

Using team work to solve problems creatively

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Introduction

‘**Action research** refers to a wide variety of evaluative, investigative, and analytical research methods designed to diagnose problems or weaknesses—whether organizational, academic, or instructional—and help educators develop practical solutions to address them quickly and efficiently.’ (Concepts, 2013)

The reasons for undertaking an action research project in the classroom is to solve problems within that classroom. Teachers use action research as a way of improving learner outcomes based on evidence collected during the teaching process. The benefits of action research with regard to enhancing teacher professional development have been widely reported (Sagor, 2000; Mills, 2003; Johnson, 2005; Tomal, 2005) (Lim, 2007). I believe that my teaching approach and the outcomes of my learners will improve through the research project that I have implemented. **(1.1)**

I teach level 2 and level 3 BTEC engineering to predominantly 16-19 year olds. For the purpose of my action research project I choose a group of twelve level 2 learners to conduct my study. This action research study is part of a bigger study being undertaken nationally on Engineering Habits of Mind (EHoM) (Lucus, Hanson, and Claxton, 2014). This is the second stage of the study. The first stage identified six EHoM: Systems thinking, Adapting, Problem-finding, Creative problem solving, Visualising and Improving (Appendix A).

The second stage looks at how these EHoM can be addressed in the classroom. According to Lucas et al (2014) Problem-solving was regarded as one of the most important EHoM by all

respondents from stage one of the research. My initial research was looking specifically at problem solving; this is a massive area to research so using the information from EHoM, I narrowed my research down to team working to solve problems creatively. From my observations my level 2 learners lack this skill, when I set a group task they either talk over each other, start putting each other down or just refuse to work together. Because of this I started using group work less as it caused my learners extra stress, and they were less engaged in the lesson content. They quite often produced little to no work during these activities.

This finally led me to team working skills and my action research question. **(2.1)**

Q: If I specifically give feedback about 6 set team working skills to my learners will they work better as part of a team to solve problems creatively?

This will be measured by:

- An online creativity test at the beginning and at the end. (quantitative data, Appendix B)
- EHoM survey. (quantitative data, Appendix C)
- Observations during the intervention. (qualitative data, Appendix D)

Literature review.

I believe that by actively teaching team working skills in my lessons with problems to solve, that my learners' critical problem solving skills will improve. Although I set group activities within my lessons they do not necessarily have problems to solve. I started my research looking at problem solving as a discipline.

Mayer and Wittrock state that problem solving is "cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver" (2006, p. 287). According to Education Scotland (2014) creativity is recognised as a practical skill, one which can be taught and which everyone can achieve. Creative problem solving (CPS) is a form of

deliberate creativity: a structured process for solving problems or finding opportunities, used when you want to go beyond conventional thinking and arrive at novel and useful solutions.

CPS has been trademarked by the advertising firm BBDO. The O of the company is Alex Osborn who is widely believed to have come up with the concept of 'brainstorming' which plays a big part in the CPS process. There has been a lot of literature written about CPS since the 1960's, with Osborn's *Applied Imagination* being the first major look at the process of CPS.

Most of the research that I could find on CPS was based around Higher Education (HE) and Primary/Junior age groups. There was very little based on Secondary and Further Education (FE), this was highlighted by the Higher Education Academy '*At one time the basic problem solving skills engineering students needed were developed in school...*' and '*current A-level students are not asked to tackle multi-step problems, and if faced with a large set of information where the required objective cannot be reached in one single familiar step many will not know what to do.*' This is causing a significant problem with universities having to teach these skills.

I researched team working next; team working or collaborative learning leans heavily towards Vygotsky's ideas. He believed that there was an '*inherent social nature of learning*', this was shown in his Zone of Proximal Development. There is a large amount of research about this topic. One such study found that '*positive group experiences have been shown to contribute to student learning, retention and overall college success.*' (National Survey of Student Engagement, 2006). This was a large scale study, over a six year period, looking at how to engage learners.

There are lots of benefits to collaborative learning according to Petty (2004) '*...even that distinct life form studens quasisapiens enjoys working in groups*' However he also points out that collaboration only works well when '*the teacher is able to direct activities meaningfully*'. Bruner (1985) also agrees that '*cooperative learning methods improve*

problem- solving strategies because the students are confronted with different interpretations of the given situation.' A study conducted in 1995 looking at how collaborative learning can enhance critical thinking used two methods, Individual learning and group learning. The study found that *'both methods of instruction were found to be equally effective in gaining factual knowledge.'* But *'..if the purpose of instruction is to enhance critical- thinking and problem- solving skills, then collaborative learning is more beneficial.'* (Gokhale, 1995).

Feedback is an important part of my research question, Skinner (1968) suggests that learners need immediate feedback and if this is not received they will carry on making the same mistakes. This would then cause the learners anxiety because they would need to unlearn the wrong information before they could move forward with the right information. This is back up by Professor James Pennebaker from the university of Austin, Texas according to (Stenger, 2014). The Professor found that *'When people are trying to learn new skills, they must get some information that tells them whether or not they are doing the right thing. Learning in the classroom is no exception. Both the mastery of content and, more importantly, the mastery of how to think require trial-and-error learning.'* **(2.1, 3.1)**

Research model

Action research is research oriented toward the enhancement of direct teaching practice.

'Action research is simply a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out'

(Carr and Kemmis 1986: 162). For my research model I first selected Stephen Kemmis' 2 step cycle. I choose this model because of the relatively short time

I had for my intervention, six weeks, it also crucially had the

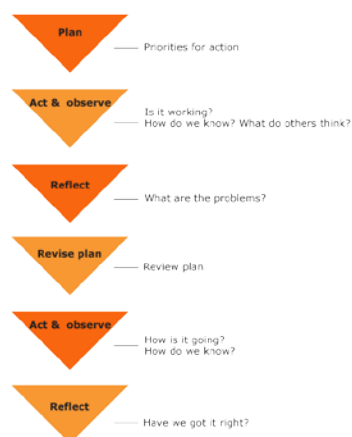
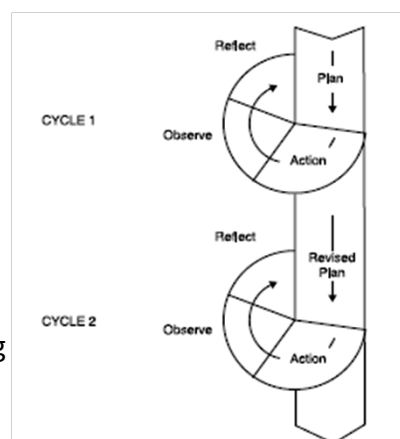
'observe' section which I needed in class in order for me to give feedback. However I could have used Kemmis and

McTaggart's 1988 adapted model which followed the same

stages or Piggot-Irvine 2005 model of Plan, Act, Reflect which

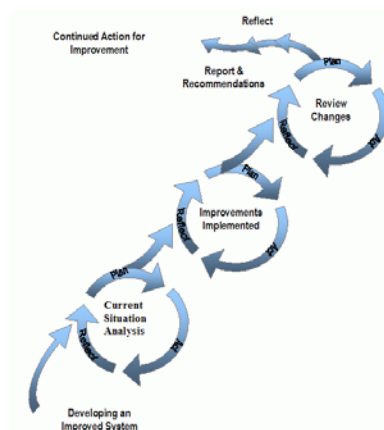
has the same cyclic theme as the Kemmis model but is missing

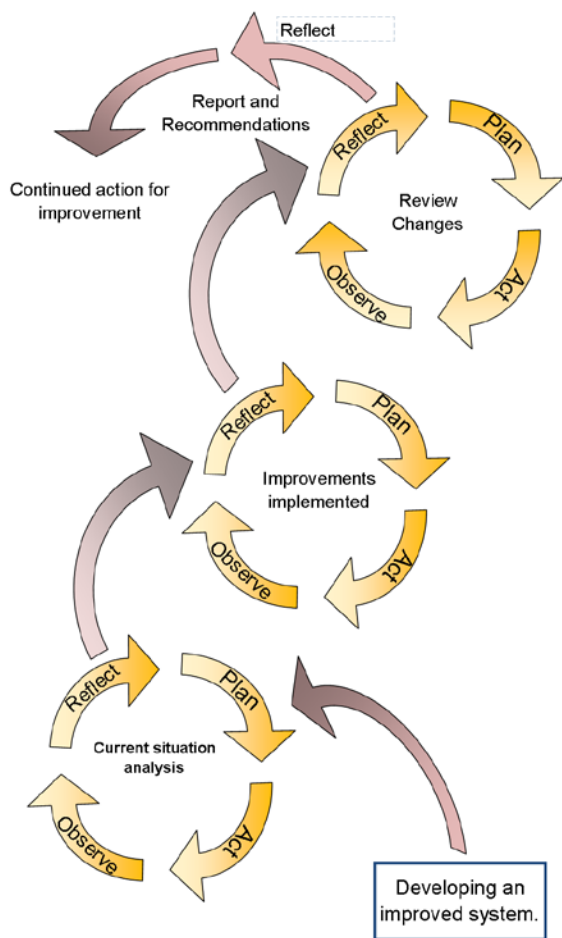
the observe section.



Formulate recommendations and develop new priorities for action

Adapted from Kemmis and McTaggart 1988





What I ended up with was a mixture of the Kemmis model and the Piggot-Irvine model. I felt that I needed the Piggot-Irvine headings for each cycle: a review of the current situation, then I needed to improve my intervention and implement those improvements, and finally review the changes and start over again if need be. This, I believe gave me greater scope for reflection and change.

Fig. 1

As you can see from the model diagram (Fig.1) I have adapted the model to suit my needs. As you can see from this model it has a self-reflecting spiral still following Kemmis' and Piggot-Irvine's original models. I have added a section to each so that you have to observe any changes. This gave me a definitive starting point with both my control group and my research group. **(1.1, 1.2 1.3)**

Implementation.

Current situation analysis: In the first session I got my learners to take an online creativity test so that I had a bench mark figure to work from, before handing out the first design challenge. I also did not give any feedback on the design challenge. I used this to analyse some of the key problems that my learners had with teamworking. It proved to be extremely helpful when finalising my feedback points, Appendix 1.

Once my points were finalised I was able to implement my improvement plan. This involved setting my learners a design task to do in groups of four. The learners had fifteen minutes to complete the task before receiving their feedback. During this cycle I decided to give general feedback to the learners about how the whole class got on, telling learners about how the class had performed and what the class needed to do to improve. During the next cycle the learners were given a design task for fifteen minutes I observed how they worked together, this time I gave specific feedback to each learner about how they had performed. This led to the cycle starting again with small changes to the feedback delivery depending on what I had observed. **(2.2)**

Research methods.

There are many different types of research methods for collecting data. Research methods generally fall into two types of data. Quantitative research which is *'Explaining phenomena by collecting numerical data that are analysed using mathematically based methods.'* (Balnaves and Caputi, 2001) and qualitative research which is *'...involves collecting and/or working with text, images, or sounds.'* (Guest, Namey, and Mitchell, 2013)

There are many ways to collect data to evaluate action research, Lucas et al (2014) suggests that there are three key principles that should be used to help decide which ones to select:

1. Choose a mix of methods, qualitative and quantitative. Ideally select three methods. This allows for triangulation of sources. Triangulating - collecting from more than two sources - helps you to be more confident that you are forming reliable judgments.
2. Data that is collected will have to be analysed, so be realistic about the time available to analyse data. For example, video recordings may take many hours to analyse if you watch them again in real time.
3. The more you can build evaluation methods into the natural process of a lesson, the more likely it is that it will get done reliably.

The three methods that I choose were: two different questionnaires, quantitative, and in class observations ,qualitative, that was also used as feedback to the learners. Questionnaires are lists of predetermined questions designed to produce various types of response, normally using a Likert scale for the answers. Some of the advantages of this method are that it is a good way of getting data about the impact on learners over a course of time, especially if administered more than once; If used as a free text style questionnaire it can also provide qualitative data as well as quantitative. Some of the drawbacks to this method are that different people can take different meanings from the same question, also if using a Likert scale learners could misunderstand the responses i.e. 'sometimes' or 'absolutely never'.

Lesson observations are real time diaries of the intervention. You could make this into a rubric style grid to help with not being able to observe and write down everything that goes on. Some of the advantages to this method are that it can be very useful if you have set things to watch for, it is unlikely that you will get contamination as the researcher (myself) is the only one taking the notes. A disadvantage to this is that it is difficult to undertake without impairing teaching quality in certain situations.

Other methods that I could have used were learner logs. Although these are a great way of encouraging self reflection and analysis of the learning that has taken place, I did not feel that my learners would be engaged in this type of method as it would involve writing and most of the learners involved dislike the prospect of writing. I also considered video evidence, even though it can capture conversations that are taking place, providing a rich source of data. I discarded it because it would be time consuming to watch back and potentially require transcription, as well as being a distraction to the learners. **(3.2, 3.3)**

Data analysis.

When analysing data it is important to triangulate, as discussed previously. This helps to make sure that a research study has vigour. Analysing the data can be done in a number of ways. For my research I will be analysing my data through charts and graphs that give clear visual representations of my findings. Then I shall use that quantitative data to find trends that link to my qualitative data. For example my quantitative data clearly shows that at the start of the intervention only three students enjoyed teamworking activities, I can back this up through the qualitative data I collected through my observations.

'Cross-checking the existence of certain phenomena and the veracity of individual accounts by gathering data from a number of informants and a number of sources and subsequently comparing and contrasting one account with another in order to produce as full and balanced a study as possible.' (OU course E811 Study Guide, 1988:54, cited in Bell, 1993:64) (McNiff, 2013)

All 12 learners in the control and intervention groups took part in the same design challenges with only the intervention group receiving feedback.(4.1)

Ethics, Politics and Confidentiality.

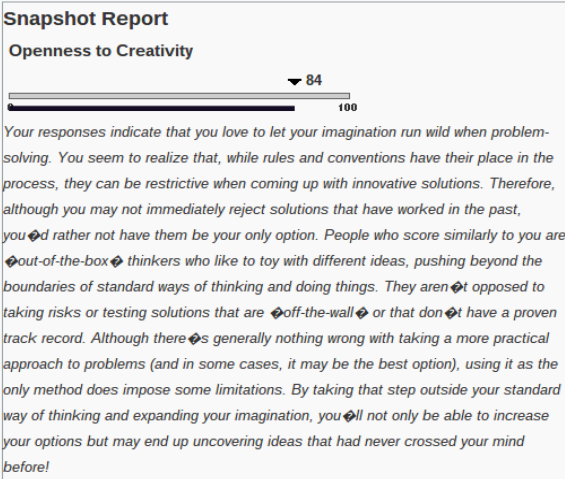
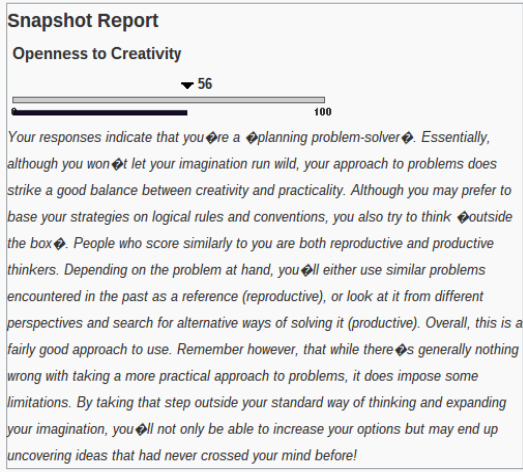
Confidentiality was the only concern I had with my research. I was worried that learners would not be truthful if they thought that there might be a consequence to their answers. To make sure that students felt that they could be honest I made cards up with learner A-L on. These were then placed in a hat and learners took a random card with their unique name on. I created a different Google form for each group so that I knew which group was which.

There was no reason to send a letter home to parents asking for permission for their son/daughter to take part. This was because my intervention was a starter activity of between fifteen and twenty minutes which I would have had in the class anyway. Thus it was not a whole change to how the learners were being taught.

There was slight political bias to my research because it is well documented in various places and by subsequent governments that we have a major shortage of engineers in this country. The EHoM research is trying to see how we can improve the amount of engineers coming out of the school and college system, hopefully by using the information compiled from the study as a whole.(2.4)

Results

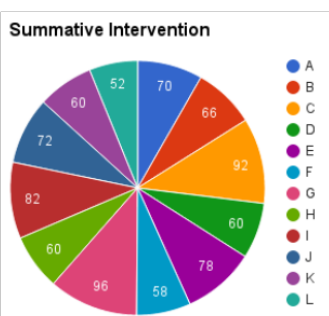
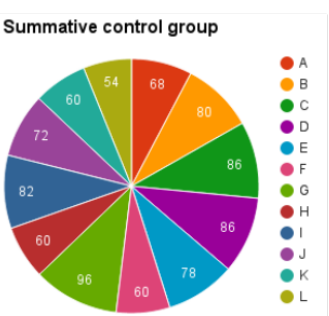
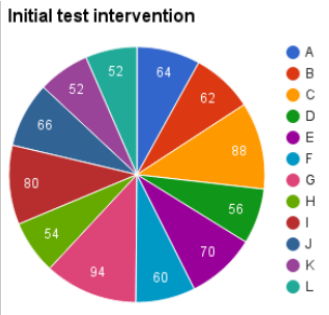
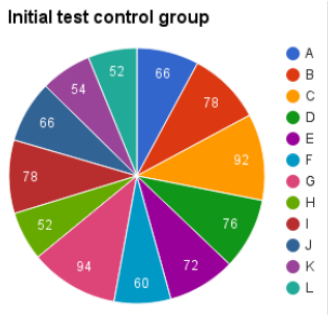
I will start by discussing my quantitative data and then comparing this to my qualitative data. My initial test was an online creativity test (Self Tests by Psychology Today, no date). This was a series of questions that return results in a format like below.



From these results I created two percentage charts for both groups, one for the initial test

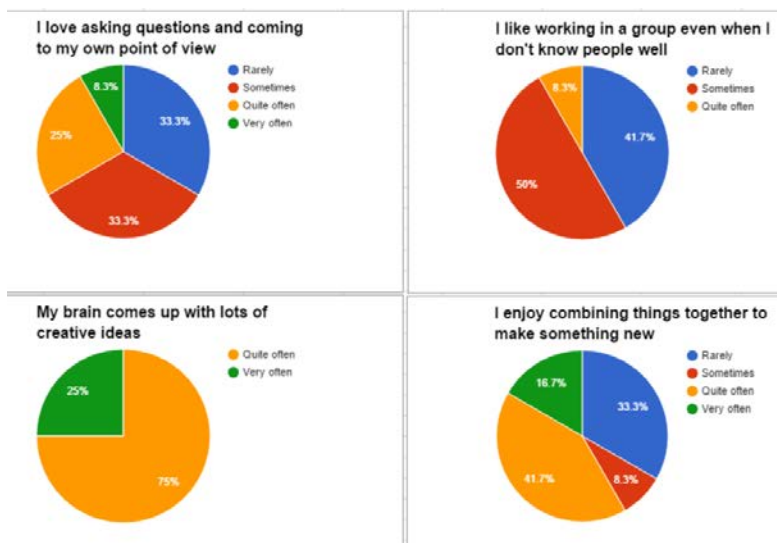
and a second for the summative test.

I was then able to use the data to work out an average score for each group. This was my first piece of data that I analysed and it showed that both groups actually improved on the scores over the 6 weeks. The control group increasing by 3.5% from 70% to 73.5% and the intervention group increased by 4% from 66.5% to 70.5%. This was interesting because, based on my observations, I would have thought



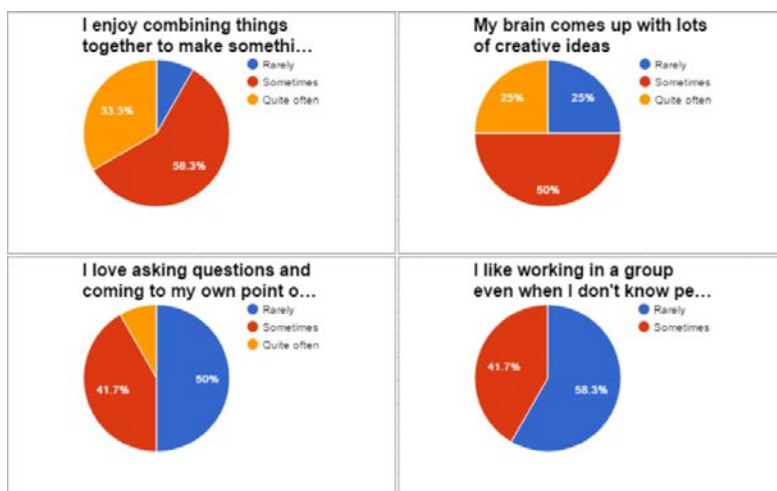
that it would have been higher than this. The next survey that I got the learners to take was the EHoM questionnaire provided by Dr. Janet Hanson. For my particular research I used four questions from this that I thought were relevant. They were:

1. I enjoy combining things together to make something new
2. I love asking questions and coming to my own point of view
3. My brain comes up with lots of creative ideas



4. I like working in a group even when I don't know people well

This showed that the learners in the control group are: likely to ask questions, they prefer not to work in groups, they feel that they are quite creative and that they enjoy making new things.



In my intervention group it showed a different story.

This group mostly stuck to 1's and 2's in the survey making them very negative about being creative. Although one of the questions that I did not use showed that they like making models which could mean that they prefer hands on work.

Week 1.

My first activity was a design challenge set by Brompton Bikes which was to design a new accessory to be sold as an after market add-on to their folding bikes. I gave the classes, in groups of four, fifteen minutes to come up with an idea. This resulted in lots of infighting and very little work produced from most groups. I gave no feedback and carried on with the lesson. These initial findings helped me to shape my questions for the second phase of my research model, the implementation and improvement plan.

Week 2

Having created my question sheet I implemented my intervention. I gave out my design challenge and observed the students working for the next fifteen minutes moving around the class making notes about how the groups were working. Again the students did not work well together and struggled to produce a design to solve the problem. When the time was up I gave my feedback. My skills to give feedback on were:

- Listening: How well the team listened to each other
- Questioning: How well did they question each others ideas
- Respect: How well did they respect each others views
- Helping: Did they help each other out
- Sharing: How well did they share ideas with each other
- Participation: Did every member of the team join in.

Week 3

This week the learners worked better they took time at the start of the activity to listen to each other, this still got heated but they attempted it. Again I walked around the room observing, this time learners managed to get a solution to the challenge. At the end of the activity I gave group and individual feedback to the learners pointing out who had done well, who had not and which group had work best together.

The learners were all very engaged at this time which I found interesting as they are normally rather noisy.

Week 4

This week the groups were more organised; they still had arguments but worked reasonably well. Two out of the three groups managed to get more than one idea down, I observed that these two groups had also started listening to each other better instead of talking over each other. This week I was very specific as to who I gave feedback too, only praising the learners who had put the most effort into the task.

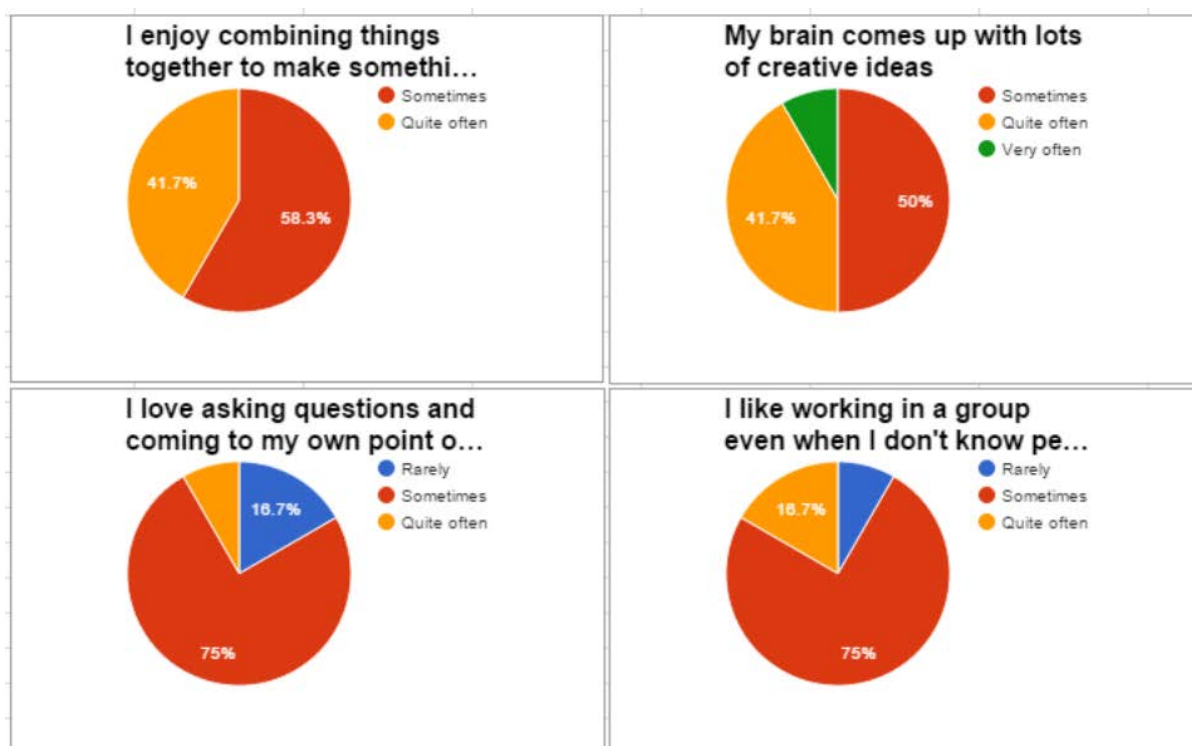
Week 5

During this week I saw the biggest change in the groups. They got straight on with the task helping each other out, along with the stronger ones in the team encouraging the less able.

Every group managed to produce more than one solution with one group producing four different ideas. I asked the learners if they felt that their teamworking skills were improving to which they all agreed that they were. When asked about how well they could solve a problem individually some of the class thought that they would struggle on their own.

Week 6

This was to be my final week of the intervention. This week I decided to get them to create only one idea. This was a vehicle to transport an old lady around her extremely large garden. Again they all started really well and used separate paper to come up with ideas before settling on one. With this challenge there was a twist, with five minutes to go I told them that the vehicle had to get the lady across the lake in her garden. After some initial groans they started working well. They all seemed to be working together to solve a common problem. With two minutes to go I told them that the lady was blind. All three teams had different ideas on how to get the lady around her garden ranging from tyres that over



inflate when she wants to go over the lake to a hover vehicle. I felt that with this particular challenge all the learners worked well together. After the activity I gave them my final feedback and asked them to complete the creativity test and then the EHoM test. They

creativity test was shown earlier. The EHoM scores were as follows: The control group were relatively unchanged, whereas the intervention group had improved marginally, showing that they now don't mind working in a group. **(4.1, 4.2, 5.1)**

Conclusion

This action research project has made me look at how I give feedback and how it can influence the way that learners think. By having set points to give feedback on has made me realise that the feedback that I have been giving is too general. When I think about the my question **'If I specifically give feedback about 6 set team working skills to my learners will they work better as part of a team to solve problems creatively?'** have I achieved it, looking at my data you can see that the learners in both groups improved on the creativity test. What the test doesn't show is that learners in the intervention group produced more initial designs during the activities by weeks five and six, with less quarrelling. Learners in the control group still produced a solution to the challenge but the solution was down to whoever was the strongest in the group. It could be argued that both groups improved on the creativity test because of the practice undertaken during the activities, also that with more group work in the class, even without the feedback, that students would work better together over time. However my observations of the groups shows that when given feedback about the key team working points highlighted learners improved quicker and produced more ideas collectively.

Recommendations

One of the keys areas that I would like to look at following this research is the type of problems that learners have to solve.

The problems that learners were subjected to were all design based, would the intervention strategy also work for maths problems or electronics problems? This would be where the strategy should be used moving forward. Also the intervention was too short, six weeks was not long enough to get a comprehensive amount of data.

Moving forward into the next academic year I will be using this strategy from the start using a variety of different problems. I will use my research model as a six week intervention for each cycle. This should give me a better gauge of how the intervention is working. I will also need to develop my feedback strategies through CPD and my own studies so that I can be more specific with targeting each of my team working questions. **(5.2)**

Evaluation

I have approached action research with a view that it will improve how I teach and possibly the outcomes for my learners. I liked the format of 'if I do X will Y happen' as a question model as it gives a very clear understanding of what you are trying to achieve. Planning the intervention well before hand is the key to action research, this takes time and effort but guarantees that your intervention will run smoothly. The implementation did not take away from any of my teaching time as all of my activities were designed to be a starter to the lesson. Although I have spoken about giving specific feedback to students about their own performance, I feel that this was difficult to do in the time available while walking between groups. It might be better to make a rubric for some of the feedback with a smaller personalised section instead. I feel that my strengths are in the delivery of the intervention and methods of recording evidence. However I need to improve my data analysis skills as I have struggled to analyse the data that I produced. I will be adding this to my CPD needs for the following year. Overall I was pleased with the results and how the students' team working skills improved.**(6.1, 6.2)**

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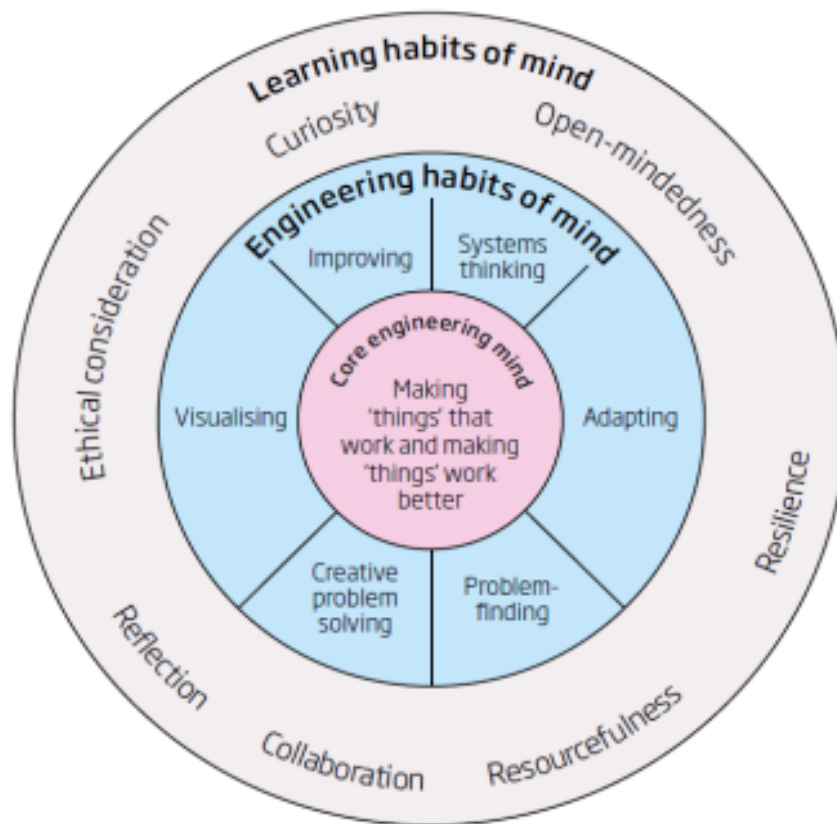
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Appendix A



Appendix B

Creative Problem-Solving Test

20 questions, 10 min

Do you typically approach a problem from many perspectives or opt for the same old solution that worked in the past? In his work on human motivation, Robert E. Franken states that in order to be creative, you need to be able to view things from different perspectives.



Creativity is linked to fundamental qualities of thinking, such as flexibility and tolerance of ambiguity. This Creative Problem-solving Test was developed to evaluate whether your attitude towards problem-solving and the manner in which you approach a problem are conducive to creative thinking.

This test is made up of two types of questions: scenarios and self-assessment. For each scenario, answer according to how you would most likely behave in a similar situation. For the self-assessment questions, indicate the degree to which the given statements apply to you. In order to receive the most accurate results, please answer each question as honestly as possible.

After finishing the test, you will receive a Snapshot Report with an introduction, a graph and a personalized interpretation for one of your test scores. You will then have the option to purchase the full results.

Appendix C

Group:

Date:

EHoM survey

- 1 = rarely (or never)
- 2 = sometimes
- 3 = quite often
- 4 = very often (or always)

Date.....

Name.....

Class.....

- | | | | | |
|---|---|---|---|---|
| 1. I like making links between things in my head | 1 | 2 | 3 | 4 |
| 2. I enjoy putting things together to make something new | 1 | 2 | 3 | 4 |
| 3. I'll check and check again until I am happy | 1 | 2 | 3 | 4 |
| 4. I love asking questions and having my own point of view | 1 | 2 | 3 | 4 |
| 5. I like thinking out loud when I am being imaginative | 1 | 2 | 3 | 4 |
| 6. I like making models to show my ideas | 1 | 2 | 3 | 4 |
| 7. I like making what I've done better | 1 | 2 | 3 | 4 |
| 8. I explain how well I am doing to my teachers or friends | 1 | 2 | 3 | 4 |
| 9. My brain comes up with lots of good and new ideas | 1 | 2 | 3 | 4 |
| 10. I like working in a group | 1 | 2 | 3 | 4 |
| 11. I stick up for what I think when talking with other people | 1 | 2 | 3 | 4 |
| 12. I work hard and practise to get better, even when it's tricky | 1 | 2 | 3 | 4 |

Appendix D

Skills shown	Who showed them and how did they show them?
Listening skills How well did they listen to each others ideas?	
Questioning How well did they question each other through discussion?	
Respecting How well did they respect each others ideas?	
Helping How well did they help each other?	
Sharing How well did they all share ideas?	
Participating How well did each member of the team join in?	