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Education Partners

MIT's Science and Engineering Programme for Teachers 2023

Reflection reports from the Welsh educators representing Wales

Llywodraeth Cymru
Welsh Government

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MIT's Science and Engineering Programme for Teachers 2023: Reflection reports from the Welsh educators representing Wales

Background

For one week each summer, the Massachusetts Institute of Technology (MIT) – the world's leading STEM university – hosts an annual Science and Engineering Programme for Teachers (SEPT). The programme is open to 55 teachers from around the world.

Participants undertake a week-long programme of professional learning, which includes lectures from leading scientists, training with the latest education technology developed at MIT, and undertaking workshops with an outstanding group of passionate educators – professors, students, researchers, and teachers from around the world.

Through the MIT Global Teaching Labs (GTL) in Wales programme, which is fully-funded for schools and colleges across Wales by the Welsh Government and delivered by Equal Education Partners (EEP), the Welsh Government Education Directorate has a close working relationship with MIT. Through this partnership, the Welsh Government Education Directorate secured 4 places for educators from Wales to participate in SEPT 2023.

The participating Welsh educators, representing each area of Wales, attended the SEPT programme at MIT. The educators immersed themselves in the professional learning offered and brought it back to Wales for further dissemination.

Sharing lessons learnt with STEM colleagues across Wales

As a condition of Welsh Government funding the place of each representative, each participating teacher from Wales was required to:

- Produce a brief reflective report on their time at MIT and its impact;
- Lead a professional learning opportunity for wider STEM colleagues in their school; and
- Lead a professional learning event aimed at colleagues across Wales, hosted online and supported by EEP.

These will act as professional learning resources for STEM educators across Wales.

This document summarises each educator's reflective report, sharing their lessons learnt and applicability to the Welsh education system.

To register your interest in the online professional learning event, please email Rebecca Martin (Senior Associate for International Partnerships at Equal Education Partners) on rebecca.martin@equaleducationpartners.com or fill out this form. This session will take place online on Tuesday 25th June at 4pm.

For more information

To find out more about MIT's Science and Engineering Programme for Teachers, please visit https://sept.mit.edu/

MIT SEPT July 2023 Visit: Reflection Report 10/7/2023 – 14/7/2023

Huw Smith

I was so lucky to have had the opportunity to visit MIT in Massachusetts in July of this year. Along with three other science teachers from Wales, we met, worked with, and got to know an amazing group of STEM educators from all over the world – in a truly inspirational setting.

We were introduced to many great teaching activities and resources in the MIT labs over the week. The main activities and workshops are listed below:

- **The use of AI as an educational tool.**
- **Using Scratch coding to create simple games.**
- **Locating Learning in Play – creation of card games such as Buffalo, to promote learning and connected learning.**
- **The Systems Thinking Iceberg**
- **Fields of Systems Change**
- **Shadowspect** https://education.mit.edu/project/shadowspect/
- **Using facial recognition software to program a screen-based avatar.**

Which of these resources support teaching of the New Curriculum for Wales?

My choice would be:

- **Using AI in education –** the use of AI to create progression maps and formative or summative assessments.
- **Simple game creation using Scratch.** (to support the DCF and What Matters 6 in Science & Technology – Computer Science)
- **Creating & programming a social robot using facial recognition and scratch** (as above)
- **Locating Learning in Play – creation of card games** (to support learner progression through developing recall and connected learning e.g., Buffalo Game)

The activities I would be most interested in introducing to my learners would be;

- **Locating Learning in Play – creation of card or computer games to promote learning and develop connected learning.**
- **Game creation using Scratch.**

The reasons for introducing learners to these would be to encourage them to develop computational thinking – getting learners to code through writing algorithms and using block coding – which is the type of programming used by Scratch, Microbit and Crumble. There is a need to develop these skills as part of the What Matters Statement 6 "Computational Thinking" in the science & technology AOLE - and for the DCF in the curriculum for Wales.

Locating Learning through Play can be used to improve learner recall of knowledge – and develop connected learning - which are two of the elements of Progression.

The resources I would be most interested in introducing to science and technology teachers would be;

- **Using AI in education –** the use of AI such as Chat GPT in schools – To reduce teacher workload and to support developing the new curriculum.
- **Locating Learning in Play –** creation of card games such as Buffalo to promote and improve pupil learning and connected learning.
- **Systems Thinking Iceberg –** To Heads of Year – to probe for a greater understanding of systems dynamics leading to an "event".
- **Fields of Systems Change –** To middle and senior leaders – to consider steps needed to drive improvement while bringing your team and the wider community with you.
- **Shadowspect –** to Maths & Numeracy Colleagues – to improve geometry and spatial awareness.
- **Creating & programming a social robot using your laptop's camera –** to IT Colleagues – to show them the latest versions of scratch that can incorporate facial recognition.

How do you think the MIT SEPT programme will change your practice / thoughts on STEM teaching moving forward?

The most valuable lesson I learnt over my week at MIT was that playing games can improve learning. Playing "Buffalo" with a group of teachers in the MIT labs showed me that learning can be fun - and that there was a huge potential for developing learning about all sorts of topics through game and role play. As an example of this closer to home - I was amazed to see how my daughter could name historical buildings while on holiday in Florence and Rome. She had never been to these buildings – but could name them through the gameplay of "Assassin's Creed".

As part of one of the MIT workshops, we created a Scratch-based game which could be used as a quiz for students to play, but would also test their knowledge and understanding of Newton's Laws at the same time.

Screen-based quizzes could be extended to many different STEM topics – but could also support coding development.

My main learning point of the amazing week at MIT was the realisation that STEM learning could be enhanced through gaming - and the games could include screen-based, card, board games – or role play.

The main thing is to make learning about STEM fun.

As STEM lead for GwE, and as a result of my visit to MIT this summer, our professional learning activities in November of this year have introduced AI, Crumble and Microbit coding to science and technology teachers across North Wales. We have worked closely with Technocamps and our Digital lead to develop Microbit coding opportunities for bringing the sciences and technology together in themes and learning journeys such as Transportation and Health.

I am very grateful to the Welsh Government and Equal Education Partners for organising and funding our visit to MIT.

Without a doubt it was the ultimate professional STEM learning experience! Thank you.

SEPT Programme Report – Summer 2023

Alun Rennolf, Ysgol Gyfun Gŵyr

Spending a week at MIT during the summer was a wonderful opportunity to learn at one of the best universities in the world, but it was also an opportunity to spend time with experienced teachers from across the globe. The report below expands on three of the areas that I felt were ones for me to develop in my personal learning as a teacher, and in our school as an organisation as well. I am aware that hearing about experiences on their own is not necessarily of value to your learners in the classroom so, where appropriate, I have included links to any work or tasks that have been developed as a result of the visit to MIT, and any interesting further reading. If you would like to contact me to discuss any element of what has been noted in this report, you are more than welcome to contact me via my Hwb email address, RennolfA6@hwbcymru.net.

1. Robotics as a field to develop cross-curricular links

It became clear when having professional conversations with the other teachers who were on the training programme how much attention was being given to studying robotics as a field, especially in the USA with national competitions such as FIRST Robotics1 encouraging learners to engage with the field. When discussing with those teachers from the USA, it became clear how much robotics work was happening in their schools, and how little robotics work we were doing in our school in comparison. Perhaps other schools in Wales are in the same situation as us; aspects of robotics are taught in clubs, in workshops or on trips, but robotics as a field is not incorporated into our curriculum. Certainly, there are separate aspects to be seen, with computer science, coding and building machines being taught in our curriculum, but there was no opportunity to connect those separate aspects in the way that robotics as a field does. It was clear that we are at a loss in that regard, and that robotics needs to be placed in our curriculum in order to make key connections across our learning and experience area.

The result of this was to develop a unit of work for year 7 which presents robotics as a field, with the intention of developing and presenting units in year 8 and 9 over the next few years. Follow this link to access those resources (available through the medium of Welsh). You are very welcome to use these and modify them as you find useful.

2. System Leadership Considerations

The second aspect was about leadership, after receiving a lecture from Professor Peter Senge. He introduced system leadership as a framework for leadership, defining system leadership as a web of interdependent relationships, a web of behavioural practices and the structures that emerge because of those things. According to that definition, a collection of schools in a local authority could be a system and a classroom could be a system, so the model is useful on many levels. Considering my department and my classroom as such systems, and my role as a leader through that framework, was both challenging and beneficial.

Senge identified three key skills for effective system leadership;

- a clear aspiration
- the ability to discuss reflectively
- and a deep awareness of the system they are leading.

System leadership in the classroom

To apply that to the work of a classroom teacher, three questions arise directly from those three considerations above. Firstly, do we communicate our aspirations for our learners consistently and clearly, whether that is a vision for the tone of our classroom or an aspiration for a particular learner's progress in some aspect of our subject? Of course, as teachers we have aspirations for our learners, but do we communicate those to them?

Are we using reflective discussions with our learners to encourage progress towards our aspirations. Such discussions are useful in many different contexts. Teachers may be familiar with the idea of reflective discussion in the context of restorative practices in terms of behaviour, but why not hold reflective discussions in the context of subject progress or learners' mental health and wellbeing?

Finally, do we really have an understanding of the system we lead? Do we have a deep awareness of our classrooms and the learners in them? When asking that question, we have to face the truth that we often bring our assumptions towards what happens in our lessons, but it is healthy for us to recognise and revisit those assumptions consistently. Of course, for experienced teachers, any assumptions we have in a particular situation will often be based on years of experience, but we must realise that our classes are complex systems that are constantly changing.

The short discussion above highlights the type of questions that arise when applying a system leadership framework to a specific context. I would encourage teachers and leaders at all levels to investigate further into system leadership, and consider how adopting the mindset of a system leader could benefit their learning and their leadership. Follow this link to read more about system leadership.

3. Using Scratch to build simulations of physical systems

Many of us are familiar with Scratch as a platform for developing coding skills with blocks, and writing simple programs, but spending time at MIT inspired me to ask how I could take my use of Scratch further in my classroom and use it for learners to build their own simulations. Often, as a department, we use PhET Simulations to demonstrate phenomena, so that learners can explore the relationship between variables; those simulations are great, but there is no opportunity for learners to develop any element of the simulation for themselves.

Our learners learn coding skills with Scratch in year 7, and use simulations to explore scientific concepts. However, to create the crucial cross-curricular connection, the key link between the coding skills and creating a simulation to demonstrate a scientific concept was missing. I set out to create a series of simple simulations that learners of different ages could produce for themselves; there are links to those below (available only through the medium of Welsh).

- A simulation to show how temperature affects the speed of gas particles
- A simulation to show how changing temperature affects the vibration of particles in a solid
- Penny Probability Experiment
- Energy Transfers Calculator
- Dice Probability Experiment

You are welcome to use these in your classes if you find them useful, and I welcome any feedback on them!

MIT SEPT July 2023 Visit: Reflection Report

Nathan Melly

Introduction

The Science and Engineering Programme (SEPT) for Teachers was advertised as "drinking from a firehose", to the extent that the information and knowledge that is thrown at you is staggering. It was an absolute pleasure to have the chance to learn from a vast selection of experienced professionals while sharing it with a selection of teachers from all walks of life across the world.

This reflection will primarily focus on my newfound knowledge from the programme and its practical application within the Welsh curriculum. Initially, I adopted the mindset to learn and refine my teaching practice as well as understand how I can apply this in the constantly evolving Welsh Science classroom. One of our priorities at Ysgol Gyfun Cwm Rhymni is to be able to provide enriched and unique opportunities within Science. MIT has assisted this goal by facilitating this wonderful opportunity and I hope to make future collaboration projects in the near future. The University is a pioneer of innovation, technology and robotics, therefore witnessing these exciting advancements first hand has given me useful insights into solutions as well as potential challenges. As educators in the field of Science and Technology, it is our duty to prepare our learners in the best way possible in encouraging curiosity and innovation as per our "what matters" statements.

My main goal in attending the SEPT was to improve my understanding in the use of games and artificial intelligence (AI) in teaching. I have always had a passion for the potential educational benefits of AI and video games, so I particularly enjoyed the seminars on their applications and how it can improve teaching practice. The relatively recent emergence of AI such as Chat GPT presents unique challenges in education when it comes to assessment, but I was curious to find out its uses as a learning tool. In addition to the assistance of grading, the resource development aspect is also intriguing as a teacher who takes pride in creating worksheets and classroom materials. My main takeaway is the limitless potential of these new technologies, and pondering how these technologies could revolutionise how teachers prepare assessment and plan engaging lessons.

My week at MIT presented opportunities to learn more about how games can incentivise the learning process, rather than providing a material reward. I was honoured to experience other teachers in my field of specialism and work together to produce a game of our own.

The main focus of my game was the "the use and design of simulations." During the final day we had the opportunity to try the games developed by other groups. It was particularly interesting considering how game difficulty was essential for creating engagement, whilst also measuring how successful the games were at accomplishing learning objectives.

Key Lectures and Workshops

I was part of the Use and Design of Games & Simulations thematic track so the afternoons of Monday, Tuesday and Thursday were all spent on this workshop. One of my other colleagues from the Welsh contingent was part of the Broadening Participation in STEM thematic track.

Monday 10/07/2023
Eric Klopfer - Games and Simulations
Sarah Wharton - Introduction to Scratch
Workshop 1 - Learning through Play and testing different games

Tuesday 11/07/2023
Peter Senge/Lana Cook - Compassionate Systems
System Dynamics Workshop
Workshop 2 - Creation of Card games and uses for learning

Wednesday 12/07/2023
John Gabrielli - Memory and Learning in the Human Brain

Thursday 13/07/2023
Sarah Wharton - RAICA Responsible AI for Computational Action
Robot or Not? The Social Robot
Workshop 3 - Completion of game designed gradually over the past few workshops

Friday 14/07/2023
Presentation of games and trialling the games of other groups

Key Lessons Learnt

Using games and simulations for learning

This talk helped to change my perspective on gaming as a learner and teacher and acted as the start of my understanding of the design process. I have consistently played games throughout my childhood and adult life and have now only seriously considered its implication in a classroom setting. I have previously understood the use of games for entertainment and for learning but struggled in envisioning its implementation in a STEM class.

The expectation of a learning game in most contexts is that you get to play and enjoy a game as a consequence of proving your learning - this is called the "chocolate covered broccoli" approach. This is where the play is a reward for learning. The alternative to this, a now more popular and successful approach is to incorporate them with each other, causing the learning to be happening in conjunction with playing the game.

Gaming is an incredibly popular medium for entertainment due to its unique brand of fun. The "joy" of gaming is found in frustration, as a game that is too easy to complete does not provide any challenge. Opposingly, a game of too high a difficulty would lead to unproductive frustration and likely lead to the participant giving up. This challenge or "Hard fun" is where engagement is at its highest.

The principal can be applied to Vygotsky's Zone of Proximal development, where the optimal learning zone is applied to a game with the correct amount of fun is located between what the pupil is capable of and what they are unable to do.

In fact, many game developers aim to locate the completion of challenges within their games right on the edge of the "unachievable" providing a particularly strenuous challenge. In order to cater for pupils of all abilities, the idea of dynamic difficulty adjustment should be introduced to encourage the pupils to challenge themselves. This means to allow the game to adjust to the player, challenging the player without requiring them to choose the difficulty themselves.

Freedom of Play

The pillars of the freedoms of play are described as the following:

- **Effort**
- **Exploration**
- **Failure**
- **Identity**

These are all considerations when designing a game.

Effort - This encompasses the idea that players have the freedom to choose how they approach challenges, progress, and interact with the game mechanics. This allows for player autonomy, giving the player choice over their investment into the game and their skill progression within the game

Exploration - Allowing this can help personalise a gaming experience. Allowing players to explore the game world freely encourages curiosity and discovery. It's essential because it fosters immersion, providing opportunities for players to simply enjoy the environment created by the developers.

Failure - This helps the game provide consequences to decisions and allow for clearly defined goals. These are provided through measurable and consistent feedback within the underlying model. This creates a sense of responsibility and impact, making the player's choices feel meaningful , which adds depth to the game experience.

Identity - This refers to the player's ability to create and express themselves within the game itself. The game itself can be a vehicle for an individual to express themselves in different ways.

All of these should be considered if designing a game is the main objective of a task.

Introduction to Scratch

I had only encountered Scratch once before, so I was intrigued to find what I could learn that could be applicable to my lessons and department when this was introduced.

I have very little experience with coding so I was very pleased with the simplicity that was offered using Scratch. Using the guide used on from the demonstrator, we could follow and write code step by step to create a simple game. The software uses block based code so it could be written by clicking menu prompts, followed by dragging and dropping pre-written lines of code.

The commands are pre written and colour coded, allowing for simple learning and repetition of steps. By using this system, I could simply create paths for my created character to move up/down or sideways on a determined route. Additionally, by setting a starting and end point I created visible feedback from simple code. Through working with others already more proficient in using this tool, I would learn other ways of customising the game such as adding other objectives and adding consequences leading to failure (an example being = leaving the path assigned).

Systems Awareness

One recurring challenge for us as teachers is motivating pupils. No matter the enthusiasm that a teacher has for their own subject, this is not always the case when trying to encourage learning in the classroom.

There are two separate forms of motivation, these being aspiration and desperation. Aspiration involves cultivating a positive outlook toward their future. It revolves around fostering a sense of hope, ambition, and purpose in pupils with an emphasis on self improvement and achieving long term goals. Sustained commitment can help pupils develop perseverance to face challenges. Alternatively, desperation arises from immediate stress or pressure. This can be driven by demands, deadlines or uncertainties, which can result in impulsive or reactive behaviour,

To create a "thinking" classroom, one where all pupils are fully engaged in the learning, systems must be put in place to inspire them. This lecture used the analogy of an iceberg to describe the buildup leading to a classroom incident in the form of disruption. An example of this is what's shown (the visible portion of the iceberg) is often in the form of disruption, while the factors leading to this are all " under the surface". These factors include a lack of understanding, focus and feeling left out can all contribute to a pupil's contribution to a lesson.

However, the key feature is to align a goal. Our purpose as teachers is to prepare our pupils for the challenges they'll face even after leaving education, so the systems should adapt to suit this.

Memory and Learning

The structure of how we assess pupils at a secondary level is often reliant on memory, so the practice of developing pupils memory skills is incredibly important. The research presented showed that repetition is the most effective strategy for remembering, and the capacity for memory is at its highest at age 20. This supports teaching through integrated practice, where topics are covered frequently as opposed to blocked practice, covering topics one at a time. Integrated practice allows for frequent refreshment throughout the school year whereas blocked practice will not revisit past topics/modules.

Memory can be split into two categories, implicit and explicit. Implicit memory refers to the unconscious, unintentional influence of past experiences on present behaviours, thoughts, or actions. Alternatively explicit memory refers to the intentional recollection of past facts, events, and information.

For comparison explicit memory involves conscious recollection, while implicit memory operates at an unconscious level, influencing behaviour without conscious awareness. We can use this knowledge to target the development of certain skills in pupils. Focusing on the implicit will help with performing tasks automatically such as writing and reading, whereas focusing on the explicit can improve academic performance through recalling information and critical thinking.

Artificial Intelligence in Schools - RAICA Responsible AI for Computational Action

The use of AI is now universally accepted and in education developments are beginning to change the landscape as we know it. While AI holds immense potential in education, it's essential to use these technologies ethically and focus on enhancing the learning experience rather than replacing human interaction and guidance.

For teachers, AI can be a fantastic tool in reducing workload through accelerating administrative tasks and planning. The vast amount of easily accessible resources through using AI provides teachers with a much larger pool to pull resources from to create content for their lessons. This streamlining process can help provide inspiration to vary up course content in schools, and provide new and innovative ways for pupils to engage with it.

Furthermore, through the analysis of data AI can provide other services such as the automation of marking and grading tests and the personalisation of lessons. The study of the individual pupils' progress can help give insight to educators and help tailor a more personalised learning experience.

For pupils it can provide a different avenue for them to develop their skills or help them grasp concepts at their own pace. Additionally it can offer additional support through providing explanations and offering guidance in various subjects. It's an instant and constantly accessible tool available outside the classroom and can even provide experiences that aren't offered in school. Examples being developed include the use of games, virtual reality and simulations in the pursuit of learning.

It must be acknowledged that if not used responsibly AI has the potential to provide a "shortcut" to the learning process and replace the important teacher-led aspects of education that are paramount in our pupils' development. Collaboration between school and pupils is crucial in ensuring that this risk is minimised.

The MIT Philosophy

During the week I had the experience to talk to and learn from many professionals, and when learning the process of administration it struck me on the different ways MIT teaches its students. The university strives to create "problem solvers and team workers" and their approach is to create more traditional "all rounders" within their discipline. Students are expected to take 8 modules within Humanities and Sociology subjects along with their specified degree subject. This attitude can also be applied to our new cross curricular application in our new curriculum.

Application towards the Welsh Curriculum

Games and Simulations for learning

There are many ways in both creation and the playing of games is applicable to our new curriculum. First what must be considered is the type of game created and within which discipline. The creation process certainly fosters collaboration and within our new curriculum there is ample opportunity for this. If they develop the skills to create a game as an effective learning tool within one area of learning experience then there is potential to use this as a replicable blueprint for other subjects.

The game itself can be catered to whichever skills you seek to be developed. A memory game can not only enhance memory for subject terminology but can be used to connect dates or equations. Not only this but the creation and play of memory games can improve fine motor skills, short term memory and perseverance. If they were to create and play a quiz game instead this targets the enhancement of subject knowledge along with creativity and innovation.

Why integrate playing memory games as part of the curriculum?

Games encourage consistent active participation, very rarely can engagement be guaranteed in other tasks but the playing of games requires this. In order to keep track of game progress, focus and concentration are key to track the placement and content of cards. Whilst providing a challenge to the brain to remember information, patterns, or sequences, it also provides regular practice that can enhance memory retention and recall abilities. These benefits are universal across age groups as it can be used in primary school to aid in the learning of new subjects or languages, whilst also aiding secondary students attempting to recall facts for examinations at GCSE level.

Using these games as a learning device can promote social interaction between pupils and help build confidence. Playing a game fosters an atmosphere that allows for natural progression as pupils feel more relaxed. This could have excellent application in Welsh Language schools, where it can actively encourage pupil interaction in Welsh. Many pupils who attend Welsh schools come from homes where no Welsh is spoken at all and it is most effective to maximise the amount of time pupils use the Welsh language. As a teacher in a Welsh medium Secondary, I have seen first hand the effect the COVID 19 Pandemic has had on the language progression of our pupils, particularly concerning speech and reading. I believe any tool that can help in both of these aspects is especially useful.

Workshop Game concept - Food Chain Frenzy

We decided as a cohort to divide into subject disciplines in order to create a game targeted to an audience of our choice. Using our shared expertise in the same field we could create a game targeting the skills/information that were most important for secondary school pupils. As a biology teacher myself, I had formed a group with other biology teachers on the course.

Reflecting on the past lectures and ideas that have been developed by some of us in the group, we decided to create a memory game. Our concept was simple, to outline a clear win condition through collecting a food chain and adding a competitive element through disallowing your opponent. The learning objective was to test the student's knowledge of certain environments, while also testing their knowledge of trophic levels and predator-prey relationships.

Through adding various food chains from different habitats into the game, players can compete to steal important organisms to prevent the completion of chains for the opposing player.

Our game was designed for pupils who have been introduced to the topic, so are aware of the definitions within a food chain, but through playing the game other teachers who tried it noticed how much they'd learned about organisms' role in their habitats. The collecting of pairs means you track your own progress, but for effective strategy the player must also track their opponent.

I believe these models can be replicated and adjusted not only for difficulty in the same subject area but for uses in other areas such as humanities. This could be used for locations, historical figures or dates, while providing a good platform for when pupils need to learn two sides to a debate to answer a question fully.

What other aspects can improve memory in pupils?

The consistent theme in improving memory is active participation, pupils should never feel like they aren't fully occupied by the task at hand. Within science, modules are taught one at a time across the year per term in the form of a topic within biology, chemistry and physics. This may be counterproductive in the long term as by the end of the year most of the topics covered in the first term would have been forgotten. Reviewing course content over spaced intervals provides a more structured format for a more holistic and comprehensive approach to learning.

This approach to improving memory can be integrated to the Welsh Curriculum through enriching learning through life experiences. Through practice and relating STEM concepts to real life, this has proven to help memory. Diversifying the way we teach through multiple modalities can also enrich pupils' experience. Memory itself can be reinforced through presenting information in multiple channels, such as visual and auditory channels to accommodate different learning styles.

Scratch - How is this useful?

In the pursuit of enabling pupils to understand the digital technologies we use everyday, coding has fast become a foundational skill for this exact purpose. The Scratch software is a block based programme which is easily accessible for school pupils in Wales. The programme is visually appealing and requires very little in the form of typing, as blocks can be selected, then dragged and snapped together. Coupled with a simple four directional format it's very easy for beginners and does not require any prior programming knowledge.

Programming using more recognised software such as Python can be initially intimidating for younger learners, so Scratch provides a useful stepping stone.

The nature of the platform is collaborative, allowing pupils to share projects with each other, and using worked examples they can take inspiration from games or simulations designed by others. Furthermore, this can foster creativity and can be converted to cross curricular activities by having collaborative projects between subject disciplines. Most importantly, programming proficiency itself will only become increasingly valuable in the now technology driven world.

Robotics - Is teaching robotics and the designing of a social robot useful?

This was a field I had very little familiarity with. As a science teacher I was intrigued by the nature of robotics but hadn't heard of the field until I was an adult, so was surprised at the availability and abundance of robotics at secondary level in the USA. Speaking to other educators provided important context as to why they considered it important, so reflecting on this I plan to create and teach robotics as part of our school's science curriculum for KS3 this year.

As teachers we want to provide ample opportunity for pupils to use scientific inquiry and curiosity. Robotics can provide a window into far more modern aspects of modern technology to foster inspiration among pupils. The early incorporation of teaching robotics helps pupils acquire competencies crucial for success in our rapidly advancing technological landscape. Access to robotics could drive engagement and give opportunities in tech driven industries which are expected to grow in terms of recruitment, the major industries being AI, automation, engineering and software development.

A project that I will try to implement in our school is the designing of a social robot. This will be done in groups, in stages across multiple lessons. Starting with coming up with a concept and ending with a presentation, learners will create a full design of a social robot, listing how its technology helps it adapt to its purpose.

The definition of a social robot is a robot designed to communicate and interact in a social and interpersonal manner. They are designed to make interactions between people and machines more natural, of which many innovations already exist in our homes. Pupils will be encouraged to take ideas from creations such as the Roomba (a robot vacuum cleaner) for their own idea. Working in groups will also foster collaboration in the design process, whilst they'll also be encouraged to incorporate other technologies such as cameras, facial recognition and GPS.

Conclusion

My perspective on science teaching has certainly changed after the completion of this professional development. Our new curriculum offers a chance for us to strive to improve on our current model for teaching science and there is certainly scope for this to happen. The very nature of science creates an inevitability that the correct answer to many questions shift due discoveries or interpretation of evidence. In the information age, this has been accelerated as access to this information is abundant.

Within the sciences discoveries are constant, so certain aspects will always be "out of date" as events and discoveries outpace the speed curricula can be modified to fit. Furthermore, if we attempted to cover as much as possible to imitate this, this would encourage short term memorisation over deeper learning, in a rush to cover content.

Looking to the future, it must be considered if we are teaching science in the way outlined in the new curriculum. As per our first "what matters" statement for Science

As ethically informed citizens, learners will need to consider the impact of our actions and of scientific and technological developments, locally and elsewhere in Wales, as well as in the wider world, asking 'Just because we can, does that mean we should?'

Within the framework of Science and Technology we emphasise the scientific method, and the concept of theories which are based on observable evidence. The constant exposure of information, regularly through short form videos on social media content can affect their attention span and critical thinking when assessing this information. For our pupils to grow to be ethically informed citizens it is key that they acquire and retain this ability to assess information and its validity, to prevent the spread of misinformation.

As an addition to the teaching of the scientific method, more emphasis should be put on the effect of bias and societal implications. Our science education should prepare our students to assess the world around them critically and to persevere through the challenges they'll face later in life. Not all pupils will become scientists, but all face societal pressures that can affect their decision making, so all we can do is give the tools to make a firm and informed choice.

MIT SEPT 2023 Reflection Report

Ellie Denscombe

During the SEPT programme for teachers 2023 my chosen thematic track was 'Broadening Participation in STEM'. We delved into various barriers to participation including gender, cultural differences and socioeconomic factors. It was the latter that was of most interest to me as the gender discussion was focusing more on how to increase the number of females opting for STEM subjects as their chosen tracks. We discussed a number of strategies to broaden participation and below I have included links to some useful online resources and research relevant to Wales. It is important to note that many of the resources are not restricted to STEM teaching, but are of general use in supporting the four purposes, integral skills, cross curricular skills and cross-cutting themes.

Creating norms, building community and laying foundations

Overview

This session helped to reinforce the importance of establishing a proactive approach to creating a positive learning environment. As teachers it is our job to set the foundations for our learners to experience respectful interactions which support their academic successes whilst also contributing to their social and emotional development.

Reflections / lessons learnt

As established teachers / educators we can often take it for granted that our learners are aware of our expectations without us being explicit or offering clarity. It was a useful reminder that even through our individual classroom management strategies we are able to support several aspects of the Welsh curriculum.

The creation of norms will ensure we have a positive classroom culture / ethos by creating a shared identity and collective responsibility. This can be achieved by encouraging our learners to collectively agree on how they will communicate with, and support each other. Norms help to clarify expectations and contribute to effective classroom management. Frequently revisiting the agreed norms allows teachers to address disruptive behaviours and can also promote respect for diversity and inclusion.

Creating norms will also help us to provide opportunities for our learners to develop their social and emotional skills, supporting them to navigate relationships, resolve conflict and communicate effectively. The creation of norms will also help to build trust between teachers and their learners as they see that we respect their input, which in turn will encourage learner voice.

By addressing certain social values such as kindness, empathy and tolerance towards others we can create classroom environments where every learner feels valued and respected.

Useful Links / Resources

The following resources are a useful starting point and the strategies can be easily adapted to fit the needs of the specific needs and dynamics of different classrooms.

Responsive Classroom:
This is an evidence-based approach to teaching that focuses on the social, emotional, and academic growth of students. The website offers resources and strategies for creating a positive classroom environment, including the establishment of norms.
https://www.responsiveclassroom.org/

Edutopia – 8 Proactive Classroom Management Tips:
https://www.edutopia.org/article/8-proactive-classroom-management-tips/

Teaching Tolerance:
Teaching Tolerance has resources for promoting equity and inclusion in the classroom, including activities and guidelines for establishing norms that emphasise respect, empathy, and understanding.
https://www.learningforjustice.org/

Centre for Leadership and Educational Equity (CLEE):
https://www.schoolreforminitiative.org/download/forming-ground-rules-creating-norms/

Cross-cutting themes for designing your curriculum:
https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/cross-cutting-themes-for-designing-your-curriculum#relationships-and-sexuality-education-(rse):-statutory-guidance

https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/cross-cutting-themes-for-designing-your-curriculum#diversity

Application to the Welsh curriculum

Four purposes:
Ethical, informed citizens of Wales and the world

Cross-cutting themes:
RSE has a positive and empowering role in learners' education and plays a vital role in supporting them to realise the four purposes as part of a whole-school approach. Helping learners to form and maintain a range of relationships, all based on mutual trust and respect, is the foundation of RSE. These relationships are critical to the development of emotional well-being, resilience and empathy. An understanding of sexuality with an emphasis on rights, health, equality and equity empowers learners to understand themselves, take responsibility for their own decisions and behaviours, and form relationships that are fully inclusive, reflecting diversity and promoting respect.

Diversity at its most basic, means being aware of the characteristics of others and treating others with compassion, empathy, understanding and equity, regardless of those characteristics. Valuing the different contributions and experiences of those in our social groups strengthens the connections between us and supports the well-being of all members of those groups.

5 developmental pathways – belonging, communication and well-being.

Recognising implicit / unconscious bias

Overview

Implicit bias is defined as the attitudes or stereotypes that unconsciously affect our understanding, actions, and decisions. These biases are not consciously controlled and may be activated involuntarily, even among individuals who do not consider themselves prejudiced or biased.

There are 6 key features of implicit / unconscious bias:

Unconscious nature – we are not aware of our biases or the impact they have on our perceptions and/or behaviours.

Automatic activation – our implicit biases can be automatically activated in response to stimuli and/or situations, leading us to make quick judgements or decisions without deliberate thought (Appendix 1).

Influence on behaviour – our implicit biases can influence our behaviour e.g. how we interact with others, how we make decisions and how we navigate different social situations and/or contexts.

Impact on perception – implicit bias can shape how we perceive and interpret information leading to biased judgements based on factors such as race, gender, age, or social category.

Rooted in socialisation – implicit bias is often rooted in societal and cultural norms and can be shaped by exposure to stereotypes, media portrayals, cultural influences, and personal experiences.

Existence across diverse groups – implicit bias can exist across diverse groups of people, and individuals may hold biases even if they consciously reject stereotypes or discriminatory beliefs.

Reflections / lessons learnt

We looked at several examples that could be classed as 'common examples' of implicit bias including racial bias, gender bias and bias relating to different social categories. Jenny was keen to make the group aware that implicit bias does not necessarily align with someone's conscious beliefs and as individuals we often act in a way that contradicts our explicit values (our individual principles / beliefs / standards that we consciously and clearly endorse e.g. honesty, equality, integrity, respect for diversity).

The Implicit Association Test (IAT) is a useful tool that teachers can use to measure their own implicit bias and start to understand the potentially negative impact these can have on our own promotion of diversity and inclusion, and on our decision making processes. I found this particularly interesting with regards to some peoples implicit bias regarding eFSM learners and often unconscious lower academic success / potential expectations.

This session was a driving force behind me signing up to Challenging Education and delivering a whole school training session on RADY principles and strategies to help overcome learned helplessness. This psychological barrier leads our most vulnerable learners to believe they have no control over their situation / circumstances resulting in them not bothering to try to change or improve. This can be a significant barrier when trying to broaden participation across the curriculum and not just in STEM.

Useful Links / Resources

Implicit Association Test (IAT) – take a test:
https://implicit.harvard.edu/implicit/takeatest.html

Whitford, D. K., & Emerson, A. M. (2019). Empathy Intervention to Reduce Implicit Bias in Pre-Service Teachers. Psychological Reports, 122(2), 670–688. https://doi.org/10.1177/0033294118767435

Raising the Attainment of Disadvantaged Youngsters (RADY)
https://challengingeducation.co.uk

https://challengingeducation.co.uk/wp-content/uploads/2021/10/CBC-RADY-Final-Evaluation-Report.pdf

Application to the Welsh curriculum

By recognising our own implicit bias we will be better equipped to support our vulnerable groups of learners including eFSM learners, YC, MOD, EAL and those with ALN, to name a few.

In turn this will also ensure as teachers we are supporting cross-cutting themes such as RSE, Human rights and Diversity.

Four purposes:
Ethical, informed citizens of Wales and the world

Understanding microaggressions

Overview

Microaggressions can happen as a result of implicit / unconscious bias. They are recognised as the everyday verbal, behavioural, or environmental indignities (whether intentional or unintentional), that communicate hostile, derogatory, or negative prejudicial slights and insults toward culturally marginalized groups.

- coined by Dr. Chester Pierce in 1970
- resurrected by Dr. Derald Wing Sue in 2003

> "People who engage in microaggressions are ordinary folks who experience themselves as good, moral decent individuals. Microaggressions [...] are outside the level of conscious awareness of the perpetrator"

Although seemingly small, they can take a psychological toll on their recipients and make their environment (in our case, a school) feel hostile.

- Perpetuate stereotype threat
- Create more barriers to success in school

Reflections / Lessons learnt

This session highlighted how by recognising and addressing microaggressions we can promote inclusivity within our classroom. When our learners feel seen, heard, and respected, they are more likely to engage actively in learning.

Teachers are role models for their learners and it is important for us to model respectful behaviours. By addressing and preventing microaggressions, we will automatically model respectful behaviour, which will in turn encourage our learners to treat each other with empathy and kindness.

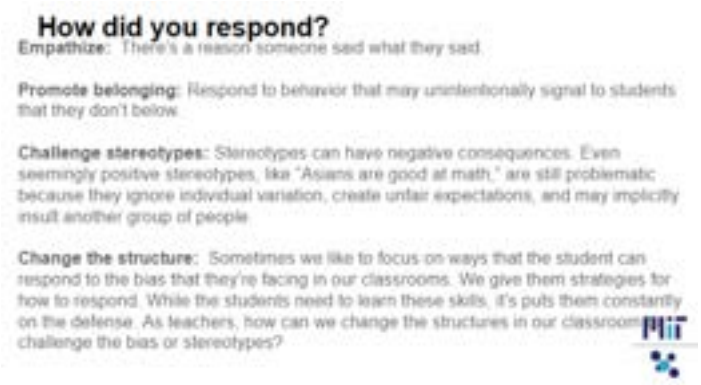
By actively working to understand and address microaggressions, teachers will cultivate empathy. They develop a deeper understanding of the diverse experiences of their learners, creating a more empathetic and supportive learning environment.

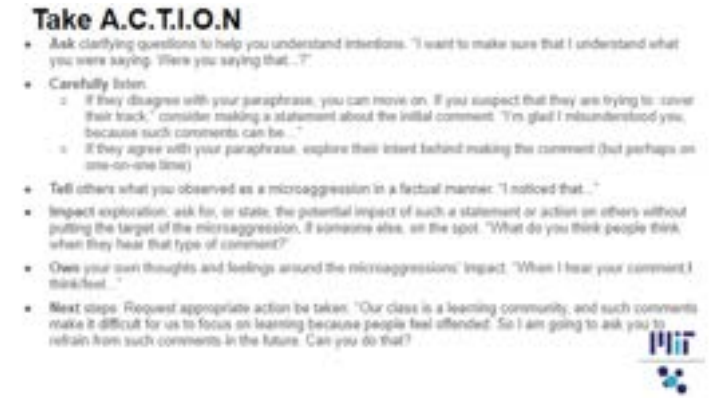
Ultimately, Jenny helped us to better understand how addressing microaggressions is a continuous process that contributes to the development of inclusive, respectful, and equitable educational spaces. Teachers who actively work to create such environments enhance the overall learning experience for their learners and contribute to positive social change.

Useful Links / Resources

https://www1.ucdenver.edu/offices/equity/education-training/self-guided-learning/diversity-equity-and-inclusion-101#ft-what-is-a-microaggression-0

Lewis, C. M., DuBow, W. M., & McMullen, K. (2019, February). Leading Conversations about Microaggressions, Bias, and Other Difficult Topics. In Proceedings of the 50th ACM Technical Symposium on Computer Science Education (pp. 805-806).





https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design/#a-curriculum-accessible-to-all

Application to the Welsh curriculum

Critical Thinking

Addressing microaggressions promotes critical thinking skills. Teachers can engage their learners in conversations about bias, stereotypes, and discrimination, encouraging them to think critically about sensitive topics such as identity, diversity, and inclusion.

A curriculum accessible to all

Teachers who are attuned to microaggressions are more likely to evaluate and adapt their curriculum to be inclusive and representative of diverse perspectives. This enhances the educational experience for all learners.

Cross-cutting themes:

RSE, Diversity

Four purposes:

Ethical, informed citizens of Wales and the world

Inclusive assessment

Overview

Inclusive assessment refers to the design and implementation of assessment practices that strive to be fair, equitable, and accessible to all students, regardless of their diverse backgrounds, abilities, or characteristics. The goal of inclusive assessment is to create an environment where every learner has the opportunity to demonstrate their knowledge, skills, and understanding without facing unnecessary barriers. Inclusive assessment should always align with the principles of diversity, equity, and inclusion in education.

Reflection / Lessons Learnt

This session certainly helped us to reflect on the type of formal assessments we use and highlighted the necessity for using a variety of assessment methods to accommodate different learning styles. Suggestions included a mix of written assignments, oral presentations, projects, and group work, all designed to give a more holistic overview of the learners progression.

An interesting part of this session focused on the importance of giving clear instructions and expectations to minimise any ambiguity and reduce anxiety related to assessment. Again, I felt this was a good reminder to established teachers that we can often assume that our learners will automatically know what they need to do to complete assessment work.

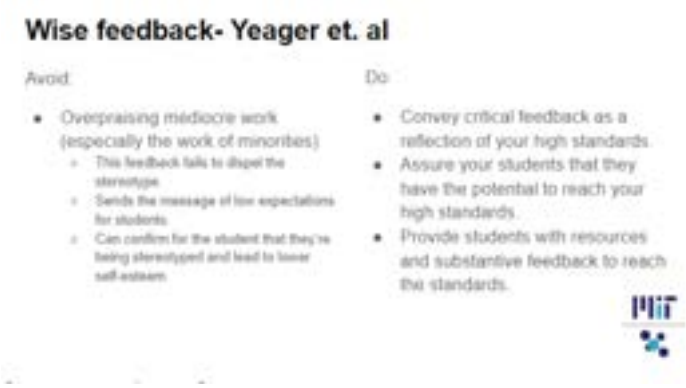
Feedback for improvement should always include constructive feedback that supports learning and learner improvement. Feedback should always be provided in a timely manner and should be bespoke to the individual to help them understand their strengths and areas for development. This session highlighted how hard we work to provide our learners with fair opportunities to demonstrate their knowledge and skills and how much thoughtful consideration goes into various factors that may impact a learner's ability to engage with and succeed in assessments.

Underpinning all of this lies the principle of real life or authentic contexts. Our learners are more likely to make progress if they can understand why they are learning. This session encouraged me to ensure as an AOLE we are making appropriate and better use of the resources we have available to us already such as the Careers Wales website and the CWRE toolkit.

Following this session I also read Rosenshine's Principles regarding 'pedagogy for teaching'.

Useful Links / Resources

Breaking the Cycle of Mistrust: Wise Interventions to Provide Critical Feedback Across the Racial Divide



https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design/#assessment

https://careerswales.gov.wales/job-information

https://careerswales.gov.wales/sites/default/files/images/careers-and-work-related-experiences-toolkit_2.pdf

https://www.pearson.com/en-gb/schools/subject-resources/science/why-science-matters/scientist-of-the-month.html

https://www.structural-learning.com/post/pedagogy-for-teaching-a-classroom-guide

https://www.structural-learning.com/post/rosenshines-principles-a-teachers-guide

Application to the Welsh curriculum

Assessment

The overarching purpose of assessment is to support every learner to make progress.
Assessment should focus on identifying each individual learner's strengths, achievements, areas for improvement and, if relevant, any barriers to learning. This understanding should be used by the practitioner, in discussion with the learner, to ascertain the next steps required to move learning forward, including any additional challenge or support required.

Opens learners' eyes to the full range of career possibilities, including non-stereotypical roles and opportunities they may not have considered previously.

We have now started to include links to potential careers linking to lesson content at the end of our PowerPoints to allow our learners the opportunity to carry out further, independent research into different career paths.

The addition of Careers Wales links at the end of each lesson PowerPoint also helps to embed the authentic context.

Cross-cutting themes:

CWRE

Hands on learning including the use and design of games & simulations (Track 2). An introduction to Scratch for simple game design (delivered by Sarah Wharton

Reflections / Lessons learnt

From the group presentations on day 5 and the lecture which was an Introduction to Scratch on Day 1 the key message I took was that game design offers learners experiences that promote creativity and innovation, critical thinking and problem solving and collaboration.

Such experiences not only offer hands-on, experiential learning opportunities but they also enhance academic learning and develop essential skills for success in a dynamic and rapidly changing world.

The MIT 'Teach with App Inventor' promotes computational thinking but currently I feel we may be limited by resources within our school setting to make full use of this as a teaching resource.
Having access to the shared MIT App Inventor CTCT Curriculum folder has however allowed me to deliver a departmental training session on the use of Scratch.

Computational thinking is a problem solving and analytical skill set that involves learners having to break down complex problems into smaller, more manageable parts. A common misconception is that computational thinking is about programming, but it is not. It can support programming, but it is actually a method for approaching problems and organising your thoughts.

It is important for us as teachers to not let our learners believe that computational thinking is limited to computer science / computer scientist. It is a valuable skill that will benefit them in a technology driven world.

Useful Links / Resources

https://scratch.mit.edu/

https://appinventor.mit.edu/explore/teach

https://education.lego.com/en-gb/

https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design/#cross-curricular-skills

https://hwb.gov.wales/curriculum-for-wales/designing-your-curriculum/developing-a-vision-for-curriculum-design/#skills-integral-to-the-four-purposes

Application to the Welsh curriculum

Cross curricular skills: Digital competence

Computational thinking
Teaching computational thinking skills will develop our learners problem solving, logical reasoning and analytical thinking by encouraging them to approach problems in a systematic and algorithmic way.

Algorithmic Design
Scratch allows learners to develop a step-by-step set of instructions to ether solve a problem or achieve a desired outcome. We will look into how we could use this for our learners to design a game centred around food chains and webs.

The IT department has also incorporated this into their Year 7 SOL and so we researched further opportunities to offer coding as an enrichment activity. We are currently applying for PTA funding to pay for the registration for the Lego Coding competition.

Integral skills

Creativity and innovation
By involving our learners in the (game) design process we can tap into their natural curiosity and creativity. When engaged in something that is of interest to them, learners are more likely to become intrinsically motivated which in turn will lead to them participating in a more creative and innovative process.

Problem solving and critical thinking
Game design in itself requires learners to think critically and problem solve. The design process will require them to consider aspects such as rules and objectives and they will need to make decisions about the educational value of their game.

Planning and organising / real world innovations
As game design is often a collaborative process, by encouraging our learners to collaborate they will learn to communicate effectively, share ideas and work towards a common goal. These are essential skills for developing an innovative mindset, and learners will understand that many real world innovations are born from collaborative efforts. They will learn that they 'need to work effectively with others, valuing different contributions'.

Planning and organising / prototyping
Learners will discover that their initial ideas may need to be refined or adapted following testing and feedback. This will help to 'build their resilience and develop strategies which will help them manage their well-being'.

Cross curricular skills
Game design will typically involve elements from different subjects such as maths (numeracy), language (literacy), art and design technology. Learners will need to integrate their knowledge and skills from across the curriculum to create both a coherent and engaging game. This will also promote holistic thinking and creativity.

Hands-on learning
Game design is an experiential learning activity which allows learners to apply theoretical knowledge to a practical project. The practical application promotes creativity by allowing them to link abstract ideas to tangible outcomes.

Since the training the department have looked to incorporate lessons into the Year 9 physics SOL focusing on game design (produce an educational board game on the topic of Electric Circuits with a particular focus on resistance).

Thank You.

Cardiff
02920 697129

No. 3
The Old Building
Tŷ Cefn
Canton
Cardiff
CF5 1QL

equal
Education Partners

MIT's Science and Engineering Programme for Teachers 2023

Reflection reports from the Welsh educators representing Wales

Llywodraeth Cymru
Welsh Government