Investigating student's and teachers' experiences of the implementation of the flipped classroom model in year 9 physics

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Investigating students' and teachers' experiences of the implementation of the Flipped Classroom model in Year 9 Physics

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Abstract

This dissertation describes a two-half term study studying the impact of flipped learning approach on students' engagement. This study aims to investigate whether and how this pedagogical method can influence the engagement and attainment of Year 9 IGCSE Physics students in an independent boys' school. The literature review shows evidence the flipped learning can have mixed results on students, and this study aimed to assess the extent to which this teaching method can be successful for students of all abilities. The study used control and an experimental group and conducted two research cycles. The students' engagement were measured using the MSES questionnaire (Wang et al. 2016) and via qualitative interviews with selected students.

The main MSES findings revealed that the flipped learning has a negative impact on the student's engagement, but there is significant uncertainty in the results. However, there are positive elements to be considered, such as the promotion of collaboration and peer teaching. Teacher interview outcomes suggested a growing discrepancy between high and low achieving students when flipped learning is implemented. At the same time, the physics department faced some challenges to implement the method efficiently, particularly during online learning. The Physics assessment results following the first research cycle showed no significant differences between the control and the intervention group. This evidence will inform my department the upcoming year in order to draw a new strategy for the correct implementation of flipped learning through collaboration and sharing of successful practice in classrooms.

1. Rationale

For many students, Physics is considered one of the most challenging subjects in English secondary education and across various other countries (Coe 2008; DeWitt et al. 2019; Kessels et al. 2006). In literature, students have outlined several reasons that justify the nature of this subject. First of all, it is perceived as a more demanding subject compared to other sciences, like Biology. One of the reasons is that students often tend to find gaps between the taught material and real-life applications (Cuff 2017; DeWitt et al. 2019). Also, Physics' theoretical nature and strong link with Maths creates a sense of abstractness, which, on many occasions, hinders the understanding of students (DeWitt et al. 2019).

Concerning the school under study, students manage to achieve top grades in their GCSE Physics exams to a percentage of 95% of 9-7 in the national exams of 2019. However, my experience as a practitioner in this new school has shown that a considerable proportion of students and particularly low achievers show significant difficulties in comprehending questions and working independently. This effect is usually evident in homework, where students tend to complete only a proportion of their

set tasks. On the other hand, high-performing students introduced to GCSE coursework face difficulties constructing and synthesising knowledge to achieve top marks (grade 9) in their final exams.

From the outset, this led me to search in literature for a classroom method that would be suitable to address my findings and would be practical, efficient, and applicable to my teaching practice. It then required some additional requirements to be met. For example, this teaching method should have the potential to be applied in a wide variety of Physics units. For ethical reasons, the method's design also had to be sustainable, considering the school's expectations, planning time and resources, and all involved parties' needs. This refers mainly to the students and colleagues who would participate in the study (BERA 2018). Also, this method had to be practical to be incorporated into the Physics department's scheme of work and show the potential to create a positive impact on a more long-term basis.

It was expected that the new school year's most defining characteristic would be the uncertainty in the school settings. Therefore, as a researcher, I also had to consider possible ramifications in my practice that might occur as a result of the recent COVID pandemic. It was expected that there would be variants in the rates of COVID across the year and across students who would have internet connectivity issues or students that would get sick, which would prevent them from being at school. Therefore, there was a necessity for creating a classroom environment that will generate opportunities for adaptation. Consequently, I had to consider choosing a teaching method that could control this uncertainty and support the implementation of my research.

In addition, in the school under research, e-learning is becoming increasingly widespread. Particularly in Year 9, students have benefited this year by the school's e-scheme getting access to personal laptops. As students become more familiar with using technology for learning, it seemed logical for this study to focus on Physics' learning in a more meaningful way taking advantage of this new asset. Cultivating students' ICT skills for GCSE physics early, could create the potential for new student-centred activities which stimulate students more actively, enhance their creativity, basic understanding and learning independence in and out of the classroom (Županec et al. 2018). Therefore, it was practical for my study to be based on a digital environment and how this would help increase students' engagement and attainment in Physics lessons.

The flipped classroom has been growing in popularity in recent years and has been recognised as a teaching approach that can be beneficial and promotes positive learning opportunities (Bond 2020). However, there is a limited number of published articles investigating the application effects of Flipped Learning approach, particularly in Physics. Most studies focus on upper-secondary or tertiary

education in North America and Asia, with only a limited number of published articles coming from the United Kingdom (Bond, 2020). In particular, only one study referring to physics (Kettle 2013) and three masters' studies have been identified, examining various factors on Flipped Classroom in Key Stage 4 or Key Stage 5 (Bonsall 2017; Taylor 2017; Nicholas 2014). Recognising these research gaps, the goal of this study is to investigate students' engagement and academic achievement in the Flipped Physics Classroom method.

The school under study appears to be more adept at using flipped classrooms in recent years, as a few teachers encouraged student-led tasks, especially in online learning lessons during coronavirus closures in the previous year. However, flipped homework is not widespread across the department and school; therefore, an initial discussion with colleagues will illuminate the potential obstacles to the successful application of flipped learning at school.

Hours of traditional homework is set daily to pupils across the school with strict deadlines. During remote learning, initial observations have shown that flipped learning tasks are often pushed to the bottom of students' priority list and tend to be either rushed or not completed. As a result, teachers may not plan their next lesson with confidence if some students have not completed the flipped homework task. This means that they may have to review the flipped homework task in detail, impacting negatively organised and well-prepared students who spent the time to complete it.

For these reasons, I will pursue action research by developing and teaching a series of Physics lessons following the Flipped learning (FL) approach for Year 9 students. I hope that after applying a cycle of interventions, students will increase their ability and confidence to work independently, improve their academic achievements and become more consistent with flipped homework. Also, it is hoped that collaboration with colleagues from the Physics department will lead to further discussions with an aim to improve students' academic results using this pedagogical approach and possibly change the culture of learning in the school under investigation. This study's final goal would be to create a potential for a change in the learning culture of Physics education in school to a more student-led approach focusing on KS3 and particularly Year 9 students. Student engagement in Physics will play a crucial role in addressing this problem.

The research will focus on investigating the benefits of flipped learning for lower school pupils. Year 9 at school under study are mixed attainment, so I would be interested in exploring how we can use flipped learning as a department to help support pupils in these year groups and particularly the lower attaining students. Some flipped learning strategies that have been considered will include student-friendly digital quizzes and individualised assessments that more explicitly assess maths and practical

skills to identify weaknesses. In this way, the teacher could devote more centralised support for underperforming students in the classroom.

2. Literature Review

1.1 Introduction

Within the literature, the term "Flipped Classroom" (FC) has been portrayed the last decade as an instructional model which shows potential in bringing technological tools in education and therefore contributing to the digitalisation of schools (Akçayır & Akçayır 2018; Weiß & Friege 2021; OECD 2018; Bond 2020).

The Flipped Classroom (FC) model has gained real momentum, becoming the centre of attention of modern computer-assisted instructional methods, with OECD (2018:76) seeing a "great promise" at this practice by embedding technology in classrooms, supporting individualised instruction and increasing face-to-face learning time for students. FC popularity has also been reported in tertiary education, where professors flip their classes to improve the declining lecture attendance over the past few years and address the demand for flexible and high-quality learning via digital tools online (Strelan et al. 2020). However, despite the growing reputation and publicity, the research outcomes on the FC impact on students varies widely across the literature (Weiß & Friege 2021). This becomes particularly evident for student perceptions of FC and performance outcomes by implementing this teaching model (Bond 2020; Bishop & Verleger 2013). This section will describe the FC definition, the advantages and disadvantages of this method, and current evidence of its impact on student engagement. In addition, the findings of this review will help inform the structure of the FC intervention, illustrate the potential implementation challenges, and allow comparisons with this study's outcomes.

In their literature review from 2000-2020, Weiß & Friege (2021) reported a spike of published articles on FC, starting from 18 records in 2012 to 844 records in 2020. Thus far, the majority of studies originate from North America and Asia, and they are heavily focused on university learning settings, with only around ten percent (10%) of literature showing relevant studies at secondary education (K-12) (Bond 2020; Weiß & Friege 2021). However, it is argued that most articles are forming part of individual empirical research, and for this reason, such studies can rarely be replicated in new educational settings.

1.2 Literature Review Findings on Flipped Classroom

1.2.1 The Definition of Flipped Classroom

The rise of Flipped Classroom model in secondary education took a primary step forward by its pioneers Bergmann & Sams (2012). With a supporting theoretical framework based on cognitive load theory, schema theory and social constructivism (Bishop & Verleger 2013; Strohmyer 2016), the Flipped Classroom(Inverted Classroom) is a pedagogical method that places students in the centre of learning by allowing educators to invert their instruction. More specifically, teachers need to adapt their teaching philosophy into "that which is traditionally done in class is now done at home, and that which is traditionally done as homework is now completed in class" (Bergmann & Sams 2012, p.13). Students are required to review and understand instructional material (videos, notes) the night before while the actual classroom time is now freed up for active learning activities, including problem-solving and hands-on activities with teachers undertaking a more guiding role (Lo & Hew 2017a; Bergmann & Sams 2012).

However, numerous authors (see Bishop & Verleger 2013; Weiß & Friege 2021; van Alten et al. 2019) have questioned the usefulness of this empirical definition. It is argued that there is no consensus on whether video lectures should be the central element of the Flipped Learning definition or whether a more holistic definition should be provided. In addition, from my experience, the Physics Department of the school under study occasionally provides self-explanatory worksheets to be completed before the next day's lesson. Can these tasks be considered a form of flipped learning? The studies mentioned above support that this idea would not be valid. In fact, they align with Bishop & Verleger's (2013) philosophy arguing that videos should form an integral part of the dissipation of knowledge in Flipped Classroom. In conclusion, it is suggested that the flipped classroom should be "an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside of the classroom" (Bishop & Verleger 2013, p.5). Lo & Hew (2017) agreed on the importance of videos as an educational tool, noting that students were less prepared when provided with textbooks. They reported that text-based materials could not permeate information effectively as they lack the "elements of lecturing such as teachers' explanation and elaboration of concepts" (Lo & Hew 2017, p.5). On the other hand, teachers using video or audio materials as a new knowledge medium can help students understand concepts better by asking questions before the classroom time. In honouring this suggestion, this study will focus on providing videos and audio material in the FL implementation for the next day lesson preparation.

1.2.1 Flipped Classroom impact on Attainment

When assessing the effectiveness of the Flipped Classroom, it was important for this study to include literature following a structured and concrete instructional design. The reason behind this decision was that several reviewed articles failed to provide a uniform, detailed and transparent FL design, including learning objectives, selected content and instruction selected for in-class and out-of-class activities. Lee & Lai (2017) made it clear that lesson design has a crucial role in the effectiveness of this teaching approach. Four studies have been selected to meet the above criteria and examine the effects of flipped learning classes on student attainment (Nicholas 2014; Taylor 2017; Jensen et al. 2015; Yong et al. 2015; Frank Finkenberg & Trefzger 2019).

Nicholas (2014) undertook an FC study on the topic of Chemistry with two different groups, a GCSE Year 10 class (cross-sectional study) and a Year 12 class (longitudinal study) studying for their International Baccalaureate (IB) course. During his project, he supplied students with video material and semi-structured notes as part of their autonomous homework learning, having the option to ask questions to the peers and teacher. He focused solely on the analysis of IB exam performance. The results showed that students' attainment improved by a 7% increase on average. However, he expressed a reservation as to what extent this outcome was down to improvements in lesson planning or flipped learning itself.

Finkenberg & Trefzger (2019) showed the effectiveness of the FL approach with grade 11 Physics students, which translates to Year 12 (16 years old) in England. In his three-month study, 151 students were categorised into control and treatment groups. The findings showed that students who followed the FL approach had a significant learning gain than the group following the traditional approach. The intervention was successful also in increasing students' self-determination. They claimed that the intervention was successful as it provided opportunities for differentiation and individual learning support for high and low performing students.

Taylor (2017) reported findings on his study with three Y12 Flipped Classes, noting that high-performing classes outperformed low-performing classes after the intervention. However, a limitation of this study is that both groups received the same intervention. In addition, it was noted that the absence of control groups would not allow opportunities for meaningful comparisons.

However, insights from literature are not always positive. Jensen et al. (2015) investigated the hypothesis of whether teachers are primarily responsible for the quality of student learning in a classroom. Their study encompassed a similar methodology with the abovementioned studies splitting

their classes into flipped and non-flipped setups and using active learning content to support both groups whilst controlling all other factors. The active learning materials included opportunities for the students to engage with the course through "puzzling phenomena" (p.3), make hypotheses and presentations, solve higher-order problems, and undertake summative assessments in the form of quizzes. It was identified that the flipped classroom showed minimal benefits compared to the traditional approach. They argued that active learning mechanisms taking place in the classroom remain the primary criterion determining students' content understanding. However, they supported that if active-learning mechanisms are scarcely employed in a regular lesson, the flipped classroom can facilitate such conditions.

1.2.2 Flipped Classroom impact on engagement

Flipped Classroom interventions have been implemented in attempts to measure students' engagement. Bond (2020), in her systematic review of the research corpus, identified that there had been several studies measuring the three dimensions of engagement separately. More information about the identity of these dimensions can be found in the following section 1.4.

One such characteristic study on engagement was the work of Ayçiçek & Yelken (2018). In their investigation, they used a control group and a flipped learning group. Their post-test scores showed that while the control groups engagement remained the same, the classroom engagement of the intervention group had increased. The authors attributed the success of flipped learning to the opportunities that this method provides in increasing the lesson fun, coursework productivity and competitive atmosphere.

1.3 Theoretical Framework

Before proceeding to the analysis of how flipped learning can influence students' engagement, there will be a review of the theories that support this teaching method. Bond's (2020) review of the flipped learning literature from 2012 to 2018 indicated that only 42% (n=45) were guided by a suitable theoretical background. A few studies have supported their framework using the four pillars of F-L-I-P developed by the widely recognised pioneers of flipped learning, Bergmann and Sams (Flipped learning Network 2014). Bond (2020) also highlighted that from the minority of studies mentioned earlier containing a framework, four out of ten supported their research using established learning theories such as social constructivism theory or social development theory. The second most common option was related to the social cognitive theory

The following section will describe in greater detail the learning theories utilised by this study. This strategy will help identify the key theory features that contribute to the success of flipped learning and, more precisely, how these theories can impact students' engagement. Since there is no widely accepted theory for the flipped learning approach (Turan & Goktas 2016), this study will only focus on highly cited theories and not explore the whole spectrum of the corpus. Therefore, focus has been given to:

- The four pillars of F-L-I-P
- Cognitive Load Theory
- Schema Theory
- Sociocultural Theory

Schema Theory and Sociocultural Theory have a close relationship and are overlapping with Cognitive Load Theory. Also, Cognitive Load Theory's key elements are depicting well how Flipped Learning can improve students' reasoning, teamwork and enable teachers to be efficient in their practice of this teaching method (Strohmyer 2016). These theories, combined with the four pillars of F-L-I-P, will inform further this study on how learners engagement fluctuates with this intervention.

1.3.1 The four pillars of F-L-I-P

Muir & Geiger (2016) used the **F**lexible Environment- **L**earning Culture - **I**ntentional Content - **P**rofessional Educator (F-L-I-P) framework to analyse their data and discuss the implications of their study. In practice, the pillar of "**Flexible environment**" refers to the suitable re-arrangements that have to take place in a classroom to support students' group work or independent learning.

Whilst the educator is the primary source of knowledge in a conventional teacher-centred model, the flipped learning style, in turn, intentionally shifts the "**Learning Culture**" to a student-centred model. In such environments, class time is used to address subject content more thoroughly and provide a fertile environment for students to collaborate extensively. In such a classroom culture, students can actively assimilate knowledge as they interact with their peers in meaningful activities to construct and assess their learning in a genuinely personal manner (Muir & Geiger 2016; Flipped learning Network 2014).

Flipped classroom interventions also require educators to be "**Intentional**" on course materials choice by strategically identifying the content which should be taught directly and the materials which need to be reviewed by students as part of their homework. The "intentional content" can be achieved in a physics classroom by creating suitable notes and/or videos for students and differentiation of taught

resources to make it accessible and meaningful for each learner (Muir & Geiger 2016; Flipped learning Network 2014).

The fourth pillar of flipped learning involves the "**Professional educator**" role. A professional educator must constantly engage with students, provide them with feedback either individually or holistically to help them assimilate knowledge efficiently. It is also essential for teachers to welcome constructive feedback from colleagues and develop the mastery to manage the controlled chaos in lessons. Lastly, teachers also need to reflect on their teaching by conducting formative assessments and observing student interactions (Muir & Geiger 2016; Flipped learning Network 2014). In combination with Quin's (2017) argument that teacher-student relationships play an essential role in shaping students' engagement, one could notice that educators remain the critical ingredient for the facilitation of the flipped learning method (Flipped learning Network 2014).

Even though the concept of F-L-I-P provided well-established guidelines for the successful implementation of flipped learning, it is limited by the fact that it relies on empirical evidence in the absence of support by a suitable conceptual framework. Therefore, in light of the vague aforementioned empirical theory, the focus will be given to educational theories, which might offer a deeper insight.

1.3.2 Cognitive Load Theory

For this section, "Cognitive load" will be used as a term to describe the ability of an individual to process auditory and visuospatial information and is directly linked with our working memory (Castro-Alonso & Sweller 2020). Cognitive load theory was originally developed by Sweller (1988) and describes "how human cognitive architecture allows us to learn, think and solve problems" (Sweller 2019:1).

According to the theory, when students are engaged in complex problem solving, a specific cognitive load exerts upon them (Sweller 1988). An example of this theory is depicted when students are taught foreign language nouns or symbols of the periodic table for the first time. It is evident that a low cognitive load will be imposed on students as each symbol/noun does not interact with the other. However, if these symbols are presented in an algebra equation because they are interrelated and sensitive to changes, they will impose a heavy working memory load on students (Sweller 2019).

In their book, Clark et al. (2005) outlined the three forms of cognitive load: the intrinsic load, extraneous load, and germane load. As it is explained, the intrinsic load relates to the mental strain exerted on students by the complexity of the lesson material. Elevated intrinsic loads require higher levels of memory coordination, and they are often evident when students address challenging

problems in Physics. When solving such problems, students not only need to remember the physical quantity each symbol represents but also the mathematical equations and physical concepts that apply to the problem. All of these must synchronise together in order to reach a solution. The extraneous load is mainly influenced by the teaching method followed by an educator. Clark et al. (2005) named this type of load as "irrelevant" to the lesson objectives as it wastes valuable cognitive capacity which could be used more efficiently. Poor lesson design can impose a substantial extraneous load on students and may lead to weak learning outcomes and increased time for students to understand the lesson content (Clark et al. 2005). Unlike extraneous load, Clark et al. (2005) see germane load as the "useful" load constructed by a learner during the instruction. This type of load is imposed on students when learning the necessary skills to accomplish a task or reach a mathematical solution. The cognitive load theory merits attention when designing a flipped learning lesson as the three forms of load have an accumulative effect on learners. Therefore, it is suggested that educators should consider optimising the germane load while eliminating the extraneous elements of load. Rich audio-visual presentations, sustaining learners' attention, and segmenting information that restricts memory capacity are considered helpful strategies to reduce this type of cognitive load (Clark et al. 2005).

Through the lens of cognitive load theory, flipped learning provides instructors with the tools to effectively control their instructional design and, consequently, the extraneous load imposed on students. For example, notetaking and listening in a lesson can be set as homework, while the instructor's guidance can support students to perform heavier cognitive load tasks in the classroom. In this way, students can acquire mastery of the content efficiently (Strohmyer 2016; Sweller 1988). In addition, the theory provides a valuable account of how flipped learning videos should be designed. Slemmons et al. (2018) argue that segmenting information into small blocks via short duration videos can be particularly beneficial for younger students who lack experience in handling increased extraneous cognitive loads when they assimilate new knowledge.

However, what is not yet clear is the relative importance of various behavioural, social, or affective factors related to the cognitive load theory when referring to the cognitive effects of the learning process (Moreno 2006; Strohmyer 2016). Moreno (2006) argues that factors such as students' fear of failure, peer collaboration, self-efficacy, and other personal characteristics such as age, gender, and culture can influence students' cognitive load tolerance. On the basis of these findings, Strohmyer (2016) suggested that "students who have limited experience with abstract tasks, those whose place a lower value on learning and students who focus on mastery level learning may avoid or resist heavier load learning". He concluded that educators need to consider these student personal elements and shape their instruction to suit students' needs. With cognitive load theory considered as an

educational theory with certain weaknesses there will be a review of the schema theory and sociocultural theory to assess other possible elements that may influence how knowledge is structured and also how our interactions with the natural world may play a role to this.

1.3.3 Schema Theory

The Schema theory shares a similar rationale with the Cognitive Load theory and provides an additional supporting role to the theoretical background of Flipped Learning. The term "schema" was initially introduced by Piaget & Cook (1976) as a mental structure describing how a student constructs new knowledge. Under Piaget, when an individual is exposed to an external environmental stimulus and assimilates a specific experience, this leads to the construction of a schema (Piaget 1964; Piaget & Cook 1976). The theory also suggests that students can make meaning of new information when making connections with pre-existing knowledge (schemata) (Carrell 1983). More specifically, when an individual is engaged with a novel concept, the stimulus should be compatible with a pre-existing schema to be fully assimilated. To show how schemata play a role in learning, Yu & Zhu (2019) used the example of the sentence "this is a very cute dog". In a classroom, students with different pre-existing schemata may relate this sentence to a range of dog images based on their past experiences and background, showing that a simple sentence can still create ambiguity in understanding. Unlike Cognitive load theory, this theory emphasises the cognitive mechanisms that lead to the construction of schemata, rather than focusing solely on the cognitive load imposed by an activity (Moreno & Park 2010). Therefore, it is suggested that reducing the extraneous load (instructional design) may not impact positively learning unless it is accompanied by well-designed activities which can link well with the nature of students' developed schemata.

Schema theory formed the central focus of McVee et al. (2005) and Yu & Zhu (2019) studies. Both suggested that schema development moves away from simply referring to knowledge internalisation in the classroom and expands to include the acquired experiences from students through their personal sociocultural interactions. Therefore, a teacher has a critical role in developing such learning experiences through suitable tools (conversation, videos), which can help students become active participants in constructing new knowledge. Developing well-established schemata supports the learning process of new concepts, as it alleviates the restrictions imposed by the working memory capacity (Moreno & Park 2010; Yu & Zhu 2019). There are two reasons for this advantage. Firstly, pre-existing concrete schemata can be processed by working memory as one block rather than multiple separate segments. In addition, such schemata are processed spontaneously, which reduces the cognitive load imposed by an assignment or mathematical exercise (Moreno & Park 2010).

Schema theory shows a relationship between learning and the established web of mental representations of an individual (Strohmyer 2016; Yu & Zhu 2019). Through the lens of this current theoretical background, flipped learning supports well the development of new schemata through suitable adaptations in lesson instruction (Yu & Zhu 2019). Therefore, educators need to consider students' pre-existing experiences and refine their lesson design accordingly. Furthermore, the Flipped model enhances learning efficiency by using pre-class learning materials such as videos that have integrated lower order thinking activities. Such materials act as an excellent mediator of information that can contribute towards the creation of cognitive schemata. Therefore, teachers can facilitate in-class activities focusing on more complex thinking activities. With this teaching method, the educator aims to promote autonomous learning at home so that students can re-shape and develop their schemata further in class (Strohmyer 2016; Yu & Zhu 2019).

It becomes apparent that the schema theory shows multiple perspectives of how Flipped Learning can aid student learning and recall concepts. However, it is not clear how students' schemata tend to shape compared to traditional teaching, as there are limited empirical studies in current literature (Yu & Zhu 2019). It would be interesting for this study to investigate further how students' schemata formation may change through the flipped classroom framework.

Social Constructivism (Social Development Theory)

Although the schema theory provided a concrete theoretical framework of how students learn through schema constructs and re-shaping their mental structures, it shows shortcomings as it ignores cultural interactions and complex relationships in a classroom (McVee et al. 2005). For this reason, Social Development Theory has been selected as a theoretical supporting tool that could illustrate better how sociocultural factors influence schema emergence in the Flipped Learning method.

The theoretical foundations of this theory have been pioneered by Vygotsky (1978:56), who argued that "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first between people (interpsychological), and then inside the child (intrapsychological) … All the higher functions originate as actual relations between human individuals". In this manner, Vygotsky stressed the importance of the learning environment, particularly the relationship of a student with his peers and teacher, in creating and expanding a learner's zone of proximal development (ZPD). This concept indicates the academic potential that a student could accomplish with the help of an instructor or through interaction with capable classmates. In addition, it has been argued that the role of a teacher in such social environments is highly influential or, at times, decisive in helping students reach a new stage in their developmental level, and especially in cultivating children's abstract thinking.

The flipped learning can facilitate rich social environments, which allow educators to differentiate their instruction to suit students' own learning styles and abilities (Toivola 2016). As explained by the author, this method provides fertile ground for students to begin learning based on their own cognitive ability and current ZPD. At the same time, teachers are solely responsible for optimising learning by enhancing further the quality of learners' ZPD through social activities which promote creativity and critical thinking through experimentation and collaborative tasks. In essence, school class time is used for active learning, which requires the participation of students in the learning process in order to expand their learning experiences (Moran 2018; Toivola 2016; Strohmyer 2016; Erbil 2020).

Cooperative learning can be integrated with Flipped classrooms with a variety of learning activities. Erbil (2020), within the context of Vygotsky theory, suggested that the learning together technique can be an effective classroom strategy. Students can be assigned specific roles, with each role assigned with a relevant video. The student is responsible for becoming an expert in a particular part of the theory, and he/she can combine the acquired homework knowledge via a group task in class. This technique is named Jigsaw, as fragmented knowledge of every individual in the group has to be assembled in order to provide a complete knowledge map. Secondly, students could be placed in heterogeneous groups to achieve a particular team goal and achieve learning mastery as a whole. The advantage of this activity is that students themselves can control whether their peers have watched their preparation video, and the teacher can also evaluate the extent of learning taking place out of the classroom. In this manner, the learners become aware that they are expected to be involved and engage within their assigned team.

Social Constructivism can be considered a worthwhile theoretical framework as it contains several essential elements for this study. First of all, the theory moves away from meaning-making through individual actions, as suggested by Piaget and recognises the influence of social processes on individuals (Cole & Wertsch 1996). Furthermore, this theory considers interpersonal interactions between educators, students, and peers and places a particular focus on IT tools and their role in enabling learning within a classroom (Strohmyer 2016). Finally, one of the questions raised within this study relates to how flipped learning can facilitate such opportunities, as presented by this theory.

1.4 Defining Engagement

In her recent article, Bond (2020) has outlined an increasing number of publications providing evidence of the flipped classroom benefits and drawbacks in secondary education. However, only a small percentage of the research corpus has provided an accurate description of the term "engagement". For example, Akçayır & Akçayır, (2018) in their study, whilst concluding that the flipped

model could lead to improvements in student engagement, they have omitted to provide a suitable theoretical framework to support their construct. Therefore, the reader might not form a clear idea about which critical elements of engagement are directly linked with students' outcomes. In their review of the research body, Henrie et al. (2015) observed similar evidence. For this reason, they concluded that "if research on this topic is to gain theoretical cohesiveness, definitional clarity about engagement and its sub-constructs is critical".

There is an evident diversity in the literature over the definition of engagement due to the range of motivational theories selection to support their research (Fredricks et al. 2016). Several authors have supported their theoretical background using self-determination, self-regulation or goal theory to define the role of student engagement without regularly using a critical lens (Fredricks et al. 2016). At the same time, several studies have operationalised engagement as time spent on an activity or attendance in classes, which shows that there is no consistency in the definition of this construct across the field (Henrie et al. 2015; Fredricks et al. 2016). The level of this term's complexity has been conveyed well with the idea of the three blind men describing an elephant. Each description is based on the man's own perceptions of the animal, but none can provide a consistent holistic picture or show its "emergent properties" (Eccles 2016, p.1).

The current research landscape seems to have reached a consensus that engagement has a complex and multidimensional nature as a construct (Ben-Eliyahu et al. 2018; Eccles, 2016; Fredricks et al. 2016), with an ongoing debate in the research community about the number and the different types of engagement (Henrie et al. 2015; Bond et al. 2020). Even though there is a broad acceptance of the three sub-constructs (behavioural, emotional, cognitive) of engagement which will be analysed later, there is a debate on whether and in which manner the social dimension of engagement should be integrated and utilised by the literature (Eccles 2016; Wang et al. 2016; Fredricks et al. 2016). The work of Wang et al. (2016) was the first to structure a successful bifactor model that measures all four dimensions of students' engagement in school science under the umbrella of global engagement. In recent years, there seems to be a limited number of research studies, including instruments that conceptualise the quadrilateral nature of engagement, particularly in flipped learning (Bond 2020).

In addition to the aforementioned, Wang et al. (2019) argue that a series of studies do not differentiate when defining engagement and disengagement, rather than evaluating and analysing these constructs on the same continuum. This suggests that most studies treat disengagement as an outcome of low levels of a specific engagement dimension risking a spectrum of factors in which students can express their disengagement to be omitted or not being considered at all. Wang et al. (2015) have indicated

that positive features of students' engagement should be methodologically analysed differently compared to the negative elements and should be treated as a different concept.

Whilst engagement remains an essential factor for learning outcomes, the multidimensional nature of this concept makes it challenging for the derivation of a unified definition that would satisfy the research community (Solomonides 2013). However, this study needs to cement its theoretical framework with a suitable definition. For this reason, the definition from Bond et al. (2020) has been selected and will be utilised further:

1.4.1 Engagement Dimensions Definition

"Student engagement is the energy and effort that students employ within their learning community, observable via any number of behavioural, cognitive or affective indicators across a continuum. It is shaped by a range of structural and internal influences, including the complex interplay of relationships, learning activities and the learning environment. The more students are engaged and empowered within their learning community; the more likely they are to channel that energy back to their learning, leading to a range of short and long-term outcomes that can likewise further fuel engagement" (Bond et al. 2020, p.3)

This current study will also utilise the definitions of Wang et al. (2016) to describe the various dimensions of engagement and disengagement.

Behavioural Dimension of Engagement

"Involvement in academic and class-based activities, presence of positive conduct, and absence of disruptive behaviour". (Fredricks et al., cited in Wang et al. 2016:17)

Students' behavioural engagement can be measured in terms of attention, participation, concentration, homework submission, and classroom rules compliance (Fredricks et al., cited in Wang et al. 2016).

Emotional Dimension of Engagement

"The presence of positive emotional reactions to teachers, peers, and classroom activities, as well as valuing learning and having an interest in the learning content" (Finn 1989; Voelkl 1996, cited in Wang et al. 2016:17)

Cognitive Dimension of Engagement

"Is defined in terms of self-regulated learning, using deep learning strategies, and exerting the necessary cognitive strategies for the comprehension of complex ideas." (Zimmerman 1990, cited in Wang et al. 2016:17)

The cognitive engagement has been measured with items about the use of shallow and deep learning strategies to learn and understand material, self-regulation, and persistence. (Greene 2015, cited in Wang et al. 2016:17)

Social Dimension of Engagement

"The quality of social interactions with peers and adults, as well as the willingness to invest in the formation and maintenance of relationships while learning." (Wang et al. 2016:17)

Each dimension contains several indicators/elements (see questionnaire) which will be…. (Fredricks et al. 2016; Bond 2020; Wang et al. 2019)

While there have been studies that address and review the impact of disengagement when students pursue (Bergdahl et al. 2020).

1.4.2 Engagement and motivation

There has been a disagreement in the research body about whether the constructs of engagement and motivation should have the same meaning and be treated with a similar manner. The prevalent idea is currently that motivation acts as a precursor of engagement where the former represents the intention and the latter the action (Reschly & Christenson 2012).

In other words, motivation is "the underlying sources of energy, purpose, and durability, whereas engagement refers to their visible manifestation" (Skinner & Pitzer 2012:22). Eccles (2016) describes the two terms as when "the rubber meets the road". In this analogy, "the car's wheels represent the psychological components of engagement, and the road represents the activity or setting in which the individual is engaged. In a sense, the wheels were enacting the motivation of the individual within the context of the road" (Eccles 2016:71). More clearly, engagement comprises of an action-related dimension (behavioural) and two internal dimensions (cognitive/affective) in contrast to motivation which relates to intent (internal) (Reschly & Christenson 2012). For example, we can have a student who could be motivated but not being engaged in a lesson. As we understand, while motivation is vital, it is not adequate for engagement (Appleton et al. 2006).

When Fredricks et al. (2004) analysed and defined engagement and its dimensions, it became clear that this term forms a metaconstruct that subsumes motivation, with particular dimensions of engagement overlapping or being identical to motivation (Reschly & Christenson 2012). For example,

in the study of Bond et al. (2020), motivation appears to be part of the affective engagement, while in Reschly & Christenson (2012), motivation forms part of cognitive engagement (motivation to learn).

Research Questions and Research Methods

My literature review has been formed in such way to lead towards the area of this study's interest. As mentioned in the rationale, the aim was related to whether flipped learning can be an effective method of teaching for IGCSE Physics in the school under research and, secondly, whether this pedagogical method can support students with varying learning needs. The research quest naturally leads to the following question:

How can Flipped Classroom Model be used to support Year 9 students in Physics?

In order for this study to answer this question the following sub-questions will be investigated in this study,

Research Question 1: To what extent can the Flipped Classroom Model affect Year 9 students' engagement in Physics

Research Question 2: How can the Flipped Classroom Model influence academic achievement in Physics?

Research Question 3: How do teachers experience the implementation of flipped learning in Year 9 Physics classes (during online learning)?

3. Methodology

3.1 A practitioner research approach

The current study will pursue practitioner research conducted by myself (the researcher). At the same time, I possess the role of the professional (teacher) carrying out action research to investigate the impact of my intervention to benefit my classroom practice and students' learning (Denscombe 2017). The research is comprised of two research cycles. The first cycle involves the design and implementation of the research project, followed by a second cycle in which the retrieved knowledge will inform and feedback directly into my practice (McAteer 2013; Denscombe 2017; McDonagh et al. 2020). In contrast with traditional positivist research, where teachers and researchers have separate roles, this methodological approach enables practitioners to improve their practice further and develop their theory (McAteer 2013; McDonagh et al. 2020).

There is a range of potential advantages which make this methodology approach suitable for the current study. Firstly, action research is designed to enable the collaboration between teachers,

placing practitioner knowledge at the heart of the process. This collaboration can enhance the reliability of interpretations, as personal journal reflections and data collection can be compared with colleagues' and students' experiences to inform future interventions (McDonagh et al. 2020). Moreover, this research approach can increase the autonomy of the interventions as it resolves practical issues positively, enabling the practitioner to question practices in the literature and adjust the implementation of research (McDonagh et al. 2020; Denscombe 2017).

However, there are also drawbacks to action research. In contrast to various other types of methodology, the extended research autonomy restricts the scope and scale of the study. Any potential research outcomes and conclusions would be limited to the school under study context and limit the freedom for further generalisations (Denscombe 2017). Nevertheless, since this study aims to enhance the development of academic knowledge and provide answers to flipped classroom practice enquiries, this limitation should not restrict the practical relevance of the research.

3.2 The Sample and School

The school under-study is a highly selective independent day and boarding all-boys school located in South England. After a brief presentation of the research study during an INSET day in January, seven IGCSE Physics teachers, including myself, consented to take part in the study. Most colleagues were unfamiliar with Flipped Classroom; however, I introduced the method's fundamental principles and activities before the first research cycle data retrieval.

In early January 2021, the government announced a national lockdown for England. The new rules immediately affected the school, requiring a switch to online learning delivery of lessons. In addition, under the new restrictions, the school had to introduce an Interactive Learning Timetable that required teachers to carefully consider how to balance the number of homework tasks to be completed outside of normal lesson time.

Therefore, I expected such restrictions would lead teachers to implement Flipped Classroom fluidly and inconsistently, with significant elements being ignored in remote learning. For this reason, the data collection focused solely on the two classes of Year 9 Physics pupils I taught personally. In this way, consistency could be ensured when data would be analysed.

Year 9 was considered as a suitable year group for some additional reasons. Firstly, the selected students studied their first IGCSE year; therefore, it was expected that exam pressure would not influence student engagement levels negatively. Secondly, the presence of two mixed ability Year 9 sets offered an opportunity to be categorised into an intervention and a control group, which provided fertile ground for suitable comparisons. Finally, Year 9 students benefited from the school's Laptop

Scheme, becoming equipped with high-spec school devices. Training took place for pupils unfamiliar with these devices, and IT support was available for those facing technical difficulties.

The two groups that participated in the study will be named Class A and Class B. From these participants groupings, 6 students from Class A (Intervention) took part in focus group interviews for the first research cycle and 5 students from Class B (Intervention) for the second research cycle. Also, 7 students from Class A and 16 students from Class B provided pre-intervention questionnaire responses as well as post-innovation responses for both research cycles 1 and 2. Even though a higher percentage of students participated in all cycles, particularly from Class A, the sample mentioned above was selected to ensure consistency in results.

3.3 Questionnaire Selection

A pre-existing engagement instrument was adopted as a foundation for the current study's questionnaire. Also, as a researcher, I wanted to ensure that students expressed their own opinions and that I had minimal influence over their intervention perceptions. This would provide a clearer picture of how students are engaged in a Flipped Learning environment. The nature of questionnaires provides such an advantage, as data can be analysed without external bias, as interpersonal factors are eliminated (Denscombe 2017). In addition, considering that part of Flipped Learning involves completion of tasks at home it would be challenging for this study to directly observe and assess students' engagement out of the classroom. Data collected via the use of questionnaires could resolve this issue.

However, statistically speaking, the small available sample would not be promising generalisable and reliable results (Denscombe 2017). Due to small sampling, it was also expected that findings might show an absence of statistical significance on correlations between the control and intervention groups (Denscombe 2017). There has been a review of the surveys used in the literature to measure student engagement. A synopsis of the articles reviewed for this current study is presented in Table 1 below.

Table 1: Synopsis of reviewed articles using instruments to measure engagement.

Article Reference	**Importance of the study as presented in the review corpus**	**Strengths relevant to the current study**	**Weaknesses relevant to the current study**
(Moran 2018)	Probed student engagement and perceptions of Flipped	• Relevant to secondary education –	• The number of items (81) of the original MSLQ

	compared to traditional methods in a secondary English Language Arts classroom.	sample of Year 7 students • Field observations recorded the variance of three engagement components which allows comparisons	questionnaire would make coding a challenging task and could exhaust students • Not all scale items addressing engagement
(Lo & Hew 2020)	A design-based study supporting the student engagement in a Flipped Mathematics Class	• A solid theoretical engagement framework supports the designed scale • The scale includes three engagement categories	• Limited precision due to the small number of integrated items (14) • Task design relevant to Maths Education
(Fredricks et al. 2018)	Probes a range of factors influencing student engagement in secondary maths and science	• Uses a well-developed student engagement scale that includes all four engagement dimensions, including separate social engagement indicators (Wang et al. 2016) • The selected instrument is quite reliable and includes a sufficient volume	• Absence of relevant results related with Flipped Learning which limits comparisons with the current study's survey results

		of integrated items (33)	
(Olakanmi 2017)	Investigates the effect of the Flipped Classroom Model on students' academic performance and attitudes in secondary Chemistry	• The research has been conducted in the secondary science environment – comparisons can occur • A thorough review of the FL corpus on student attitudes • Used a replicable questionnaire with an excellent reliability coefficient	• The selected Chemistry Attitude Scale included several instrument items referring to laboratories (Demircioğlu et al. 2005). This would not be applicable for the first research cycle of the current study • The instrument shows absence of explicit reference to engagement dimensions

Following the review of the pros and cons of reviewed articles measuring engagement levels, the Math and Science Engagement Scale (MSES) (Wang et al. 2016) utilised by Fredricks *et al.* (2018) was considered a suitable survey instrument for this current research. Fredricks et al. (2018) utilised this instrument to elicit student views on how social interactions and specific classroom tasks may affect students' engagement and disengagement levels in science. The selected instrument was based on the self-system motivation framework developed by Ryan & Deci (2000), and it was developed to assess the correlation between the universal engagement factor and the uncorrelated individual engagement dimensions.

An important reason for selecting this instrument was the presence of items measuring the four separate engagement dimensions. The MSES also offered high predictive validity and would be advantageous compared to a questionnaire designed by myself. More specifically, Wang et al. (2016) structural equation modelling analysis showed that their designed instrument better predicted the

general engagement factor than the specific engagement dimension factors. In addition, their cognitive pretesting ensured that students understood instrument items as intended, which implies that statements were worded clearly, making them suitable for young students (Wang et al. 2019). Finally, their study showed that the instrument was supported by good predictive validity and measurement invariance between demographic student groups (Wang et al. 2016).

Measuring school engagement is not trivial, as its multi-faceted nature can lead to inconsistencies between the various dimensions of engagement. For instance, in some studies, "Effort" has been categorised as a behavioural engagement component while others as a cognitive engagement component (Wang et al. 2019). It is also argued that the lack of consistency in theoretical conceptualisations for engagement among studies could result in the construction of items with diverse meanings, making comparisons a challenging task. Therefore, it is suggested that a mixed-methods approach could solve this issue and capture the complexity of engagement holistically.

The MSES instrument is comprised of a 5-point Likert scale and contains 33 items assessing the four dimensions of engagement in science:

- **Cognitive Engagement (8 Items)**

Cognitive engagement involves items related to instruction promoting deep learning, self-regulation, and assimilation of learning material. (E.g., "I think of different ways to solve a problem").

- **Behavioural Engagement (8 Items)**

This dimension involves items related to student' involvement, homework consistency and participation in classroom tasks. (E.g., "I keep trying even if something is hard").

- **Emotional Engagement (10 Items)**

This dimension involves items related to the degree of students' interest or disinterest on the learning material, degree of appreciating learning and emotional reactions towards activities, peers, and teacher (E.g., "I look forward to Science class").

- **Social Engagement (7 Items)**

This dimension involves items related to the degree of students' drive to interact socially with peers and sustain meaningful relationships in lessons (E.g., "I try to understand other people's ideas in science class").

As a whole, the MSES items indicate how closely students were related to a specific statement. For example, the Likert Scale ranged from 1 for "Strongly Disagree" and 5 for "Strongly Agree" (Fredricks

et al. 2018; Wang et al. 2016). Before statistical analysis was carried out, the negative items were reserve coded as they probed students' disengagement on tasks, e.g. "I don't care about people's ideas" (Appendix 5), rather than worded positively for the majority of statements. Following Fredricks et al. (2018) methodology, the class item scores for each engagement dimension were averaged so that higher scores would represent higher levels of engagement. The utilised questionnaire can be found in Appendix 5. The statistical analysis of questionnaire responses can be found in table 2. Data collection via MSES questionnaire occurred before the start of cycle 1, after the end of cycle 1 and by the end of cycle 2, allowing comparisons between the two intervention periods.

3.5 Teacher & Student Interviews

Seven Physics teachers consented to be interviewed and provide their views on Flipped Learning. It was considered beneficial for this study to conduct semi-structured interviews to allow robust data to be collected for analysis (Brinkmann & Kvale 2018b). The list of interview questions asked to teachers can be found in Appendix 6, and a part was adapted from Nicholas (2014) as it would be interesting for this study to compare the interview outcomes on teachers' perceptions of the flipped style. In addition, even though there was a specific question sequence in place, semi-structured interviews, from their nature, allow flexibility to conversation changes which provided opportunities for more information to be elicited on teacher's views (Brinkmann & Kvale 2018a).

Following the suggestion of Nicholas (2014), the interview questions were categorised into items relevant to the Flipped Learning Structure and items relevant to colleagues views on students' engagement and homework consistency during the intervention. In addition, the interview scripts were coded into simple fixed categories which would allow further correlations between data (Brinkmann & Kvale 2018a). For the subsequent student interviews, the "Interview Questions Decision Matrix" was utilised from the study of Strohmyer (2016) found at Appendix 1.

3.6 Ethical Considerations

This methodology aimed to comply with the suggested educational research guidelines by BERA (2018). In addition, this study ensured to follow high research standards and procedures as dictated by the University of Oxford's Central University Research Ethics Committee (CUREC). The letter of research approval from CUREC can be found in Appendix 3.

The current practitioner research work was susceptible to ethical issues due to the binary nature of myself being a researcher and professional. Therefore, this study had to consider potential risks concerning conflicts of interest with the participants (students and colleagues) (BERA 2018). This study had to make sure that participants interests would not be compromised during the implementation of the research. Since the primary purpose of this research remained the

development of the teaching practice in the Physics Department, students' and colleagues' interests were maintained at the heart of this investigation. In the course of the study, however, further actions took place to ensure that students' interests would sustain a central role, even if this resulted in being at the expense of the probe.

For this reason, this study made sure that the participating Year 9 groups would receive the same intervention. This rationale led to the development of two research cycles. In the first cycle, the two Year 9 classes were categorised in the experimental and control group and in the second cycle, the two groups were swapped in order for both groups to receive the same treatment. In addition, collaboration with the Physics Department teachers who were not characterised by a similar binary researcher/practitioner nature ensured that their research involvement would still maintain students' interests as a top priority. Finally, proper revision provision took place to ensure that students would still be covering the topic efficiently and correctly, which would reduce the risk of intervention's adverse effects.

In order to approach the research ethically, this study also sought consent from the headteacher of the school under-study (Appendix 2). The headteacher's signed approval ensured that additional "voluntary informed consent" (BERA 2018: 5) from students as well as written permission from parents would not be required. However, I ensured that the participants, orally and in writing about the voluntary nature of the study. In addition, relevant information stating the anonymity of participants was provided on the first page of questionnaires and at the beginning of interviews. An example can be found in Appendix 4.

All collected data were treated as confidential. The data process took place on digital devices that were password protected. Individual participants are required to provide consent to be considered in the research data collection. Also, they had to provide verbal consent for their interview audio recordings to be collected and analysed and to acknowledge that they had the right to withdraw at any point.

3.7 Collaboration Rationale

Collaboration with the Physics Department was considered an essential part of this research. It was hoped that colleagues' valuable perspective of the Flipped Learning implementation would result in rich data collection derived from their practical experiences and ideas. Teacher participants views would also help to construct a more comprehensive view of the underlying factors explaining the quantitative analysis results. In addition, it was hoped that collaboration would lead to a greater understanding of how this approach can support students' learning in the school and how it can improve the pedagogy. As the intervention progressed, there was a target for research findings to be

presented in a departmental meeting, allowing more detailed discussions into how flipped learning can be used most effectively in the following year.

3.8 Flipped Classroom Intervention

3.8.1 Introduction

The study intended to select a Physics Unit that could be taught efficiently through the Flipped Learning approach for a particular year group. Therefore, it was considered sensible to avoid selecting exam groups that could be negatively impacted by adopting this novel teaching technique. In addition, it was critical for this intervention to be implemented at a GCSE year group. This would allow me as a researcher and teacher participants to reflect on the depth of learning in the classroom and how to take advantage of this technique to help students prepare for their future GCSE examinations.

The Year 9 Physics scheme of work was reviewed in a departmental meeting during autumn, and it was considered suitable for the intervention to take place in January. This would allow the department to deliver a new Physics Unit, Energy Resources and Energy Transfers. Relevant discussions considered the selected topic suitable as it combined mathematical applications, such as correct use of equations and a good understanding of Physics through the correct use of appropriate scientific language.

The first research cycle lasted 6 weeks, from January to February half term, which coincided with the national lockdown due to COVID-19. As learning was expected to be delivered only through online meetings via Microsoft Teams, it was becoming evident that the active learning element of Flipped Learning would be heavily impacted due to the absence of classroom activities. Therefore, careful consideration had to be given to the intervention design for that current period. The literature contained minimal information about the implementation of Flipped Learning for online environments. Hew et al. (2020) provided one of the few suitable methodological frameworks for such learning conditions, following the 5E framework (Engage, Explore, Explain, Elaborate, Evaluate) (Bybee et al. 2006). This study was also influenced methodologically by Lee & Lai (2017) and F. Finkenberg & Trefzger (2019), who used control groups for their study.

3.8.2 Design of lessons

The study design adopted the traditional approach for one Year 9 group (control) and the flipped learning approach for the second Year 9 group (intervention). All students were required to complete the MSES questionnaire interviews and Flipped Learning perceptions questionnaire before the intervention and after the completion of the unit. Also, a focus group of students were selected for an interview.

The flipped course required students to access Microsoft Forms and complete pre-class homework before each lesson. The homework, including the MS Forms link, was upload on the school's digital learning platform (Firefly) 3 to 4 days before every lesson. Thus, students would have ample time to complete their homework. This digital tool contained a series of online instructional videos (2 to 4) carefully selected from YouTube educational channels to **engage** students' curiosity on a particular Physics topic. Learners were also expected to use a series of available keywords and summarise the video, articulating their understanding of concepts (**explore**/**explain**). Multiple-choice questions were also integrated into MS Forms as part of a formative learning assessment. Students also had the option to use Microsoft Teams to ask questions by submitting messages on the year group chat function (**explain)** (Hew et al. 2020).

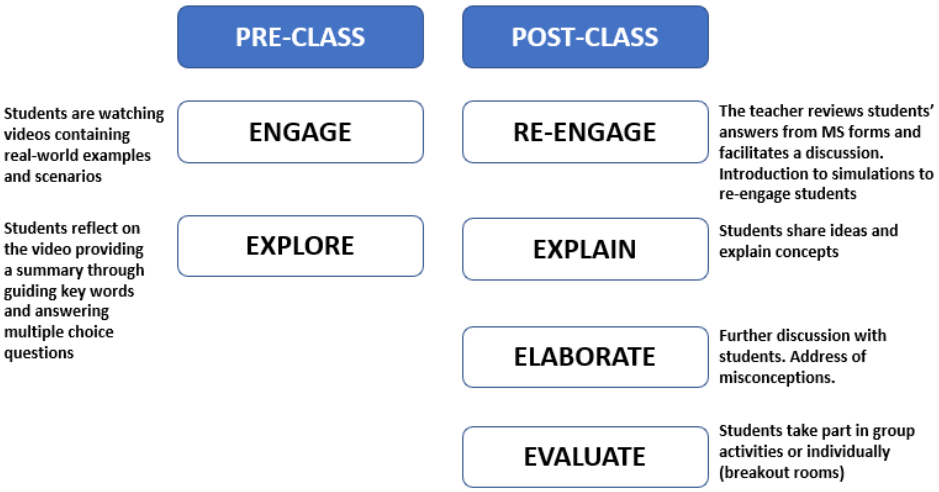


Figure 1: 5E framework utilised as part of this study's online Flipped Learning design (Intervention Group), adapted from Hew et al. (2020)

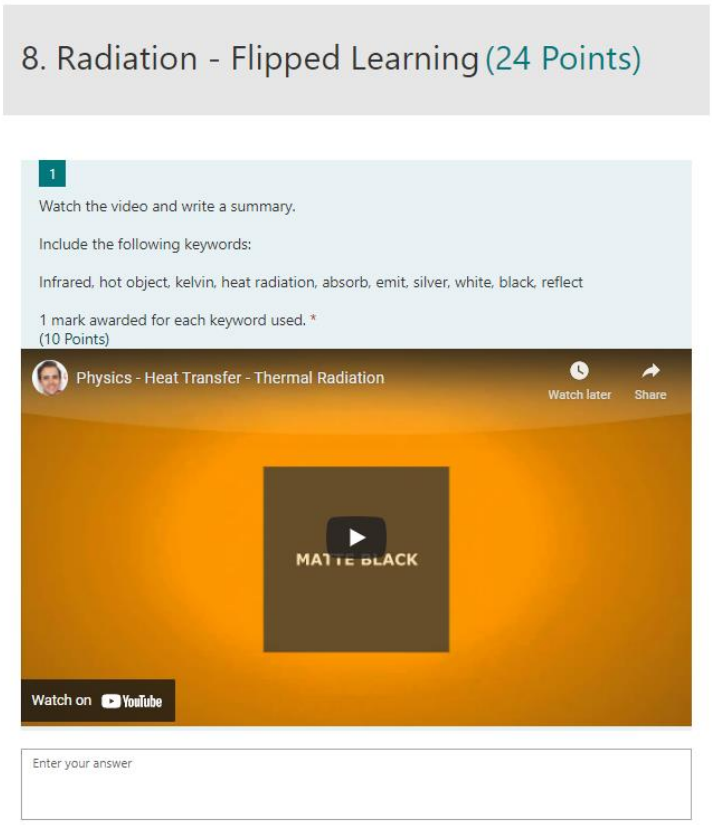


Figure 2: Example of an out-of-class (online) *activity* in lesson 8

During the online lesson time, the pre-class multiple-choice questions were utilised as a starter activity to get students **re-engaged** through relevant discussion by sharing their acquired ideas on the topic (**explain**). Following the quiz review, the learners were engaged with various activities on MS OneNote, involving physics problem-solving exercises, simulation tasks and presentation tasks to assess their level of learning (**evaluate**). In addition, through MS Teams, students could be assigned into breakout rooms, enabling them to collaborate and discuss their ideas with peers by working in small groups of two or three. In this way, teachers had the opportunity to visit every breakout room and provide suggestions or tips to students who needed additional help (Hew et al. 2020).

The design of the traditional online course involved the delivery of a 10-minute theory explanation via PowerPoint presentations and the use of videos available from the flipped pre-class tasks, followed by a session similar to the activities available for the flipped class on Microsoft OneNote. As there was no time availability, students would complete the rest of their learning tasks as part of their homework.

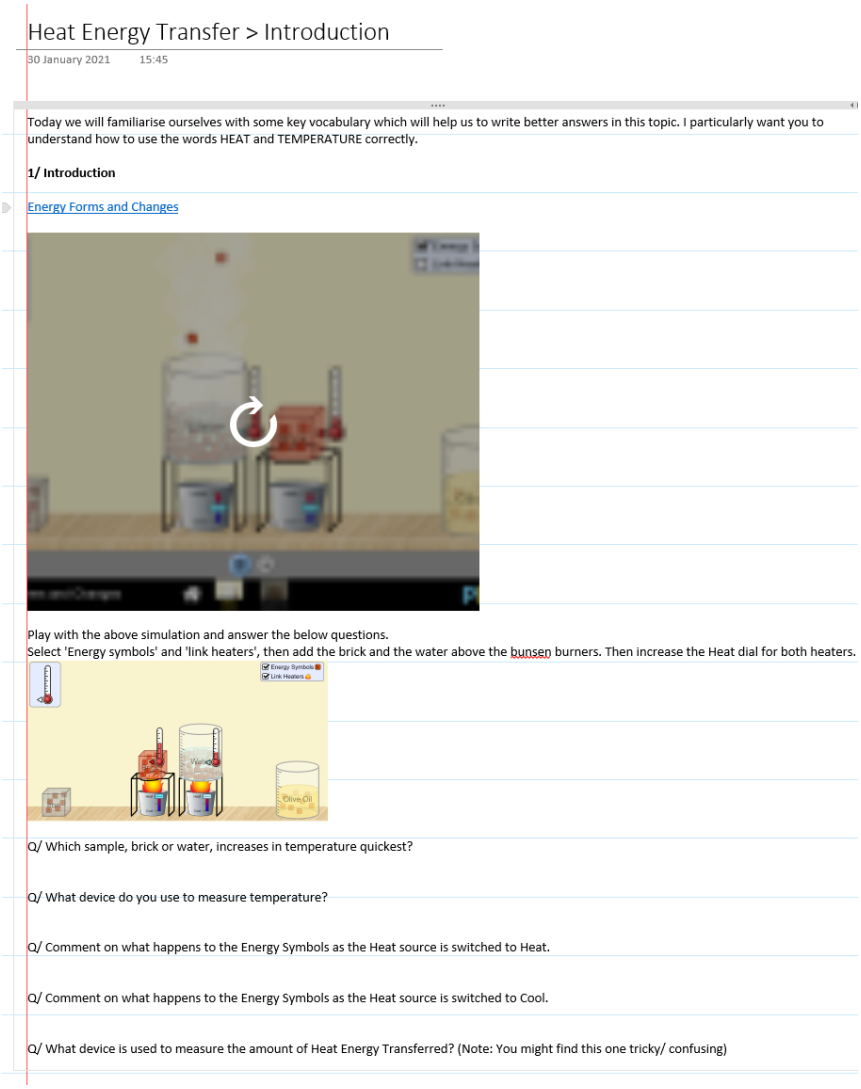


Figure 3: Example of an in-class (online) *activity* in lesson 2

Data were collected from focus-group interviews offering an initial picture of the flipped approach implementation in the first research cycle. Teacher interviews were also crucial in pinpointing the flipped learning instruction benefits and challenges and determining the intervention's impact on students' learning. Based on the interview outcomes, which will be discussed thoroughly in the findings section, the following areas were addressed ahead of the second cycle:

- Selection of short, concise, and explicit videos
- Selection of strategies ensuring high Flipped Homework Consistency
- Promotion of in-class student collaboration
- Building a culture of regular in-class feedback and extensive support for all students
- Additional support for teachers lacking experience and FL implementation ideas

- Creating a culture for FL ideas' exchange and dissipation
- Providing a viable online space for students to ask questions while completing their FL homework
- Promotion of active learning activities

The above strategies were shared and discussed in the departmental meeting prior to the second cycle. The teachers were given the freedom to choose which strategy to prioritise according to their own flipped instruction philosophy. Providing colleagues with such flexibility was considered more appropriate for several reasons. Firstly, it was evident that the vast majority of teachers had already integrated some of the elements mentioned above in their FL instruction. As a result, continuing to implement these strategies would not provide new knowledge to the study. In addition, it was expected that the colleagues might have a potential bias towards a specific innovation of their preference. Lastly, providing the teachers with freedom of choice would help them to test a range of new suggestions, which could lead to the discovery of a new idea that could improve the effectiveness of Flipped Learning to greater levels, with the potential for this idea to be researched more thoroughly in the future.

The second research cycle was crucial for assessing the efficacy of this method in a typical schooling environment during the February-March half term. The selected topic of the second cycle was Sound and Energy Resources and Astrophysics which lasted eight weeks. A similar data collection strategy was followed, including focus group and teacher interviews and the provision of the MSES question. Also. In the second cycle, when the two groups were swapped. Finally, voice memos in the form of a diary were also taken during the cycle 1 phase, recording experiences and reflections regarding the manner that the implementation of flipped learning was taking place.

4. Findings

4.1 Research question 1: To what extent can the Flipped Classroom Model affect Year 9 students' engagement in Physics?

The first research question in this study was "How can Flipped Classroom Model be used to support Year 9 students in Physics". This was categorised further in three sub-questions relevant to engagement, learning skills and academic achievement. A two-cycle research intervention took place, including a mixed-methods data collection.

4.1.1 Phase 1: Quantitative Data

Following the implementation of the Flipped Learning Model, the survey aimed to collect information about intervention and control group's engagement in Physics. The questionnaire was administered to both Class A (Cycle 1 Intervention Group) and Class B (Cycle 2 Intervention Group) at the end of the February half-term and the end of April half-term.

The questionnaire instrument included 33 questions in positive and negative form (Wang et al. 2016). In addition, an open-ended questionnaire adapted from Strohmyer (2016) was utilised to elicit from participants additional information about their Flipped Learning experiences. For the purpose of data analysis, it was decided that it would also be beneficial for this study to utilise the indicators of student engagement and disengagement as presented by Bond (2020) (Appendix 7). After providing their views on the intervention, the students would have to click the indicators that described their engagement or disengagement accurately in lessons. Once each score had been recorded in MS Forms, the sum of clicks from the class was calculated. It was hoped that this analysis would provide an additional simple tool to provide richer data on the students' engagement in Flipped Learning. Once their response data were scrutinised, analysis outcomes were shared with the students during their interviews to gain further insight into their choices over the engagement indicators. Due to the small sample numbers involved in the study, statistical analysis of the engagement results was not pursued as it was considered that it would not provide significant correlations between the two groups. Also, the standard deviation in table 2 results is quite significant, which does not allow comparisons with certainty.

Flipped learning assessment results

Table 2: Results of MSES questionnaire analysis

	CLASS A (9J)				**CLASS B(9F)**	
		Intervention Group	**Ctrl Group**		**Ctrl Grp**	**Intervention Group**
	Pre-Intervention	**Post Cycle 1**	**Post Cycle 2**	**Pre-Intervention**	**Post Cycle 1(Ctrl)**	**Post Cycle 2(Int)**
Cognitive Engagement	**3.66**	**3.14**	**3.39**	**3.75**	**3.38**	**3.70**
Standard Deviation	0.44	0.38	0.72	0.45	0.48	0.55

Behavioural Engagement	**3.54**	**3.63**	**3.57**	**3.83**	**3.93**	**3.69**
Standard Deviation	0.80	0.59	0.73	0.48	0.48	0.65
Emotional Engagement	**3.43**	**3.40**	**3.29**	**3.68**	**3.78**	**3.56**
Standard Deviation	0.48	0.33	0.40	0.64	0.53	0.66
Social Engagement	**3.67**	**3.73**	**3.61**	**3.83**	**3.86**	**3.56**
Standard Deviation	0.55	0.50	0.58	0.42	0.37	0.55
	Year Average (%)	**Post Cycle 1(Int)**		**Year Average (%)**	**Post Cycle 1(Ctrl)**	
Test Score	55.9	49.8		53.8	48.6	
Standard Deviation	13.6	16.2		15.0	15.7	

It was considered helpful for this study to calculate the mean score of all four dimensions and retrieve an overall engagement value. Figure 1 shows the initial examination of the results for the research cycle one. A discernible shift is noticed in all mean engagement values and a particular negative impact has been recorded on the overall engagement for both classes which could possibly attributed to the online learning and the absence of practicals and active learning opportunities for students. The intervention group, Class A, shows a significant decrease in overall engagement compared to Class B, mainly attributed to the drop in cognitive engagement and emotional engagement levels. Conversely, it appears that social engagement has shown a discernible positive shift for Class A, which could reflect the increased exposure of students to collaborative activities. Usually, such activities were facilitated in break-out rooms during the online learning period. Such break rooms provided opportunities for extensive discussions to take place between pupils. The changes in behavioural engagement were minimal compared to the pre-intervention period. However, it needs to be noted that the changes on the graph were characterised by a significant standard deviation, ranging from 0.4 to 0.8, which does not allow confidence for solid conclusions to occur.

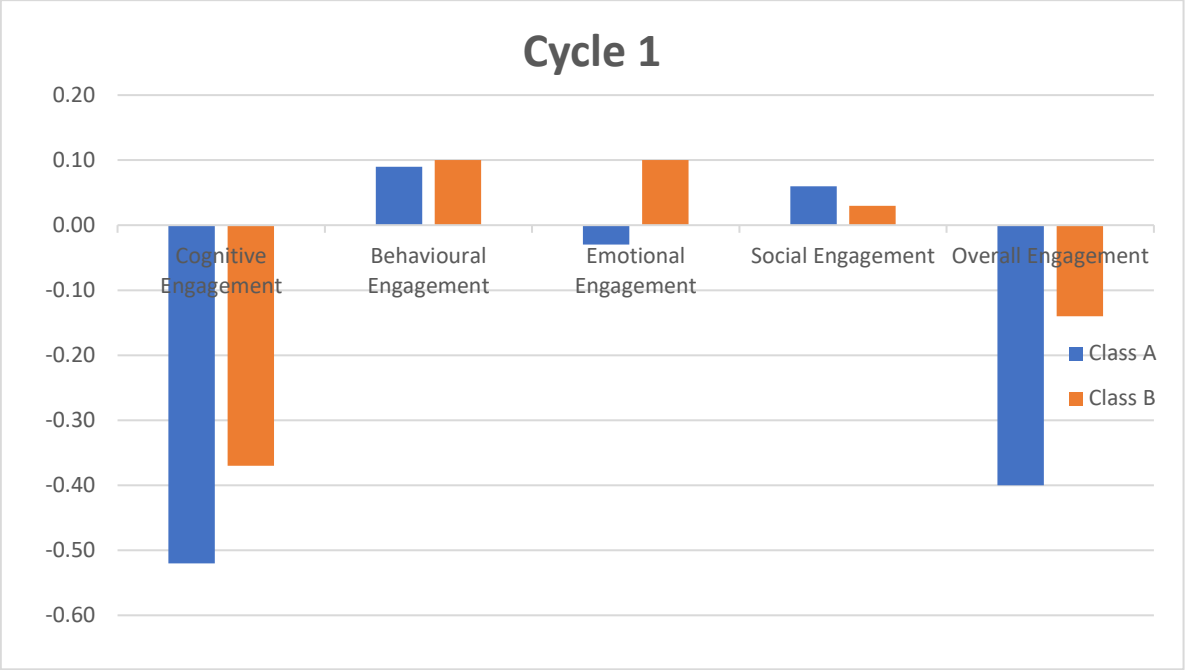


Figure 4: Graph showing the changes in mean scores for all four dimensions of engagement following research cycle 1.

Figure 1 shows that the majority of engagement dimensions for Class B (Intervention group) were heavily impacted by the cycle two intervention. It is surprising how the overall engagement of group B dropped by more than a mean score of 0.4, while for the same research period Class A (traditional teaching group) showed minimal changes. Class B showed an increase only in the cognitive engagement column, which is more slighlty more elevated than Class A. This increase in scores was expected as the adapted flipped homework materials from cycle 1 provided more opportunities for students to reflect in lessons, develop their independent learning skills and ability to self regulate. At the same time, behavioural, emotional and social engagement levels dropped slightly with a higher drop for Class B in each category. In addition, it is particularly striking how the column of social engagement is considerably lower to Class A, considering there were several more opportunities for flipped learning students to participate extensively in active learning activities, including debates and physics practicals and share their ideas and experiences from their flipped homework.

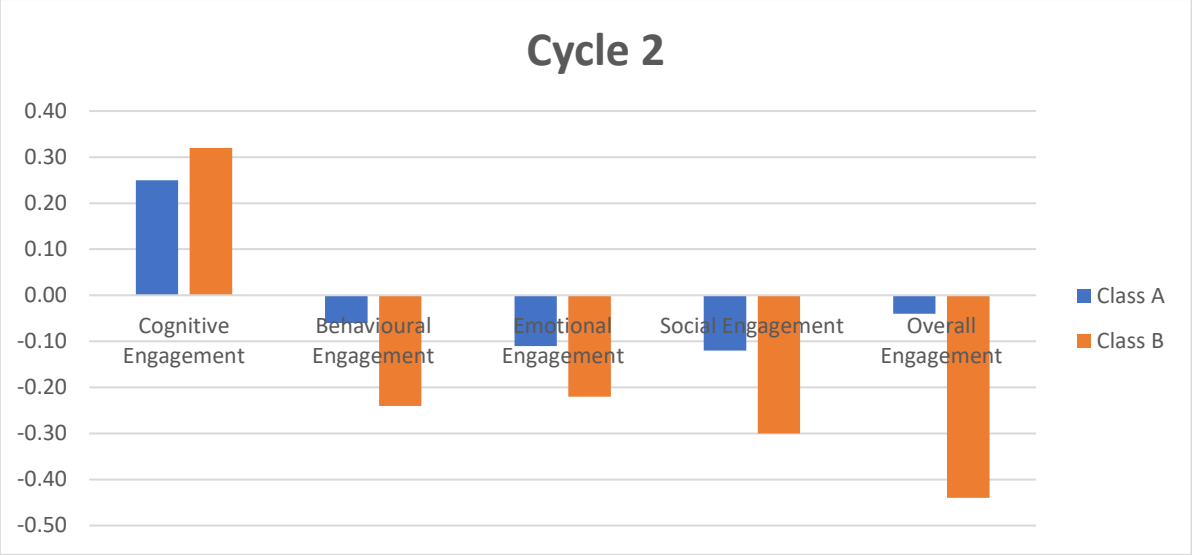


Figure 5: Graph showing the changes

Affective Engagement/Disengagement and Flipped Learning

The cognitive engagement was coded following the work of Bond (2020) (Appendix 7). The affective engagement dimension was also including constructs related to the social engagement in her study, however there will be a separate analysis of the latter in the presentation of results.

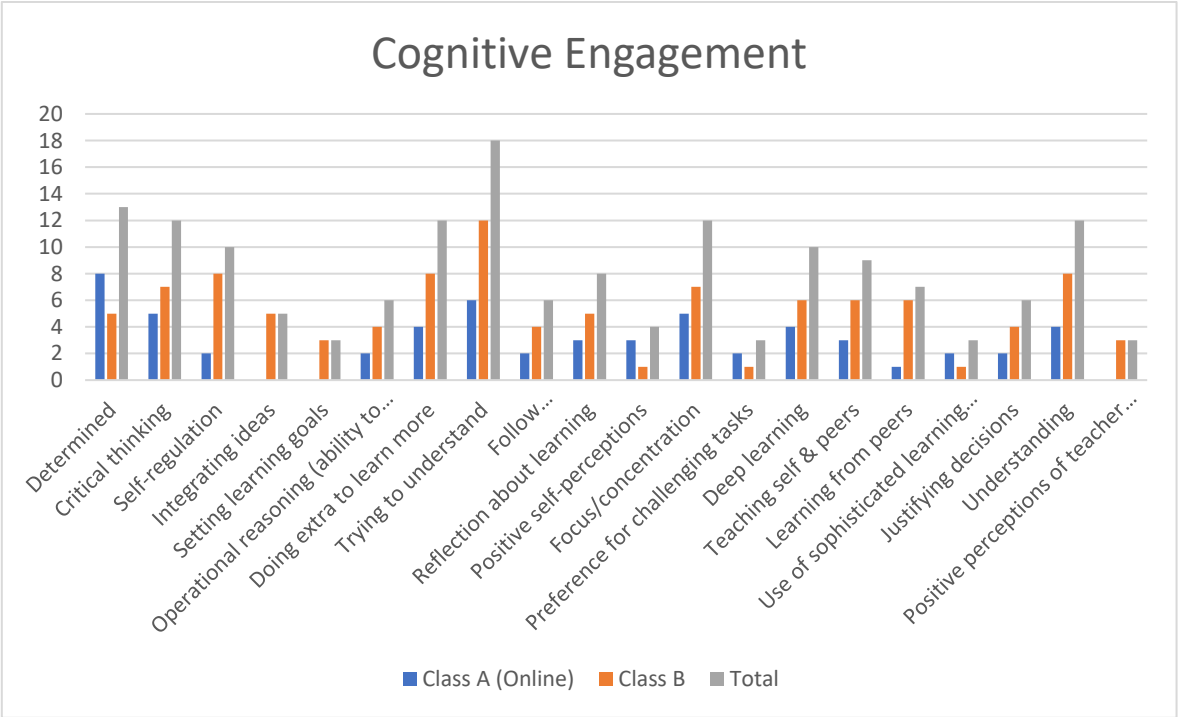


Figure 6: Graph showing the total number of cognitive engagement indicators selected by each student who participated in the flipped classroom intervention.

Figure 6 displays the cognitive engagement areas affected by the implementation of flipped learning for Class A and Class B, acting as intervention groups. The results in cognitive engagement showed that the students were experiencing a range of positive influences by the flipped approach. The most popular choices were Trying to understand, Doing Extra to Learn More, Determination, Focus/Concentration, Teaching Self and Peers and Self-Regulation. The following interviews section below will analyse the reason why students have selected these indicators. What also becomes apparent is that Class B has clicked more frequently across the whole categories range, showing that flipped learning possibly influenced students more positively in the second research cycle.

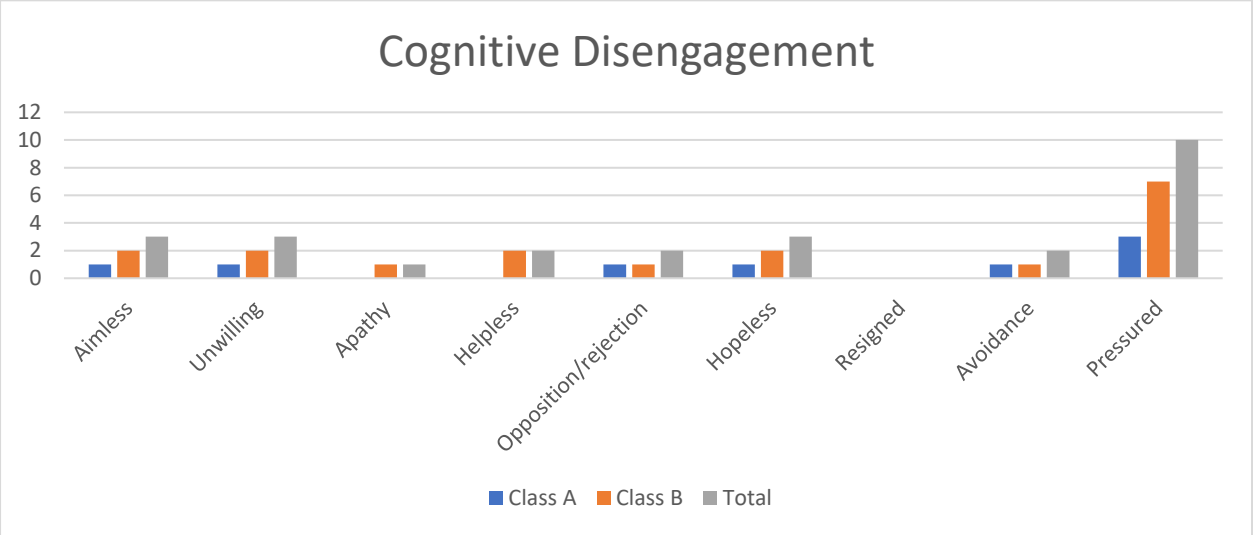


Figure 7: Graph showing the total number of cognitive disengagement indicators selected by each student who participated in the flipped classroom intervention.

Figure 7 displays the cognitive disengagement areas impacted by the implementation of the flipped learning. A overall of ten pupils felt pressured, an effect which is particularly notable mainly for the second research cycle. It is essential to be mentioned here that in the second cycle following the COVID lockdown, students started their full academic programme of the school under research. Therefore, students had to follow a heavy timetable, which included participating in co-curricular activities, such as clubs, societies, and sports. The material presented to the students before class potentially created additional stress and pressure for them to comply with their daily homework workload.

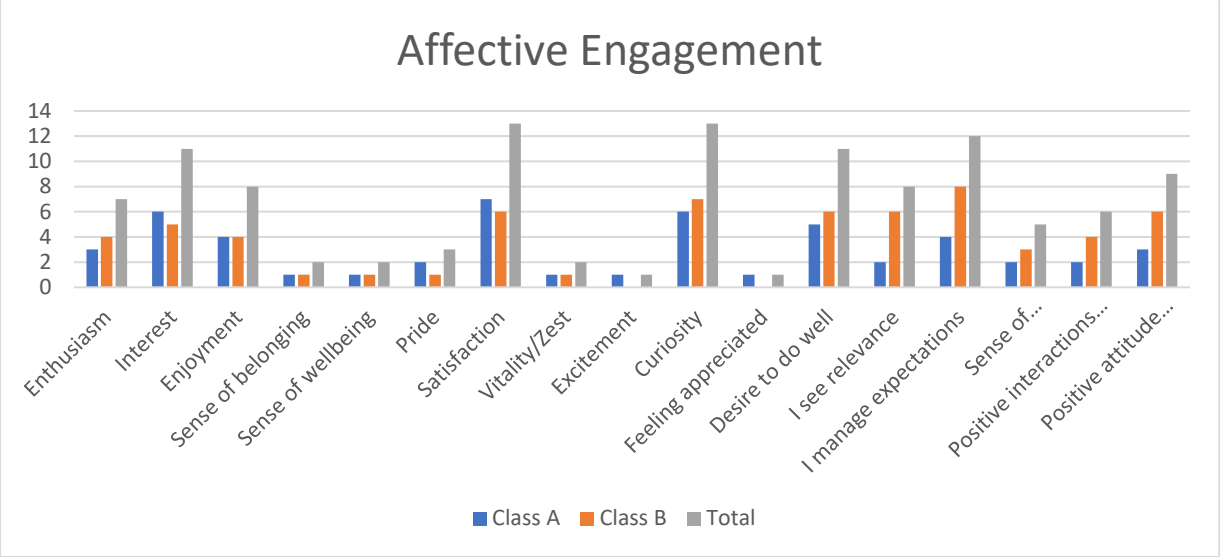


Figure 8: Graph showing the total number of affective engagement indicators selected by each student who participated in the flipped classroom intervention.

The boys also referenced various affective engagement constructs they experienced in the flipped physics lessons and were clear that flipped learning increased their interest, curiosity, and lesson satisfaction significantly. A strong message that I recorded from my diary reflections showed that students were keen to take good notes in the MS Forms, and it was evident that the vast percentage of students were asking more sophisticated and more frequent questions. Some clicks also showed that this pedagogical style improved their ability to meet the teacher's expectations. It is also interesting that only a total of 6 students selected “positive interactions” and “sense of belonging” showing an agreement with the previous results of Figure 1 and 2, which illustrated a minimal impact of flipped learning on engagement dimension particularly in cycle 1.

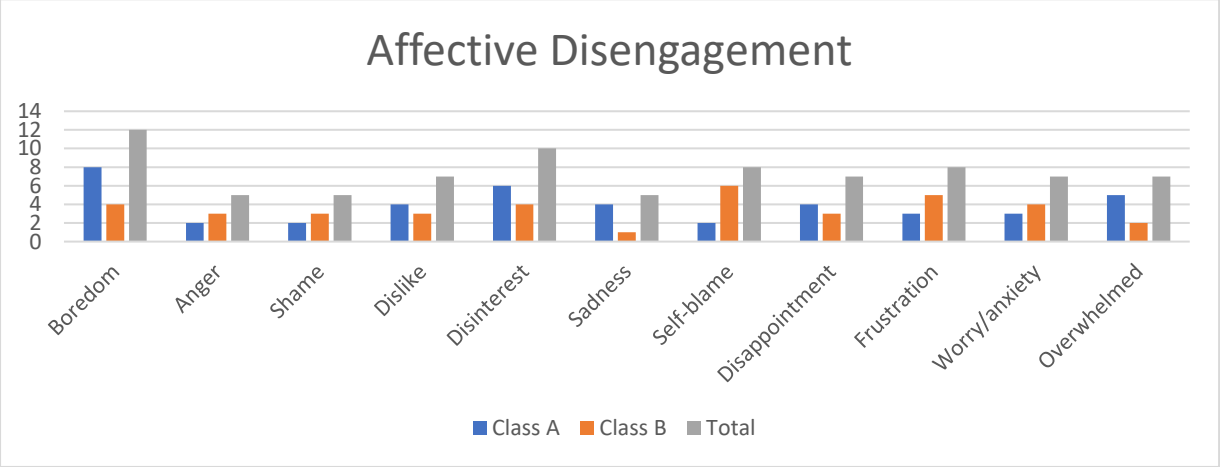


Figure 9: Graph showing the total number of Affective disengagement indicators selected by each student who participated in the flipped classroom intervention.

When asked about Affective disengagement in the questionnaire, the students' views were distributed across a range of constructs as it is depicted in Figure 3. The Boredom construct stands out particularly for Class A, while disinterest and self-blame for both classes.

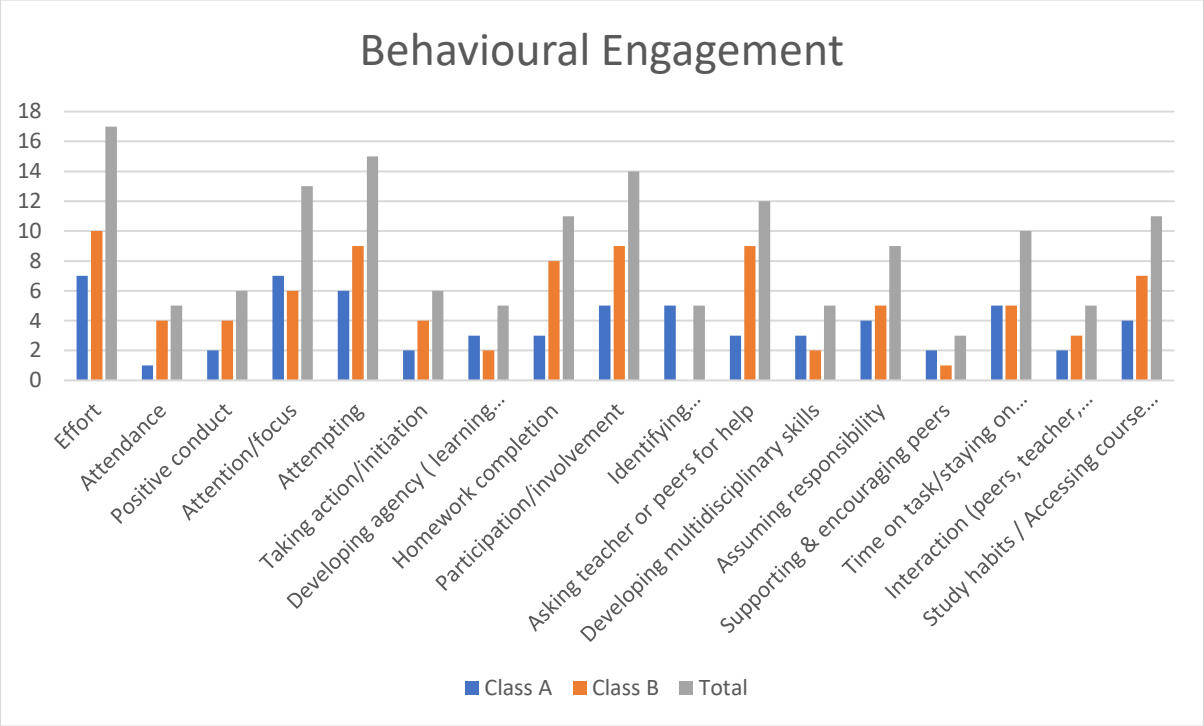


Figure 10: Graph showing the total number of behavioural engagement indicators selected by each student who participated in the flipped classroom intervention.

On examination of behavioural engagement total scores, it emerged that flipped learning mainly had a positive impact on boys' effort in and out of class, participation and attempting. Therefore, the data suggest that their confidence was enhanced during the intervention. The diary reflections also agree that students were attempting their homework, presenting a homework consistency of about 90%, indicating that most students were sufficiently prepared for the upcoming lessons. In addition, a satisfactory level of competence was shown when students attempted their provided worksheets.

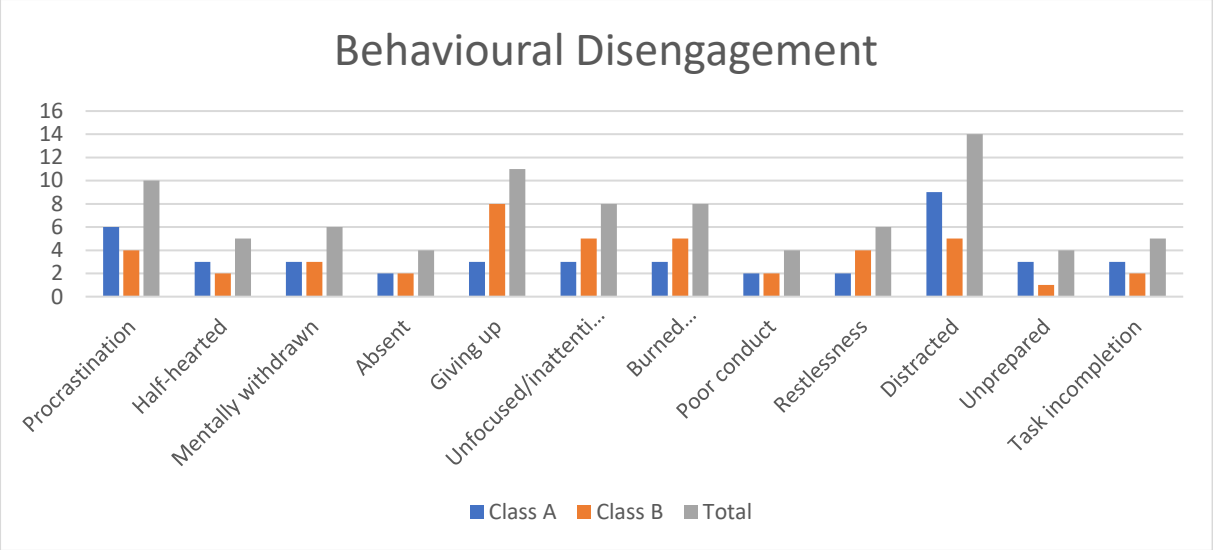


Figure 11: Graph showing the total number of behavioural disengagement indicators selected by each student who participated in the flipped classroom intervention.

Behavioural disengagement was centred on three leading indicators for this study. The "Distracted" indicator was by far the most prominent indicator showing the difficulty of students to watch videos as part of their homework and eliminate factors influencing their concentration. Similarly, students reported a challenge in addressing procrastination, and at times, they end up giving up on their tasks. Finally, a significant number of students of Class B was influenced negatively by the difficulty of their homework, which was particularly vocalised at the end of the second cycle.

4.1.2 Phase 2: Qualitative Interviews

Following the data analysis from Phase 1 on the influence of flipped learning on student engagement dimensions, students from Class A and B were invited to participate in a short interview of 15 to 20 minutes duration. It was hoped that each group would provide richer data and views about the questionnaire outcomes related to why boys selected specific engagement indicators. Also, the interview aimed to elicit pupils' views on flipped learning compared to the traditional teaching method as well as receive suggestions to improve future flipped lessons in physics.

Class A – First Research Cycle (Online Learning)

Both research cycle interview groups comprised six students, each categorised in Student A, B, C onwards. Most students from both intervention classes voluntarily opted to participate; however, as the study aimed to retrieve a pluralistic breadth of views, students were chosen from a vast ability

range. In addition, two students were selected from the lower attainment band (< 50% mean score in tests), two students from the middle attainment band (<60% score) and the top attainment band (>60%). The selected group was largely positive about flipped learning in their responses. The confidence in the online classroom due to their homework preparation was a particular highlight.

"I think that flipped learning was very effective especially to me because I felt like I came to class knowing of what were learning and I felt more confident in the classroom after this." Student A

"One time I was going to ask a question about the work but then I remembered it was in the flipped learning page." Student B

"Most of the time I was proud for remembering all the keywords and pushing myself." Student C

"It is more suited for people who like to work ahead or progress their own way. In the normal teacher led lessons, the teacher only says the same thing, the same way, once, whereas a video can be re-watched, paused and the comment checked. This version of classroom is better for older, more mature students, as some in our class struggle to stay on task when a teacher is not leaning over their shoulder." Student D

A high performing student acknowledged flipped learning as an effective teaching method due to the flexibility of students to control the pace of their learning. However, he also referred to the challenge he faced to stay motivated and suggested that this pedagogical method is more suitable for highly engaged students who show characteristics of self-regulation and determination. In addition, each of the videos took approximately 15 to 20 minutes of watching time, which included the multiple-choice questions, resulting in a total homework time of about 30 minutes. Some students find the completion this homework time quite excessive:

"Flipped learning was a good way to refresh our memory…. it took us a relatively long time to complete, sometimes around 30 minutes" – Student E

When students were asked about whether Flipped learning made them think deeper about Physics, most responded negatively mentioning that there was no impact. Similar comments were provided in line with the above view, which shows that the in-lesson activities did not provide opportunities to stretch students' physics abilities further. In addition to the above, it became evident that not all students were engaged in social interaction and collaboration when in break-out rooms. Some were

even brave enough to mention that they played video games while asked to complete tasks during the lesson.

"When on a computer, games can be played, when in a book, very little can cause digression." Student D

"We as students did not communicate in class during the flipped learning." Student F

However, when students were engaged in discussions, it helped them to understand the topic further:

"Hearing my friends' answers to the topic also helps me improve my model answer to certain questions". Student C

Students summarised that staying focused during the flipped homework was a challenge for them, and interaction with the teacher was not as extensive as in the pre-intervention era, which hampered their ability to engage well with the lesson. They also suggested that they needed a platform, like MS OneNote, to complete their video notes and found the multiple-choice questions more beneficial than open-ended questions, which could be avoided and decrease their workload. Furthermore, they mentioned that it helped them to use the provided keywords in order to write their video reflections which was part of their flipped homework. Therefore, it was thought for the flipped MS Form to maintain the text box following the video, labelled as "notes". This also considered as a useful tool to provide evidence for the teacher of students' preparation before the lesson, and also, it could act as a reflection area for students on their learning from videos.

"All the questions had to be multiple choice in order for it to be (self)marked. This was bad as we could not do any reasoning questions. I think the questions where we have to explain is the best way for us to learn." Student E

Finally, pupils summarised their positive feelings about the intervention and mentioned that they would like to continue learning with this pedagogical method frequently. Despite the rich ideas and suggestions, the limited interview time did not permit an opportunity for a further discussion over their engagement indicators selection of students. This part of the interview became a priority for the second research cycle. As a final point, they emphasised that the number of videos needed to be less than three and they should have a short duration of a maximum of 7 minutes. There was also a strong

feeling that students did not engage appropriately during the in-lesson tasks, which led me to think about activities promoting discussion. Therefore, as outlined in the methodology, there was a decision for amendments in flipped teaching according to students' recommendations.

Class B – Second Research Cycle

The students expressed mixed views for flipped learning in the second cycle. On the one hand, students shared their enthusiasm for this teaching method and their improvement in their learning independence. Further examples are outlined below:

> *"It is a lot more efficient for me because I can go back and re-look things I missed". Student A*
>
> *"It provokes our independence; it doesn't give us the excuse to always ask the teacher and always get given spoon-fed answers. Makes us interact with our brain and using the videos and the information to put into an answer." Student B*

Another pupil who was performing well in physics throughout the year expressed his view that:

> *"It helped me increase my relative understanding of the subject compared to when I am learning the stuff in a lesson or fumbling through a homework." Student C*

On the other hand, students expressing their frustration and the failure of this learning approach to improve their learning skills. When students were asked to describe their perceptions of the flipped classroom, some of them mentioned that:

> *"Quite poor. Lack of engagement between teacher and students. Just feels like we hear stuff and write it, not actually understand it as you would with normal teaching." Student D*
>
> *"I haven't found my engagement with other students different with flipped learning, however I have struggled to be involved with ground discussions in the classroom. With this in mind, I personally feel that my learning has fallen behind." Student E*

Similarly to the first research cycle, the majority of students considered the videos helpful, expressing how simple it was for them to rewind the clip and helping them to prepare before the following lesson. However, they argued that they would prefer suitably only one video for watching at home and a smaller number of multiple-choice questions. Some students also argued that learning through a video format is not treated as a proper learning method:

"For some people Flipped Learning was like an excuse to get the work done without actually learning…." Student C

Some pupils recognised that this pedagogical approach could positively influence their interactions with peers and assist them in progressing their learning. This phenomenon was also recorded in the personal diary where it was observed that the vast majority of students participated in conversations and took part in lesson debates, especially in the energy resources debate lesson:

"There were a couple of questions…and sometimes asked to my partner, what is happening here?.... and they would ask me similar questions." Student B

The boys also had a number of ideas about the choices of Class B towards specific engagement and disengagement indicators. Regarding the "managing expectations" indicator, students suggested that the quiz format was providing a clear homework structure for them and due to the self-marking factor of MS forms, they had a good understanding of their current knowledge before entering the classroom.

"You're give a point of view, once you've done forms, whether you're gonna do well on this topic or not well." Student C

On the other hand, there is substantial "pressure" build up for students when they learn with flipped learning. There appears to be a consensus that pressure tends to be caused by two main factors, the grading system of the quizzes and the perceived limited time spent in lessons for proper content review before practice.

"I felt like if we're going to do something like that would need to be in the classroom and go through it slowly, question by question." Student D

"If you have a shorter learning for the homework, you can put more concentration on to that topic of the subject." Student C

"[with flipped learning] people realise that they are really responsible for their own grades." Student F

"I think frustration is a key factor…. I felt frustrated that I couldn't have the access to ask questions and that leads to me having a less motive attitude to complete the quiz." Student B

Research question 2: How can the Flipped Classroom Model influence the academic achievement in Physics?

Analysis of Test Results

Table 3 shows that Flipped Learning students performed slightly better, achieving a higher average of 1.2%, with standard deviations between groups remaining roughly the same at a 0.5% difference. However, it is evident that the intervention group achieved a higher mean average of 3.1% across all taught topics throughout the year, which shows that this group perform consistently better independently of the intervention.

Table 3. Energy topic examination results after the implementation of the Flipped Learning approach in Cycle 1 (Online Learning).

Control Group	Percentage (%)	Year Average (%)	Intervention Group	Percentage (%)	Year Average (%)
Student 1	48.3	61	Student 1	82.8	78
Student 2	41.4	35	Student 2	34.5	30
Student 3	69.0	76	Student 3	55.2	75
Student 4	58.6	51	Student 4	51.7	37
Student 5	58.6	45	Student 5	31.0	47
Student 6	69.0	75	Student 6	41.4	55
Student 7	34.5	48	Student 7	48.3	53
Student 8	27.6	28	Student8	65.5	57
Student 9	44.8	60	Student9	44.8	53
Student 10	51.7	45	Student10	24.1	58
Student 11	27.6	55	Student11	62.1	66
Student 12	31.0	47	Student12	55.2	70
Student 13	37.9	39	Student13	48.3	61
Student 14	31.0	35	Student14	48.3	44
Student 15	75.9	63	Student15	48.3	51

Student 16	58.6	47	Student16	65.5	75
Student 17	27.6	42	Student17	41.4	51
Student 18	55.2	55	Student18	58.6	59
Student 19	69.0	87	Student19	13.8	29
Student 20	55.2	61	Student20	75.9	63
			Student21	48.3	62
Average	**48.6**	**52.8**		**49.8**	**55.9**
Standard Deviation	15.7	15.0		16.2	13.6

For this reason, an additional strategy was employed to gain further insight into the results. IBM SPSS 28 was utilised to help with the interpretation of the data of the two student groups. Therefore, an independent-samples t-test was conducted to compare the intervention and control group outcomes. In particular, the t-test looked to compare whether the variances between groups means are equal following an evaluation of the significance of the t-test ($p<0.05$). The test showed no significant difference in mean scores for the two groups (one-sided $p=.411$, two-sided $p=.821$). In conclusion, the data suggest that this approach does not seem to impact students' attainment in general.

Research question 3: How do teachers experience the implementation of flipped learning in Year 9 Physics classes (online learning)?

Departmental challenges

During the interview, the participants were asked about their perceptions of flipped learning. In general, my colleagues were appreciative and satisfied with the well-planned homework resources availability and the opportunity to remain flexible with their in-class instruction. They were also helpful by offering valuable feedback, which was used to improve the second research cycle. At the beginning of the first research cycle and the following weeks of the intervention, teachers scarcely requested clarifications or further instructions regarding this novel teaching method, which implied that they had no difficulties adapting to this new instructional approach. However, when interviews were conducted, it became clear that this was not the case for every colleague. For example, one colleague stated that:

> "*I actually did some of the flipped tasks during the lesson time, rather than pre-lesson time. So, I'd start a lesson by doing the flip task, and then I draw out a question from that by looking at their answers and then I'd go address some of those and give them some more examples*." Teacher A

Similarly, a teacher highlighted that although he was confident in how to implement flipped homework correctly, it was not clear for him how to undertake this approach in the online classroom:

> *"…in the classroom, I don't know how that work has a dynamic for getting the boys to sit there (completing work), and then I will be a bit redundant."* Teacher B

Even though both teachers mentioned that the initial instructions were clear and did not require further clarifications, their statements indicated they encountered some challenges in shifting away from their usual traditional lessons' instruction.

The need for collaboration was also expressed during the interview by some engaged colleagues. More specifically, they expressed an interest in learning more about flipped in-lesson activities that worked well for other colleagues:

> *"….and then the next thing is to think about how teachers can follow up on the MS Forms because I think that could be really interesting popular research*" Teacher C

Colleagues' views were divided on whether "Energy" was a suitable topic choice for Flipped Learning. On the one hand, teachers believed that flipped approach could only be of value when implemented on topics requiring written explanation and recall of factual content or definitions. It was argued that practising calculations would require a more traditional teaching approach that would allow real-time identification of students' mistakes in the classroom. The complicated nature of maths seems to deter teachers, most likely linked with their lack of experience on this method's efficiency in students' schemata reconstruction. Their claims could also be related to the inherent, intrinsic load imposed on students by the complexity of mathematical calculations. However, considering there were minimal opportunities for equations practice in the Energy unit, their claims seem to be unjustified. On a positive note, the visualisations of homework clips were considered valuable, mainly because there were limited opportunities for practical demonstrations during the online learning period.

On the other hand, there was a view that maths could be integrated with the flipped environment through carefully designed videos and worksheets that promote differentiation. A colleague suggested that suitable maths skills videos and resources could already be used by the Maths department and proposed an inter-departmental collaboration to support students efficiently in maths. However, it was stressed that such endeavour might impose a considerable increase in workload due to excessive planning.

Student-related benefits and challenges

The interviews also revealed essential flipped learning elements influencing student engagement. Most of my colleagues, including myself, showed an agreement in flipped homework inconsistency, receiving around 80% to 90% response rate for the assigned flipped tasks, ranging from two to four students per class coming unprepared to the lesson. In addition, they revealed that it was challenging for them to ensure students got engaged with the assigned tasks. Several teachers addressed this issue by prohibiting students from participating in the in-lesson active learning activities and asking them to do the preparation instead. Another colleague stated that he praised students for doing their work. On the other hand, some colleagues gave their underprepared students flexibility to complete their pre-class homework for the next lesson, removing one of the main inherent advantages of the teaching method, the pre-lesson preparation.

A teacher participant suggested that the success of Flipped Learning depends on building good relationships with students through excellent lesson planning. He outlined the untailed risk of asking students to prepare for an upcoming lesson and then using classroom time to repeat the same concepts. He mentioned that implementing this teaching approach: "only works if the (homework) questions are quite easy for students to mark themselves" and stressed the importance of facilitating discussions with students on their quiz answers with a tone of fun.

When teachers were asked how they experience flipped learning in the classroom, all interviewed colleagues raised the issue of increased disparity between the higher and the lower attainers in the class:

"*Once they came back, it was tricky, because there's varying engagement. So, the good kids who've done all the work…they would want to ask very advanced questions. And that was great because you can talk to them about that. But if the other kids had not studied…. they will be basically excluded from learning at that point because they can't follow the call*" Teacher D

"*Weaker students won't get as much benefit from it. So, it's kind of maybe separating the attainment gap…. the other issue is still that the students are so busy and then flipped learning doesn't get the same attention or seriousness from the student in terms of doing the homework*" Teacher E

The educators outlined occasions where students would experience boredom as they were required to listen to the teacher explaining previewed concepts to the lower-attaining or underprepared students.

The activation of students outside the classroom had some pleasing outcomes as well. The teachers observed that some students were able to express themselves more accurately, using correct scientific

terminology. However, responses elicited showed a consensus that students' vocabulary levelled up amongst the year group. It was interesting also that flipped learning effect was also evident for weaker students, being able to recall basic concepts more vividly. As one teacher said:

> "*Their questions were much more in-depth; they were asking much more specific things because they've had more time to process an idea and then come up with a question of their own*". Teacher C

While another two very experienced teachers commented:

> " *Many of them really got the idea about changing density with convection, that maybe in the past, they hadn't. I feel the boys may well have a better understanding now than present Year 11*". Teacher E
>
> "*I saw a really good use of vocabulary for something that I hadn't talked about or discussed previously, it was about the concept of absolute zero and Kelvin temperature…. following the flipped learning task, without any prompting by me, they started using those terms in other lessons and contexts, in a correct way".* Teacher F

This is an interesting finding, as evidence shows that flipped classrooms can support students effectively in accessing top marks in GCSEs. Benefits were also highlighted for motivated low achievers. Nouri (2016) argued that traditional lectures tend to be fast paced at times associated with ineffective learning for such students. Therefore, flipped learning helps low achievers to improve concepts assimilation as they can review homework at their own pace by pausing and rewinding videos, discussing thoroughly with their teacher and peers in class, and reflecting on their learning.

Such collaboration opportunities were illustrated by a colleague who argued that:

> "*I got them to do (activities) in pairs, there were opportunities for discussion there. We've had a bit more time to focus on how they would work the answers……they were able to pick up on where each other they hadn't (….) worded it in a sensible way…and inevitably they were better*". Teacher G

However, the effectiveness of this approach for year 9 students was questioned. The same teacher argued that students lacking motivation and interest in Physics might find it difficult to participate and engage with the online materials. It was suggested that sixth form students are more likely to be benefited due to their mature approach to learning and increased motivation levels.

Flipped Learning Departmental Effectiveness

Having gathered data on teachers' overall opinions of the flipped classroom after the first research cycle, an additional questionnaire was provided at the end of the second cycle. The study aimed to determine the overall efficiency of teachers in implementing flipped learning. In addition, it was hoped that potential findings would be valuable for revealing critical areas for development for the following academic year. The questionnaire included statements as retrieved from the Flipped learning Network

(2014). The sentences were constructed to inform teachers how to correctly engage with this teaching method by incorporating the four pillars' guidelines in their pedagogy. In addition, the interview group had to choose how frequently they implemented the FL concepts in their practice during two research cycles. Six teachers participated in this survey. The tables below illustrate the flipped learning strategies implemented by the department after the two research cycles.

Table 4: Flexible Environment

Flipped Learning Strategies	Never	Rarely	Sometimes	Often	Always
I establish spaces and time frames that permit students to interact and reflect on their learning as needed	0%	0%	**57%**	**43%**	0%
I continually observe and monitor students to make adjustments as appropriate.	0%	0%	**29%**	**71%**	0%
I provide students with different ways to learn content and demonstrate mastery	0%	0%	**57%**	**29%**	**14%**

Regarding the flexible environment criteria, the department partially met this expectation in shifting their practice to a student-centred approach. Most teachers reported that they enacted this FL principle well by allowing students time to discuss ideas in lessons and differentiating their in-lesson resources sufficiently. However, the first statement shows that the Physics Department should focus more on developing a student collaborative interacting environment when flipping lessons, including activities that promote dialogue and trade of ideas. Therefore, in the synchronous classroom, an effort should be placed in the development of team project presentations, group activities including debates, and practical activities.

Table 5: Learning Culture

Flipped Learning Strategies	Never	Rarely	Sometimes	Often	Always
I give students opportunities to engage in meaningful activities without the teacher being central.	0%	0%	**57%**	**29%**	**14%**
I scaffold these activities and make them accessible to all students through differentiation and feedback	0%	**14%**	**43%**	**43%**	0%

During interviews, teachers revealed a noticeable discrepancy between high and low performers in year 9. The "Learning Culture" table reveals what potentially could be one of the reasons behind this effect. Table 5 suggests that there were limited opportunities for personalised and differentiated learning as presented in item 2 which would enable all students to make progress in the classrooms. The flipped clips provided some opportunities for differentiation at home and were constructed in an accessible manner to engage all students. However, it revealed that more emphasis should be placed on constructing differentiated resources which would adapt well to students' ability and preparedness.

Table 6: Intentional Content

Flipped Learning Strategies	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
I prioritise concepts used in direct instruction for learners to access on their own.	0%	**29%**	**14%**	**57%**	0%
I create and/or curate relevant content (typically videos) for my students.	**14%**	**29%**	**43%**	0%	**14%**
I differentiate to make content accessible and relevant to all students.	0%	**14%**	0%	**86%**	0%

Table 6 illustrated that half of the teachers only partially met the first statement. The evidence suggests that some colleagues had an inherent difficulty moving away from traditional teaching methods, showing that some appear to be hesitant to transfer control of classroom learning to students. Table 7 findings also show that more training is required on how teachers could utilise the in-lessons environment efficiently.

Table 7: Professional Educator

Flipped Learning Strategies	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**

I make myself available to all students for individual, small group, and class feedback in real time as needed.	0%	0%	**29%**	**43%**	**29%**
I conduct ongoing formative assessments during class time through observation and by recording data to inform future instruction.	0%	0%	**57%**	**29%**	**14%**
I collaborate and reflect with other educators and take responsibility for transforming my practice.	0%	**14%**	**29%**	**43%**	**14%**

5. Discussion

SQ1: Engagement

Taking into account the outcomes of Phase 1 of quantitative data and Phase 2 qualitative interview data, this study will aim to investigate this evidence and reveal whether and in which manner students' engagement was influenced throughout the two cycles of intervention.

The data from the MSES questionnaire have shown that there was a decrease in the mean scores of engagements for both Class A and Class B. It is also evident that both cycles recorded a similar drop in engagement to a mean score of about 0.40. However, the considerable standard deviation with scores ranging from 0.4 to 0.7 shows that the drop in engagement cannot be considered significant. The outcomes of this study do not comply with the existing literature suggesting that flipped learning can improve classroom engagement (Ayçiçek & Yelken 2018). The result is considered surprising as, particularly in the second cycle, students had the opportunity to participate in active learning activities, such as environmental resources debates or practical activities that required them to measure the speed of sound.

Following the considerable uncertainty in the previous overall engagement outcomes, it was considered appropriate for the study to look deeper into the individual engagement dimensions to elicit more detailed information about flipped learning. It emerged from the engagement indicator questionnaires in the survey that boys may show a series of positive elements in all dimensions of engagement.

The Year 9 boys expressing their views about the impact of flipped learning on their cognitive engagement and indicating that their most prominent choice was "trying to understand" and "doing extra to learn more" illustrates they could access the videos. Therefore, students had an abundance of assimilated schemata, as suggested by Yu & Zhu (2019), which potentially made them motivated

and confident to engage with activities and support their in-class learning further. This was also notable in the behavioural engagement indicators, which shown an enhancement of participation, attempting and effort. That said, these results agree with Olakanmi (2017), who similarly documented that several pupils increased their active participation and collaboration in flipped lessons. The author also showed that students experienced deeper thinking and critical thinking, an element that was rare for this study according to the pupils' interviews.

SQ2: Attainment

The academic performance of students was assessed during the lockdown period when students were attending online lessons. In the quantitative analysis of results, it has been shown that there is no significant correlation between the results of the control group and the intervention group of the study. In conclusion, the data suggest that the flipped approach does not generally seem to impact students' attainment. This is evidence that supports the findings of Jensen et al. (2015).

It must be noted that even though there are studies in the literature review showing positive academic results, general findings in the research corpus remain divided in flipped learning. For example, Bond (2020), studying 107 publications, has revealed mixed outcomes concerning students' academic performance in secondary schools. As argued by Jensen et al. (2015), it could be possible that the group's performance might not have been influenced by Flipped Learning due to the absence of extensive active learning opportunities in class. Therefore, considering that this approach took place during the lockdown, there were minimal opportunities for correct implementation of student-centred tasks, which might have influenced this outcome positively. What also becomes clear is that the refinement of homework resources over the first cycle of research seems not to impact students' understanding of the Heat Energy Unit. It also leads to the argument that improvements in the learning processes do not necessarily translate into attainment improvements. However, the interviews with Class A students illustrated that they experienced an enhancement in their recall memory and their ability to use the provided keywords from the flipped homework during online lessons. Students could also potentially utilise their notes from MS Forms for test revision, which could theoretically increase the efficiency of scoring higher marks in future assessments.

SQ3: Teachers' Perceptions

Colleagues have varied opinions about the implementation of Flipped Learning for all topics in Physics. Regarding the Physics topic choice of Heat and Energy Transfers during online learning, this pedagogical method could work well only to recall factual content and simple concepts rather than applying physics in mathematics problems. Conversely, colleagues were suggesting the universal application of this method across the Physics curriculum. The literature has suggested that creating

relevant resources could be a potentially challenging task, indicating that this is a common phenomenon amongst first-time users of flipped approach (Lo & Hew 2017a). The authors suggested that resources design needs to take place progressively. In addition, considering that flipped learning materials require substantial time to be created, educators could start taking small steps in planning at a sustainable pace (Grypp & Luebeck 2015).

There was an unprompted agreement between teachers that the flipped learning approach can increase the gap between the higher and lower performers. The interview results are in agreement with Kettle's (2013) findings which showed that flipped learning is more suitable for high-attaining and motivated learners. According to Kettle (2013), such students can flourish and develop their independent learning skills with this learning method effectively due to their higher levels of motivation and time organisation. A similar phenomenon was observed by Lo & Hew (2017b), with students coming into class without remembering what they had learned out of the classroom. They proposed that teachers should spend time clarifying misunderstandings and, at the same time, providing advanced problems for high-performing students to mitigate this issue. As another solution, students could also be grouped in the classroom according to their ability or preparation confidence (Clark 2015). Therefore, well-prepared students could work independently on advanced problems, while underprepared students could revisit their flipped homework with their teacher or using their laptops.

The extent to which Physics teachers can implement the flipped learning was investigated during the teachers' interviews. There were occasions where the intervention implementation was problematic, particularly in the first stage of research, during online learning. The findings echo the study of Nicholas (2014), who identified colleagues who had set up their flipped classrooms incorrectly, with students completing notes during the lesson. Their study outlined that such users may not comprehend flipped classrooms' benefits or need more time to adjust to this teaching approach. Grypp & Luebeck (2015) empirical findings suggested that educators should accept the change by embracing the characteristics of the flipped instruction and trialling new methods in the classroom. However, this may require access to academic journals and specialised materials to which they may not have access. Most importantly, it is argued that educators should collaborate in the task design of flipped learning tasks, as opportunities will be presented for them to exchange their experiences and receive practical feedback from colleagues (Mazur et al. 2015). In addition, according to Bond (2020), teachers could also improve their flipped instruction by exchanging ideas via professional networks on social media (Twitter). Emphasis should also be placed on building a classroom culture of expectation (Muir & Geiger 2016). In such classrooms, underprepared students will be forced to discuss ideas with their peers and teachers will renounce their responsibility to explain the whole

lesson to the class. Such culture could be developed further with communication amongst colleagues. Departmental meetings could be used as a hub for creative ideas and experience sharing of successful student-led tasks. Classroom observations could also provide fertile ground for valuable discussions on flipped learning.

The guidelines of the Flipped learning Network (2014) also provided an overview of the colleagues' efficiency in implementing the flipped learning approach. In general, correct strategies were followed to ensure that students made progress with this teaching method through sufficient collaborative activities. This effect led teachers to experience a change in students' learning, experiencing improvements in students' vocabulary, oral explanations of concepts and more sophisticated questions. The comments above correspond with the work of Hultén & Larsson (2018), who interviewed teachers implementing this pedagogical approach. They suggested that flipped classrooms can increase students' confidence, question quality and activity in lessons. Many teachers were also devoting time to review the flipped homework quizzes properly and facilitate exciting discussions with students to help them learn more deeply. Hew et al. (2020) has also discussed a similar solution, suggesting that the activation and evaluation of pre-class learning increase the effectiveness of flipped learning and helps students understand concepts more deeply and address their misunderstandings.

6. Conclusion

The study aimed to answer the main question on how flipped learning can support Year 9 students in Physics. For this reason, the investigation within the context school has shown a mixed variety of results concerning this pedagogical method. Regarding the students' engagement during both research cycles, results suggest that the overall engagement of both participating groups decreased within a point of uncertainty. However, pupils mentioned that this novel teaching method is impactful and can influence students positively. Positive elements have been recorded in all four dimensions of engagement, and results agree with the literature, with increased homework consistency, participation, peer-teaching, quality questioning and note-taking standing out. In their justification, students argued that they could control their learning and set their own pace as flipped videos provide this flexibility, similar to Olakanmi (2017) study. However, it becomes apparent that the usage of more than 2 or 3, five-minute videos tend to significantly increase their cognitive load, which appeared elements of disengagement.

Many pupils from both classes also suggested a series of Flipped Learning drawbacks, such as homework pressure, boredom, mainly during online learning, and frustration. Pupils commented that pressure was derived from the fact that flipped homework was assessed, and therefore if students did not perform well, this led to negative feelings and withdrawal.

Findings from teachers' interviews were rich in information, but they were also mixed. From their experience, the flipped classroom can lead to sophisticated questions in the synchronous classroom, which can spark interesting conversations. However, it was also evident that flipped learning was more suitable for high attaining students, who were more proactive in completing their flipped homework properly. On the other hand, demotivated students who potentially covered only parts of their pre-lesson work were falling behind and unable to participate in those interesting conversations, which could potentially impact the class as a whole. This view corroborates with the findings of Chen et al. (2014). Last but not least, there was evidence of the difficulty of colleagues and myself to implement the flipped learning approach accurately, which potentially could explain the considerable record of disengagement dimensions outlined by students in the study.

6.1 Implications

Due to this study, I reflected on the impact of my findings on the school context. My findings suggest that flipped learning is a suitable method of teaching that is not particularly efficient for younger year groups and especially low attainers in Year 9. If this approach is implemented in KS3 or KS4, it needs to be moderately implemented and, of course, accompanied with rich accompanied resources which can be differentiated for students of various abilities in synchronous classrooms. Also, it would be advised that the physics department have weekly meetings to discuss ideas about how this method can function well in real classroom scenarios. Also, it becomes evident that students would need to have the right incentives to participate more in lessons and become more consistent with work. In a future opportunity, the physics department could utilise simpler versions of these quizzes, providing only the essential information for students in order to maintain their motivation.

6.2 Limitations

This study should be evaluated within the context of its inherent limitations. The most significant limitation of this study is the student available sample, which makes it challenging for results to be considered generalisable and reliable (Denscombe 2017). We also need to consider that the statistics data derived mainly from only two classes with a total number of roughly 40 students. Therefore, it is possible that most of the outcomes may be statistically insignificant. On the other hand, this study aimed to investigate the influences of flipped learning on students' engagement and attainment.

Therefore, it was considered logical for multiple data collection strategies to be employed to decrease the results' interpretation bias.

In seeking trends with engagement, the sample was decreased significantly to include only the students who consistently completed all three questionnaires. This resulted in a dramatic reduction of the Class A student sample to a total of seven students. On the other hand, Class B maintained a higher percentage of responses as about sixteen students consistently provided their answers for the three questionnaires. Therefore, it was challenging for this study to elicit meaningful outcomes in terms of students' academic performance and engagement.

During the first research cycle, the physics assessment has not accurately judged the performance of year 9 students at the test as the flipped learning took place during the lockdown. Therefore, the implementation of this pedagogical approach was absent of its fundamental elements of active learning. Even though there was an attempt for students to participate in online breakout rooms and collaborate, the established learning environment could not simulate the real classroom learning environment accurately.

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8. Appendices

APPENDIX 1: Student Interview Questions

Interview Questions	Relationship to Conceptual Framework
1. Describe how you perceive the flipped classroom compared with the traditional classroom. 2. What differences have you experienced between how you interact with other students in a flipped classroom, compared to a traditional classroom, if any? How has this impacted your learning?	Sociocultural theory
3. Describe how watching videos before coming to class has influenced your learning. What do you like and dislike about learning this way?	Cognitive load Theory Sociocultural theory
4. What differences, if any, do you notice between the role of a teacher in a flipped classroom, compared the role of a teacher in a traditional classroom? How do you feel about these differences?	

5. Describe a situation in the flipped classroom where you felt you were in charge of your own learning.	
6. How has the flipped classroom changed how you learn physics, if at all? What do you like and dislike about learning this way?	Cognitive load theory & schema theory
7. What ways, if any, does flipped learning make you think deeper about physics?	
8. In what ways, if any, has flipped learning contributed to your ability to work through difficult challenges?	
9. Describe times in class when you work with other students. What do you like and dislike about this aspect of flipped learning?	Sociocultural theory
10. What is the most challenging aspect of a flipped classroom from your perspective? Why is this such a challenge?	Cognitive load theory sociocultural theory schema theory

APPENDIX 2: Headteacher Letter

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Director Professor Jo-Anne Baird

[redacted]

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and Teaching at Oxford University, supervised by Dr Liam Guilfoyle. In my final research project *"Investigating students' and teachers' experiences of the implementation of the Flipped Classroom model in Year 9 Physics"*, I will explore the Flipped Classroom (FL) pedagogical approach in KS3 Physics classrooms. Also, I will collaborate with the Physics Department to develop a research-informed scheme of work and investigate their perceptions of implementing this pedagogical method.

The research will take place across the Year 9 cohort in Physics lessons. I will seek the support of Physics teachers volunteering to teach a series of lessons using the FL pedagogical approach. During our departmental meeting in November, all colleagues teaching this cohort agreed to support this study. The research will focus on students' attainment, engagement and ability to work independently. Subsequent research will investigate how the FL approach is being implemented and to what extend is having an impact on classroom practices.

By participating in the research, the school would be contributing to a project that will deepen our understanding of the FL pedagogy which could contribute towards developing ways of improving boys' engagement and attainment in the school in the future. It will also contribute to Physics education more widely. I hope to conduct this research between January 2021 and August 2021, and I intend to conduct anonymous surveys, lesson observations (video & notes) of FL implementation in classrooms and audio/video recorded anonymous interviews with students and teachers after seeking their consent.

Oxford University has strict ethical procedures on conducting ethical research, consistent with current British Educational Research Association guidelines. The University also recognises, however, that my study is a piece of practitioner research, and that schools already operate with the highest ethical standards. Therefore only your formal consent as headteacher is necessary, and not that of individual parents or staff. However, throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teacher and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor Dr Liam Guilfoyle (liam.guilfoyle@education.ox.ac.uk) and me, and only used for academic purposes. It will be kept for as long as it has academic value.

If you are happy for me to proceed with this study, please confirm that using the attached reply form. If you have any concerns or need more information about what is involved, please contact my supervisor. Further, if you have any questions about this ethics process at any time, please contact the chair of the department's research ethics committee, though: research.office@education.ox.ac.uk. I look forward to hearing from you.

[redacted]

APPENDIX 3: CUREC Approval

CUREC Application ED-CIA-064

[redacted]

Tue 05/01/2021 13:41

[redacted]

Dear Nick

Title and reference number: An investigation into the impact of the Flipped Classroom model on KS3 students' engagement in Physics ED-CIA-064

The above application has now been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

If your research involves participants whose ability to give free and informed consent is in question (this includes those under 18 and vulnerable adults), then it is advisable to read the following NSPCC professional reporting requirements for cases of suspected abuse
http://www.nspcc.org.uk/Inform/research/questions/reporting_child_abuse_wda74908.html

Should there be any subsequent changes to the project which raise ethical issues not covered in the original application you should submit details to research.office@education.ox.ac.uk for consideration.

Good luck with your research study.

Yours sincerely,

[redacted]

Member of DREC

APPENDIX 4: Questionnaire Introduction

Physics Education Survey (Trinity Term)

This questionnaire has already been completed by most of you in January.

We would like to know in this second quiz how flipped learning might have changed your experiences in Physics. Therefore it would be appreciated if you complete the questionnaire below.

This questionnaire has questions about you, and about your experiences and interests related to Physics in school. This information may help us to make your school better.

There are no correct or incorrect answers, only answers that are right for you.
Please think carefully and give answers that reflect your own thinking.

Some questions may seem strange to you. If you are in doubt, please feel free to email [redacted] at [redacted] This is not a test!

For most questions, you simply put a tick in the appropriate box.

Your answers will remain anonymous and they will not be shared (including your class teachers).

THANK YOU!
Your answers will be a big help.

APPENDIX 5: Student Questionnaire

Cognitive Engagement

1. I go through the work for science/math class and make sure that it's right.
2. I think about different ways to solve a problem.
3. I try to connect what I am learning to things I have learned before.
4. I try to understand my mistakes when I get something wrong.
5. I would rather be told the answer than have to do the work (rev)
6. I don't think that hard when I am doing work for class (rev)
7. When work is hard, I only study the easy parts (rev)
8. (S) do just enough to get by (rev)/(T) do more than required in class.

Behavioral Engagement

9. I stay focused
10. I put effort into learning science/math
11. I keep trying even if something is hard.
12. I complete my homework on time
13. I talk about science/math outside of class
14. (S) don't participate in class (rev)/(T) participate in class.
15. I do other things when I am supposed to be paying attention (rev)
16. If I don't understand, I give up right away (rev)

Emotional Engagement

17. I look forward to science/math class.
18. I enjoy learning new things about science/math.
19. I want to understand what is learned in science/math class.
20. I feel good when I am in science/math class.
21. I often feel frustrated in science/math class (rev)
22. I think that science/math class is boring (rev)
23. I don't want to be in science/math class (rev)
24. I don't care about learning science/math (rev)
25. I often feel down when I am in science/math class (rev)
26. I get worried when I learn new things about science/math (rev)

Social Engagement

27. I build on others' ideas.
28. I try to understand other people's ideas in science/math class.
29. I try to work with others who can help me in science/math
30. I try to help others who are struggling in science/math
31. I don't care about other people's ideas (rev)
32. When working with others, I don't share ideas (rev)
33. I don't like working with classmates (rev)

Note. (rev) indicates reverse coded items; (S) refers to student item only; (T) refers to teacher item only.

APPENDIX 6: Teacher Interview Questions

Flipped Learning Structure

- What is your perception of Flipped Learning?
- What is your opinion on the implementation of Flipped Learning approach for the Energy Unit in Year 9?
- Would structure notes provision improve the Flipped learning homework?
- Did you feel confident about Flipped learning? Did you expect more information from me to help you find ways of implementing it?
- How did you find the duration and quality of selected flipped homework videos?
- Would you make amendments to the Flipped Learning homework structure?
- How did you find the type of questions used for the Flipped Learning homework?
- Would you like to participate in the second research cycle? Do you see yourself implementing Flipped Learning next year?

Flipped Learning Student Engagement and Learning Skills

- How consistent are students in completing their Flipped homework?
- Have you noticed any difference in terms of learning skills improvement or depth of learning taking place?
- What is students' opinion about Flipped Learning? Are they engaged?

APPENDIX 7: Indicators of student engagement used for questionnaire

Cognitive Engagement		
Purposeful	Critical thinking	Self-regulation
Integrating ideas	Setting learning goals	Operational reasoning
Doing extra to learn more		Trying to understand
Follow through/care/thoroughness		Reflection
Positive self-perceptions & self-efficacy		Focus/concentration
Preference for challenging tasks		Deep learning
Teaching self & peers		Learning from peers
Use of sophisticated learning strategies		Justifying decisions
Positive perceptions of teacher support		Understanding

Affective Engagement		
Enthusiasm	Interest	Enjoyment
Sense of belonging	Sense of wellbeing	Pride
Satisfaction	Vitality/Zest	Excitement
Curiosity	Feeling appreciated	Desire to do well
Sees relevance	Manages expectations	
Sense of connectedness to school/university/within classroom		
Positive interactions with peers & teachers		
Positive attitude about learning/values learning		

Behavioural Engagement		
Effort	Attendance	Positive conduct
Attention/focus	Attempting	Action/initiation
Developing agency	Homework completion	Confidence
Participation/involvement	Identifying opportunities/challenges	
Asking teacher or peers for help	Developing multidisciplinary skills	
Assuming responsibility	Supporting & encouraging peers	
Time on task/staying on task/persistence		
Interaction (peers, teacher, content, technology)		
Study habits/Accessing course material		

Indicators of student disengagement

Cognitive Disengagement		
Aimless	Helpless	Resigned
Unwilling	Opposition/rejection	Avoidance
Apathy	Hopeless	Pressured

Affective Disengagement		
Boredom	Disinterest	Frustration
Anger	Sadness	Worry/anxiety
Shame	Self-blame	Overwhelmed
Dislike	Disappointment	

Behavioural Disengagement		
Procrastination	Giving up	Restlessness
Half-hearted	Unfocused/inattentive	Distracted
Mentally withdrawn	Burned out/exhausted	Unprepared
Absent	Poor conduct	Task incompletion

Indicators of engagement and disengagement (Bond 2020)