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'I want to challenge myself': the use of Self-Regulatory techniques to enhance Self-Efficacy in a Year 7 science class

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Abstract

Success in the classroom has increasingly been attributed to self-efficacy. This has been partially permitted through the use of self-regulatory techniques. Although research has recently increased into these two areas, the application of self-regulatory techniques to enhance self-efficacy in younger secondary school students is still largely unexplored. This action research study focused on implementing self-regulatory techniques into a year 7 science class in a British comprehensive school, with the aim of increasing student levels of self-efficacy. A sequence of lessons were delivered, that incorporated self-regulatory learning. Levels of both self-efficacy and self-regulated learning were measured before and after the sequence, using a range of data collection methods. Findings suggest that a significant increase in self-efficacy was a result of the introduction of self-regulated learning techniques. The study points towards the importance of increasing self-efficacy, in younger students, as well as possibilities for future research.

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Introduction

Students being able to learn for themselves has increasingly become a matter of importance to educational practitioners. It is widely believed that self-regulated learning is the key to students’ success in academic performance. However, a student’s own perceived ability can arguably be just as important. It is thus, that this study aims to address whether these two approaches to learning can complement each other. More precisely; whether self-regulated learning can enhance students’ self-efficacy. Although most previous research in to self-regulated learning has been carried out in higher educational learners, this study aims to address the needs of younger learners. The basis of this research is the idea that if self-regulated learning and increased self-efficacy can be installed in students from an earlier age, these skills can then be used throughout their education. This would expectantly lead to students with greater academic success. This study aims to raise self-efficacy in a group of year seven students (12-to-13 year olds), via the introduction of self-regulated techniques, in their science lessons. Science, often being perceived as one of the most challenging subjects, is therefore a suitable subject for this research into raising self-efficacy to be conducted.

This action research study will begin with a review of the current literature, which ultimately suggests that self-regulated learning is important in raising student’s self-efficacy. It will then go on to outline the methodology used in this study, and the limitations of these methods. Next, the findings of this action research study will be presented, followed by a discussion of these findings. Key findings include increased levels of self-efficacy in students, while using self-regulated techniques, as well as key examples of student feedback and responses. The study then goes on to explore alternative explanations for these findings, as well as suggestions for further research based on the findings of this study. Finally, implications that the findings of this study will have on future teaching practice are discussed.

Literature Review

What is self-efficacy?

Psychologist Albert Bandura defined self-efficacy as 'one's belief in one's own ability to succeed in or accomplish a task' (Bandura, 1986, p.76) and believed that this impacts the way that a person approaches tasks, especially those that they consider to be difficult. In the first instance, his research focused on phobic individuals successfully, for example, touching a snake. Although the subjects could appreciate that, with the correct handling, they would come to no harm, they differed in their own beliefs in their ability to carry the techniques out safely (Bandura, 1986). He labelled this difference in beliefs amongst the subjects as 'self-efficacy'. Bandura argued that the types of outcomes people anticipate are mostly impacted by their judgements of how well they will perform in the situation, rather than any other factor that can affect motivation (for example, outcome expectation). Similar situations might include public speaking or petting a dog.

Zimmerman (2000) demonstrated that self-efficacy could be used as a performance based measure of perceived capability which can be closely linked with student's performance. Like Bandura (1986), he also suggests that self-efficacy is distinct from other related motivational constructs because it is not sensitive to differences in experience or situational context.

For the purposes of this action research study, the term self-efficacy is defined in a similar way to that of Bandura and Zimmerman. When referring to self-efficacy the study is referring to a student's own belief in their ability to perform and carry out a task to a standard that they perceive to be good, specifically in their science work.

Using Bandura's (1986) example of touching a snake, a comparison might be made to a student who is sitting a science test. It is their own perceived ability that will impact how well they do on the test.

Sadi and Dagyar (2014) investigated the importance of self-efficacy among high school students and found a positive relationship between students' applying and understanding of biology and their self-efficacy surrounding the topic. They therefore argue that self-efficacy is required for an effective teaching and learning process. The importance of self-efficacy in learning has also been outlined by Lee, Hayes, Seitz DiStefano and O'Connor (2016), who found self-efficacy (among

other intrinsic motivational factors) was key in mediating achievement in science. It is clear from this research that self-efficacy is vital in achieving academic success and that a student's self- belief in their ability has a positive relationship with a willingness to learn and achieve.

What is self-regulated learning?

Boud (1988) wrote about how a considerable number of students that are going on to further study 'have learned only the skills of learning by being taught'. He claims that students are unable to set their own goals, monitor their own learning or evaluate what they have learnt. He therefore believes that there should be a new emphasis on the acquisition of knowledge, rather than the transmission of knowledge to equip students for the conditions of the twenty first century. Boud's (1988) beliefs encapsulate a vast emerging idea that teaching should now focus on more self-regulatory techniques, to the benefit of students. The skills and competencies that students will need to thrive in the 21st century have been defined several times (Candy, 2011; Dede, 2007). A common theme is however, that the provision of self-regulatory learning techniques is linked to an increase in these skills and would equip students well for future study or work.

Zimmerman (2008) is a key researcher in self-regulation and his definition is much agreed upon. He defines self-regulated learning, as a cycle of just three stages. These include:

1. *Forethought*- learners preparing work before their study

2. *Volitional control/Performance control*- the learning episode in which students use processes such as metacognition, self-instruction and monitoring their own behaviour and attention

3. *Self-reflection*- when learners review what happened in the volitional/performance control phase and use this to inform the next forethought phase

At the core of Zimmerman's (2008) self-regulated learning is the idea that the student must be in control of their own learning and the consequences of it. They must consistently monitor and adapt their learning techniques until success is met, without the continuous intervention of a teacher. If a student does this then all three stages of Zimmerman's cycle should be met and with it, self-regulated learning accomplished.

Helpfully, both Zimmerman and Pons (1986) previously summarised what exactly self-regulated learning strategies are and what they consist of (Table 1).

Strategy	Definition
Self-evaluation *	Student-initiated evaluations of the quality or progress of their work
Organising and transforming	Student-initiated overt or covert rearrangement of instructional materials to improve learning
Goal-Setting and planning	Student setting of educational goals and planning for sequencing, timing, and completing activities related to those goals
Seeking information *	Student-initiated efforts to secure further task information from non-social sources
Keeping records and monitoring	Student-initiated efforts to record events or results
Environment structuring *	Student-initiated efforts to select or arrange physical setting to make learning easier
Self-consequences	Students arrangement or imagination of rewards or punishment for success or failure
Rehearsing and memorizing	Student-initiated efforts to memorize material by overt or covert practice
Seeking social assistance *	Student-initiated efforts to solicit help from peers, teachers, or textbooks
Reviewing records	Student-initiated efforts to re-read tests, notes or textbooks

Table 1: A summary of self-regulatory techniques, adapted from Zimmerman and Pons (1986)
Those that are coded (*) were directly included in this study's sequence of lessons.

To summarise, Zimmerman (2008) states that self -regulated learning processes are whereby the learner is in control of their learning and evaluates and adapts it to meet a learning goal (whether that be teacher or student set). Using Zimmerman's (2008) work, in this study, the term 'self-regulated' refers to any learning which the student is responsible for and which requires them to regulate their own learning, with the aim of meeting a learning goal.

What has past research found on the relationship between self-regulatory techniques on self-efficacy?

Self-regulatory learning has been shown to have positive effects on various constituents of self-efficacy, including self-monitoring, self-evaluation, and persistence. A meta-analytical review of seventy studies, carried out by Multon, Brown and Lent (1991), found a significant positive effect

between students' self-efficacy and persistence. However, it is important to highlight that a lot of the authors own papers, from previous years, were used and chosen over papers by other authors on the same topics. This could hint at some researcher bias in the results of this meta-analysis. The meta-analysis also covered all education types and ages and there is no obvious clarification as to how these ages were chosen and if there was a fair distribution of the different types of education. Further, although self-efficacy was shown to be raised through self-regulatory techniques, this was still only by 12 percent. Nevertheless, included in the meta-analysis was research carried out by Schunk (1981), which concluded that an increase in self-efficacy leads to a dramatic increase in persistence, which has positive impacts on skill acquisition and academic performance. An increase in persistence correlates with an increase in effective self-monitoring, as Bouffard-Bouchard, Parent and Larivee (1991) found, which then in turn, was found to have positive impacts on self-evaluation, with students being better able to judge outcomes of their self-monitoring. These pieces of research provide clear results, supporting the idea of self-regulatory techniques in enhancing self-efficacy in students. The basis of the research was that self-regulatory techniques can enhance self-efficacy, including persistence. However, when analysing research into persistence, and whether self-efficacy affects it, it is important to understand that occasionally a lack of persistence can be mistaken for students completing tasks quicker due to other factors, rather than a lack of persistence. There is no evidence that this was addressed in these studies, or accounted for in the conclusions, so the results should be taken with caution.

The meta-analysis (Multon et al. 1991) was also not science specific, unlike Kingir, Tas, Gok, and Vural's (2013) research. Kingir et al. (2013) studied the relationships among constructivist learning environment variables, motivational beliefs, self-regulation, and science achievement in Turkish middle school students (aged 14). Overall, self-efficacy was found to be the biggest predictor of how well students could master their science work. However, the relationship between self-efficacy and self-regulation was not found to be significant. Despite this, Kingir et al. (2013), did suggest that teachers should undertake more teaching techniques where students have the opportunity to take responsibility because students are more likely to develop higher interest in the tasks they are doing. However, as the results themselves point out, there was no significant relationship found between self-efficacy and self-regulation in this school and so it does not provide a basis for Kingir et al.'s (2013) advice to necessarily be followed.

Tsai, Ho, Liang and Lin (2011) also investigated self-efficacy levels in students studying science. They analysed self-regulated 'project work' and found that, in a group of 337 students, self-efficacy could be negatively correlated with lower-level conceptions of learning science, while students with higher levels of self-efficacy had higher-level conceptions of learning science. So, students who had increased self-efficacy were more likely to hold higher, more positive opinions when it came to learning science. The study also found that those students who tended to view scientific knowledge as uncertain were likely to possess lower self-efficacy toward learning the science content. However, the focus of Tsai et al.'s (2011) paper was to investigate student interaction while carrying out self-regulated project work, rather than students as individuals and their own self-efficacy levels. Therefore, although the research does suggest that self-regulation is important to self-efficacy, these results were not the main focus of this study.

The role of self-regulation in the self-efficacy of higher achieving students is an area that has also been addressed in relatively recent years. McCoach and Siegle (2003) studied the differences between 'gifted achievers' and 'gifted underachievers' with possible links to self-regulation and self-perceptions. They found that both groups had high academic self-perceptions, but gifted achievers had more positive views towards school and this was then related to increased self-regulation. This difference in self-regulation was linked to motivation and concluded to be the main factor affecting the academic achievement of the two groups. However, a major flaw behind these findings is that none of the students were screened for evidence of learning disabilities, Attention deficit hyperactivity disorder (ADHD) or other medical, emotional, or psychological problems. The study itself even points out that academic underachievement of gifted students can sometimes be linked to one or more of these problems. On this basis, no truly direct link can be made from its findings between self-regulation and achievement of gifted students, without dispute of another underlying cause.

Although there are possible flaws in these pieces of research into self-regulatory learning and its impacts on self-efficacy, there are many pieces of research to suggest that self-regulation is closely linked to self-efficacy levels. For example, Brinter and Pajares' (2006) research provided robust evidence of a correlation between self-efficacy and past mastery experiences. This could be expected as self-efficacy can be effected by experiences that a student may have encountered in the past. For example, if a student has failed at a task in the past, they are likely to have less efficacy in themselves to complete the task anew. Self-regulatory learning would therefore be replaced for a

more dependant learning style, whereby the learner believes they are more likely to succeed. Lin and Tsai (2013) investigated those situations in which high self-efficacy levels tend to be higher in students. They found that students who consider learning science in terms of preparing for exams tend to hold lower self-efficacy in relation to science learning. Together with Brinter and Pajares' (2006) research, this could perhaps suggest that those students who experienced failure in science lack self-efficacy in their ability in science in the future. The knock-on impact would then be to adopt a more dependant learning style, and to be less of a self-regulatory learner.

The impact of self-regulation on self-efficacy was again recently shown in work carried out by Lee et al. (2016). Lee and his colleagues examined the relationships between academic self-efficacy and self-regulation (among other variables) in secondary school students. Surveys whereby the students were required to rate their confidence about getting each grade in their exams, as well as their level of self-regulation when it came to carrying out school work, were used. Interestingly, self-efficacy was linked directly to academic achievement in the students, and self-regulation was indirectly linked to this academic achievement too.

Conclusions

To summarise, self-efficacy is centred around a learner's belief that they can carry out a task successfully, and research so far tends to suggest a link between the adoption of self-regulatory learning techniques and increased levels of self-efficacy. A lot of the research concentrates on particular types of students (e.g higher achievers, higher education students) but tends to agree that one of the biggest predictors of a student's success is self-efficacy and self-regulation. However, the acquisition of self-regulatory techniques at an earlier age has not been widely researched, and could provide a basis for academic success from an earlier age, via increased levels of self-efficacy. This action research therefore aims to use the findings of previous literature to raise self-efficacy in a group of year 7 students (aged 11-12), via the adoption of more self-regulated techniques.

Methodology

Research Questions

The primary question that this study is aiming to address is 'Does the use of self-regulatory techniques enhance student's self-efficacy while studying science?'. There are three sub-questions that will help to inform the primary question:

RQ1. What is students' self-efficacy towards learning science before using self-regulatory techniques?

RQ2. How do students respond to using self-regulatory techniques while studying science?

RQ3. How do self-regulatory techniques impact self-efficacy in student's when learning science?

Action Research

This study was an action research study. This means that a problem was identified (low self-efficacy) and measures were then put in place to try and resolve the problem (self-regulatory techniques). The ultimate aim of an action research is to transform and improve one's practice. It is a cyclical process that involves planning, acting, observing, and then reflecting. This can be summarised using a Lewin spiral (see Figure 1), named by subsequent authors after Kurt Lewin, who first coined the phrase 'action research' when looking into how to affect permanent social change and suggested a similar three step method of doing so, through research (Lewin, 1958).

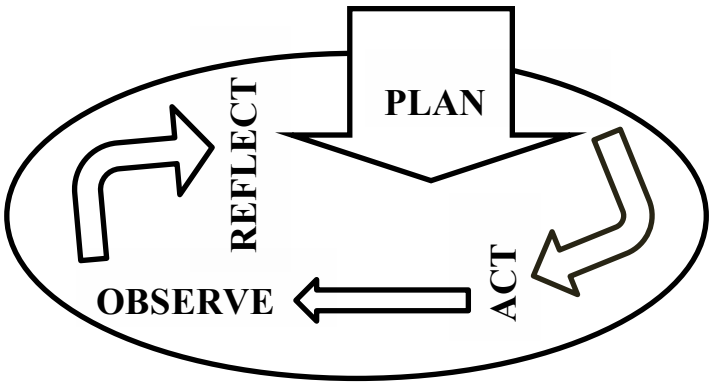

Figure 1: An example of a Lewin spiral used in an action research study (redrawn from Wilson (2013), based on Kemmis & McTaggart (1988))

Many behavioural psychologists, including Kemmis and McTaggart (1988) have since used it to carry out social research. Due to the time constraints of this action research, only one cycle of the Lewin spiral was undertaken. Usually one cycle of a Lewin spiral leads to modification and improvements of practice, using knowledge gained in the previous cycle. Action research is something which teachers do to inquire about their practice, rather than attempting to develop generalisations (Wilson, 2013).

Outline of lessons

The action research study included a series of three lessons covering the Key Stage 3 OCR 'Cells to Skeleton' module to a group of 27 year 7 students (ages 12-13 years). The lessons specifically covered the skeleton, joints, bone marrow and associated diseases.

Each lesson in the sequence took the same format. A brief outline of what students would be learning about that lesson, as well as the key content was delivered for no more than 10 minutes at the start of each lesson. Each student was then given a grid (an example can be found in Appendix 1), in which the learning objectives, and the linked tasks were outlined. Learning objectives were divided into three levels; Bronze, Silver and Gold, with each level increasing in complexity. Each level contained three tasks. The first two provided opportunity for the students to learn and understand the content and the third task provided an assessment-like task for students to assess their learning. Students could decide which level they started on and were free to move between levels.

As well as the students choosing and evaluating their own work, a range of self-regulatory techniques were introduced within the tasks themselves. For example, in lesson 2, task 2 of the silver level, students had to critically analyse a model they had made themselves during task 1. Table 1 shows the self-regulatory techniques that were used in this study (See section 'What is self-regulated learning?').

Data Collection and Analysis

A variety of data collection methods were used in this study. These methods are shown in Table 2, along with the timing of their collection relative to the progression of the study.

Research Question	Data Sources
RQ1 - What is students' self-efficacy in learning science before using self-regulatory techniques?	1- Questionnaires (SRQ-A) 2- Questionnaires (PCS) 3- Baseline observations of student's interactions in science lessons
RQ2- How do students respond to using self-regulatory techniques while studying science?	4- Interview with observer 5- Student feedback questions and Choice of task 6- Student work outcomes
RQ3- How do self-regulatory techniques impact self-efficacy in students when learning science?	7- Repeated Questionnaire (PCS) 8- Movement between levels 9- Interviews with students
Timing 1, 2 and 3 will be collected before self-regulatory techniques are introduced. 5,6 and 8 were collected during the sequence of lessons. 4,8 and 9 will be collected after the sequence of lessons has been completed.	

Table 2: Summary of data collection methods and timing of collection relative to sequence of lessons, as well as the sub-questions they will address

Observations

Systematic observations were used in this action research study, which has its origins within school classrooms. There are limitations with this method, the most obvious of which is that what one observer records as having happened, may be different to another observer. In addition to this, the chances of the observer having boosted sensitivity towards certain signals (in this case possible examples of self-regulated learning) also provide a possible limitation to the use of observations. Having said this, the use of systematically recording data within the lesson should lower the chances of these limitations influencing the findings, and observations still provide a rich source of information, especially when observing students that the observer knows the 'usual' behaviour of (Denscombe, 2014).

Observations were made for a short period of time before and during the sequence of lessons. These observations were made by an observer who looked for evidence of self-regulated learning and any marked differences in self-efficacy among the students throughout the sequence. Zimmerman's (2008) three stages of self-regulatory learning were used as indications that self-regulation was occurring. Student interaction and comments were taken as indications of self-efficacy.

At the end of the sequence of lessons, incidences of self-regulated learning before and after the sequence of lessons were compared for any differences.

Questionnaires

Examples of the questionnaires used can be found in Appendices 2 and 3.

Questionnaires provide a considerable amount of research data in a relatively short period of time, with little difficulty to arrange. Further, all questions are standardised, which means that there is little scope for any data to be affected by the manner in which the question is being asked or interpersonal factors. However, pre-coded questionnaires (such as that used in this action research study) can be frustrating to the respondent. Further, there is no obvious way to check that respondents have been truthful in their answers, which has the potential to 'scew' findings (Denscombe, 1999).

Initially each student was given the Academic Self-Regulation Questionnaire (SRQ-A) to determine whether there was a difference amongst students in both their self-regulation and self-efficacy levels. It has been used in studies before (for example, Grolnick's (1989) work into children's self-regulation and perceived competence at completing school work). It addresses the reasons why school children do their work, and how competent they believe themselves to be at it. Once this was established each student was given a Perceived Competence Scale (PCS) questionnaire to establish starting self-efficacy levels. This is a simple questionnaire with only four questions that aims to assess a student's feelings of competence about being able to master the material in a course. It has been used in past research to assess this in medical students (Williams, 1996). Under the circumstances, and following on from the initial longer questionnaire in which the students became restless and distracted, this short questionnaire was thought to be the most suitable way forward. The questionnaire gives a numerical indication of self-efficacy. This same questionnaire was repeated at the end of the sequence of lessons, to measure any differences in self-efficacy.

The student responses to the questionnaires were recorded and quantified. Scores for self-efficacy of each student were compared before and after self-regulated learning techniques were introduced. The scores were then checked for statistical importance using a two-paired test in the statistical analysis programme, MINITAB.

Student Feedback Questions and Choice of Task

The student feedback questions have similar disadvantages and advantages of that of questionnaires. However, these questions provide 'open-ended' questions, which could deter students from getting frustrated, and perhaps provides an opportunity for students to provide more detailed and insightful answers (Denscombe, 2014).

At the end of each lesson in the sequence, students answered three questions. The questions were the same each time and aimed to understand which tasks students started on each lesson and why, as well as whether they are able to effectively self-evaluate their own learning. The questions, what they aim to address and the relevant research question is outlined in Table 3.

Question Number	Question asked to student	Aim of the question	Research Question
1	Why did you start on this activity?	To understand the thinking of students behind which activity they chose and any possible links to self-efficacy	RQ3
2	Which activity will you start on next lesson?	To understand whether perceived performance in one lesson leads to impacts on self-efficacy for future choice of tasks	RQ3
3	Did you meet the learning objectives?	To understand whether students can effectively self-evaluate their own learning (a key aspect of self-regulatory techniques)	RQ2

Table 3: Questions asked to students at the end of each lesson in the sequence

The responses to these questions were thematically analysed. Common answers, surrounding a central theme, were recorded, as well as any responses that did not fit any of these common themes.

Student Work Outcome

Documentary data (in this action research study, the students work) provide vast amounts of information and are easy to access. They also provide permanent data that can be analysed over a long period of time. However, it requires the observer to interpret what the students, who produced them, are trying to convey and this can be subjective. This is especially the case in this action research study where it cannot always be guaranteed that the students have used the associated self-regulated technique to complete the work (Denscombe, 2014).

Each student had to have completed tasks 'ticked off' by a class teacher before moving on to the next task. This was a way to ensure that students had fully understood the content behind the task and that the task had been completed to a satisfactory standard. This also provided a way to keep track of work and levels completed by the students. Successful work completed using self-regulated techniques in students' books were coded for using red pen.

After the sequence of lessons, the number of tasks completed by each student was recorded, and whether they had used the associated self-regulated learning technique considered.

Interviews

Interviews are similar to questionnaires, in that the data comes from what the students tell the researcher and in this action research study they were in the form of semi-structured interviews. This is where the researcher has a clear list of issues to be addressed and questions to ask but the order in which these topics are covered is flexible. The advantage of interviews is the depth of the information that the researcher receives, as well valuable insights that the likes of questionnaires and observations may not provide. However, the validity of the data that they do provide is not always high. What people say they prefer and what they think do not always reflect the truth. Further, the questions asked and answered given can be affected by the identity of the researcher and in this action research study, the students were familiar with the interviewer (Denscombe, 2014).

5 Students and the observer were interviewed one on one. The students were interviewed for around 10 minutes each and the observer was interviewed for 15 minutes. The students were selected for interview based on their self-efficacy scores before and after the sequence of lessons (using the PCS questionnaire), and whether these had improved or not. Responses to the questionnaires were used to decide this. The interviews took a semi-structured style, whereby there are set questions that must be answered but the order in which these questions are asked, and any further questions based on what students' responses were, differed between interviews. Table 4 shows the students selected for interview and their self-efficacy scores before and after self-regulatory techniques were introduced. The interview with the observer took a more conversational like style with key points being raised and a chance for the observer to comment on anything interesting that was observed. Permission was asked before the interviews took place. Interviews were recorded and all names changed.

Student	Self-efficacy score before lessons	Self-efficacy score after lessons	Difference in self-efficacy scores
Hettie	21	18	-2
Emma	19	19	0
Roan	12	18	+6
Mike	15	22	+7
Eva	10	21	+11

Table 4: The self-efficacy score of students selected for interview

After all of the interviews had been conducted, key themes from the answers were recorded for each individual student, and then all five students together.

Ethical Considerations

The action research study is an attempt at improving student's self-efficacy using self-regulation. This should therefore positively improve student's learning, without any drastically negative impacts. Anonymity was used throughout the study and permission was asked of the school, students, and their parents/guardians. The British Educational Research Association's ethical guidelines for educational research (BERA, 2011) were adhered to throughout.

Validity, Reliability, and Limitations of the Study

This study is looking at how self-regulatory techniques influence self-efficacy in students and there are a range of techniques and data collection methods in which this can be measured. This study uses a range of both quantitative and qualitative data collection methods to provide more than one data set for conclusions to be drawn from. The choice of method used depended on the sub-question that the data was intended to answer (See Table 1, Section 'What is self-regulated learning?'). The use of this integrative logic should provide more valid and reliable conclusions on the impact of self-regulatory techniques on self-efficacy in students. Although the integrative logic behind the study's data collection methods aimed to make the study as valid and reliable as possible, as with all studies, this study also had limitations.

In addition, as students could choose their own level and the tasks associated, it meant that not every student's experience of self-regulatory techniques was identical. For example, a student

carrying out the 'Bronze' level tasks during lesson 1, would not be using the same self-regulatory techniques as a student carrying out the 'Silver' level tasks during the same lesson. Due to this it is difficult to firmly assess which self-regulatory activities are the best at improving self-efficacy.

Finally, as with all educational research, there were external factors that could not be controlled that impacted the research. For example, students not being present for all the lessons, as well as students willingness to participate in lessons.

Findings

RQ1: What is the students' self-efficacy towards learning science before using self-regulatory techniques?

Prior Attainment

As this is the students first year of secondary education prior attainment data is based on primary school achievement and tests upon entry to secondary school. Based on these results, the school categorises the students upon entry into one of three groups. The three groups are 'High', 'Medium' and 'Low'. Those students in the 'High' group are expected to be gaining some of the highest scores in tests amogst the class. Those students in the 'Medium' group are expected to be achieving within the middle range of scores for the class, and those in the 'Low' group are expected to be gaining the lowest scores in the class. The students are not aware of which group they are in. Figure 2 shows the amount of children in each group in the class. Most students in the class fall into the 'High' group (14 students), with only a small number in the 'Low' group (6). This higher prior attainment could indicate some existing self-regulation.

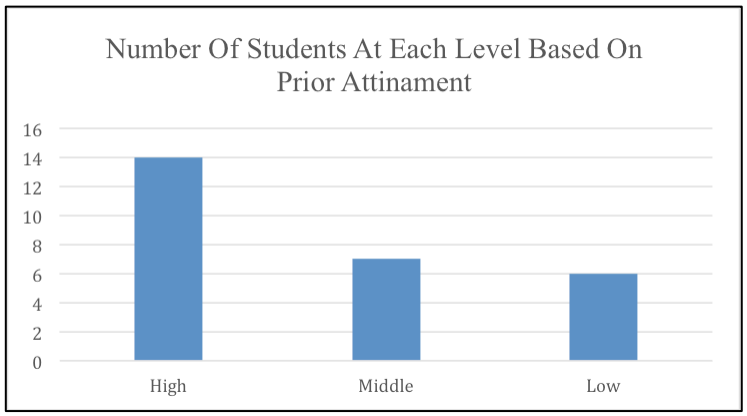

Figure 2: The number of students at each level

Baseline Observations

Most science classes before the study's sequence of lessons consisted of the teacher leading activities and demonstrations. Students then completed one or two activities alone before leaving the class. Based on Zimmerman's (2008) stages, there was little 'Forethought' by students in lessons, largely because content was delivered, directly followed by students completing a pre-prepared task. This was however, usually followed by an episode of 'Volitional control' where students used their newly acquired knowledge in completing a task. Zimmerman's third stage of self-regulation, 'Self-reflection' was evident only when classes went through answers to the set tasks, as a class. Overall, there was little evident self-regulatory learning occurring within the science lessons.

When looking at the students' self-efficacy it was evident, through observation, that there was a range in students' self-efficacy surrounding their science learning. It was often the same few students answering questions and contributing to lessons, with the majority of the class resisting making contributions. From observation it appeared that this was out of fear of getting answers incorrect, which Henry (difference in self-efficacy score: +3) provided some insight into when he exaplained 'People will laugh at you if you get the answers wrong'.

Existing Self-Efficacy and Self-Regulation

Below are the results of the questionare (SRQ-A) used to determine whether or not the class had a range in their self-efficacy and self-regulation (Figure 3). The questionnaire was split into four sections. The first three measured self-regulation, from which an average score was taken, and the last section was used as a self-efficacy measure. Students chose an answer on a scale from 'Very true' to 'Not at all true'. Each response is then given a numerical value, and from this scores estaiblished.

Results for levels of self-regulation ranged from 11 to 27.3 (Series 1 in Figure 3), with an average of 22.3. Results for self-efficacy ranged from 11 to 31, with an average of 23.3 (Series 2 in Figure 3).

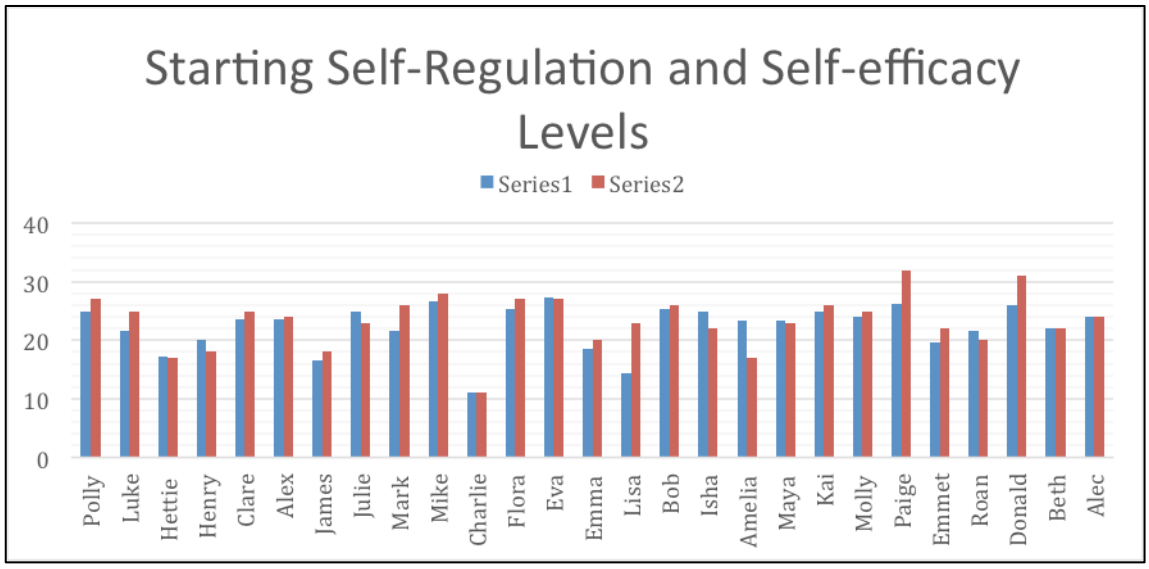

Figure 3: Results of the SQR-A questionaire
which indicate the starting levels of self-efficacy in the students

To summarise the findings for RQ1, which looked at students' self-efficacy prior to self-regulatory techniques being introduced, it is clear that prior attainment for the class was relatively high, which could indicate some existing self-regulation. However, in class observations there was little evident self-regulation taking place. When it came to self-efficacy, observations suggested that there was a range in students' attitudes towards their science work. This was confirmed by the large range in scores that the SRQ-Q quesitonaire measured (11 to 27.3). This would indicate that within the study class, the students had a range in starting levels of self-regulated learning and importantly, also a range in self-efficacy towards learning science.

RQ2: How do students respond to using self-regulatory techniques while studying science?

Observations

Delivery of the key concepts surrounding the science that the students had to learn enabled students to more confidently get on with tasks independently. Once this had been delivered, students mostly got on with their chosen tasks quickly. By the third lesson all students knew the format well and lessons ran smoothly. This increase in student's confidence in what to do within the lessons was evident through the amount of questions asked by students. In the first lesson, many students asked exactly what it was they had to do, whereas by the final lesson there were only one or two students asking for this information.

When looking for Zimmerman's Forethought phase, there was not much evidence for students having pre-prepared any material or having read up on any of the topics (they were informed what they would be before the lesson). When asked, students were unused to this idea and it became obvious that unless it was set as compulsory homework, it was not something they would think of doing.

When looking for Zimmerman's Volitional control phase, it was interesting to find that, students who often caused disruption to the usual lesson format, were more willing to get on with their chosen tasks, and required less intervention during the lesson for behaviour related disruption. For example, Roan, a student who usually needs frequent behaviour related intervention, needed little intervention in this sequence of lessons. By lesson 3, the only intervention that was needed was in the start of the lesson in retrieving a task. Students also often discussed work with other students in the class and were more frequently asking other students for help. For example, I found that by lesson 3, compared to lesson 1, students asked me, as the teacher, less questions about the content, and when they did, they often came in pairs because one student had asked the other student and then when neither could answer, they would ask me for guidance.

Lastly, looking for Zimmerman's self-reflection phase, when students were asked how they were doing on a particular task, most gave responses that included some indication of self-evaluating their work. However, this was not often in depth with responses being like that of James (difference in self-efficacy score: 0), when he was asked how his work was going during lesson 2, replied 'It is OK miss, I have done task one and now I am almost done with task 2'.

Students were also given the opportunity to self-evaluate their learning at the end of each lesson via questioning, answers to which are detailed later (See section 'Student Feedback Questions').

Overall, when compared to the baseline observations, students were more willing to get on with the tasks in this sequence of lessons. There were less behavioural interruptions and students were more likely to ask other students for help.

Student Feedback Questions

Students were asked to self-evaluate their work at the end of each lesson (a key component of Zimmerman's (2008) self-regulated learning). This was question 3 (See Table 3, section 'Student

Feedback Questions and Choice of Task') which asked the student 'Did you meet the learning objectives?'.

Within the answers, timing was raised as an issue for students' not meeting learning objectives. Julie (difference in self-efficacy score: -3) provided some insight into this when assessing her work in lesson 2 by stating 'I did not meet the learning objectives this lesson because I could not get all three tasks done. The lesson was too short'.

The students then did not evaluate whether they had met any of the learning objectives by completing one or two of the tasks. Instead they focused on their inability to finish all tasks as a failure.

The answer that was second most common (8 responses) was a judgement by the student as to whether they found the tasks they had done that day hard or not, rather than whether they had met the learning objectives of the lesson.

Although almost all students self-evaluated their work at the end of the lesson, there was great discrepancy in how well this was done. A lot of students simply stated yes or no. There were only 8 cases, throughout the sequence, where students referred to the given learning objectives and judged whether they had met them and provided insight into how they had or had not. Only Eva did this consistently at the end of each lesson in the sequence.

Students work outcome

In lesson 1, 75% of students successfully completed the level they started on and therefore used the corresponding self-regulatory techniques. In the remaining students, although they did not complete the level, 93% of them used self-regulatory techniques to complete the tasks.

In lesson 2, 68% students successfully completed the level they started on, and therefore used the corresponding self-regulatory techniques. 100% of those students that did not complete a level, still used self-regulatory techniques in the tasks that they did complete.

In lesson 3, 85% students successfully completed the level they started on and used the associated self-regulatory techniques. 96% of those students that did not finish a level still used self-regulatory techniques in the tasks that they did complete.

To summarise the findings for RQ2, which looked into how students responded to using self-regulatory techniques in science work, there was no evidence of forethought by the students when it came to their science work. However, there was evidence of a good amount of Zimmerman's (2008) volitional and control phase. Students were less disruptive and more often asked other students for help and assistance in completing tasks. When it came to self-reflection, most students did not go into much detail when evaluating their work and scarcely referred to learning objectives. Notably, time was raised as an issue, with students who failed to complete all three tasks in a level, quickly assuming this was a failure in their science learning. Most students did, however, complete tasks using the accompanying self-regulatory techniques, even when not able to finish all three tasks in a level.

RQ3: How do self-regulatory techniques impact self-efficacy in students when learning science?

Questionnaires

A questionare (PCS) was given to the students before and after the sequence of lessons. This gave numerical representations of the self-efficacy of the students. The changes in self-efficacy in students are shown in Figure 4. The average starting self-efficacy score was 16.63 and the average self-efficacy score after the sequence of lessons was 19.9. The average difference was an improvement of 3.26 (with a range of -3 to 11). Only three students had negative self-efficacy scores. The highest improvement in self-efficacy was shown in Eva, with a sccore of +11 and Hettie and Julie experienced the biggest negative impact on their self-efficacy with a score of -3. The data was tested for a statistical difference using a paired t-test, in MINITAB. Significance was found (p-value <0.001, T-value = 4.56), with a high level of confidence (95%). It is therefore with confidence that it can be presumed that a real difference in self-efficacy was found before and after the sequence of lessons involving self-regulatory techniques.

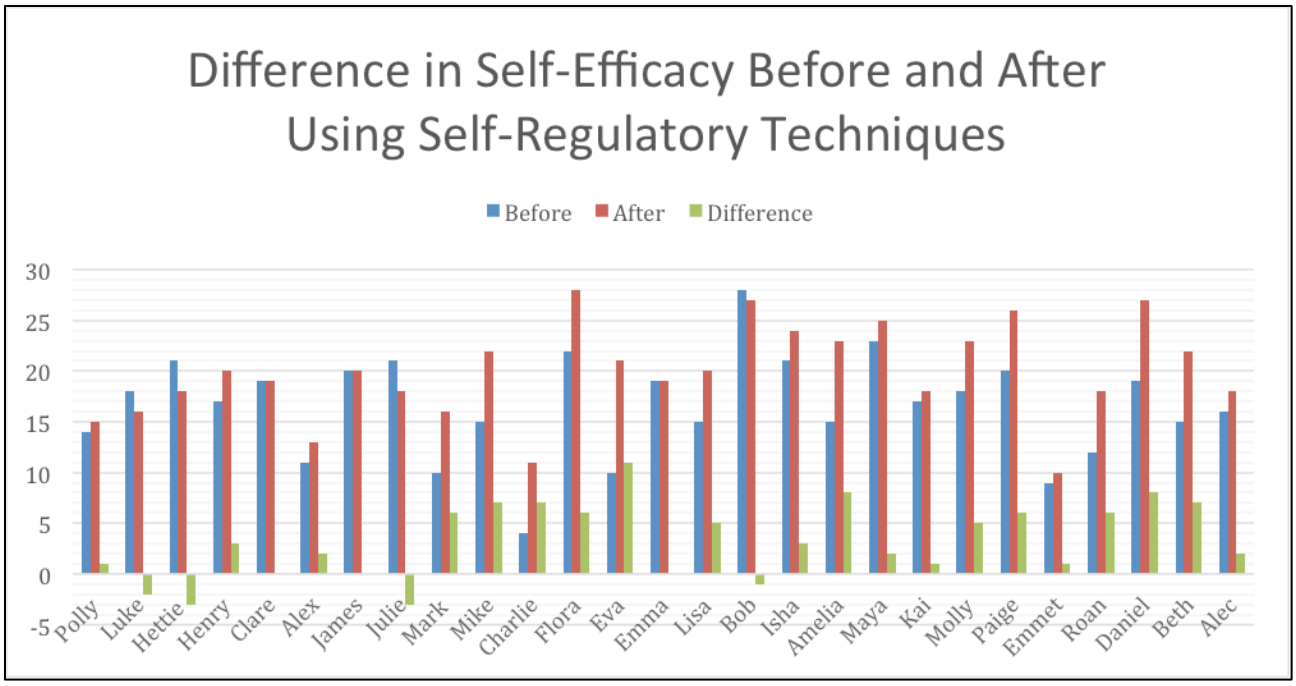

Figure 4: Self-Efficacy scores before and after the sequence of lessons using self-regulatory techniques, with differences

Hettie, who got one of the largest negative impacts on self-efficacy, along with Julie (both with a difference in self-efficacy score of -3), was test-orientated and asked often about what she needed to understand to get marks on a test, again reiterating this point in her interview when she commented that 'I think I could improve in science to get extra marks in my tests'. This, along with the data, could indicate a low self-efficacy and perhaps low self-regulation, as work by Lin and Tsai (2013) indicates. However, it is also important to point out that although Hettie had one of the largest decreases in self-efficacy among the group, she also had one of the highest starting (and ending) measures of self-efficacy at 21 and 18 respectively. So, although she had a decreased self-efficacy, her final score was still fairly high in the group.

Eva, who had the biggest improvement in self-efficacy (+11), was observed, before this sequence of lessons, to be a quiet girl who rarely participated in class discussions and was worried when she got answers wrong. This changed over the sequence of lessons in the study. Eva was more willing to ask questions and participate in lessons where self-regulatory techniques were being used. When asked about this during an interview Eva explained that she 'liked choosing the level and working through it'on her own, in her own time'.

Student Feedback Questions

Students were also asked why they chose to start on the level they did each lesson (Question 1. See Table 3, section 'Student Feedback Questions and Choice of Task'). Responses to this question surrounded three main themes. The first, and most common, is described in Eva's answer at the end of lesson 2 which simply stated, 'I wanted to challenge myself'. Eva gave this answer after she had finished the silver level, having finished Bronze the lesson beforehand.

The second was that they thought the others were too difficult for them to complete, as Luke described at the end of lesson 1, by answer that 'the rest were too difficult', after completing the bronze level.

The last theme for responses was that they thought a certain level was a level suited to their ability. Charlie, after having completed the silver level at the end of lesson 1, responded that he had chosen that level because 'the level was right for me'.

The only obvious change in these responses across the lesson sequence, was that the number of students wanting to challenge themselves increased between lessons.

Students were also asked which level they would start on in the following lesson and why (Question 2. See Table 3, section 'Student Feedback Questions and Choice of Task'). When looking at the students' responses to the question, a vast number of students only put the next level and no reason as to why (the movement between levels is detailed later in the report. See section 'Movement between levels'). However, when students did give a reason as to their choice, the most common answer was because they had done that level in the current lesson and felt it the correct level for them, as Roan (self-efficacy score: +6)) answered in lesson 3, when he explained that he had done the silver level tasks because 'it seems the right level'.

The next most common answer was similar to the most common answer to question 1, that the students wanted to challenge themselves. This is important, arguably more so then the movement between levels, because it suggests that students were experiencing increases in their self-efficacy, as they wanted to challenge themselves and so, presumably, had the self-efficacy to believe that they could tackle more challenging science work.

Movement Between Levels

Figure 5 shows how students changed between levels each lesson. It compares which level the student started on in the first lesson of the sequence and which level the students chose in the final lesson. 13 students moved up a level over the sequence, which makes it the most common movement. 10 students stayed on the same level and 4 students moved down a level. Overall movement was never between more than one level below or above.

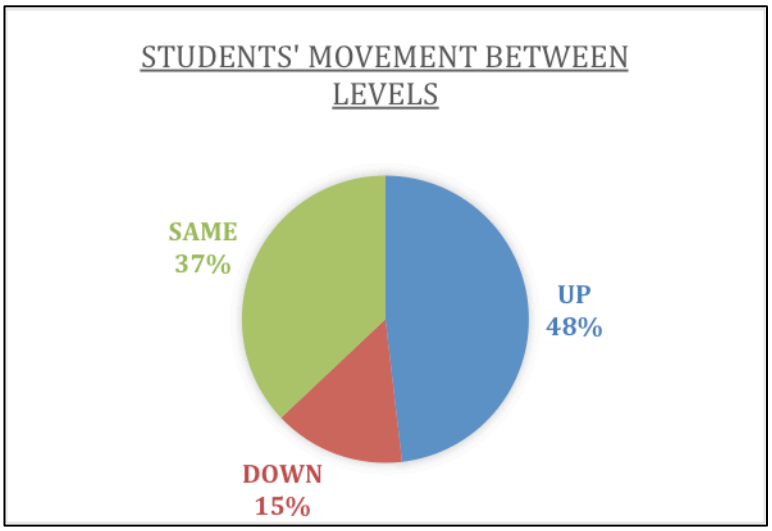

Figure 5: Students movement between levels during the sequence of lessons

This overall positive movement between levels strongly suggests that the sequence of lessons, and thus self-regulatory techniques did have an impact on the students' self-efficacy. Students moving up levels were possibly experiencing increases in self-efficacy, which was indicated by Mike (difference in self-efficacy score: +7) in his interview when he recalled 'I was really good at the silver and it was too east, so I did the gold the next lesson'.

To summarise the findings for RQ3, which looked at how self-regulatory techniques impacted self-efficacy in students, overall students' self-efficacy scores significantly increased, with only 3 student's self-efficacy scores decreasing. Out of the three students whose scores did decrease, two of them still had some of the highest self-efficacy scores overall. This overall increase in self-efficacy is supported by the positive movement of students between levels, with most moving up 1 level through the sequence of lessons. The common explanation of wanting a challenge could indicate positive self-efficacy also. Having said this, no students moved up two levels, from Bronze to Gold during the sequence of lessons.

Discussion

Key Findings

Overall, self-efficacy was significantly raised in the students and students adopted an increased use of self-regulatory techniques over the sequence of lessons in this study, when compared to levels before the study. The students cited wanting to challenge themselves as a key decider in their positive movement between levels, and timing as an issue when it came to finishing levels. However, those tasks that were completed were often done so using self-regulatory techniques. There was a notable increase in students seeking guidance from peers, as well as a decrease in disruptive behaviours. However, not all students successfully evaluated their own learning, often not going into sufficient detail.

Impact of findings

This study has provided evidence towards self-regulated learning having a positive impact on self-efficacy levels in students while learning science. This is shown through an increase in the average self-efficacy score of +3.26. Self-efficacy may be key to student success and any way in which this can be increased could lead to increased academic performance in students and achievement in learning science.

A key example of the impact of increased use of self-regulated learning techniques on self-efficacy in this study, is through the student, Eva. Eva had the largest increase in self-efficacy (+11), and was also the only student to consistently self-evaluate her work after each lesson. Before the sequence of self-regulatory lessons Eva was noticed to be a quiet student who rarely participated in lessons. Although her participation in class discussions did not noticeably increase, the amount of work she completed did increase noticeably. In interview, she mentioned that being able to do her work at her own pace meant that she felt more able to complete work. For students, like Eva, the use of more self-regulated techniques in lessons could provide a basis for improved academic achievement and self-efficacy.

Although previous research has indicated a link between self-regulation and self-efficacy, most of this research was carried out with students in their later years of secondary education, or students undergoing higher education, whereas this study focussed on year 7 students, at the start of their

secondary education. Securing increased levels of self-efficacy during lower years could provide students with positive attitudes towards their own learning, that they then take with them throughout their secondary education, including examination years. Understanding how these increased self-efficacy levels can be obtained, such as through self-regulatory techniques, provides the basis of raising student's self-efficacy levels. This study has provided evidence towards this.

In this class of 11-12-year-old students, most indicated wanting to challenge themselves, which possibly provided the basis for wanting to move up levels, and simultaneously gain a deeper understanding of the science they were learning. Installing this mind set from an early age could, again, provide a good grounding for later years in education. This study also provided evidence suggesting that even though these students are younger then when most previous research into installing self-regulatory techniques has been carried out, the students can complete the tasks using the techniques to a good standard (over 90% in each lesson).

Implementing the idea of teaching younger students how to learn, particularly those in Key Stage 3 (years 7-9) was the aim of a three year-long study at 'Sea View' school in the south of England (James and Neil, 2016). The study found that by teaching the students how to learn and including self-regulated techniques, closed attainment gaps and saw students often exceeding their targets. This study, along with the findings of this action research study suggest that perhaps using self-regulated learning techniques could have major positive impacts on younger students learning, leading into success in later years.

Relationship of Findings to Other Studies

Both self-regulation and self-efficacy have been studied in detail, especially over recent years and this study aimed to support and provide more knowledge into these areas. These studies include that of Lin and Tsai (2013), who found that those with exam-orientated mindsets, are less likely to use self-regulatory learning techniques and be more dependent on teachers. This study could provide more evidence towards this idea, through the example of Hettie, who had a decrease in self-efficacy of -3, a low commitment to using self-regulatory techniques and was also extremely test-orientated.

When investigating self-regulation and self-efficacy, Bouffard-Bouchard et al. (1991) concluded that those students who had increased persistence, had increased levels of self-evaluation. However, also noting that in some cases, students who worked quicker could be mistaken for students with a

lack of persistence, and vice versa. In this study one of the biggest feedback points from students when it came to evaluating their own work was the issue of timing. Using Bouffard-Bouchard, et al.'s work (1991), it could be suggested that if in this study, students were given a longer period of time to complete tasks, this could have had impacts on their levels of evaluation and perhaps therefore their overall levels of self-efficacy.

The students in this study were mostly high achievers, having achieved high results upon entry to the school and in previous tests at primary level. The results of this study could therefore add to the work of Lin and Tsai (2013) who found that high achievers tended to use more self-regulation. Although the students did not provide much evidence for self-regulation before the sequence of lessons, they quickly adopted the techniques, with over 90% in each lesson using them successfully. Nevertheless, the students did not adopt the self-regulatory aspect of forethought before their lessons, and there was little evidence that the students, although largely high achievers, could effectively self-evaluate their learning.

The findings of Kingir et al. (2013), led them to suggest that having more self-regulation in lessons could improve student's interest in their work. This study could provide evidence of this as students completed a noticeable increase in work during lessons, and were observed to be keen to start choosing their tasks and get on with completing them quickly. The students interest in their own work was also evident in those students who were previously often disruptive to lessons, needing less intervention during the self-regulatory sequence of lessons in this study.

Finally, Lee et al. (2016) provided evidence that self-efficacy was directly linked to academic achievement, and that self-regulation was indirectly linked to academic achievement. Although this study did not directly look at academic achievement, in terms of grades as Lee et al. (2016) did, it did find a link between self-regulation and self-efficacy. Using Lee et al.'s (2016) work, alongside the findings of this study, it is possible to suggest that an increase in self-regulation could lead to an increase in self-efficacy, which in turn could lead to an increase in academic achievement. However, further research would have to be undertaken to confirm this link between self-efficacy, self-regulation and attainment.

Alternative Explanations

Although this study hopes to provide evidence towards self-regulatory techniques enhancing self-efficacy, there are of course alternative explanations for some of the findings. Firstly, it is important to note that this is one class, in one school and that the findings of this study may not be applicable to all educational settings. For example, the students in this class happened to be mostly highly achieving, an indication of a tendency to be able to self-regulate well and having increased self-efficacy levels to begin with. This study's findings of increased self-efficacy due to increased self-regulation may not have been found in a class of mostly lower performing students.

In addition to these alternative explanations is the novelty aspect of the lessons. The students had not had lessons in this format before and so were keen to take part. Their willingness and commitment to the sequence of lessons could have had impacts on their learning. It could be that after a longer sequence of this lesson format, students would have become less interested in their learning and their self-regulation, and with it their self-efficacy could start to decrease.

Implications for Research

Although this study has aimed to provide evidence towards the use of self-regulatory techniques in enhancing self-efficacy, it has raised questions of its own. Firstly, this was a short sequence of lessons and so cannot account for what would happen to students' self-efficacy after using self-regulatory techniques over a longer period of time. Further research into the long-term impacts of self-regulation on self-efficacy would provide this insight.

Further, this study did not include all aspects of self-regulation (see Table 1. Section 'What is self-regulated learning?'). Further research could investigate the value of including all aspects of self-regulation, and its impacts on self-efficacy. More precisely, it could study which specific aspects of self-regulation have the most significant impact on self-efficacy. This study also did not find a robust and significant way to increase student's self-evaluation skills. Self-evaluation, being one of the most important parts of self-regulation, could have positive impacts on self-efficacy and so investigating ways into increasing self-evaluation skills would be beneficial.

Finally, this study did also not conclusively determine the impact of using self-regulatory techniques on students' academic achievement, specifically in examination scores. Further research

could focus on this aspect of using the techniques, and aim to provide evidence as to how using these techniques impacts the examination of students and attainment outcomes.

Conclusion and Implications for Practice

This action research study has provided evidence towards the value of using self-regulatory techniques in the classroom, with the aim of increasing self-efficacy levels in students. On this basis, it would be advised that teachers aim to include more of these techniques, to the benefit of their students. When considering the use of self-regulatory techniques, teachers may find it valuable to consider the prior academic achievement of their students as well as their baseline self-efficacy levels. The use of self-regulated techniques could also provide students, who are often disruptive to lessons, a way to learn that minimises their behaviour related interventions. Using self-regulated techniques could also increase the likelihood of students learning from one another, as well as providing students with little confidence, a learning environment that increases their self-efficacy and thus their learning experience.

However, although this research provides a basis for the recommendation of using self-regulatory techniques in the classroom, the results of this study are only truly applicable to the class of students involved. Although some of the techniques used, and their effect on the students, were positive, it is important to note that that does not conclusively mean that they will have the same impact on all students. Further, this research used a range of self-regulatory techniques, whereas further investigations may want to focus on a particular aspect that has the most impact on increasing self-efficacy levels in a particular group of students. In addition to this, further research into the long- term impact of using self-regulatory techniques could be valuable in truly understanding their impact on self-efficacy in students.

When it comes to my own teaching practice, I will endeavour to include more self-regulatory techniques, with the aim of improving my students' self-efficacy. However, I will ensure to take into consideration the students' prior academic achievement, as well as taking into account each classes individual learning needs. This action research was carried out with one class, and I think it is importatnt to continue to carry out similar work with other classes and apply the results to my teaching, with the aim of improving academic achievement in that particular class. This will

hopefully make me more aware of how my students learn best, and how best I can support them to fulfull their academic potential.

As made clear, this study was an action research and another cycle would have been carried out if it was not for time restrictions. Using these results I would prioritise investigating how the students' self-efficacy would be impacted if they were to evaluate their own learning successfully, while also paying attention to how this impacted on the levels of disruptive behaviour and whether students continued to seek guidance from peers. I believe that this would provide insight into whether evaluating learning is a key component of self-regulated learning tehcniques, in terms of inproving self-efficacy, while also looking at whether the short term benefits of the self-regulated learning techniques were upholded. Trying to also minimise time restrictions would also be beneficial however, perhaps not possible in a school setting.

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Appendix 1

An example of a learning grid given to all students. This grid is from Lesson 1.

BRONZE LEARNING OBJECTIVE: Describe why we have a skeleton and what a joint is	**SILVER** LEARNING OBJECTIVE: Explain how a joint works	**GOLD** LEARNING OBJECTIVE: Describe the major different types of joints, with an example of each, and explain how they work
TASK 1: Complete the word fill	TASK 1: Complete the word fill on the 'Joints' worksheet	TASK 1: Complete the worksheet titled 'Joints of the body'
TASK 2: Label the diagram of a skeleton and the questions on the worksheet	TASK 2: Complete the worksheet 'Muscles and moving'.	TASK 2: Complete the worksheet titles 'Joint Tissues'
TASK 3: Complete the word fill on the 'Muscles' worksheet	TASK 3: Make a model joint and complete the accompanying sheet.	TASK 3: Make a model joint and write down any problems or flaws you can find with the model. (i.e how is it not like a real life joint?

Appendix 2

SRQ-A Questionnaire

The SRQ-A questionnaire given to all students before the sequence of lessons. The questionnaire aims to measure existing self-regulation and self-efficacy. Students could circle one of the options as an answer.

WHY I DO THINGS

Name: _____ Age: _____

Grade: _____ Boy or Girl Teacher: _____

A. Why do I do my homework?

1. Because I want the teacher to think I am a good student.

Very true Sort of true Not very true Not at all true

2. Because I will get in trouble if I do not.

Very true Sort of true Not very true Not at all true

3. Because it is fun.

Very true Sort of true Not very true Not at all true

4. Because I will feel bad about myself if I do not do it.

Very true Sort of true Not very true Not at all true

5. Because I want to understand the subject.

Very true Sort of true Not very true Not at all true

6. Because that is what I am supposed to do.

Very true Sort of true Not very true Not at all true

7. Because I enjoy doing my homework.

Very true Sort of true Not very true Not at all true

8. Because it is important to me to do my homework.

Very true Sort of true Not very true Not at all true

B. Why do I work on my science work?

9. So that the teacher would not yell at me.

Very true Sort of true Not very true Not at all true

10. Because I want the teacher to think I am a good student.

Very true Sort of true Not very true Not at all true

11. Because I want to learn new things.

Very true Sort of true Not very true Not at all true

12. Because I will be ashamed of myself if it did not get done.

Very true Sort of true Not very true Not at all true

13. Because it is fun.

Very true Sort of true Not very true Not at all true

14. Because that is the rule.

Very true Sort of true Not very true Not at all true

15. Because I enjoy doing my science work.

Very true Sort of true Not very true Not at all true

16. Because it is important to me to work on my science work.

Very true Sort of true Not very true Not at all true

C. Why do I try to answer hard questions in science?

17. Because I want the other students to think I am smart.

Very true Sort of true Not very true Not at all true

18. Because I feel ashamed of myself when I do not try.

Very true Sort of true Not very true Not at all true

19. Because I enjoy answering hard questions.

Very true Sort of true Not very true Not at all true

20. Because that is what I am supposed to do.

Very true Sort of true Not very true Not at all true

21. To find out if I am right or wrong.

Very true Sort of true Not very true Not at all true

22. Because it is fun to answer hard questions.

Very true Sort of true Not very true Not at all true

23. Because it is important to me to try to answer hard questions in class.

Very true Sort of true Not very true Not at all true

24. Because I want the teacher to say nice things about me.

Very true Sort of true Not very true Not at all true

D. Why do I try to do well in science?

25. Because that is what I am supposed to do.

Very true Sort of true Not very true Not at all true

26. So my teachers will think I am a good student

Very true Sort of true Not very true Not at all true

27. Because I enjoy doing my science work well.

Very true Sort of true Not very true Not at all true

28. Because I will get in trouble if I do not do well.

Very true Sort of true Not very true Not at all true

29. Because I will feel really bad about myself if I do not do well.

Very true Sort of true Not very true Not at all true

30. Because it is important to me to try to do well in science.

Very true Sort of true Not very true Not at all true

31. Because I will feel really proud of myself if I do well.

Very true Sort of true Not very true Not at all true

32. Because I might get a reward if I do well.

Very true Sort of true Not very true Not at all true

Appendix 3

PCS Questionnaire

An example of the PCS questionnaire given to students both before the sequence of lessons and after. It aims to measure self-efficacy.

What do I think of my science learning?

1	2	3	4	5	6	7
Not at all			Somewhat True			Very True

1. I feel confident in my ability to learn science. ☐
2. I am capable of learning the material in science. ☐
3. I am able to achieve my goals in science. ☐
4. I feel able to meet the challenge of performing well in science. ☐