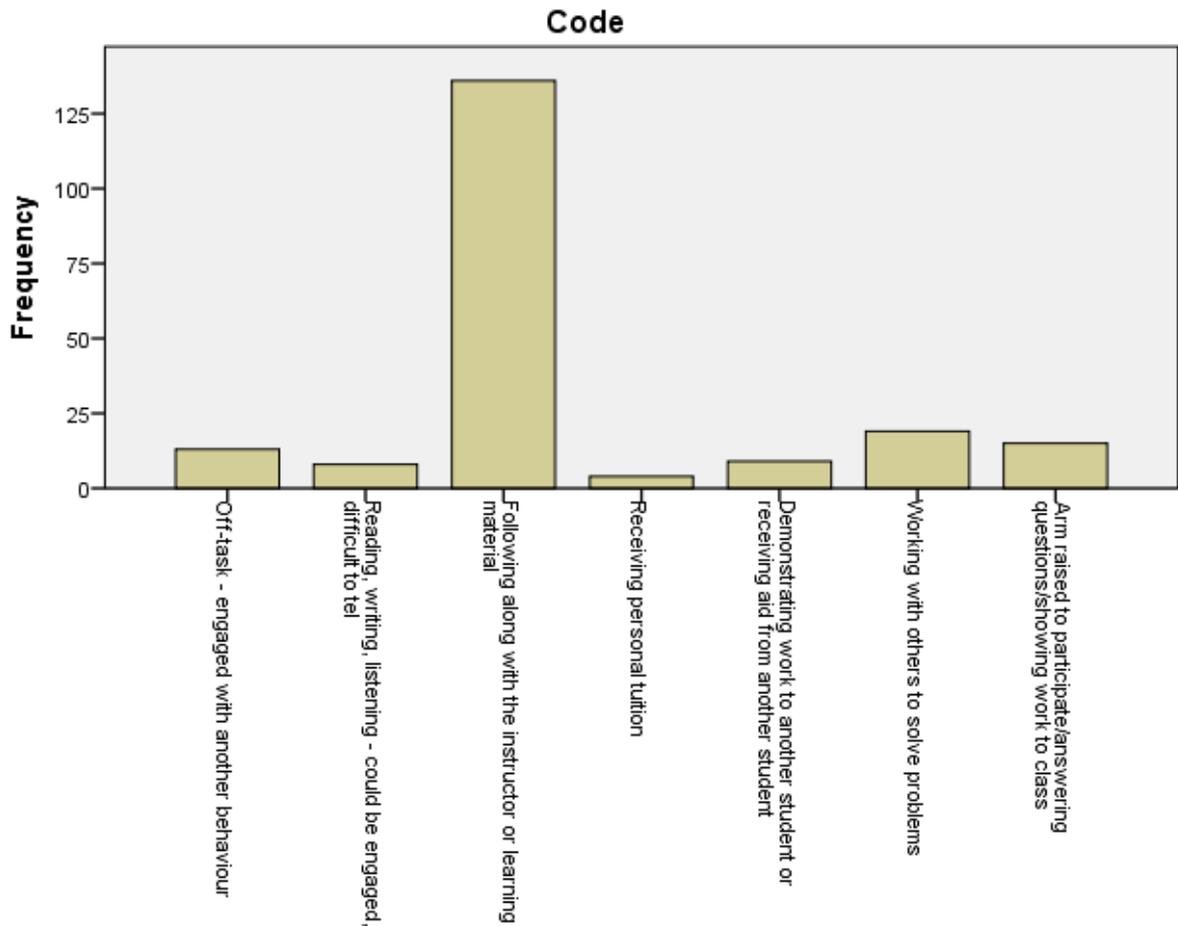|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	48	20.7	23.1	23.1
	discussing with class or talking through sequence	56	24.1	26.9	50.0
	Group Based Discussion	4	1.7	1.9	51.9
	Monitoring Groups	12	5.2	5.8	57.7
	Monitoring class	76	32.8	36.5	94.2
	Ask to show work	12	5.2	5.8	100.0
	Total	208	89.7	100.0	
Missing	System	24	10.3		
Total		232	100.0		

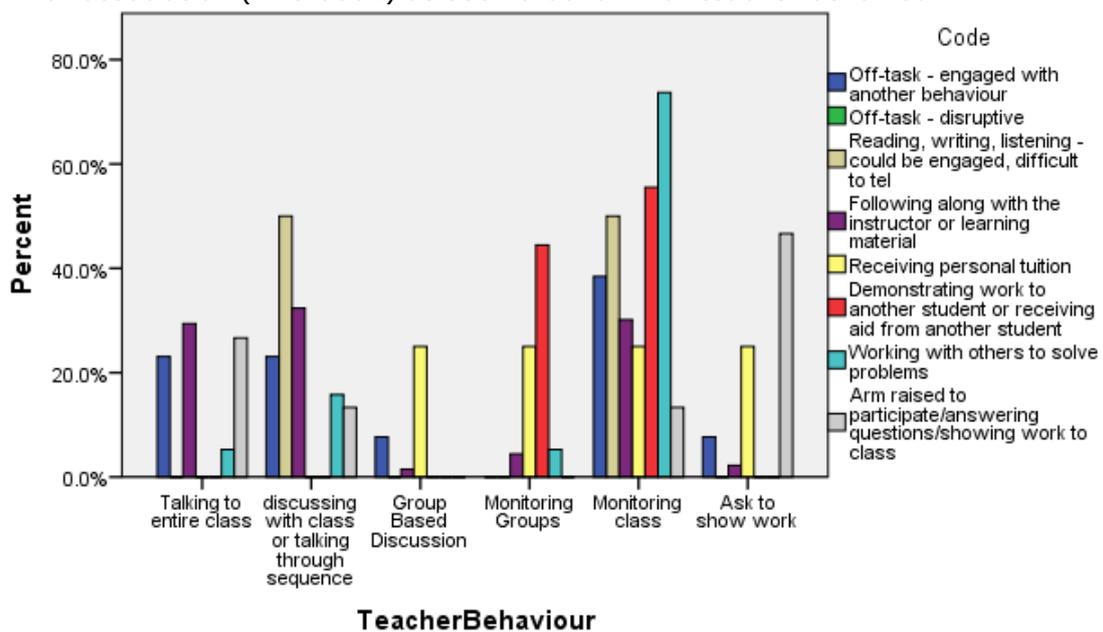*Overall Engagement – StP*

More instances of whole class engagement observed (P<0.0001).
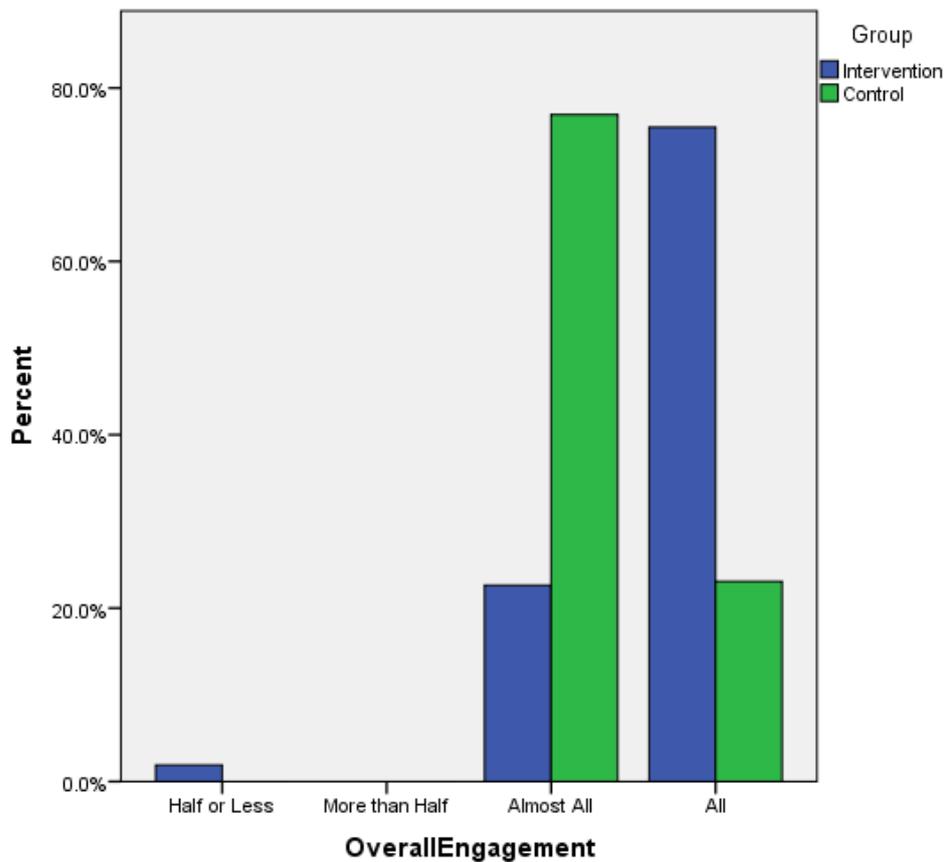
Detailed Learner Behaviour – StP
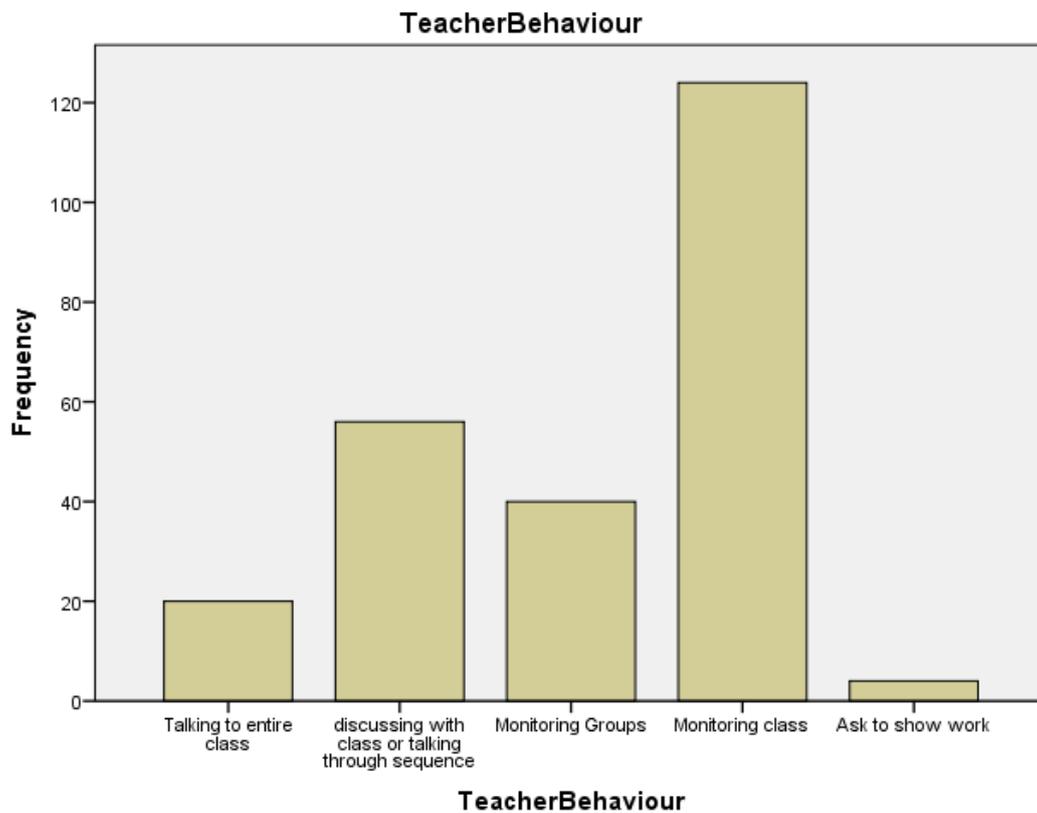
As per other groups, detailed learner behaviour as follows:

Similar association (P<0.0001) as seen thus far with teacher behaviour.

Teacher Behaviour – CtK Yr 8

Breakdown for CtK teacher behaviour is as follows:

Teacher Behaviour

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	20	7.9	8.2	8.2
	discussing with class or talking through sequence	56	22.2	23.0	31.1
	Monitoring Groups	40	15.9	16.4	47.5
	Monitoring class	124	49.2	50.8	98.4
	Ask to show work	4	1.6	1.6	100.0
	Total	244	96.8	100.0	
Missing	System	8	3.2		
Total		252	100.0		

Statistically significant difference when compared to the control (p<0.0001) as detailed in the following graph:
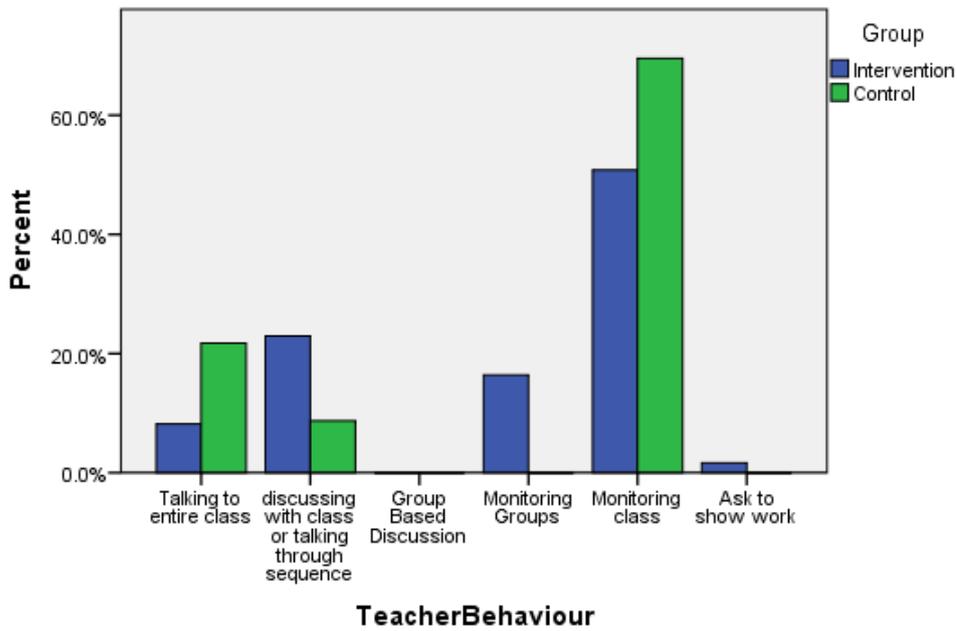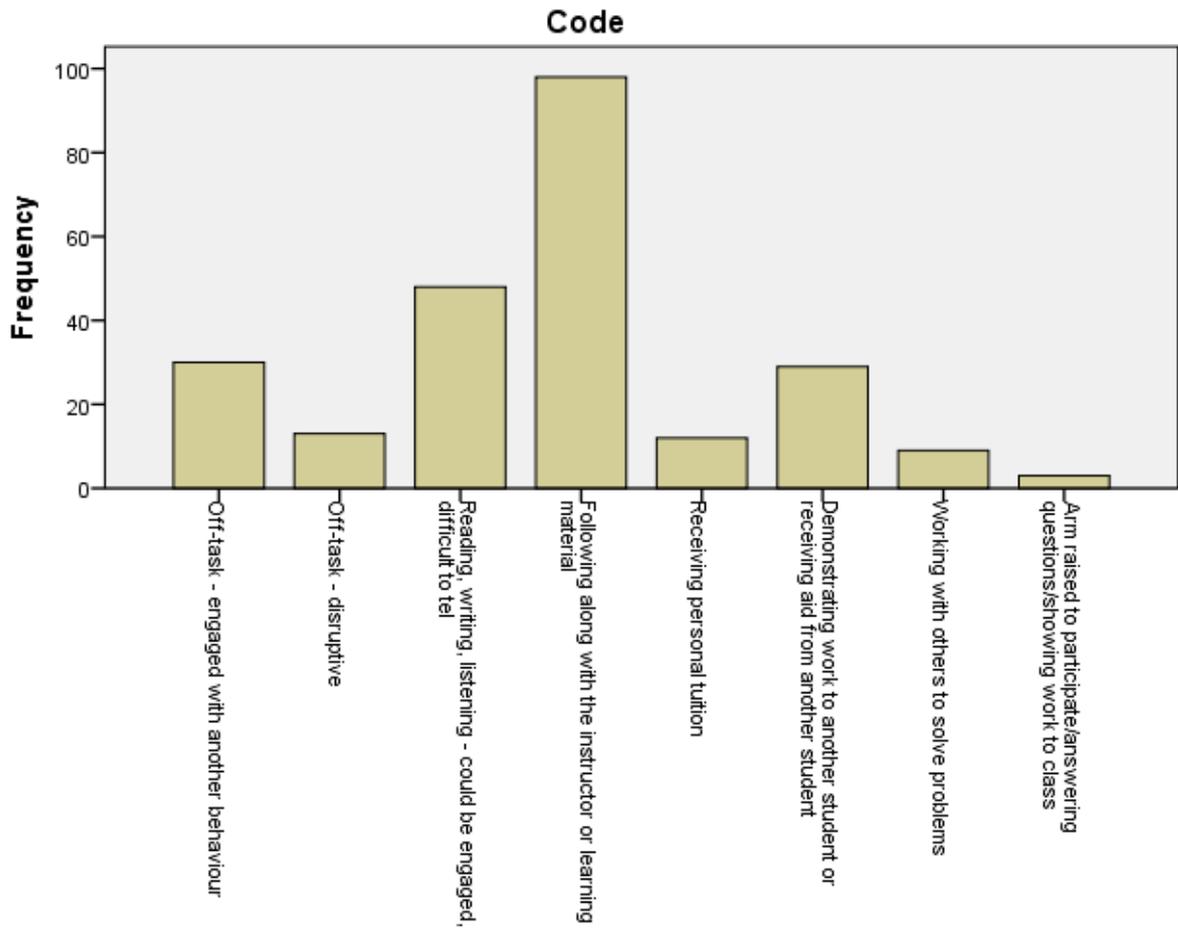
Overall Engagement CtK

As per other groups, statistically significant difference compared to the control of general engagement measures (p=0.015).
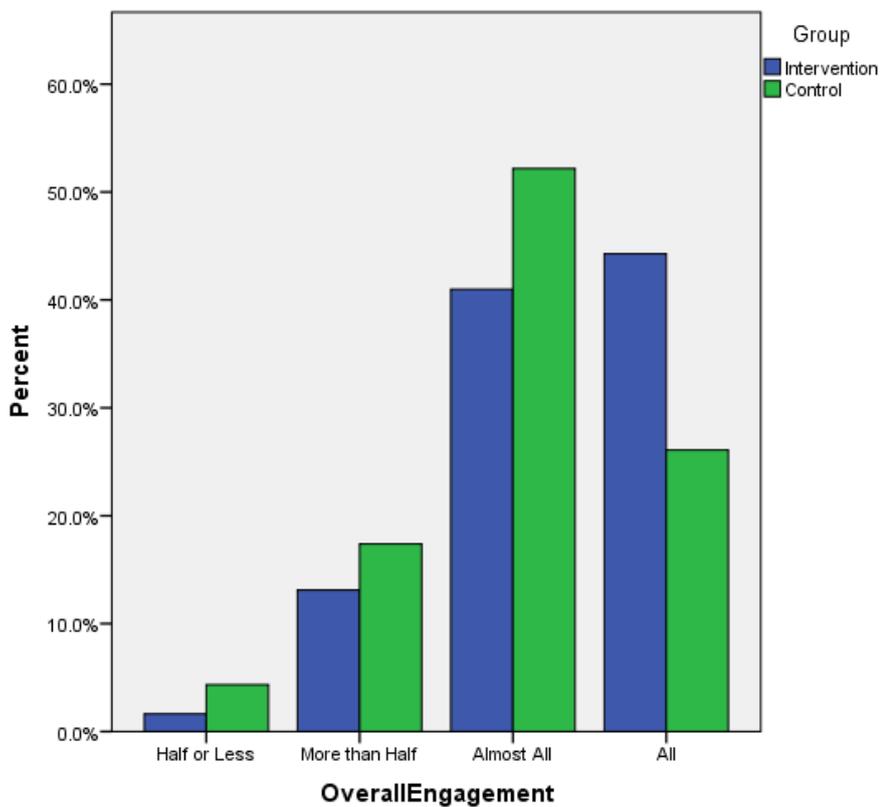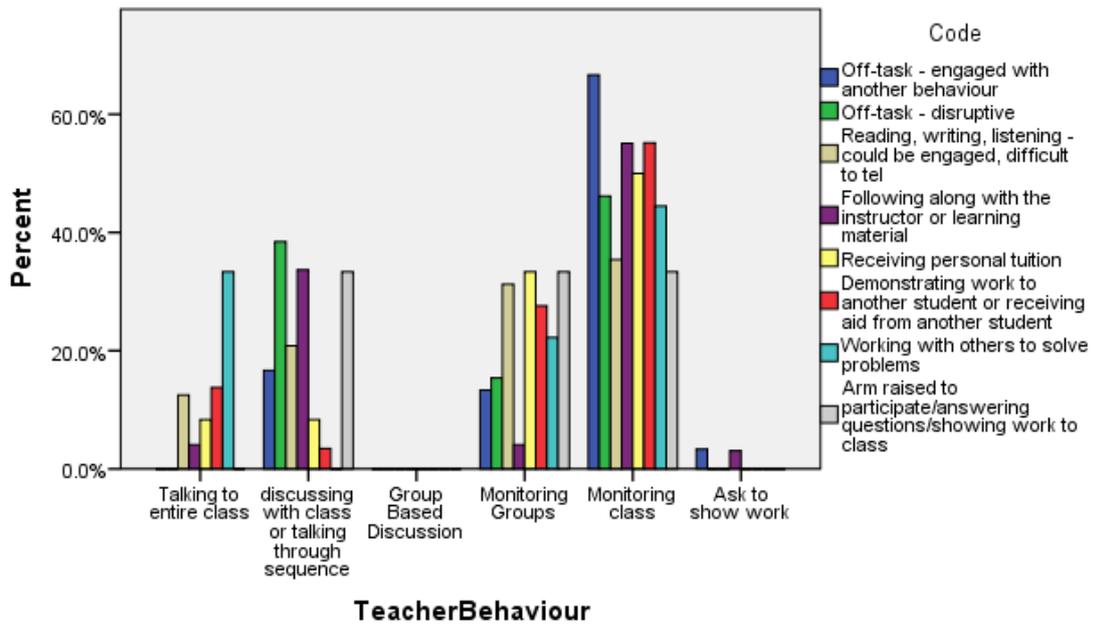
Detailed Learner Behaviour – CtK

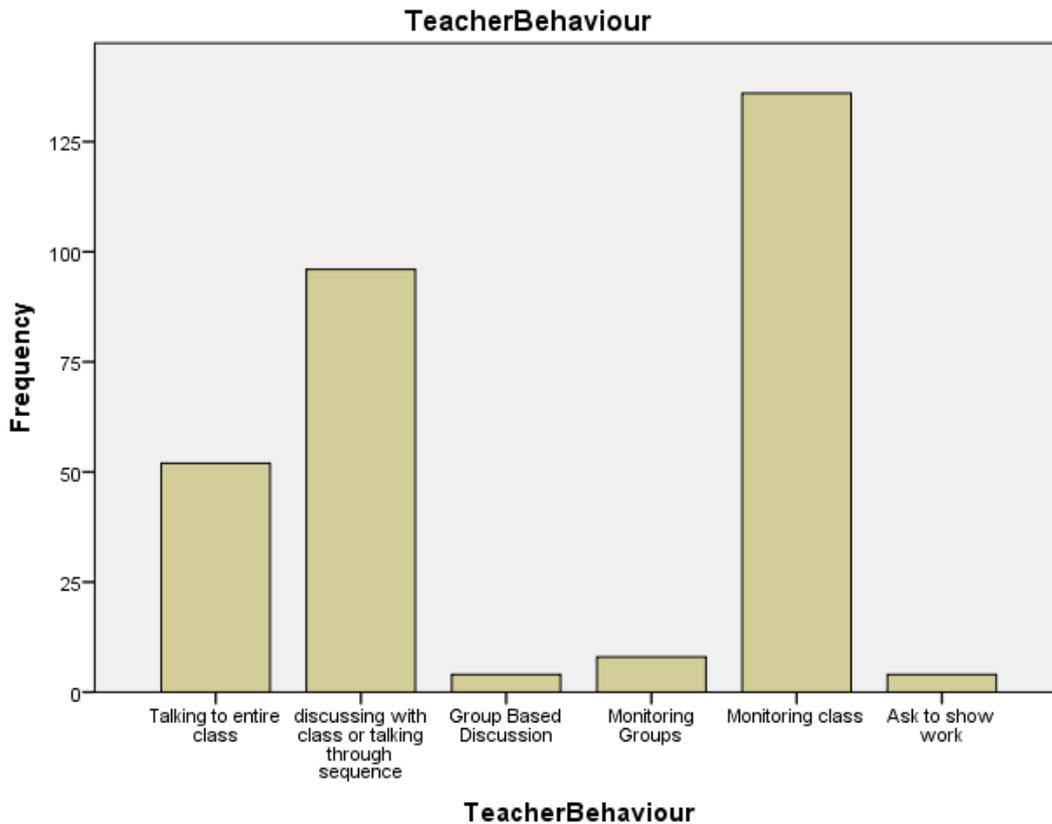Overview of observed learner behaviour:

Statistically significant difference among teacher behaviours (P<0.0001) in line with other findings thus far.

Teacher Behaviour – OK Yr 10

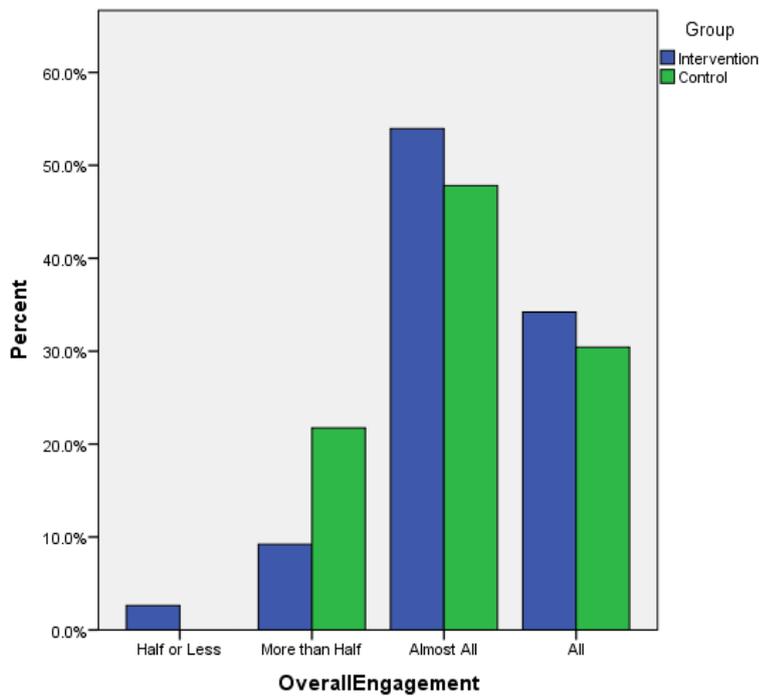Teacher behaviour for Year 10 intervention sessions as follows:

Teacher Behaviour

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	52	15.7	17.3	17.3
	discussing with class or talking through sequence	96	28.9	32.0	49.3
	Group Based Discussion	4	1.2	1.3	50.7
	Monitoring Groups	8	2.4	2.7	53.3
	Monitoring class	136	41.0	45.3	98.7
	Ask to show work	4	1.2	1.3	100.0
	Total	300	90.4	100.0	
Missing	System	32	9.6		
Total		332	100.0		

Again, statistically significant difference between the control and the intervention groups for the kind of teacher behaviour most often utilised (P<0.0001).
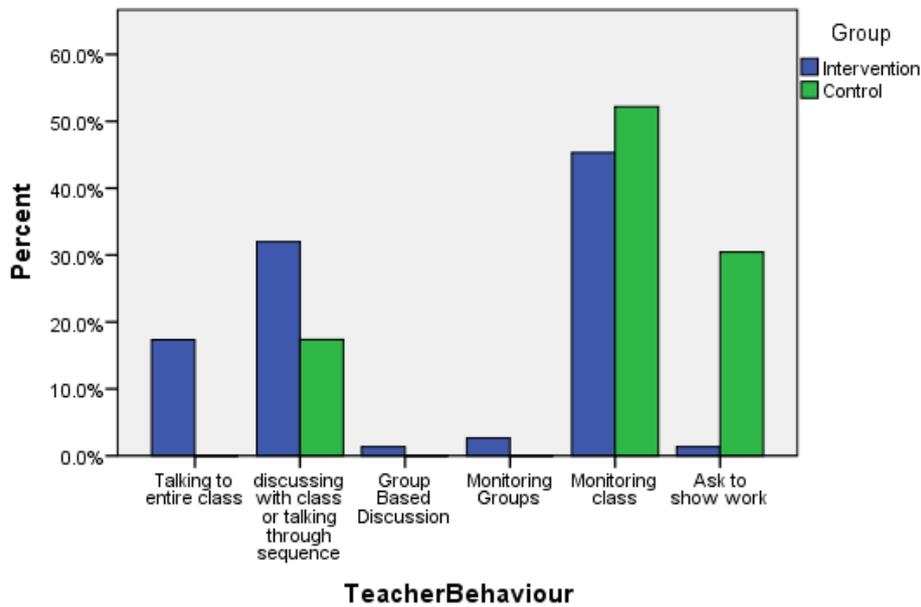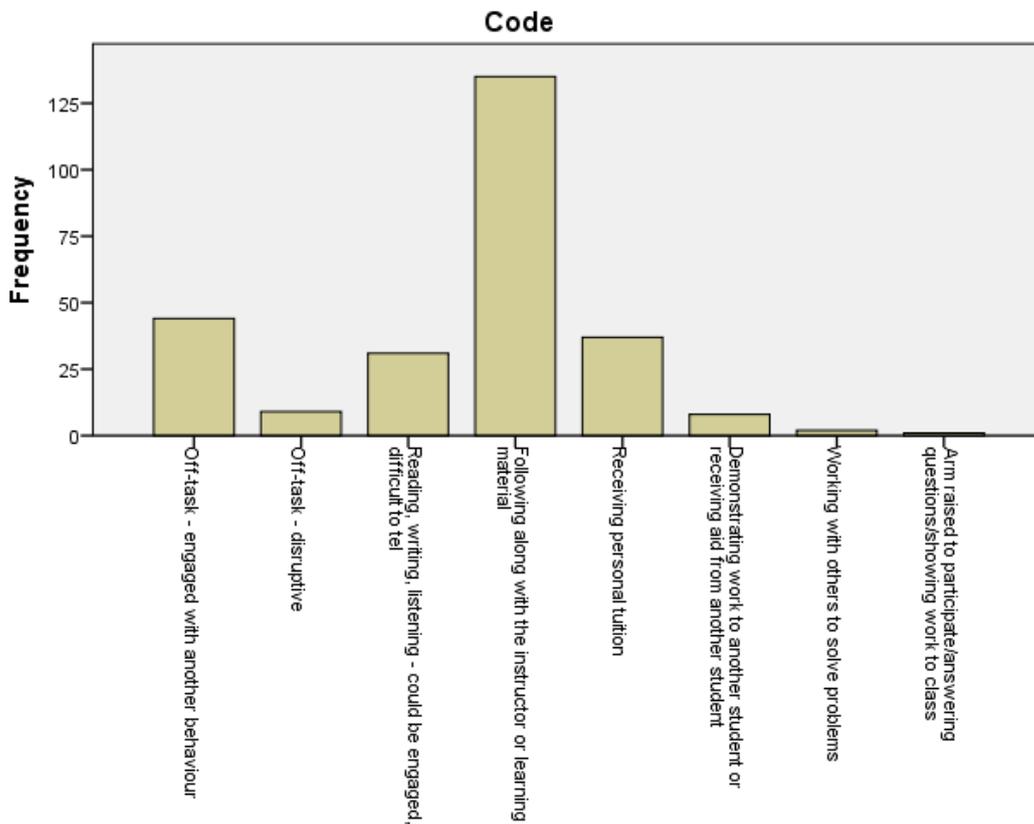

Overall Engagement – OF Yr 10

Statistically significant difference compared to the control with more observations of both "almost all" and "all" in the intervention (P=0.006).

Detailed Learner Behaviour – OF Yr 10

Overview of observed Learner Behaviour for OF Year 10 group within intervention sessions:

Interestingly, a similar spread here despite the complex individual needs of the learners within this school suggesting a similar intervention effect on learning, further supporting the role of game making in promoting inclusive education.

Unlike other groups, however, there was an increase in the number of observations made of working with other during the teacher behaviour of talking through steps:
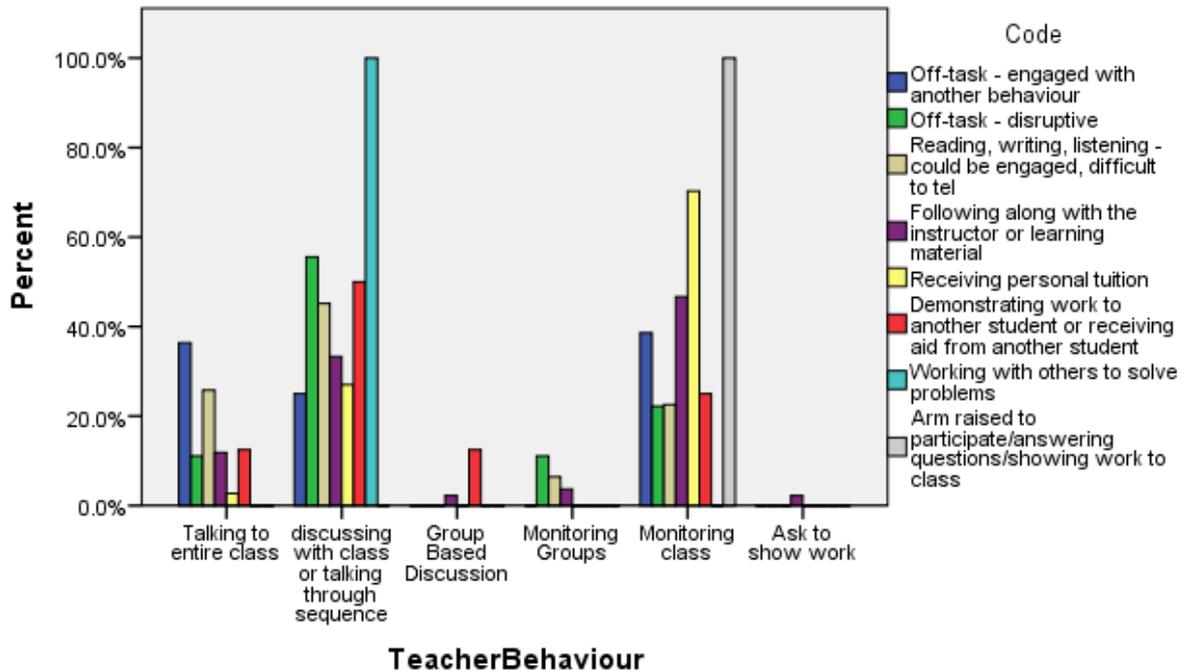
This could be due to the use of TA's within the school or specifics of the sessions that the observation tool could not identify.

Teacher Behaviour – OF Yr 12

Spread of teacher behaviours for the intervention session in OF Year 12 is as follows:

TeacherBehaviour

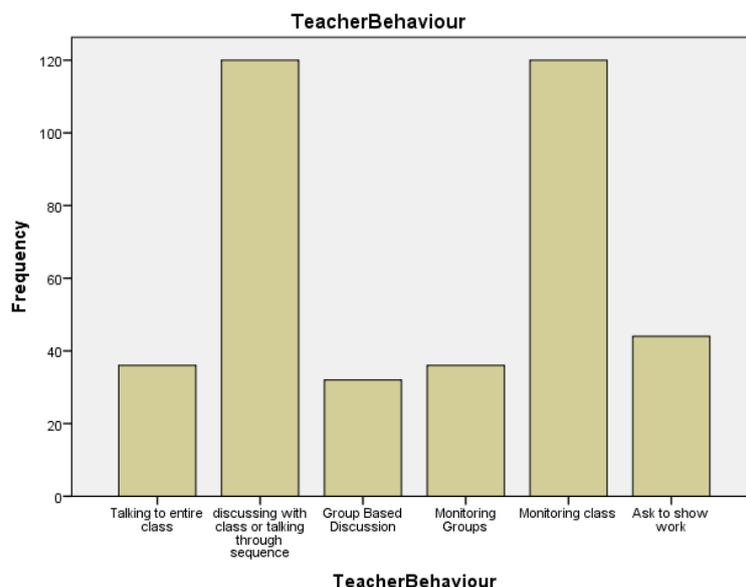|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Talking to entire class	36	9.0	9.3	9.3
	discussing with class or talking through sequence	120	30.0	30.9	40.2
	Group Based Discussion	32	8.0	8.2	48.5
	Monitoring Groups	36	9.0	9.3	57.7
	Monitoring class	120	30.0	30.9	88.7
	Ask to show work	44	11.0	11.3	100.0
	Total	388	97.0	100.0	
Missing	System	12	3.0		
Total		400	100.0		

As per previous groups, this is statistically significant when compared to the control (P<0.0001).
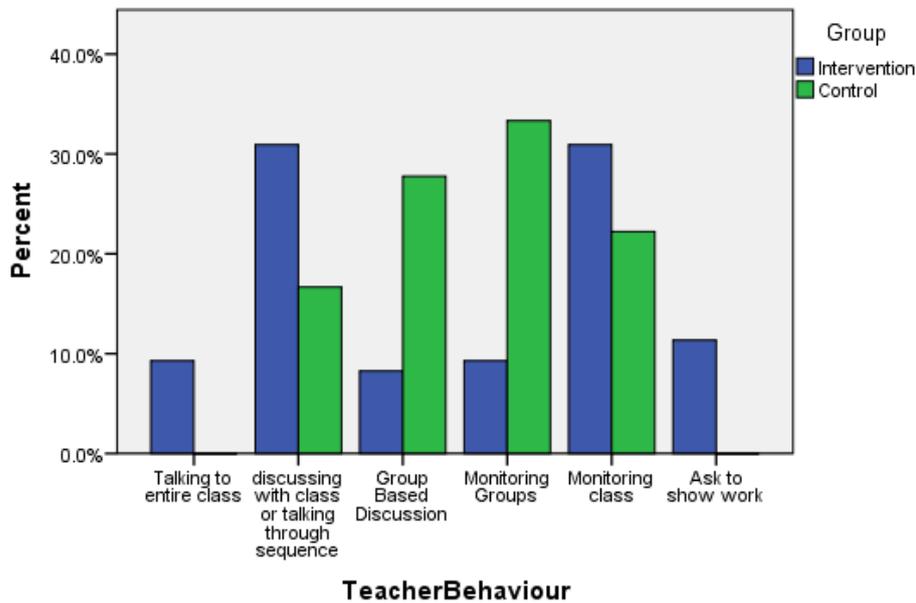
Overall Engagement – OF Yr 12

The intervention sessions held more observation of "All" engaged in comparison to the control (P<0.0001).
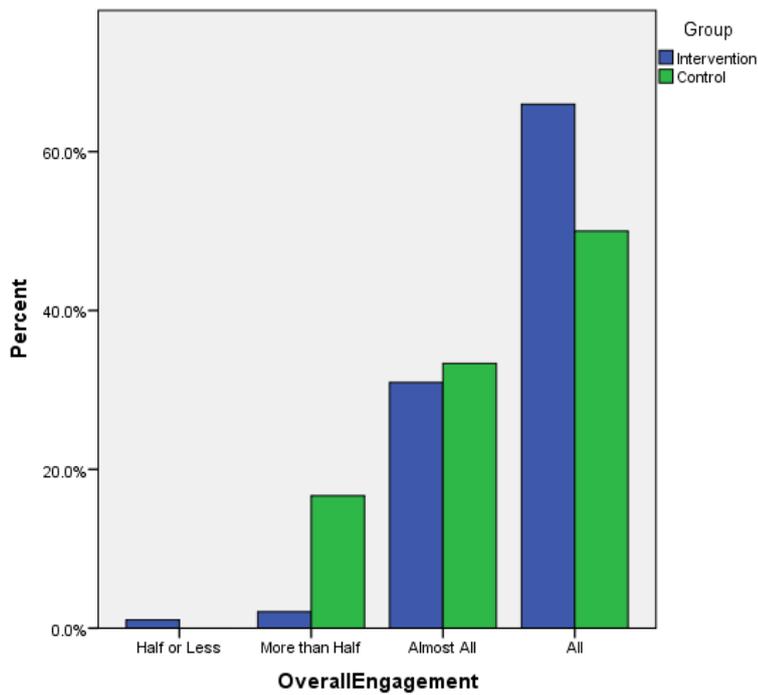
Detailed Learner Behaviour

Similar spread for learner behaviour as seen in other groups:

As seen in other groups the teacher behaviour of monitoring the class and discussing through steps appeared to hold more instances of unengaged learner observations compared to other categories (P<0.0001).
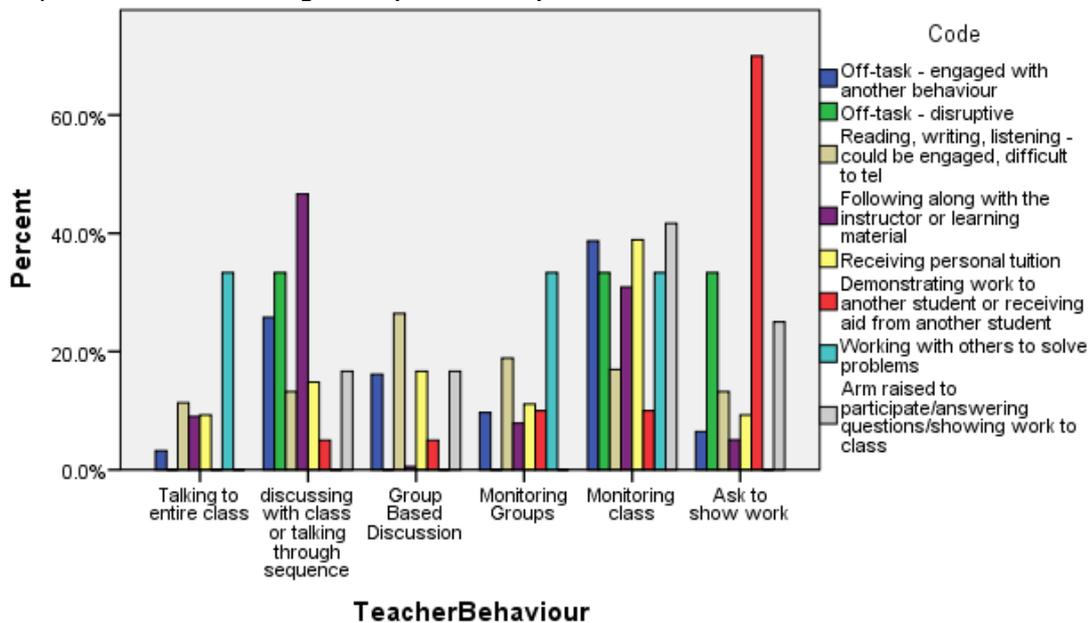
7.4 *Annex 5 - Lesson Plan Examples*

LESSON PLAN A

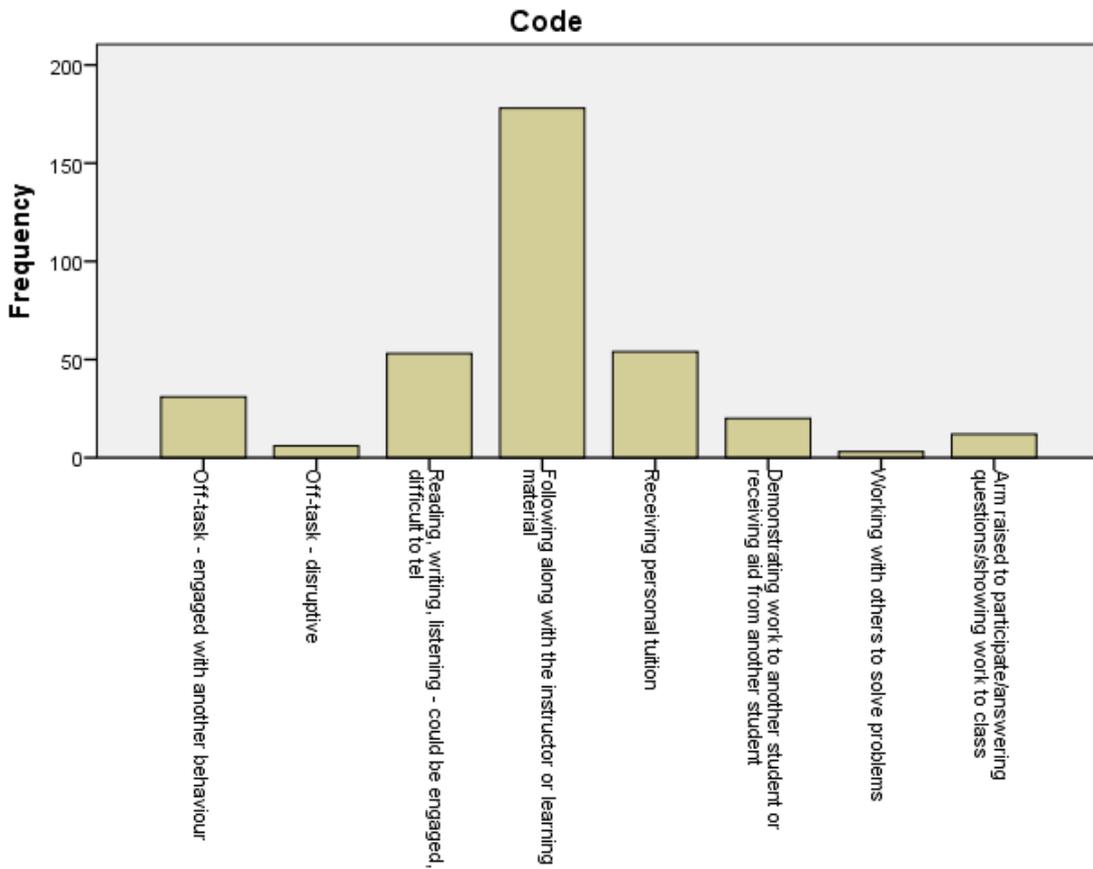| Context & Profile				
Author: NVA and NTU	Title: Applying Pocket Code to Science: *Broadcasting and receiving messages*	Timescale: 1hr	Year group/age: Yr8	No in group:
Relevant contextual information on learners:				
How does this lesson fit into the subject curriculum or the wider curriculum?		Prior learning of learners		
Science: Pupils can use appropriate language when discussing respiration. **Computing**: to create and plan a sequence of instructions developing coding practices. **Maths:** Algebra, use of co-ordinates.		Pupils have been introduced to the basic functions of Pocket Code. It is expected that between the first Pocket Code lessons pupils have worked on creating a lung model in a practical science lesson, or extended their knowledge to begin to understand how the diaphragm works.		
The Learning				

Groups	Intended progress (Learning Objectives)	How will this progress be demonstrated?	Assessment of progress by…
All	==Understand== how to use broadcast, adapting a mini-game exploring broadcasting and receiving messages. To ==understand== how the diaphragm causes the lungs to inflate and deflate.	By the end of the session pupils will have created the Science-based mini-game exploring broadcasting which has some interactivity. This will be shown to their peers and teacher.	Pupils answering closed question through the use of the **Correct or Incorrect** game.
Organisation			

Resources: PPT or Screen casting with IWB 1 tablet per pupil Work books & axes and web research. **Support**: Vocabulary on board.	Working with others: Learners:

Timings	Content		Cognitive / Behavioural	Learning scenario*
To start with...				
15 mins	**Quick starter**: **Activity: broadcasting cards** Pass around the *When I receive* broadcasting cards. See – Broadcast cards Explain that broadcasting is transmitting a message that is received by other objects (include simple diagram for explanation see - *Broadcast activity*) Pupils wait until a message is broadcast to them and follow the instruction given. *Definition: An object transmitting a message which is received by other objects.* **Download** – *Broadcast template* (**11863**) **Model** – Create your first object by drawing or taking a picture of the lung model showing exhalation (breathing *'out'*). Add a look, by drawing or adding a photo pulling out the diaphragm to represent inhalation (*'in'*).		C/B	I/FG
Main learning				
25 – 35 mins	Pupils working independently, taking photos/exploring Pocket Paint and adding text where appropriate. Show the scripts for the objects – pointing out elements of the code. (See: *Broadcast: Science* **5370** – to help with this) (See Broadcast Component Science guide) **Support**: programming vocab on board.		C	I/FG
Plenary / extension				
10 mins	**Extension**: Explain in as much information as possible what is happening within this respiration process and with the broadcast function, whilst using the mini-game. Record this explanation onto the program using the **Start sound** brick.		C	I/SG
	Plenary: **Download** - *Correct or Incorrect – Broadcasting* (**11992**) pupils to answer quick-fire questions. - Use the **broadcasting** method of answering the questions to assess their understanding of broadcasting from the lesson. (see *starter-plenary game – correct or incorrect* for details)		B	
	Homework: Think about the term 'inventory' and how this is connected to gaming. Give examples.			

LESSON PLAN B

Context & Profile				
Author: NVA and NTU	Title: Applying Pocket Code to Science: *Using the quiz template and backpacking*	Timescale: 1hr	Year group/age: Yr8	No in group:
Relevant contextual information on learners:				
How does this lesson fit into the subject curriculum or the wider curriculum?		Prior learning of learners		
Science: Pupils can use appropriate language when discussing respiration. **Computing**: to create and plan a sequence of instructions developing coding practices. **Maths:** Algebra, use of co-ordinates.		Pupils have been introduced to the basic functions of Pocket Code. They have begun to understand and apply their knowledge with basic components of game design.		

The Learning			
Groups	Intended progress (Learning Objectives)	How will this progress be demonstrated?	Assessment of progress by…
All	To <mark>demonstrate</mark> their <mark>understanding</mark> of **Broadcasting** by <mark>applying</mark> the component to the correct or incorrect starter game. <mark>Understand</mark> game design components, and <mark>apply</mark> to a mini-game through backpacking. To <mark>understand</mark> that gases move to and from the blood by diffusion.	It is expected for homework that pupils noted down questions based on the respiratory system, especially focussing on diffusion. They will apply their knowledge in a quiz template; adapting the content and backpacking objects into it.	Pupils answering specific questions in an activity

Organisation	
Resources: PPT or Screen casting with IWB 1 tablet per pupil **Support**: Vocabulary on board.	Working with others: Learners:

Timings	Content	Cognitive / Behavioural	Learning scenario*
To start with...			
15 mins	**Quick starter**: **Correct or Incorrect – Broadcasting (11992)** pupils to use **Broadcast** in the starter to answer quick-fire questions. *Apply this activity to areas you wish to assess and confirm their knowledge on topic areas.* Begin by playing *Diffusion* **(5419).** Discuss other game design components within the game (e.g. score, high-score) **Download -** *Quiz template* **(9992)** – play through this together: what game features do you notice? **Backpacking** Use the guide - *(backpacking guide)* to show an example of how to resolve mistakes (copy the *quiz template* program, delete parts of it – *perhaps the score HUD* – backpack the deleted parts from the original). Allow all pupils to try this – *how else could this be used?*	C/B	I/SG/FG
Main learning			
25 – 35 mins	**Model:** using the program *quiz template;* add a question chosen from the homework task to the program – discuss the answer with the pupils, add the answer and 2 incorrect answers (very simply) to the correct looks Work independently, creating and adding the questions to the quiz.	B/C	I/FG
Plenary / extension			
10 mins	**Extension**: Can you add your own sound effects and recorded voices to the game?	C	I/SG
	Plenary: Pupils to discuss quiz questions so far – which work well and which need to be improved for a multiple choice answer?	B	
	Homework: Note down questions on Specific areas for revision		

LESSON PLAN C

<table>
<tr><td colspan="6">Context & Profile</td></tr>
<tr>
<td>Author:
NVA and NTU</td>
<td>Title:
Applying Create@School to Science: Creating scores</td>
<td colspan="2">Timescale:
1hr</td>
<td>Year group/age:
Yr8</td>
<td>No in group:
TBC</td>
</tr>
<tr><td colspan="6">Relevant contextual information on learners:
TBC</td></tr>
<tr>
<td colspan="3">How does this lesson fit into the subject curriculum or the wider curriculum?</td>
<td colspan="3">Prior learning of learners</td>
</tr>
<tr>
<td colspan="3">Science: Pupils can use appropriate language when discussing respiration.
Computing: to create and plan a sequence of instructions developing coding practices.
Maths: Algebra, use of co-ordinates.</td>
<td colspan="3">Pupils have been introduced to the basic functions of Create@School.
They have begun to understand and apply their knowledge with basic components of game design.</td>
</tr>
<tr><td colspan="6">The Learning</td></tr>
<tr>
<td>Groups</td>
<td colspan="2">Intended progress (Learning Objectives)</td>
<td colspan="2">How will this progress be demonstrated?</td>
<td>Assessment of progress by…</td>
</tr>
<tr>
<td>All</td>
<td colspan="2">Understand how to use and make a scoreboard in Create@School and apply it to scientific activities.

Demonstrate your understanding by correctly labelling areas of the diffusion process.

<mark>To understand that gases move to and from the blood by diffusion.</mark></td>
<td colspan="2">It is expected for homework that pupils created a program called Diffusion and one object (a blood cell) with two looks (one red, one blue).

<mark>By the end of the session pupils will have made a mini-game exploring scoring which has some interactivity and a link to diffusion.</mark>

This will be shown to their peers and teacher.</td>
<td>Pupils answering specific questions in an activity</td>
</tr>
<tr><td colspan="6">Organisation</td></tr>
<tr>
<td colspan="3">Resources:
PPT or Screen casting with IWB
1 tablet per pupil
Work books & axes and script handouts.
Support: Vocabulary on board.</td>
<td colspan="3">Working with others:

Learners:
TBC</td>
</tr>
<tr>
<td>Timings</td>
<td colspan="3">Content</td>
<td></td>
<td></td>
</tr>
<tr>
<td colspan="4">To start with…</td>
<td>Cognitive / Behavioural</td>
<td>Learning scenario *</td>
</tr>
</table>

15 mins	**Quick starter**: **Correct or Incorrect:** Pupils to demonstrate their understanding of **Broadcasting** by applying (individually, or in small groups) the component to the *Correct or Incorrect* starter game. *Apply this activity to areas you wish to assess and confirm their knowledge on topic areas.* **Model** – Taking a photo of the alveoli/diffusion process from an activity book and through editing the look in Pocket Paint, begin to label. Pupils work independently to label their photo.	C/B	I/SG/FG
Main learning			
25 – 35 mins	Pupils to download **Create a scoreboard** Then, using their program **Diffusion** and the blood cell created add the score board component.	C	I/FG
	Work independently, creating the component and then applying it to diffusion. Ask: • What colour are deoxygenated blood cells? • What happens to the blood cells when passing the alveoli? What colour are they now? • Can you create code which makes the blood cells change looks when tapped? Explain what is happening. (*Use a breakdown of code as a handout if required*)	B	SG
Plenary / extension			
10 mins	**Extension**: Can you add sound effects to the game?	C	I/SG
	Plenary: Download game **Diffusion**, play the game in pairs. Ask: • How is this linked to diffusion? • In terms of game design, what does this program have?	B	

NO ONE LEFT BEHIND

Pocket code medium term planning Science: Respiration and breathing

Year 8

Curricular Skills

By the end of this unit all children should be able to:

- Explain the differences between inhaled and exhaled air.
- Label a lung diagram.
- Measure pulse and breathing rate before and after exercise.
- Describe and label the diffusion process.
- How the diaphragm is used in the respiration process

Some may be able to:

- Describe the differences between aerobic and anaerobic respiration.

Pocket Code Skills

By the end of this unit all children should be able to:

- Understand the basic functions and navigation of Pocket Code and Pocket Paint.
- Understand some game design components and are able to apply them.
- Use backpacking and other features
- Create a science-based quiz game.

Some may be able to:

- Create their own mini-games.
- Import images and edit these in Pocket Paint

The Pocket Code skills reflect the level of a year 8 (12-13 year old) pupil. It is proposed that these PocketCode-led lessons work alongside regular lessons and can be adapted to suit your needs. The Curricular skills can be replaced by any subject, since the PocketCode activities can be adapted including downloadable games.

Pocket Code: Respiration and Breathing MTP

Lesson No.	Learning objectives	Main Teaching Content	Differentiation	Plenary	H/W
1	• Create an interactive information board which is subject specific. • To begin to understand some elements of the respiratory system.	• Create another interactive information board using the sources which are available, and selecting and organising relevant scientific information. • Record a description of the focussed areas of development	Extension: make one of your objects move around the screen.	Select pupils to show one object and its related information to the class.	Think about what features are needed to create a game – note down to discuss next lesson.
2	• Begin to use Looks, adapting a mini-game exploring changing looks. • To begin to discuss the creation a quiz which is subject specific. • Correctly label areas of the respiratory system.	• Download the **Correct or Incorrect** program to understand changing a look, asking science-based questions and pupils showing their answer. • Discuss what game features do we need to make a quiz? • label images of the respiratory system.	Support: vocab on board. Extension: show the 2 looks of the photo – 1 with labels, 1 without – tap between them.	Peer testing on labelling photos.	

			Support		
3	• Begin to use broadcast adapting a mini-game exploring broadcasting and receiving messages. • To understand how the diaphragm causes the lungs to inflate and deflate.	• STARTER: **Activity Cards - Broadcasting** • Show how the diaphragm helps us breathe in and out through Broadcast mini-game – clarifying inflating and deflating	Support: vocab on board. Extension: Record the information using a sound brick	Use: *Correct or incorrect – Broadcasting*.	Think about the term 'inventory' and how this is connected to gaming. Give examples.
4	• Begin to use variables creating a mini-game exploring an inventory. • To reinforce understanding on how the diaphragm causes the lungs to inflate and deflate.	• STARTER: **Correct or incorrect** – Pupils to answer quick-fire questions. • Building on the mechanism of breathing to move air in and out of the lungs, create the variable mini-game to build vocabulary within this action. • Adapting and debugging a template.	Extension: Explain the differences between the air we breathe in, and out.	Explain the respiration process in the program	
5	• To use a timer in Pocket Code. • To demonstrate understanding on what happens to breathing rate when we exercise. • To begin to understand and label parts of the diffusion process.	• STARTER: **Respiration Bingo –** with suggested keywords. • Use timer to work with activities during the lesson. • Measuring of pulse and breathing rate during rest. Short exercise routine – measure again. • Labelling the diffusion process.	Extension: Note down and/or discuss the process of diffusion.	Play *Diffusion* **(5419)** in partners – Discuss questions that would link to the diffusion process.	Note down questions based on the respiratory system to add to your quiz
6	• Understand game design components,	• STARTER: **Correct or incorrect** – Pupils to use *Broadcast* in the starter as quick-fire questions.	Extension: can you add sound	Pupils to discuss quiz	Note down questions on

Key:	and apply to a mini-game through backpacking. • To know that gases move to and from the blood by diffusion.	• Developing understanding of game design components through the use of a quiz template. • Developing use of backpacking	effects to the game?	questions so far	Specific areas for revision	Key:
7	• To analyse structure of the quiz. • To reinforce knowledge of lung structure. • To reinforce aerobic and anaerobic respiration knowledge.	• STARTER: Respiration bingo • Finish creating the quiz, analysing all components	Plan out the next questions / statements with a partner.	Download game: Aerobic Vs Anaerobic respiration.		
8	• Demonstrate how to upload programs • To reinforce knowledge of the respiration system and apply this to your quiz	• STARTER: Correct or incorrect – Pupils to use *Broadcast* in the starter as quick-fire questions. • When the games have been peer-tested, upload them to the PocketCode site.	Extension: Complete and ensure all game design elements work correctly, add sound effects throughout the quiz.	Upload; play another's game. Brainstorm: Was using PocketCode useful in this topic?		

Pocket Code Objective

Subject Objective

Downloadable content for this module

Pocket Code Programs	Pocket Code Edu: Guides and Resources
Correct or incorrect – Changing looks (**11993**)	Game-making framework
Broadcast template (**11863**)	Teacher training guide 1
Broadcast: Science (**5370**)	Make a quick classroom starter game
Correct or incorrect – Broadcasting (**11992**)	Edit your object in Pocket Paint
Variables: Science Respiration (**5398**)	Broadcast activity
Variable template (**11864**)	Broadcast Component - Science
Bingo - Respiration card (**12914**)	Variable template guide
Bingo – Respiration caller (**12915**)	Variable program guide - Science
Creating a basic timer (**5404**)	Bingo game guide
Aerobic Vs Anaerobic (**5411**)	Create a basic timer guide
Diffusion **(5419)**	Backpacking guide
Quiz template (**9992**)	Quiz template guide
	Pocket Paint: importing images