

## ECAD6010-7004: Researching the Learning

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Research Question: How does physical engagement aid students' development of conceptual modelling in Physics?

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|--------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------|
|                    | Targed/Target                                                   | Yr hyn yr wyf wedi'i wneud yn yr aseiniad hwn.<br><br>What I have done in this assignment. |
| Targed/Target<br>1 | To seek support from Student Services regarding the assignment. | Have adhered to advice given to me by student services.                                    |
| Targed/Target<br>2 | Limited Variety in Sources                                      | I have tried to include sources from various aspects of education.                         |
| Targed/Target<br>3 |                                                                 |                                                                                            |

## ECAD6010-7004: Researching the Learning:

### Aim, Focus, and Purpose of the Research:

As a teacher, research into education and learning is very important if you want to improve the effectiveness of your practice. Collaboration in teaching is an important aspect of it that cannot be overlooked if you are seeking to improve. The issue that interested me was whether including physical aspects to physics lessons; actually getting up and moving around to model a concept, aided in the understanding of the pupils in a mixed ability class or not. This was researched collaboratively with another student-teacher via the method of lesson study.

The first lesson study was carried out on a class of year 8 pupils (12-13 years old) where refraction of light was the concept being physically modelled; the second study was of a year 9 class (13-14 years old) where the concept was the flow of electricity around a circuit. The aim of the lesson study decided upon collaboratively between the two practitioners of this study (us as the student-teachers of the respective classes) were to answer the research question; 'How does physical engagement aid students' development of conceptual modelling in Physics?'. For my class, the class learning about refraction, this meant splitting the lesson up into two parts; a theoretical explanation and a practical explanation of the refraction of light. There were three points in the lesson where knowledge was assessed through three differentiated versions of the same question sheet; the beginning as the starter, the middle (between the theoretical and practical explanations), and the end covering the plenary. Following the lesson study, four pupils that consented to being part of the research who represented the mixed ability range of the class remained behind to take part in an informal group discussion evaluating the lesson.

### Overview of the Literature:

Educational research can be beneficial to not only the teachers, but to everyone who is involved in pupil's education. As with any social research however, it does not come without risks to the participants. As researchers, we must weigh up the potential costs and benefits that could occur during social research and decide whether the costs are outweighed by the benefits in order to move forward (Cohen et al, 2018). In doing so, the research becomes more informed and defined. Lesson study is a form of social research that can have many benefits for the people involved in it due to its collaborative nature. For teachers it gives them an informative insight into the learning that is actually taking place rather than what is assumed (Dudley, 2011). This is particularly useful when it comes to designing lessons and the scaffolding being put in place to support a pupil's learning from one stage to the next. There are however problems with educational research, and lesson study in particular; due to the time demands that are placed on teachers, they often have difficulty allocating the time needed for the full evaluative process of lesson study research (Mackintosh, 2016). This is particularly apparent in the secondary school environment where meetings are often allocated to any free time a teacher might have during the day, restricting the time they have to develop their own teaching practice. For lesson study, or indeed any other educational research a teacher might undertake, to be effective and beneficial in its outcomes time must be allocated for them; otherwise it just becomes another tick in the box of standards teachers must adhere to, and the benefit of the collaborative aspect is lost. The need for allocated collaboration time in a teacher's timetable is also backed up by a study investigating how to improve the continuing professional development of secondary teachers (Akinyemi et al. 2019).

Research needs to be an integral part of a teacher's role if teaching and learning is to become more effective. Often teachers are thought of as separate from researchers in their roles as practitioners

which has subsequently caused a divide between the two communities. The divide seems to have an emphasis on what is different between the researchers and practitioners rather than what is similar; researchers have seen teachers as defensive and of limited understanding when it comes to taking criticism whereas teachers have seen researchers as arrogant and unappreciative of the context in which they are researching and recommending change (Robinson, 2003). It has had a completely negative impact on how the two view each other's roles when in fact, they are both striving for the same thing; trying to work out what are the best methods for improving the learning taking place in a classroom. According to Donaldson (2015) in the 'Successful Futures' review, as teachers we are trying to make the younger generation ambitious, capable learners who are able to research and critically evaluate their findings. With this in mind, teachers and researchers must start to build positive relationships for the betterment of education as a whole in Wales.

Looking at the research question posed in this study, the type of instruction being used is model based. By this I mean to use relevant examples to help support, develop, and build upon model's pupils mentally create in order to understand and explain some concept in science. The benefits of this type of learning are that it improves a pupils conceptual understanding first off, but also their critical thinking and inquiry skills in science (Shen et al, 2013). This aligns with Donaldson's view for the curriculum of making ambitious and capable learners (Donaldson, 2015). Relating to the concepts themselves being taught; refraction of light and electric circuits, they are both quite abstract in terms of the understanding that is being portrayed. Models exist for teaching abstract concepts such as these, but those in the literature seem to be quite ineffective, especially for electric circuits (Hart, 2007). Due to the findings in the literature, we have attempted a different method using physical activity to try to support pupil's understanding of the concepts of light refraction and electric circuits.

### Lesson study design:

Research in education is a vital part of improving pupils learning in the classroom. It allows us, as teachers, to assess ways in which we could be helping to improve the learning experience of each individual. There are many ways in which research in the classroom can be carried out, but the method used in the research referred to in this study was a lesson study. This was carried out by two people from two different secondary schools within the same county, each observing one another for one lesson. Whilst one was delivering the lesson carrying out the activities needed for the research, the other observed the lesson focusing on 3 – 4 individual pupils that were representative of the ability range in the class. An informal group discussion was then held following the lesson with the individuals that were focused on during the lesson to assess how it went.

Lesson study as a method of research has both positive and negative aspects to it. If there is only one or a few lessons being observed during the research, it means that you only capture that class as they were on that lesson at that time of the day. When used ineffectively, lesson study can create an unnecessary amount of work for the teacher being studied without reaping the potential benefits it can bring (Teacher Development Trust, 2017). It is the teacher of the class being observed that gains the most benefits from the concluding research of the practice of lesson study if done effectively. This is due to the collaboration that comes with having two teachers involved in the processes of the reflection and evaluation of the lesson and subsequent planning for future lessons (Carroll, 2013). The observer can focus on the learning of certain individuals within the classroom while the teacher is able to focus on the learning of the whole class. The observer then feeds back to the teacher following the lesson allowing the teacher to see how they can improve their lesson based on how effective the learning was during the observed lesson. It brings the focus more directly on the

improving the learning experience of the individuals which in turn improves the effective practice of the teacher.

The data that comes from a typical lesson study, and indeed the lesson study referred to in this essay, consists of the observational notes of the observer, the reflection shared between the observer and teacher, and the responses of an informal group discussion between the teacher, observer, and pupils that encompass the range of abilities in the class. The observational notes take the form of observations about how engaged in the lesson specific pupils appear to be in terms of staying on task and their participation in the lesson. The reflection is a shared process between the observer and teacher, informing the teacher of how engaged the specific pupils were and identifying potential ways in which this could be improved. The informal group discussion further informs the teacher through pupil voice about how effective the lesson was from their point of view. By focusing on the relationship between what the pupils learnt and what content was taught during the lesson, we as teachers hope to improve the understanding gained during a lesson (Cheung and Wong, 2014).

Looking more in detail at the reflection process used following the lesson study, this was modelled on Gibbs' model of reflection (Gibbs, 1988). It is comprised of 6 stages of reflection; a description of the learning experience; feelings and thoughts about the experience following it; an evaluation of it giving both positive and negative outcomes; an analysis of the experience and situation as a whole; a conclusion about what was learned as a practitioner and what could have been improved; and finally an action plan for how to improve future practice (The University of Edinburgh, 2019). In the case of this study the experience refers to the observed lesson, and future practice refers to how to improve the attainment of learning with respect to what is taught in future lessons. An advantage of following Gibbs' cycle of reflection is that it is quite a broad, all-encompassing way to look at a learning experience; it considers the general feelings of the practitioner with relation to the experience as well as a critical evaluation of it with steps of how to improve it for next time in quite a systematic way (UK Essays, 2018). This however only focuses on the practitioner. Gibbs' reflective cycle coupled with the informal group discussion, due to its focus on the pupils rather than the practitioner, can become a very powerful and informative tool for improving effective practice in relation to teaching.

The Informal group discussion between the teacher, observer and pupils is an integral part to the reflective practice of lesson study. It eliminates the biased nature of the reflection due to its consideration of all parties and their views on how the lesson went in an ethical environment where everyone is able to speak their mind openly without being guided through questioning. Also due to the nature of group discussion, it is an immediate action that will indirectly improve future practice as it will be a driver for engagement of the pupils in the future (Promethean, 2019); so it has immediate benefits for both the reflective process of the practitioner and the future learning of the pupils. Another aspect of the lesson that the informal discussion addresses is the difference in understanding gained by the different ability groups within the class. This provides us as teachers with valuable qualitative data on how to make classroom differentiation more effective for all individuals.

### Ethical Considerations:

Talking more on the ethics side of lesson study as a form of research, decisions of how to perform the research must all be based on ethical grounds. This includes doing things like anonymising all data collected during the research; ensuring that none of the data collected has become biased, through leading questions in the informal group discussion for example; ensuring the data is stored

in a secure location, and used only for the purpose of the research question posed in this study. This also includes recognising the right, that individuals involved in the study have, to refuse consent to the research at any point (BERA, 2018). This allows for the research to not be swayed by the behaviour of pupils during the lesson study that may come as a result of being told to take part in the research rather than being given the choice. Also giving them this choice in the research seems to be beneficial for their cognitive performance (Cole and Sengchannavong, 1998).

### Lesson Study 1: Results and Analysis:

Lesson study 1 refers to the observed lesson study containing the physical activity that demonstrated the refraction of light. The lesson goals for the pupils were to understand that light slows down and bends as it passes through objects that are transparent or translucent. Assessment of the achievement of these goals was done through three differentiated worksheets; each very similar but building upon the previous one with an extension task for the more able pupils. The first worksheet proved nearly impossible for them to answer which showed they had no previous knowledge of light refraction, but by the end of the lesson most were able to complete the final worksheet correctly, showing an improvement in understanding.

In terms of the running of the lesson, it was split into a theoretical explanation of the refraction of light and a physical activity to demonstrate it. The theoretical explanation involved a car that slows down as it crosses into mud; if it crossed at an angle, it meant that one side of the car would slow down first causing a slight change in direction which was then corrected as it passed out the other side of the mud. This was also the basis for the physical activity which took place outside; the pupils were split into three groups of five, holding hands in a line and made to cross a boundary (a marked line on the floor) after which they slowed down to half their speed. By coming in at an angle, this caused them to slow down one by one subsequently changing the direction they were all travelling in. The physical activity could have been improved if there had been a demonstration by the teachers of how to cross the boundary and slow down as there seemed to be a lot of confusion with how to do this for the last group of pupils. It could also have been that the instructions of what to do were unclear to all the pupils so a demonstration would address this aspect too. Once the pupils came back into the room from the physical activity and settled, they seemed much more engaged in the work which could have had an impact on how they answered the last worksheet.

The data gathered via the informal group discussion following the lesson revealed an interesting difference between the ability groups. From the pupil response, it seemed that following the practical aspect of the lesson, the lower ability pupils gained a better understanding of the concept, whereas the higher ability gained more of an understanding after the theoretical explanation with the practical aspect confusing matters slightly. However, this could've been due to the aforementioned confusion that the last group had. Looking at this from a teacher perspective, it reveals benefits the pupils get in terms of making the lesson more accessible if both aspects are included in a lesson. Of course, to verify this more lesson studies of the same nature would have to be done.

### Lesson Study 2: Results and Analysis:

Lesson study 2 refers to the observed lesson study containing the physical activity demonstrating the flow of electricity around a circuit. Achievement of the lesson goals by the pupils was assessed via a three-page worksheet that they were to fill in at various points of the lesson. The same questions were repeated three times to assess the progression of pupil knowledge over the course of the lesson. In terms of pupil response to the questions, it was assumed that their knowledge would improve over the course of the lesson with them being able to answer more of the questions as the

lesson went on. This generally seemed to be the case with pupils being barely able to answer the questions at the beginning, with their answers improving at each opportunity to attempt the question sheet. It would also provide an indication of whether their understanding was improved by the physical example demonstrated or not. Furthermore, this could provide valuable data on how to differentiate work in the classroom to make it accessible to all ability groups by looking at how their answers compare.

In terms of how the lesson was run, it was featured as part of a revision session in preparation for a test. The lesson was subsequently quite a recall-based lesson building on previous knowledge the pupils had received over the course of the unit. This approach works for some pupils with others possibly being able to be guided through closed questioning. For the lower ability pupils, or pupils with poorer recall, the approach must be supplemented through a more accessible task; this is where the physically engaging aspect of the research has its value with regards to the lesson. The activity was demonstrated with the use of a rope where the teacher played the role of the cell (that provides a circuit with electricity, e.g. a battery) in an electric circuit whilst the pupils played components of the circuit. The rope was then pulled through the pupils' hands gently causing them to heat up demonstrating how resistance can lead to energy loss through heat in components and that electricity flows in one direction around a circuit. In terms of the number of pupils actually involved in the activity, there were only two physically taking part whilst the rest of the class observed what was happening. Additionally following the informal group interview, the pupil response to the tasks was that they had struggled with the recall aspects of the lesson, and those not engaged in the physical activity struggled to understand what it was that was being demonstrated and hence the learning was not as effective for them. To improve the learning experience of all the pupils, they could all be given the opportunity to physically engage with the activity. It also provides the benefit of making the work and knowledge accessible to all by conveying it in a different way; a more physically hands-on approach to learning. This was demonstrated by the positive impact it had on the learning of the 2 pupils involved in the interview that did take part in the physical activity. In terms of ability, these pupils were mid to lower ability with respect to the rest of the class.

Regarding what was learnt from the lesson study and informal group interview in terms of the methods of data collection from both lesson studies, they could have been improved in the way that the question sheets collected at the end could have been divided up into similar ability groups. This would allow us to assess how their understanding at the end of the lesson differed and by how much. Furthermore, by getting more pupils ranging in ability involved in the informal group discussion, it would provide a clearer picture of the difference in understanding of the different abilities within the class, but also if there are differences in similar ability students. It brings the focus more on improving the individuals learning rather than improving teaching methods. Another potential way to improve the research methods would be to undertake a lesson study of a class outside the subject area of physics. In doing so, we would be able to determine whether the research ideas discussed here can be applied across the curriculum to holistically improve pupils learning of many conceptual models, not just those that exist in physics. Comparing the two lesson study group discussions for ways to improve revealed that the physical engagement appeared to be more effective at improving the learning of pupils when they are all involved in it. Furthermore, another interesting comparison to be made between the two lessons was the fact that one involved the pupils all leaving the room. When the pupils were brought back it seemed as though they were much more engaged in the final task of the lesson whereas in the other lesson, there was a point where there was a lull in concentration; roughly 10 - 15 minutes before the end of the lesson.

### Discussion of Research Findings in relation to related literature and research:

Looking at the data from the research conducted in this study, it seemed to be that taking part in physical activity to convey a concept seems to help reinforce and improve the understanding gained from it for the pupils of middle to lower ability. Pupils of higher ability seemed to understand the concepts without the need for a physical activity, learning from just theoretical explanation alone. In terms of pupil's engagement with the lesson, this seemed to be improved following the physical activity, when it was a whole-class activity and not restricted to only a few students. A study evaluating the impact of classroom-based physical activity on pupil's academic outcomes also found that they tended to remain on-task more easily following physical activity (Watson et al, 2017). It also reveals possible implications for the timing of the physical activity in a lesson. In both lesson studies, the physical activity came towards the end of the lesson, but it had a positive effect on the learning of lower ability individuals in the classes involved and on the whole-class engagement. It indicates at potential ways in which lessons could be scaffolded involving physical activity at an earlier point in the lesson to help getting all pupils to a higher level of understanding. The level of support however should be relevant to the independent working time the pupils have during a lesson as too much support can begin to have negative connotations for their learning causing it to become superficial (Pol et al, 2015).

For my class, the class that studied light refraction during the lesson study research, the outcome the combination of a theoretical aspect and a physical activity had for the whole-class learning was very positive. It ensured pupils were all brought along at the same pace in terms of their core learning. The worksheets were also good for attaining where the level of knowledge of each individual was at during the various stages of the lesson, however pupils complained about doing similar question sheets 3 times. This was one of the limitations of the method involved in this lesson study in that it is quite hard to determine the progress of pupil knowledge over the course of only 1 hour. It needs to be done over the course of several lessons to be more effective. Furthermore, it doesn't allow for generalisations to be drawn from the data as it is only a single lesson study (Khokhotva, 2018).

Lesson studies as a form of teacher-led research are a model that was founded in Japan. Its strengths are that it encourages the collaboration of teachers in various aspects of teaching including sharing and development of resources, and the sharing of knowledge in terms developing different and better ways to teach a subject (Doig and Groves, 2011). This in turn can have a positive effect on the learning taking place. It does however have its weakness in that the behaviour of the pupils during the lesson study might not reflect how they would be were there to be only 1 teacher in the room. This is known as the Hawthorne effect; defined as the changing of behaviour of an individual due to an awareness of being observed. It definitely plays a role in the behaviour displayed during lesson study, but it is unknown to what degree (McCambridge et al, 2014).

### Conclusion:

Lesson study is a form of teacher-led research designed to improve the learning of the pupils through the improvement of the effectiveness of the teaching methods. The methods of lesson study used in this essay proved to be quite effective in answering the over-arching research question of whether physical engagement aids in pupils conceptual understanding in physics; it showed that for this lesson study using a physical activity to demonstrate a concept, in this case the refraction of light, was indeed effective in making the knowledge more accessible to the lower ability pupils, hence improving their understanding of the concept. Furthermore, a strength of having an informal group discussion following the lesson means the research is informed first-hand by pupil voice in

terms of how effective it was and how it could be improved. This not only benefits the development of my teaching practice, but it also fosters a positive relationship between teacher and pupil if the pupils are seeing their suggestions being acted upon.

Looking at the limitations of the lesson study methodology referred to in this essay, the lesson study was only confined to the subject area of physics which means it would have to be performed in other subject areas to confirm its validity. Furthermore, the lesson study only lasted for 2 lessons pertaining to 1 class each. This means that the current results are not very conclusive as they cannot be generalised. It would require us to try physical activities for a number of different concepts in physics with various age groups in order to make a generalisation of the data. Saying that, it seems that physical activities not only benefited the learning of some individuals but rather the engagement of the whole class. In terms of bringing forward my effective practice in light of the research, I will be looking for more opportunities to incorporate physical activity as a means of demonstration of scientific concepts. Furthermore, the timings of when to do the physical activity will be experimented with in future to see when it might be most effective in keeping pupils engaged in the lesson.

### Recommendations:

In light of the research undertaken in this essay, I think that more research, and an extended study should be done investigating the potential positive effects that physical activity and getting outside the classroom can have on pupil learning over a longer period. During the research at every opportunity where physical activity could be used to demonstrate a concept and reinforce learning, it should be; to be able to compare it to data on pupil progression over previous years where perhaps they would have learned the same concept, but without the use of physical activity. It would allow for generalisations to be made concerning the data and would confirm whether or not the results from this study are valid. In terms of moving forward with this, more lesson studies should be done collaborating with numerous other teachers; it builds upon teachers' knowledge of the various ways in which one can deliver subject knowledge. This can be very useful when thinking of ways to differentiate the workload.

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