CAN FLIPPED CLASSROOM IMPROVE RETENTION OF KNOWLEDGE AND SKILLS IN GCSE MATHEMATICS RE-SIT STUDENTS?

ACTION RESEARACH PROJECT BY CAIYUN FU DECEMBER 2020

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Introduction

For this action research project, I want to explore the use of flipped classroom in supporting retention of knowledge and skills in GCSE Mathematics resit students.

I currently work in a Further Education College as a Maths teacher, where I teach GCSE qualifications. Most of our students have studied Maths at school before and have failed to obtain a pass grade (currently a grade 4 in the new 9-1 syllabus). Due to the current Covid-19 situation, students attend lessons onsite once a week for 1.5 hours in this academic year instead of 2.5 hours in the previous years. In addition, students are timetabled to complete 1.5 hours self-study Century Tech work each week. Century Tech is the digital learning platform our college invest in this year to assist blended teaching and learning.

In reflection of my teaching, I have been using predominantly the traditional classroom method, which is a teacher-led method. One of the reasons is due to the nature of mathematics being difficult and many students struggle with most of the topics. In addition, the large amount of content that must be covered within the one academic year leaves very little time for student-led activities in class. However, in this traditional classroom, students don't have enough preparation before the class, learn while I am presenting and discussing the concepts and complete the day's topic with some homework. There are times when I feel that I am doing more work than the students. This cycle goes on and on, but the retention of knowledge and skills became more of a problem, which could be seen through students' poor performance in the following week's retrieval quiz. I feel that implementing some changes would be beneficial to both myself and my students.

Further to this, some students complain they're not given enough time to take the 'perfect' note they want. However, if students were left enough time to take detailed notes as they wished, little of the lesson could be done. In addition, due to the current Covid-19 pandemic, each lesson only lasts 1.5 hours, which is 1 hour shorter than previous academic years. I understand how valuable and precious face-to-face time with my students really is. To avoid wasting this time, I have to be more mindful than ever of what I do with both face-to-face time and outside-of-class time.

I have heard about flipped classrooms and have previously conducted some basic research around the area. Flipped classroom is a pedagogical approach in which the conventional notion of classroom-based learning is inverted: students are

introduced to the learning material in advance of a lesson, freeing up time in the class to deepen understanding through discussion with peers and problem-solving activities facilitated by the teacher.

Nowadays, the internet has made information widely and easily available, making students less reliant on a teacher to tell them things that can be found and read before the class. Century Tech, the digital learning platform students in our college have been using to study their maths remotely, is the tried and tested intelligent intervention tool that combines learning science, AI and neuroscience. It has all the topic-based videos and flashcards and can easily identify learning gaps and address misconceptions.

All of these make flipped classroom possible for my teaching practice. Therefore, I've wondered whether I could incorporate flipped classroom approach into my teaching practice. However, I didn't want to make any significant changes to my teaching without first considering the implications. In order to ensure I approach this in a considered and informed manner, I decided to conduct an action research project on flipped classrooms to see whether they could be beneficial and improve the knowledge retention and skills of in GCSE Mathematics re-sit students.

What is Action Research?

There are many different types of action research in the context of education, including individual and collaborative, school-wide and district-wide. All these types of action research serve the same aim: bringing about change in specific contexts – in education, this is in the context of learning.

Denscombe (2014) described action research as: 'A hands-on, small scale research project', which is typically used in the educational environment. The purpose of action research, according to Denscombe, is: 'Not only to gain a better understanding of the problems which arise in everyday practice, but actually to set out to alter things'.

According to Denscombe, action research projects have the following four key features:

1. **Practical in Nature:** Action research involves a practical rather than academic process and should look at real-world problems.

2. **Change and improvement in practice:** The aim of the action research is to implement change and result in improvement in practice.

3. **Cyclical Process**: The research process should be continuous with feedback and evaluation from initial findings leading to further investigation, so on and on.

4. **Participation**: Professionals should participate in the research process so that they investigate their own practice. It is about active not passive participation.

Action research is a cyclical and continuous process, which can be shown in the Diagram 1:
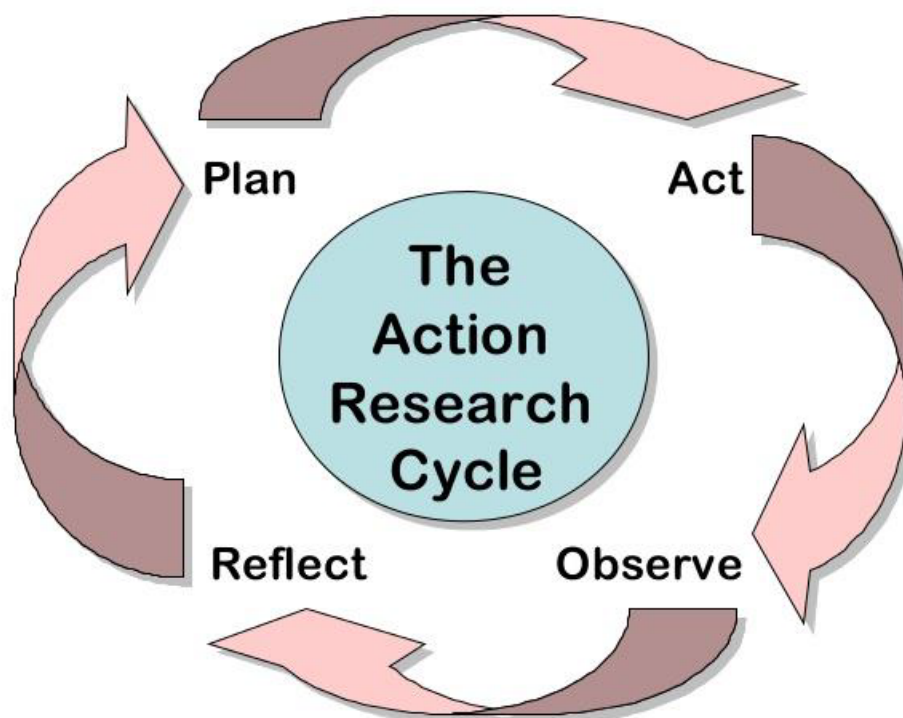

Diagram 1: The Action Research Cycle.
(https://www.slideshare.net/richard_nelson/action-research-introduction
)

Lewin (1946) proposed the action research cycle involving the following five main stages of carrying out research cycle.

Stage one: Identifying the problem – I have already done this by identifying an issue in my own teaching practice and thinking about how I can make a change.

Stage two: Data collection--when collecting the data, I need try to use a variety of methods, including both quantitative and qualitative methods, to validate my findings. I also need to consider any ethical, religious, political or confidentiality issues.

Stage three: Interpretation of data – I need to analyse the data , to figure out what it actually means and how it will affect the way I teach and the way my students acquire the knowledge.

Stage four: Action carried out based on data – following on from the conclusions, how am I going to apply it to benefit me and other teachers and our learners?

Stage five: Reflection. This is a key principle in education, as it is important to look at how effective a method is. The cycle can then continue, as during reflection further problem areas can be identified.

The Action research in this project is appropriate for the issue I have identified as a problem; it is a small enough goal that I can achieve. I may be able to produce results that can improve my teaching practice. It is also a research I can carry out realistically, as it has a fairly quick time frame, and is not going to negatively influence my normal teaching schedule. Furthermore, it can be of great benefit to me and my colleagues in the maths department as the use of action research in this project will allow me to make an informed and considered decision as to whether implementing a flipped classroom will result in improvement of performance in my students. I have already observed my teaching and have reflected upon it, I can see that I need to make some changes to improve teaching and learning. As discussed, I am currently implementing the use of flipped classroom, however, although this appears to work, I have not tested whether this is the case. It may also provide me with unexpected results. For example, I may find it works well for certain groups of students but not others and it might only work well for certain topics. The cyclical nature of the research will set in place a course of action which will allow me to continually improve my teaching.

Literature Review

Before conducting my research, I did profound research and read a range of literature regarding flipped classroom, to ensure I have a thorough understanding of flipped classroom, the theories behind it and how it should be implemented. I have noticed that even though there're lots of theories and claims that flipped classroom has positive effect on teaching and learning, but very little research was carried out to test retention of knowledge and skills in resit students.

What is Flipped Classroom?

Jon Bergmann and Aaron Sams are widely recognized as the pioneers of flipped classroom. Based on their earlier experiment on flipped classroom, they reported that in flipped class, students were interacting more and help could be directed toward students who needed it most.

Later on they launched the 'Flipped Learning Network' (FLN) to help other teachers implement flipped classrooms successfully. A formal definition of flipped learning was given by the FLN board members:

'A pedagogical approach in which direct instruction moves from the group learning space to the individual learning space and the resulting group space is transformed onto a dynamic, interactive learning environment where the educator guides students as they apply the concepts and engage creatively in the subject matter'.

Bishop and Verleger (2013) defined the flipped classroom as 'an educational technique' that consists of 'interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom.'

From both definitions, we can interpret that Flipped Classroom is a pedagogical approach which reverses the traditional teaching and learning order, and shifts from being teacher-led to student-led. In traditional classroom a teacher introduces the topic and students acquire knowledge in a classroom context and are then sent home with some homework to consolidate the learning. However, in a flipped classroom, students acquire knowledge before the class using the materials provided by the teacher and use classroom time to practice and apply concepts and ideas through discussion with peers and problem-solving activities facilitated by teachers to deepen understanding.

Theories and Principles behind Flipped Classroom

Flipped classroom is a form of blended learning based on Bloom's Taxonomy. In Bloom's taxonomy there're three domains of learning: cognitive domain (knowledge), psychomotor domain (skills) and affective domain (attitudes). Within the cognitive domain, there're six levels of cognitive tasks, from the simple remembering the facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order, classified as creating. These six levels are: (1) remembering, (2) understanding, (3) applying, (4)

analysing, (5) evaluating, and (6) creating. Bloom's taxonomy shows in a diagrammatical way how complex different kinds of learning tasks are, and how they stack up against each other.

In traditional learning (See Diagram 2), lower level of learning such as remembering and understanding is the focus in class, while students are usually left to work on activities that involve higher level of learning outside of classroom. The biggest issue with traditional classroom is that it leaves the students with little or no access to help when the help is probably needed the most, because their teacher is least available when they try to complete the higher level of learning at home. Another disadvantage of traditional classroom is that it deprives students of the opportunities to develop self-discipline and independent learning skills, because the material most amenable to self-teaching (the bottom half of Bloom) is conducted by the teacher in class.
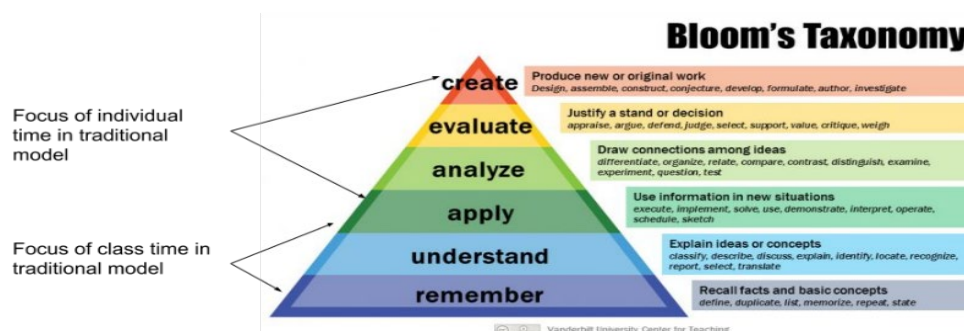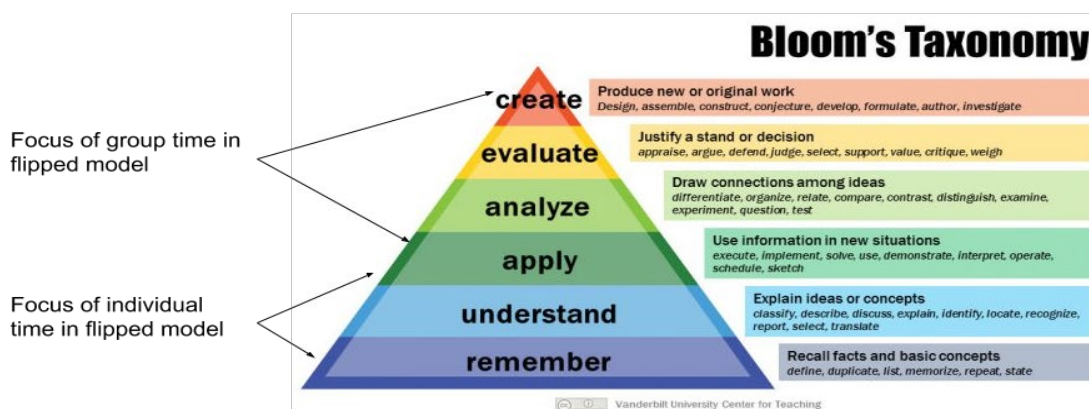

(Diagram 2 : [Re-thinking Bloom's Taxonomy for flipped learning design — Robert Talbert, Ph.D. (rtalbert.org)](rtalbert.org))

However, flipped classroom reverses the traditional learning environment by delivering instructional content outside the classroom and before the lesson time. It moves activities, including those that may have traditionally been considered homework, into the classroom so that students can practice and apply concepts and ideas in class to deepen their understanding. Now that facts and information can be easily accessed and obtained using Century Tech and other well-established websites, as you can see from Diagram 3, the flipped classroom model allows students to access the lower levels of Bloom's,

"Understanding" and Remembering," in their own time. When students come to class, they can engage in higher cognitive levels of learning with peers and teacher present, which provides the opportunity to practice knowledge in challenging and engaging tasks with their teacher and peers.

In this sense, flipped learning is not about making or watching videos, giving worksheets in class, or whatever. It's about making the most of the face-to-face time we have with students to consolidate and deepen students' understanding and extend students' learning to higher cognitive level.

(Diagram 3 : Re-thinking Bloom's Taxonomy for flipped learning design — Robert Talbert, Ph.D. (rtalbert.org))

Recent Research on Flipped Classroom

In the last decade, flipped classroom has certainly created a bit of 'buzz' on the internet due to the recent advances in technology and ideology. There have been lots of researches on the effectiveness of flipped classroom. As the mathematics professor Talbert (2018) stated, 'flipped learning research has since 2012 been growing at an exponential pace'.

In 2013, Bishop and Verleger did a survey on the research of flipped classroom. Results of this survey showed that most studies conducted explore student perceptions and the reports of student perceptions of the flipped classroom are generally positive overall. However, this survey also showed that there was very little work investigating student learning outcomes objectively.

O'Flaherty and Phillips did a scoping review on the use of flipped classroom in higher education in 2015. They pointed out that 'there is much indirect evidence emerging of improved academic performance and student and staff satisfaction with the flipped approach but a paucity of conclusive evidence that it contributes to building lifelong learning and other 21st Century skills in under-graduate education and post-graduate education.'

My study will be useful in testing the effectiveness of flipped classroom, because I teach resit students, this could have different implications. I would like to see the results for myself in my students. Furthermore, flipped classroom could be the push students need to change their grade 3 to a pass grade 4.

How I Implemented a Flipped Classroom?

I teach both adult classes and 16-18 years old students. I intended to carry out the research using two 16-18 years old groups over 3 weeks: one is taught with flipped classroom and the other with traditional classroom, but the topics I am going to deliver to both groups are exactly the same. The week before the maths topic is taught, both groups will complete a pre-learning quiz, at the end of the maths topic is taught, students in both classes will complete the same post-learning quiz, and I will mark these to check their knowledge and skills retention. The quiz scores from both groups will then be compared, and the effectiveness of the flipped classroom can be analysed. There are also external factors to consider in this research, and these will be discussed in more details later.

Carrying out the research over 3 weeks is important, as this accounts for difference in knowledge between topics. Both classes are all GCSE students. However, more than one group is important. This is also vital to reduce as much of the bias as possible. The topics I have chosen to teach for the purpose of this study are Angles for week 1, Scale and Measure for week 2, and Indices and Bearing for week 3. This does not deviate from the normal course outline

and scheme of work, and thus doesn't interfere with the normal teaching schedule or routine of the students. Week 1 and Week 3 topics are generally difficult topics for foundation GCSE students, it is likely they will have had little to no practice on these topics, due to the students previously failing. This in turn reduces the risk of prior knowledge interfering with my study. I will randomly allocate the two classes either the flipped classroom or the traditional classroom.

I have not implemented a flipped classroom before so I was aware that I might severely impact upon my students' educational outcomes. I was therefore very careful to ensure I monitor the progress of the research.

Due to the nature of the study I have chosen, there are no ethical issues associated. The students will not be exposed to any material that they wouldn't normally be in their lessons, and I will not be using sensitive data in my results in any way. I have confirmed this with my manager that I do not need any special permissions from the college to carry this out. The students will be informed of the research I am carrying out, and I will verbally collect permission from them all. They will be able to withdraw at any time, however depending on which group they are allocated to it could make little to no difference to their normal teaching lesson.

Flipped classroom generally involves the recording of lessons for students to view before the lessons. I didn't feel there was a requirement for me to make my own videos at this stage. Firstly, it is because this would involve some time and cost. Secondly, there're topic-based videos available on Century Tech and many other well-established maths websites. I currently make use of 'Century Tech' and Google Classroom. On Century Tech, there're topic related videos available, which students are required to use for independent learning for at least 1.5 hours each week. I currently ask my students in the traditional classroom to visit the videos as after a lesson so that they can reinforce their understanding of a concept. On Google Classroom, the topic-related PowerPoint and other resources such as videos links are uploaded at least one week before the lesson, so students have enough time to access them.

For the flipped classroom groups, I set the related videos as homework, topic related Power Point was also uploaded to Google Classroom for those who prefer to follow through the slides. Students watch and take notes of the videos and/or the Power Point I assigned in advance of the lesson.

In addition to students' previewing lesson materials, a flipped classroom also involves students conducting student-led activities during class time. I need to provide scaffolded activities and make them accessible to all students through differentiation and feedback.

At the start of each lesson, students are asked to complete a 15-minute pre-learning quiz, to test their initial knowledge and skills on the topic. Then 10-15 basic questions are used to test the basic concepts from the videos. It is important that the students are able to grasp and become fluent with the basics which then in turn allows the students the ability to reason and problem solve. In that time, I observed students' response to check their understanding and gave feedback if needed. Direct questioning was normally used at this stage.

When it came to the main independent exercises, students had the choice of either using the differentiated worksheets or GCSE exam questions straight away, based on their confidence. In this way, I differentiate to make content accessible and relevant to all students. Because of the Covid-19 distance rules, I was restrained from circulating as I would normally do, and the peer and/ or group activities were also eliminated. However, I encouraged students to take their initiatives to let me know when they need help. When a question was raised by one student, I would ask some other students to share their ideas first. If it appeared difficult for lots of students, I would explain it on the white board so that some other students could also hear the explanation if they needed. In about every 10 minutes, I would pick up a student who hadn't asked any question in lesson to explain how he/she solved a question. In the flipped classroom, instead of me spending half the lesson 'chalk and talking', my time were used more effectively in questioning, assessing and guiding students, to deepen their understanding and improve their problem- solving skills.

In the last 15 minutes of the lesson, students were asked to complete a post-learning quiz, to test their retention of knowledge and skills.

Methodology

I decided I would make use of various data collection methods including learning quizzes, observations and focus group. The rationale behind using this mixed methodology approach, as Denscombe (2014) stated, was so that 'by viewing something from more than one viewpoint the researcher can get a better knowledge of it'. I need some quantitative data to compare achievement of the flipped classroom group and the traditional class group. However, I don't want my research to be fully objective. It is important, in teaching in general, that achievement is not just measured by a grade. Therefore, I choose to also observe my classes and obtain feedbacks through focus group. By using a variety of different methods, I would be able to collect both qualitative and quantitative data, which would hopefully enable me to gain a complete picture and would also validate my research findings.

The week before the maths topic is taught, students in both flipped classroom and traditional classroom will be asked to complete a pre-learning quiz I have created, to test their initial knowledge and skills in the topic and also help me prepare the lesson for the following week. At the end of the topic is taught, all students are provided with a post-learning quiz, the questions are the same as the pre-learning quiz, but I will re-order the questions. I will mark the quizzes and compare the average percentage scores between the flipped classroom group and the traditional classroom group, as well as the percentage increase of the average percentage scores in each group, on each topic. As Maths is either correct or incorrect, this will provide me with quantitative data.

Alongside the quantitative data I obtain, I will also be carrying out observations and focus group. I will look at things such as engagement in the resources and understanding. I will interview students and collect their feedbacks on flipped classroom. This qualitative data provides me with an opportunity to investigate an issue in depth.

Confidentiality issues are something I have considered carefully. As the pre-learning quizzes and post-learning quizzes are valuable resources for revision topics for my students, submitting them completely anonymously would be less useful. I have decided to ask students to include their first name only on each learning quiz they complete. I can mark them and collect the data I need to use for my study. The quizzes can then be returned to the correct students, and can act as a revision tool for them, and they can see where they have gone wrong and improve their skills.

As mentioned above, there are certain elements of bias I must try to reduce the risk of. For example, my own views could be biased. To avoid this, I have not taken into account previous factors about the class, such as behaviour problem and previous assessment scores. The results will be based fully on the three weeks when I teach the topics I have chosen. Another possible bias that could be experienced is the students trying to please the researcher. As I am their teacher, this could be an issue. To minimise this issue, I have incorporated observations as well as the learning quizzes. This includes both objective and subjective data and reduces the risk of students aiming to please for the whole session. Initial knowledge of the students could also have an impact on the research. To minimise this effect, two of the topics I have chosen to teach are generally difficult and complex for the GCSE foundation students, and the students may have less experience with. I include Week 2 topic Scale and Measure which is less difficult simply because I also wanted to follow the scheme of work and course outline. All the questions on the learning quizzes are a mixture of exam questions from the previous years, meaning the resit students haven't done well in the past.

Data Collection and Interpretation

The data was collected using three methods – learning quiz, observation and focus group. Each of these is described below.

Observations

I will discuss the two groups and refer to them as flipped classroom group and traditional classroom group.

Flipped Classroom Group

In week 1, I found that the students struggled to adapt to the change in teaching style. Three students failed to complete the required work before the lesson, which made it almost impossible for them to follow the class activities. They were asked to use the class time to conduct the homework and were then required to complete the lesson activities at home. Clearly this impacted upon the experiment. However, as students realised that by not watching the videos or following through the Power Point they would not be able to participate in the class activities effectively, they started to follow the instructions in the following two weeks.

The lessons in week 2 and week 3 ran more smoothly than week 1 as the students came better prepared. I could see this clearly by observing their engagement and participation, and also through questioning them during lessons. When a question was raised by some students, lots of explanations from other students were heard before I explained it, which was encouraging to hear. Sometimes, I didn't even need to explain as the question was answered so well by some other students. The peer tutoring made students feel included, listened to and supported, which helped greatly to create an inclusive and supportive learing environment. Students liked the fact that they can watch the videos at their own pace and take detailed notes if they need. In addition, they have more time in class to apply the concepts of the topic and practice exam question in class. I make myself available to all students for individual, small group, and class feedback in real time as needed. All of these helps to deepen students' understanding and improve their problem-solving skills.

One of the most obvious improvement was the participation of the quieter, and often weaker, students. Students in this class has some particularly strong characters who can tend to dominate class discussions. Although their contributions are welcome it can sometimes discourage the less confident students from participating. During the class activities my role was changed to

that of a facilitator and I was able to direct my attention to those quieter students. This really helped me to check their understanding on the topic we were covering and provide necessary feedback. In addition, by watching the videos or following through the PowerPoint in advance of the lesson, the quieter students themselves had more confidence in answering the questions and therefore showed better participation in class.

Traditional Classroom Group

In week 1 Angles, some students were very unengaged and disinterested. I guess it was because most of them found Angles topic confusing and didn't do particularly well previously. They talked over me while I was teaching, and I had to ask one particularly disruptive student to leave the room until they had calmed down. This could have altered the dynamic of the group for this lesson. Based on the response to my direct questioning, the students demonstrated minimal understanding on the topic.

For week 2 Scales and Measure, they were mostly engaged with little behavioural issues. Upon questioning their understanding seemed satisfactory. None of the students requested or accepted additional work on the topic.

In week 3 Indices and Bearing, I had expected worse participation than week 1, as the harder the topic was the less engagement would be. However, in that week, the whole group was taught remotely because they were asked to self-isolate. Several students, who normally had behaviour issues and were less capable of maths, failed to join the remote lesson. Therefore, I was actually quite satisfied with the class participation.

Focus Group

At the end of the week 1 I conducted a focus group with the Flipped Classroom students. There were 11 students in the class and I randomly chose 6 students to participate. During the focus group I asked the students the following questions:

1. Have you enjoyed this week's lesson?
2. Do you feel that this week's teaching style has helped your learning more than previous lessons?

The responses were generally positive. Following discussions with my students I was able to determine the following:

1. The students enjoyed the lessons as they could watch the videos and take notes at their own pace.
2. They liked the starter of the lesson, when 10-15 basic questions were used to test the basic concepts from the videos. It helped them to recall the basic and key elements of the topic, which then helped them a lot in the main exercise time. Some of them said they were quite worried that they would be asked to start straight away to do practice and turned out to forget everything.
3. They did not want to see all future lessons flipped because they found it was hard work for them to prepare for the lesson.
4. Some of them didn't like watching Century Tech videos, simply because they didn't like the speaker's voice.

Before week 2 lesson I considered all the points raised by the students, in particular the point about not like watching the videos on Century Tech. For week 2 and week 3, students were provided a few options in terms of the topic related videos, to meet students' preference on the mix up of styles and voices when watching their homework. Luckily there're so many well-established maths websites with the videos to choose from. The following three are the main ones I suggested my students to use:

1. Century Tech (https://www.century.tech/)
2. Maths Geniue (https://www.mathsgenie.co.uk/gcse.html)
3. Corbettmaths (https://corbettmaths.com/)

At the end of the week 3, I conducted another focus group with the Flipped Classroom group. This time all the 11 students participated. During the focus group I asked my students the following questions:
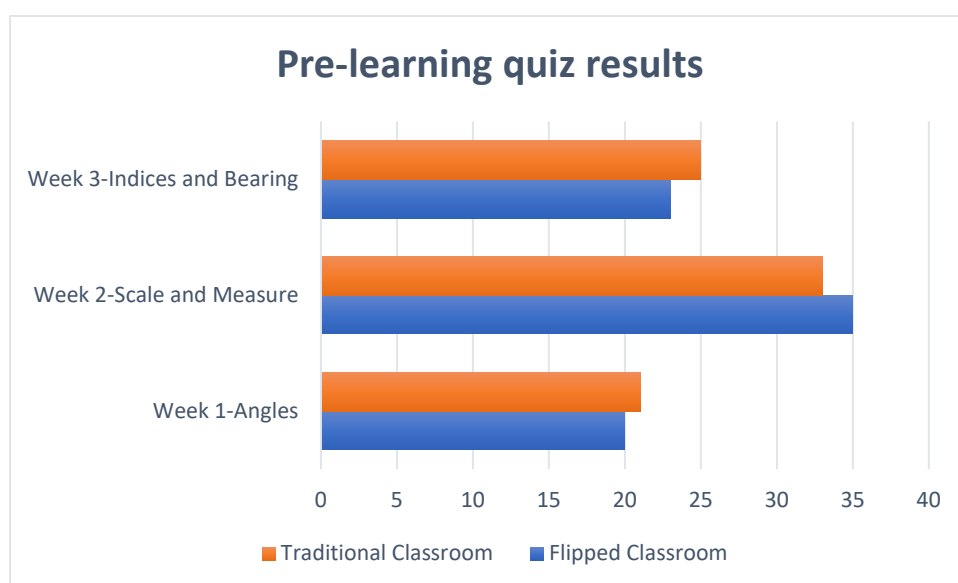
1. Have you enjoyed the lessons over the past 3 weeks?
2. Do you feel that the lessons over the past 3 weeks have helped your learning more than previous lessons?
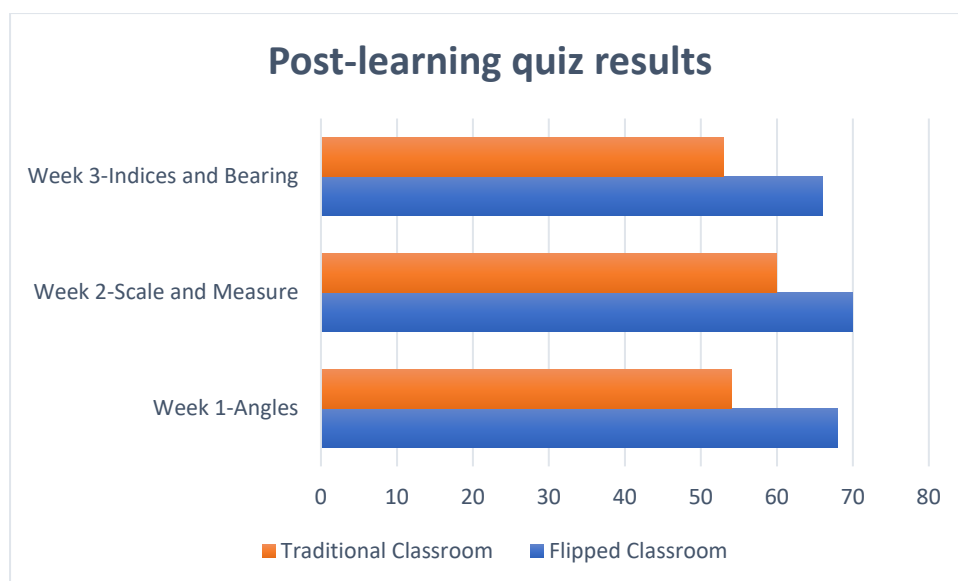
The responses were once again overall positive. Like the previous focus group, students enjoyed watching the videos and taking notes at their own pace. They liked the variety of the videos and the freed-up classroom time for them to do more practice with teacher present to help whenever needed. However, they didn't want to see all future lessons flipped because it would be too much work for them to prepare for the lesson.

As to whether or not they felt they had learnt more over the past 3 weeks, it was difficult to reach a definitive conclusion. Many students felt they would have learnt as much if I had taught them in a traditional classroom method. I personally felt they had learnt some very useful lifelong skills such as independent learning skills, self-discipline and ICT skills, but I felt many GCSE resit students had been used to be 'spoon fed' and it was not easy for them to embrace independent learning.

Learning quiz

All students present in both groups completed the pre-learning quiz the week before the topic was taught and at the end of each topic was taught. It was a short 15 minutes quiz and tested students' knowledge and understanding of key elements of the lesson. I have summarised the general results of each quiz for each group below.

Pre-learning quiz results

	Traditional Classroom	Flipped Classroom
Week 3-Indices and Bearing	25	23
Week 2-Scale and Measure	33	35
Week 1-Angles	21	20

Post-learning quiz results

The above two bars represent the average percentage score for the whole group of students in pre-learning quiz and post-learning quiz. As you can see from the chart, in the pre-learning quizzes, there was no significant difference in the results between the flipped classroom group and traditional classroom group. They both were at relatively low level. The flipped classroom group even scored slightly lower in both week 1 and week 3 topics, apart from the week 2 topic. However, in the post-learning quizzes, the flipped classroom group performed considerably better in all 3 topics, especially in the harder topics (week 1-Angles and Week 3-Indices and Bearing).

Because the questions in both pre-learning quiz and post-learning quiz for each week's topic are the same, we can compare the percentage increase of each group's average percentage score for each topic. The differences of the percentage increase in each week's quizzes are shown in the Table 1. It can be seen clearly that Flipped Classroom group has made much greater progress than the Traditional Classroom group in all of the 3 topics.

Topics	Groups	Pre-learning Quiz results	Post-learning Quiz results	Percentage Increase
Week 1: Angles	Flipped Classroom	20	68	240%
	Traditional Classroom	21	54	158%

Week 2: Scale and Measure	Flipped Classroom	35	70	100%
	Traditional Classroom	33	60	82%
Week 3: Indices and Bearing	Flipped Classroom	23	66	187%
	Traditional Classroom	25	53	112%

(Table 1: Percentage Increase in each week's learning quiz results)

In addition, I noticed with the flipped classroom group, students also attempted more questions. This is a common issue we have with resit students; their confidence has been knocked by failing. This results in a lack of trying, and they avoid the big mark questions even if they are more than capable of attempting and picking up a few marks. Many students in the traditional classroom group left a lot of questions completely blank, especially in the week 1 and week 3 as the topics were harder.

Conclusions

The rationale for this action research project was based upon the performance and views of my re-sit students and the self-reflection on my previous teaching practice, especially in the current Covid-19 situation. The large volume of content that makes up my course was pushing me down a teacher-led route and I believed implementing a flipped classroom could have freed up some teaching time and provided a solution. The aim of this action research was to determine whether or not the use of flipped classroom would have a positive impact on knowledge and skills retention of re-sit students.

In general, the students in the flipped classroom group performed better in the post-learning quizzes than those in the traditional classroom group. The understanding of the topics was evident through the results of the learning quiz, and also the amount of effort the students put in. It increased students' confidence in the topics and as a result their participation and engagement has been improved.

In GCSE Foundation level, we do not expect our students to achieve highly on the harder topics. The important thing that we emphasise is they have a go at the questions and try their best to write down their working out as much as possible. It appears that the flipped classroom group showed the greater progress on the harder topics, as learning environments created by flipped classroom are likely to satisfy students' need for autonomy and competence and, thus entice greater levels of extrinsic motivation.

My initial question has begun to be answered. The research identified that students taught in flipped classroom had more opportunities to be pushed and challenged than the traditional classroom group, through differentiated class activities. Because the students taught in flipped classroom watched the videos and/or followed through the PowerPoint before the lesson, they would have basic knowledge and concepts about the topic when they come into the classroom, and were ready to engage in higher cognitive levels of learning with peers and teacher present, which provides the opportunity to consolidate their knowledge and skills in challenging and engaging tasks facilitated by their teacher.

 Although the students taught in traditional classroom were also offered extension work and exam questions when they had finished, as were those taught in flipped classroom, they were less likely to accept. To be honest, in most of the time, there were hardly any time left in class for those who wanted

to stretch themselves in traditional classroom. The flipped classroom group worked more on applying their understanding and sharing ideas, to improve their knowledge and skills retention through in-class activities, which allows them to replicate the skills in an assessment setting. This prepares them well for the exam environment they will all experience at the end of their course.

This result is not just an improvement in grades, but also affects the student as an individual. The feedbacks I received from students in focus group regarding the flipped classroom were in general positive. Not only has it impacted on their knowledge and skills, it has built important life skills for the students, including self-discipline, independent learning, stretching and challenging oneself, focus on a task, and ICT skills. Furthermore, it has increased their confidence, as evidenced in my lessons. This can lead to more determination in an exam situation, allowing them to attempt the higher-level questions and get a few extra marks, which could make the difference between a fail and a pass grade.

Overall, I do feel that my research has confirmed that flipped classrooms can play a valuable and positive role in teaching and learning in the 21st century. Flipped learning provides the students another opportunity to take ownership of their learning and provides them with many useful strategies to investigate, learn and revise. My observations confirmed that, in general, students became more engaged with lessons. I did witness an increase in engagement from quieter students and it is these students who could potentially benefit hugely form flipped classrooms. The focus groups told me that students enjoyed the flipped classroom, even though it means a lot of preparation for them. The learning quizzes provided further evidence that flipped classroom can help improve the retention of knowledge and skills in my students.

This research has taught me as both a teacher and researcher many important things. Firstly, it has demonstrated that even as only one person, I am able to make a difference to many student's learning. It has also taught me the importance of applying the action research cycle for effective results. By first identifying the issue and researching it, you can begin to consider how you can test a solution. One of the most important steps in action research is reflection. We must take a step back and consider what we have learnt, what went well, and what we may do differently next time. This allows the cycle to continue, as you shape both yourself as a teacher and your students as learners.

For future practice, I recommend using flipped classroom to deliver some of the maths topics, if not all of the topics, to re-sit students. It is important,

however, to remember that all students are different, and have individual needs. As mentioned, I used only 16-18 year olds, which means the results may not be so prominent in a different group. Therefore, we must carefully consider the usefulness of this teaching method with our students, and their ability to conduct independent learing.

Since completing my research, I discussed the results with both of my groups. They all agreed that they prefer to be in charge of their learning, as it helps them to grow as adults moving into the working world. They also like the challenge of pushing themselves and seeing the success as a result.

Limitations of this Research

This is a relatively small action research project and the timeframe I have to assess the effectiveness is relatively short. This short time frame means my research confirms the effectiveness of flipped classroom on retention of knowledge and skills only in the short term, i.e. duration of the lesson, but I was not able to research it for the longer term. Such investigation is beyond the scope of action research, as it would need to be carried out over the whole course, not just a few weeks.

The number of students I teach also limits the significance of this research. I have 11 students in the flipped classroom group and 12 in the traditional classroom, so the statistical significance of my research is limited.

As mentioned, I teach both adult students and 16-18 years old students. For this research, I used only 16-18 year olds, therefore the results may not be so prominent in an adult group.

Furthermore, because of distance rule during the Covid-19 pandemic, the variety of the student-led activities is limited, which affected the flipped classroom more than the traditional classroom. I would expect better result from the flipped classroom if the teaching was not affected by the Covid-19.

Recommendations for Future Action Research

For future action research, I will implement flipped classrooms for different parts of the course to see if some maths topics are better suited to a flipped classroom than others. Some topics are easier than others and I consider these to be good topics to 'flip'. Some difficult topics such as simultaneous equations, Pythagoras and trigonometry, I don't think are suitable. I intend to investigate these in the future to see if it is the case.

As mentioned earlier, for this research, I used only 16-18 years old students. For future research, I will implement flipped classroom with adult groups to see whether I can get different result with different age group. Compared to 16-18 year olds, adult students have different motivations and better attitudes towards learning GCSE maths. On the other hand, adult students are probably under more pressure in their learning as they have to take into account their work and family apart from learning. All these factors might bring out different outcomes on the implementation of flipped classroom, which is worth investigating in the future.

I do think it is important to implement flipped classrooms at the start of a course. It takes time for students to get used to the new teaching style. When implementing flipped classroom from the very beginning of a course, students will have time to get used to the requirements and will be less likely to put up barriers which could impact upon them embracing flipped classrooms. In the future research, the timeframe can last longer, starting from the beginning of the course, until at least one term, so that the effectiveness of flipped classroom can be investigated in greater depth.

Reflections on this Action Research

Action Research Project was the most daunting task for me throughout the whole DET course. Therefore, I left it a bit behind of other tasks. When I was just about to get on with it in March, the lockdown started, and then it was the end of the academic year. During the summer holiday, I did lots of reading on Action Research and on Flipped Classroom, to prepare me in theories for this research project. I intended to start the trial as soon as the new academic year started. However, because of the Covid-19 pandemic, the distance and bubble rules brought chaos and constantly change on the groups of students each teacher teaches. It was not until the October half term that I was finally assured to have a set groups of students to teach.

Although I found the flipped classroom inspiring and enjoyable, I also found it was much harder work than I had expected. It is easy to assume that if students are doing activities in class then as a teacher, I can have an 'easy life'. However, this is not the case. Flipped classroom requires a lot of planning and I have to be very organised. I had to make sure students were aware of what was required of them and I had to ensure they had sufficient time to prepare. I also had to ensure I had a variety of differentiated tasks for a range of abilities for each lesson. I had to make myself available to all students for feedback in real time as needed, either individual feedback or whole class feedback. On top of all these, I had to conduct ongoing formative assessments during class time through observation and by recording data for future instruction and evaluation.

Overall, I am happy with the carrying out and results of my action research. I identified a problem in the classroom that concerned me, as I felt the students were not taking in what I was teaching. Traditional classroom limited the opportunities for students to apply and practice problem solving skills in class, due to the limited in -class time and the large volume of content that needs to be covered. My job was to help students develop their knowledge and skills, and they often came in the next week not even knowing the topic I had spent almost the whole lesson teaching the week before. I wanted to turn this around and see the light bulb moments we aim for as teachers, and have students succeeding and even surprising themselves. Flipped classroom could be the solution to the issue I identified.

My action research consisted of four main parts – planning, acting, observing and reflecting. After identifying the problem, I did lots of planning and tweaking of methods through researching literature before I decided how to

proceed. I did profound research on flipped classroom and the current research on it and then decided to test whether the flipped classroom can improve the retention of knowledge and skills in my students.

I spent lots of time considering how I wanted to answer my question and find a solution to the issue. I have found the whole experience very rewarding, as I have learnt a great deal about how to make most of the valuable and limited face-to-face time with my students and form an inclusive and supportive learning environment.

I used a variety of methods to collect data, including both quantitative and qualitative data. This helped to the validate the findings of my research.

The results of my action research confirmed that flipped classrooms can play a valuable and positive role in teaching and learning. It provides students another opportunity to take ownership of their learning and free up more classroom time to focus on applying their knowledge and skills to improve their problem-solving skills, which will definitely help them to get the grade they want in the exam.

To improve my action research, I could have extended the period of research, and also increased the number of classes I used, including the adult groups in particular. However, this would have used up more of my time to plan and organise for more classes, and I did not want to compromise the teaching of my other classes not involved.

Another point of improvement is the extent of the assessment of knowledge. As it all had to be contained within one lesson, I had limited amount of time for a test of knowledge at the end of the lesson. I chose to use only 15 minutes as an overall review of what they had learnt, however it would have been more effective if I used more time checking the full extent of their understanding. Due to time restraints, it was difficult in this situation. However, this is something I can use as a basis for improving my action research skills.

Furthermore, the shift now from a traditional classroom instruction to a classroom instruction full of activities is the target. I found it difficult for me to conduct a variety of group activities and peer activities in the current Covid-19 situation. In the future, I will work on exploring ways of collaborative learning using modern technology to improve the student-led activities in a flipped classroom.

I have learnt an awful lot in the process and if I am asked to conduct an action research again I will definitely not feel it so daunting to make a start. Not only

did I gain experience of conducting an action research project, but during the process I have learnt a considerable amount about my teaching style and believe it has been an extremely worthwhile process to conduct. I analysed my performance as a teacher and reflected upon my strengths and weaknesses. Even if I do not implement flipped classrooms on a permanent basis in the future, I have made a significant move away from teacher-led passive learning towards more student-led active learning.

In conclusion, to match the interests of the 21st century learners, I recommend teachers consider flipped classroom as a way of lesson delivery. It caters the two concerns of mathematics teachers, the time restriction and the students' interests. In my experience, flipped classroom can free up the class time to support and deepen students' understanding and can improve the retention of knowledge and skills in GCSE Maths re-sit students. In addition, it helps to develop the lifelong skills for 21st Century learners, which involves self-learning skills and the use of technology.

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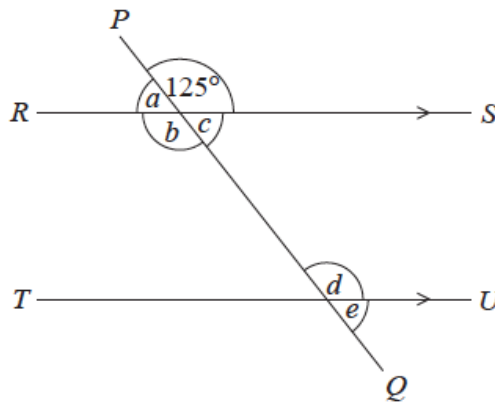
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Appendices

Example of learning quiz-week 1 (Angles)

Your First name:___

1. *RS* and *TU* are parallel lines.
PQ is a straight line.

An angle of size 125° is shown on the diagram.

Write down the letter of one other angle of size 125°
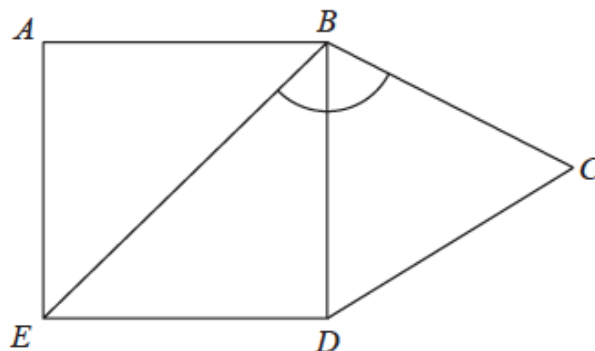
Give a reason for your answer.

....

....

(2)

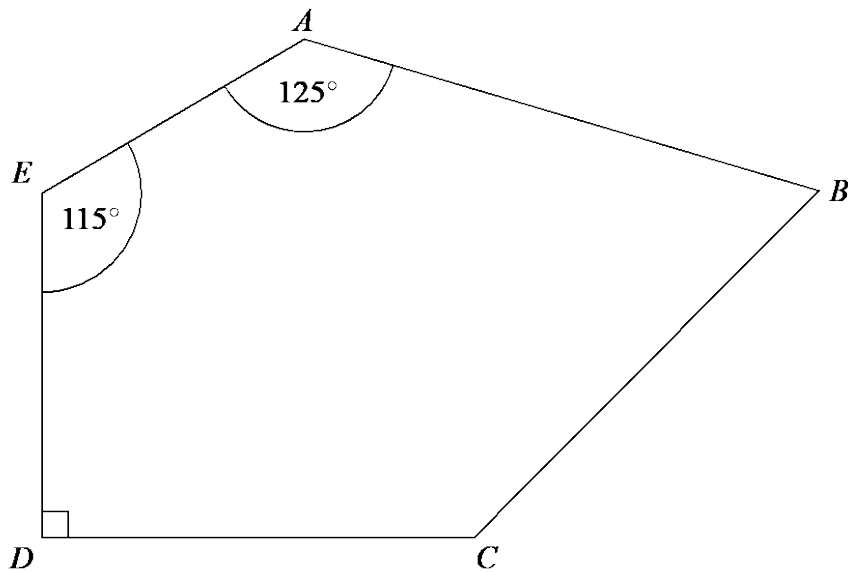**(Total for Question 1 is 2 marks)**

2. The diagram shows a square *ABDE* and an equilateral triangle *BCD*.

Work out the size of angle *EBC*. (2 marks)

(Total for Question 2 is 2 marks)

3. *ABCDE* is a pentagon.

Angle *BCD* = 2 × angle *ABC*

Work out the size of angle *BCD*.
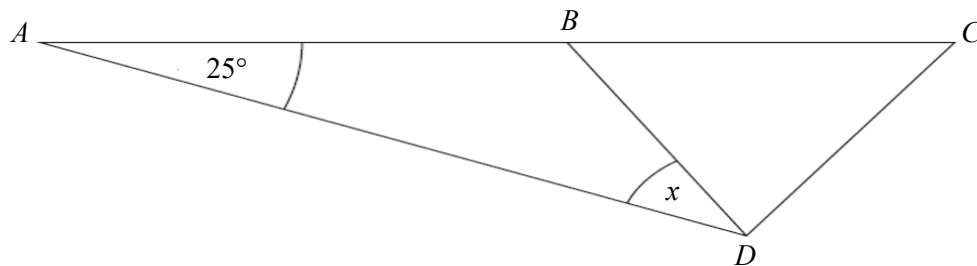You must show all your working.

(Total for Question 3 is 5 marks)

4. The size of each interior angle of a regular polygon is 11 times the size of each exterior angle.

Work out how many sides the polygon has.

(Total for Question 4 is 3 marks)

5   The diagram shows triangle *ABD* and triangle *BCD*.

ABC is a straight line.
BCD is an equilateral triangle.

Angle *DAB* = 25º

Work out the size of the angle marked *x*.
Give a reason for each stage of your working.

.... º

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(Total for Question 5 is 4 marks)