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Unlock the secret ingredient

Applying maths vocationally to produce a confident and competent workforce

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Unlock the secret ingredient *– Applying maths vocationally to produce a confident and competent workforce.*

Abstract:

During a research project in 2017 in an interview with an employer they asked one simple question that managed to flip our thinking and our focus about the embedding of maths vocationally. This question posed a consideration to set the challenge for this paper; looking at ways to embed maths vocationally to support wider ability in a new workforce for the 21st century.

The current educational landscape shows that meeting the needs of all is far from simple; there is a situation that requires innovation, juggling, barriers, demands and overall a need to provide a skilled workforce; one that is prepared for a future we can't fully predict. This project needed to look at innovative ways to future proof the workforce of the next 50 years keeping them work ready to their own retirement age; specifically looking at embedding maths in the vocational context that has been identified as an area to develop.

According to the Wolf report (2011) the gold standard in providing maths education to an acceptable level is the GCSE at C/4 or above. The counter to this is that a GCSE in maths does not always provide learners with the vocationally applicable maths they need to succeed in the workplace.

By using interviews with employers, students and teachers the research led to the development and testing of these ideas, the project arrived at exploring the development of maths in the context of basic accountancy; invoicing, ordering, billing and working out hourly rates and time sheets. A range of subjects that transcended many vocational areas and needed little specialist knowledge of vocational teaching staff.

Early findings have shown a positive response from the learners that have trialed the embedded vocationally focused maths content. Other teaching staff in the testing institution are keen to adapt and apply the concept to their own curriculum in the art and design school and appreciate the way it has been developed to need minimal prior maths knowledge by the vocational teaching staff with plans to include the research findings in future CPD events.

KEYWORDS: Embedding, maths, vocational, GCSE

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Introduction

What does the project focus on?

Focus: Why do employers feel that their new employees are unable to apply their maths knowledge in a vocational context?

During a research project for ETF outstanding teaching, learning and assessment – technical skills, national programme in 2017 we held an interview with an employer who asked one simple question that managed to flip our thinking, and our focus, almost immediately towards a more learner focused solution. We had been looking at the links between awarding bodies, college managers, teachers and curriculum and then looking at how it fitted with students and the expectations of employers and their needs too. Our interviewee was from a creative background working in advertising, he simply asked "Why are your students not your main focus? Coca-Cola always focus on their drinkers for their marketing and development so why not do the same?"

We looked at our neat looking diagrams of each stakeholder, their needs and missed the ultimate crossover and focus. We spotted that the student's needs were to get work and the employers needed a certain kind of employee. Neither the focus of the college managers, awarding bodies or regulatory bodies supported the needs fully and effectively. Our focus here was maths, specifically the application of maths in a vocational context. During our further research and interviews we discovered that there is a huge gap between the expectations of what a grade C at GCSE means and what it really offers.

There is a situation that requires innovation, juggling, funding barriers, teaching barriers, demands of awarding bodies and overall a need to provide a skilled workforce that doesn't quite fit in with the conventions and established practice we find ourselves working in.

Why do this project? *- To improve the vocational application of maths after discovering a need for this in an earlier project.*

Why did we care enough to keep going and dig deeper into this subject, aiming to find solutions that meet the needs of all stakeholders, specifically the students and employers above all else? For the authors of this paper it was clearly about a vocational responsibility to provide a suitable education that was fit for the purposes in an evolving society; to future proof the workforce of the next 50 years, keeping them work ready to their own retirement age.

Lord Jim Knight (2017) spoke at a digital futures event at the University of Hull – Preparing 21st Century Educators, about how he had held a number of jobs in his lifetime and how he saw this as a vision of how future life for young employees would be. As industry shifts and changes, as technology shapes the way we work, our industry and indeed our key economic principles of the next 50-100 years. He was quickly backed up by Bob Harrison (2017) who discussed how his young family members are already embracing technology and change at a fast pace, he discussed how much technology has changed in the lifetime of a 16 year old student entering FE education for the first time; how they have learnt to evolve with learning technology. He debunked the myth of the

digital native and went on to explain that anyone who is immersed in new technologies can learn it at the same level.

If we take forward thinking, a passion for education, input from employers, student needs and mix them up in a magic cauldron to prepare an elixir for a sustainable future; a future where a skilled workforce can develop and evolve with changes in circumstances and job roles, where students of tomorrow can learn and develop furthermore, then we will have the perfect solution. How we arrive at that will require some radical changes in behaviour, thought, and the approaches to our current education and curriculum model as it stands. We hope that our research can begin to set the stage for some of the more substantial changes that need to follow.

What is the aim of this project? - *Develop a solution to help progress the vocational application of maths in a suitable context for these learners. This should be for all learners, and not just those needing a GCSE grade improvement.*

We are well aware of a number of issues that need to be considered in how we move forward, and we appreciate that the full solutions are perhaps well beyond this research project and any evolution of it. It can however start to examine some of the areas that can lay a foundation for the shifts in focus and development to allow a solid foundation on which to build further concepts and findings.

Issues linked to the project:

The following commentary discusses thoughts around key issues that surround the context of the project research in a point by point format. All of the points raised feed into the development of the project and the thinking that surrounds it.

Wolf report (2011) gold standard GCSE – According to the Wolf report the gold standard in providing education to an acceptable level is the GCSE at C or above. The downside to this is that the GCSE does not always provide learners with the vocationally applicable maths they need to succeed in the workplace.

Employers wanting GCSE – Employers think that they want to see a GCSE at grade C or above to show a level of competence, but based on our findings, they often discover that their new employees are unable to make use of the maths in the real-world situations placed in front of them. Eg, calculating VAT, scheduling, decimalized time for pay claims etc.

Embedding improves maths knowledge and application (Casey, 2006).

Embedding maths also impacts on a wider culture leading to improved retention and awareness of being prepared for working life (Russell, 2014).

Teaching maths needs specialist knowledge (Coffield, 2008).

CPD for vocational staff is a barrier to progress. We are well aware that some teachers find that maths as well as English, can leave a level of anxiety that stands as a barrier preventing the effective embedding of such skills in vocational contexts. Not all staff are open to CPD to help improve skills

and move them on from such anxiety and worry; creating a barrier to delivering embedded maths and English to a competent level (ACME, 2011).

Technology and blended learning could offer solutions – If CPD is a barrier, can we make use of blended learning delivered by specialist and knowledgeable staff to support the development of embedded maths? Would it be suitable to do something similar for the CPD sessions so that a multi-faceted approach can be used to support skills and learning for students and the teaching staff delivering the vocational courses and curriculum.

CPD solutions could be worked on – Can we work with SLT to find solutions for CPD to up the game in terms of embedding? Any developed models can be used for English and wider employability skills too.

Students like maths focused on their subject specialism – Learning is much easier when there is a motivator. Based on our interviews, if maths is vocationally relevant learners can see the point; they can relate to why they need to work on these subject areas as they see a link to the work they may do in the future.

OFSTED like to see maths and English embedded into curriculum – analysing a number of OFSTED reports, it is clear to see that embedding is seen as good practice and is monitored during inspections. Any evidence to show suitable and vocationally relevant embedding of maths may be perceived as meeting this need.

Our college have a high intake of learners with low GCSE grades for maths in the region – The college have one of the lowest attaining cohorts (at intake) for maths at GCSE of all GFEs (General further education colleges) in the midlands. It would be fair to assume that any level of embedded maths will only help to prop up the GCSE maths courses that these learners will need as part of their study program.

Being focused on an exam and qualification as the outcome, not the vocational application of maths; The teaching to assessment method of TLA has been a hot topic over recent years. GCSEs do not prepare students for work and further study - Magnus Bashaarat for *TES* says the case for "GCSEs stifle creative teaching because teachers end up teaching to the test. So rather than the 11 to 18 school experience being conceived and delivered as a continuous, sustained and increasing curriculum that inculcates understanding and develops skills, it is instead divided into vast subject silos, only a small number of which are currently in favour with its political architects." (Bashaarat, 2019).

Literature Review

Throughout recent years, there have been many different perspectives on curriculum design and learning theories, but what is learning? There is no clear way to define learning which would please everyone.

Coffield (2008) defines learning as "the transmission and assimilation of knowledge and skills". He sees learning as a social process, one that is "intertwined and reciprocal". Many would argue with this definition and want to include something more formal and tangible which might include the terms 'stimulus/response'; a cognitive process; individual differences; constructing and developing new ideas with past experiences.

To simplify matters, the two main types of learning are *Formal* and *Informal*. Formal Learning offers a well-planned, structured programme which has been designed by the 'experts', whereas Informal Learning is seen as the "learning beyond the classroom" (Bentley, 1998), which is often unplanned and incidental. Coffield (2000) claims that "Informal Learning should no longer be regarded as an inferior form of learning whose main purpose is to act as the precursor of formal learning; it needs to be seen as fundamental, necessary and valuable in its own right, at times directly relevant to employment and at other times not relevant at all."

The learning of maths is said to be a complex process and for many it is everyone's most hated subject, seen as difficult and impossible to learn. Since 2014, 16-18 year old students are mandated to attend maths and English lessons with the goal of achieving the GCSE 'gold standard', grade 4 (C grade). The students who attend maths in FE colleges have usually failed and come to college with negative attitudes and poor experiences with maths.

Maths Anxiety (MA) is common in these circumstances and the link between learning and achieving maths qualifications is often attributed to levels of anxiety or confidence within the subject, according to the study conducted by The Nuffield Foundation (2011). Feelings of anxiety and emotions linked to the learning of maths are often overlooked. Dweck (2015) argues that it is vital to take people's prior experiences and maths mindsets into account when planning maths lessons. So how should this affect the way teachers teach maths?

Curriculum Design – why is it so important?

For too long, we have been bound by traditional curricula structure and set teaching techniques. Hence, designing the curriculum to meet the needs of everyone involved is a huge ongoing challenge. After listing all the elements and content needed to be delivered it is often hard to ensure the lessons are delivered in an engaging way to help students achieve. This is where the curriculum design becomes so vital. So how do we create engaging and inspiring lessons? As teachers and educators, we need to explore the models available to us and how best to implement them, evaluating and re-evaluating its impact as we go.

Schweitzer (2019) argues that the curriculum design should provide a "purposeful plan which improves learning". The three different types of design are subject-centred; learner-centred and problem-centred and there is a huge debate over which design is better.

- ‘Subject-centred designs’ are based around the subject content; this is usually the traditional prescribed approach to curriculum design, often used in GCSE and Functional Skills provision within schools. Rogers (2016) claims that this model often uses a didactic approach and can disengage learners and cause problems with motivation in the classroom.
- ‘Learner-centred designs’ provide a model where the student’s current level of skills and knowledge drives the learning, often requiring a differentiated approach in the classroom. This humanistic model claims that experiential learning should drive student’s learning.
- ‘Problem-centred designs’ explore the ‘how’ when looking at problems and solving them. This approach is geared to model real life experiences and problems. It offers more flexibility but can sometimes be more difficult to prepare for. The authenticity of this model is said to engage students as they can see the link with real life.

In David Russell’s Review of Literature ‘Effective Practices in Post-16 Vocational Maths’ (2014) he researched the most effective curriculum designs for teaching maths and with a vocational link. The term vocational maths refers to the maths skills needed to perform the student’s chosen vocational qualification, for example, being able to perform basic arithmetic when pricing a job for building a wall for example; or the ability to calculate percentage VAT accurately when invoicing a Photography Shoot; or having an awareness of errors in their work, and many more (ACME, 2011). Examples of embedding maths with vocational courses looks like we’re disguising the maths and hoping students don’t realise. In reality, embedded materials should help students see what maths skills are needed in their vocational courses and jobs. The Vocational maths skills identified by employers are further listed in the Findings section of this report.

Russell found that “there is an apparent disconnect noted between maths learned in school and maths required in daily working and personal life, and a challenge in ensuring that maths and numeracy teaching is relevant for employers.” He also stated that “the lack of employer input to the development of curriculum content acts as a barrier to the usefulness of GCSE qualifications in vocational settings.” Russell found that “the GCSE curriculum is outdated” and “what employers really want is a numerate workforce who are confident and competent with numbers”. His research indicates that maths tuition would be more useful if it was linked to the needs of employment which would help close the skills gap identified in the Wolf Report (2011).

Russell found that Hogden and Marks (2013) stated “the skills deficit is less about the mathematical and calculation skills and more about how mathematics is applied and interpreted.” It is also argued that “more learning needs to be done at home, in offices and kitchens, in the contexts where knowledge is deployed to solve problems and add value to people’s lives.” (Leadbeater, 2000). This also highlights the need for a different approach to teaching maths within schools and the FE sector.

So what should teachers do to improve engagement and motivation in maths?

Intervention and Embedding

Over the years there have been many initiatives to engage students in maths lessons and to improve motivation and achievements. These initiatives have explored the different interventions and designs within vocational maths. The Literature Review by Maughan et al (2016) researched which

interventions were the most effective in improving Level 2 maths outcomes. It found different types of intervention which lead to positive outcomes, these included:

- Support within existing maths classes – where additional support was provided alongside the normal maths lessons.
- Supporting teachers by offering training to selected staff – this ensured that teachers were able to have a wider knowledge of the vocational student and their courses.
- Embedded maths into vocational studies – ensuring maths is relevant and integral to students' course.
- Interventions outside of the maths class – where additional student support was provided as one-to-one extra support or by removing the student from the main maths class for one-to-one support.

The comprehensive review summarised that teachers should adapt their approaches and intervention based on the best interest of the students, one size does not fit all when it comes to learning and intervention. This is supported by Ofsted (2011) which adds the following positive interventions:

- The use of technology to motivate and develops skills with relevant topics.
- Initial and diagnostic assessment at the start of the programme is vital as this ensures teachers know of prior experiences and skills.
- The use of real-life contexts, whether embedded or not, gives authenticity and engages students more effectively.

Dalby and Noyes (2015) found that by offering integrated, contextualised functional skills maths classes the vocational students found the sessions to be more accessible and engaging as opposed to struggling with the traditional maths curriculum approach. However, Russell (2014) found that great care and planning is needed when developing an embedded curriculum. In his Report he states, that contextualised learning "improves both learners' overall understanding and the extent to which they retain the information they have learned" because the learning is relevant and purposeful. Russell states that "piecemeal contextualisation can be limiting to learners" and practitioners need to apply contextualisation across several areas of the broader curriculum to ensure embedded learning is effective.

In the work of Casey et al (2006) key findings indicated improvements when maths was embedded:

- "Learners were less likely to drop out of maths and English."
- There was higher retention with a 16% increase overall
- There was a rise of 26% in course success.

Although embedding seemed to improve outcomes, Casey et al point out that this intervention may not be the only factor in improving retention. The role of the teacher is vital to ensure intervention is successful, Connelly and Clandinin (1992) recognised that teachers should move away from being 'knowledge transmitters' and become 'knowledge producers'. Teachers should allow students to solve problems, to think critically and be allowed to struggle. Whether the student needs intervention approaches or not, they need to develop the ability to 'function' and utilise the information they have been given rather than simply repeat facts. Chappell et al (2015) argues that 'high quality training for tutors' is essential in the embedding process. Training should allow

teachers to be fully aware of the students' vocational needs. This takes time and commitment from both the teacher and the organisation (Fuller and Unwin (2003).

James and Biesta (2007) argue that "good practice is infinitely transferable", insinuating that learning and achievement is mostly reliant on good teaching but this assumes that we all have willing students who are wanting to listen and learn. The emphasis on the acquisition of knowledge assumes that all students learn everything given to them at the same rate, which is not always the case.

Institutions need to support the development of 'communities of practice' to support the "groups of people informally bound together by shared expertise and passion for a joint enterprise" (Wenger and Snyder, 2000). This is further supported by Casey et al (2006) who also state that without teamwork, contextualised learning and resources cannot be truly authentic.

Summary

Embedding learning is not without its pitfalls. Designing a combined curriculum takes time and commitment, it takes careful planning and requires all stakeholders to be involved in the planning process. Institutions play a huge cultural importance in ensuring the success of a new curriculum model. It requires teamwork, shared beliefs and values and an ability to recognise connections in shared content.

As teachers we need to allow our students more freedom to explore their own learning styles and to allow students to 'struggle' whilst solving problems. Teachers need to embrace the role of informal learning in their classroom community. They need to develop critical thinking skills; to allow students to experience 'struggle' in a safe and secure classroom environment, thus accepting that the world of work is challenging and requires students to think harder and deeper.

Research Methods

After much consideration, it was decided that this research project primarily needed qualitative data (with a small proportion of quantitative data) in order to gain a deeper understanding of the impact the research had. This allowed the researchers to measure the impacts and effects it had on the students with the hope to enable a mechanism of change within the curriculum design and offer a model for future lessons. Some quantitative data was also used to ascertain the wider need to improve maths overall for learners improvement.

Using Narrative Inquiry, offered the 'how' humans experience the world as opposed to just describing the 'what is happening?' (Connelly and Clandinin, 2011). Focus groups and interviews allowed the participants to recount their experiences and offer reasons behind their attitudes and feelings. The aim was to give the researchers a deeper understanding to find a practical solution whilst taking human feelings and experiences into account.

This practitioner-led research took place in a large FE college in the East Midlands. The research focused on a group of 20 students studying the Level 3 Photography course at the college, at an offsite venue close to the city. The focus group subject area was chosen for its accessibility to one of the researchers. The students formed a focus group where they were given embedded resources in one of their 3 hour lessons over 4 weeks, totalling 12 hours. Using the theme, ('How much are you worth?') lessons were designed to enable the students' independence and reliance on one another rather than a heavy reliance on the tutor's input.

The schedule of lessons is given below. This indicates the purpose of the activity and the findings are discussed later in this report.

Schedule of lessons:

Lesson Number	Purpose	Activity
Lesson 1	To estimate how much you would like to earn to support your dream life.	What's your dream wage? Think of the life you would like to have…what money will you need to earn? List the activities and items you would like.
Lesson 2	To identify the best value of equipment hire and total costs needed for the job.	Calculate your day rate for a job. Research equipment costs and present the information to your partner.
Lesson 3	Manage costs and create a quote.	Produce a quote to photograph 300 different items for a website.
Lesson 4	To calculate costings and VAT correctly. To present information to others.	Research Task – use a quote to predict costings for a job. Include all aspects of running a business, including your VAT. Present your findings to the group.

Full details of the lesson material used can be found in the Appendices (fig 1.4).

Once the lessons were completed, the focus group were interviewed as a whole to ensure their views emerged with one another's interactions rather than a reliance on the researchers' agenda. Some would argue that this is an unnatural setting, but in the education world it is commonplace to freely discuss and assess as a group. The interactions from this have yielded great insights into

student preferences; mind-set and general attitudes towards maths, and offered emotions held from past experiences.

Contact was later made with the participants to follow up on any further impact after the sessions. This was achieved via a short questionnaire using open-ended questions which was designed to explore how students felt about the lessons and the possible links they made to everyday life. The questions included:

- Do you have any thoughts and feelings about the 'how much are you worth?' task?
- Do you value the link the task had to employability?
- Is there anything we could have done to make the task more engaging?
- Would you appreciate further tasks to address issues like this in the future?
- Do you feel applying maths to a context that is real world useful is more relevant then textbook examples?

As part of the narrative Inquiry method, unstructured interviews were also undertaken with a variety of staff and students as well as external links. The managers involved comprised of 3 x Learning and Skills Leads; 2 x Heads of Schools; 1 x Head of Quality; 2 x Directors. The main focus group comprised of 20 students who formed the existing Vocational class. The other students formed part of the existing maths classes. The findings of this research are based on the responses from these participants.

Site	**Participants**	**Research Method Used**
Main Site	8 managers	One to One interviews
Off Site (CHT)	20 students: Photography Level 3	Focus group Field Notes
Main Site	58 vocational students attending maths lessons: 7 x Health and Social Care Level 1, 8 x Bricklaying Level 1, 6 x IT Level 1, 5 x Motor Vehicle Entry Level 3, 6 x Plastering Level 1, 6 x Travel and Tourism Level 1, 10 x Catering and Hospitality, 8 x Childcare Level 1.	Group discussion/interviews Field Notes
Main Site	14 Vocational Tutors: 3 x Hair 4 x Photography and Art 2 x Brickwork 5 x Carpentry and Joinery	One to One interviews
Main Site	8 Maths specialist tutors	Group discussion/interviews
Employer Links	5 members of the Board of Corporation 4 Employers	One to One interviews
Practitioner/Researchers	1 x Maths specialist 1 x Photography specialist	Field Notes

Vocational Staff were also interviewed to ascertain their own views on their classes and what links they make. They were asked the following questions:

- How does maths link with your vocational area?
- What maths links do you use in your classes?
- How can the maths team improve engagement?
- What worries do you have embedding maths in your classes?

Within the 58 Main Site students, free-ranging discussions established a basic understanding of the students' prior experiences and what motivates them. Questions asked included:

- How were you treated in maths prior to this year?
- What will stop you from learning and achieving in maths this year?
- What should your maths teacher(s) know about you?
- How can we make maths more interesting/relevant?
- What motivates you in maths?

Quotations from the interviews are given in the findings section of this report.

Ethics

Participants were invited to take part in a research project in education, specifically looking into developing applied maths in a vocational context, along with how and why to embed maths in a vocational curriculum. The project was conducted in line with BERA ethical guidelines for educational research 2018. Consent was sought from all individuals and institutions involved in the research and they were given the right to withdraw their input from the research. All participants are anonymised throughout the research. All information collected will be kept and stored in line with general data protection regulations.

What we expected to find:

It was anticipated that feedback would show simply that students would be engaged and want to complete the tasks set. In reality it was much larger, what we found was that the learners desired more project work based on similar skills development with a genuine appreciation of the impact it could have on supporting them in the world of work. We did not expect the learners to have such positive attitudes to this way of working in comparison to attitudes to learning maths in a traditional classroom scenario and environment. As teachers we learnt more about our students and their past experiences by listening and observing as opposed to controlling the situation fully.

Findings

The findings of this research have taken a variety of forms from a meandering journey of research. The Narrative Inquiry enables the findings to be represented as qualitative data, in the form of observations and field notes. Here is a collection of reflections from the teaching staff and students that took part in the study. Further Field notes are provided in the Appendices.

Field Notes – Maths Specialist Tutor (Appendix fig 1.1)

Summary

The maths concepts naturally arose throughout the session.

The students were engaged and helped each other.

The tutors were only asked for guidance if all the students couldn't help, for example, some didn't know what £35,000 looked like when written down.

The lessons worked because the students had a basic understanding of maths concepts.

Field Notes – Vocational (Photography/Art & Design) Tutor (Appendix fig 1.2)

Summary

The workshops appeared to be well received and the student feedback was very useful to give considerations for the future. More depth and detail along with a more specific set of instructions may be more useful for lower level learners.

Once learners were able to see the vocational relevance and the impact it could have on them gaining employment, they appeared to show a motivation that was surprisingly positive.

The students felt it a struggle but all that took part were able to produce a worthy outcome and grasp the task in hand.

The prospects for adding a wider skills base to a much larger project in future would perhaps be a good consideration based on the feedback from learners.

<u>Field Notes – Focus group of students taking part in the study</u> (Appendix fig 1.3)

What the students thought about the project workshops:

Using a random selection of students present for the workshops that looked at the how much are you worth project. They were asked to tell us about their own experience, in two instances they struggled to know what to write about so we gave them some starting points from which to discuss and place their responses in context. These questions were still designed to give and promote open answers. In all cases the feedback was gathered in line with BERA guidelines and the students have been anonymised for the feedback.

Summary

All of the learners in this feedback, and feedback taken during the class in note form, indicated that they found the project worthwhile and engaging, they clearly saw the maths element as a secondary factor and employability skills as the main focus.

It was interesting to see that Student C felt that the workshop was not a "workshop" at all (perhaps because we called it a task) and indicated they would like it to be more in depth and more workshop like; this would be an interesting development area for the future of this project.

We intentionally left the learners to find their way in the task with minimal intervention as described in our rational for the workshop; this was to prove that teaching staff did not have to be maths experts and that given time students can navigate a problem themselves. This is very clear in the feedback from student B who said they would have liked more instruction but also identified that they managed anyway. Perhaps this can be considered when developing further project work with a little more detail, but keeping the same ethos to problem solving for the students.

Student A saw a clear impact on vocational areas, and employability, and was able to see clear links between their chosen career pathway and the content of the work.

Key findings

What responses did we get?

Employers skills set needed:

Employers and industry professional feedback gave us a number of key sets of skills that they felt were required in the world of work. We distilled them down to the overarching topic of basic accountancy; invoicing, orders, scheduling, costing and tax as essential employability skills to cover a range of industries.

Findings from students' responses:

The 58 students spoken to during initial interviews had poor experiences of maths in school; 40 of the 58 felt this way. They gave distractions by others and themselves as a large barrier to learning, but, boredom and lack of self-belief also featured high in the results that impact. When asked what they felt would engage them more, the importance of relevance and 'game' type activites ranked among the main identified changes they would like to see.

Of the 20 students in the pilot 85% expressed a lack of confidence in maths prior to completing the tasks. This decreased to 35% once the scheme had been completed. One student explained, "It all makes sense, which is unusual for maths." When asked about the impact of the pilot, one student explained, "I find that tasks like these will help me or someone else with the reality of earning money in any career that they take. And I feel it kind of prepares us for what the real world is like." This quote is representative of the wider sample.

Teaching staff findings:

Vocational staff almost exclusively felt that relevance and knowledge of vocation subject area and life skills made for more effective teaching. Vocational teachers felt their own skills base and anxiety about the subject left them feeling less able to offer the support learners may need. We soon realised that the CPD need, or ways to mitigate that need, were important to any solution we developed. We were aware of the maths anxiety for learners from the Nuffield foundation (2011) but had not accounted for the impact on teaching staff.

Maths specialist teams felt that embedding was taking place but, it was not fully linked in a vocationally relevant way for the learners they were working with. They said that barriers to more embedding included time, collaboration within other teams and how to communicate effectively with vocational areas.

What surprised us?

It wasn't anticipated to see how many vocational teaching staff felt an anxiety towards maths and how they could teach it themselves in their own areas and classes. Finding this out at such an early stage meant we could develop a programme to mitigate the reliance on the vocational teaching staff in the delivery.

When the learners were observed on the student led class, we had not expected to see the self-directed and informal learning taking place the way it did. It was clear that the initial struggles of the learners didn't lead to abandonment of the project, but to problem solving taking place independently. We found clear links with the curriculum development model linking Bentley (1998)

and Coffield's (2000) comments in the literary review highlighting the importance of informal learning and learning beyond the classroom.

What were the limitations of the study?

Naturally a small sample for the pilot is not fully representative of a range of vocational areas, and being from a creative area, may not fit the traditional view of a vocational subject area. Although we did include the views of teachers and students from a range of vocational areas.

Quantifying the outcome of the research is hard in terms of quantitative data, but the qualitative feedback from learners indicates that the potential for this kind of supportive study has a greater place in the wider curriculum of vocational subjects. The nature of the narrative inquiry gives an interesting result beyond the facts and figures that limit creative responses to curriculum design.

The relatively short timeframe of the study will naturally limit the findings, but it would be nice to expand the study over more time, more areas and more specialisms. Giving an opportunity to look at the wider need for vocationally relevant employability skills development; embedding of maths, English and communication skills for a highly skilled and productive workforce of the 21st Century.

Did anything change from the original plan?

Initial plans were to integrate maths into vocational lessons for GCSE. We realised that to embed vocational maths in a GCSE curriculum is complex. What we could do was to support the GCSE by adding and embedding the maths into the personal development and vocational aspects of the curriculum. Delivery of this would need some CPD development for vocational staff, but using the system we have developed, it may need much less than embedding maths from scratch.

Recommendations

The outcome of this research has certainly led us to look at how we embed maths into our own sessions and will be implemented into our own teaching practice although we hope to explore more critical thinking skills associated with the skills development in maths and application of maths and get other teachers on board within our college.

We have several recommendations beyond our own practice for the leaders and managers in all GFEs as well as any policy makers that can incorporate the findings relating to the findings of this research.

- It is recommended that managers take the model of embedding vocational maths in the way used in this study and expand it to include different vocational areas in the college and monitor the impact over a longer period of time.
- Share the project and outcomes as a part of CPD and future collaboration inside and outside of college.
- Empower teachers to take the risks associated with trying something new in pursuit of exploration in curriculum development.
- Develop a wider community of practice for research throughout the college to explore the subject area of embedding much further.

- It would be wise to further engage a range of employers to feed into further project of this kind, perhaps taking this beyond maths and include wider employability skills as a whole.
- Expand upon the research to explore links with meeting the needs of the new OFSTED Education Inspection Framework (EIF). This could look at maths, English and wider employability skills being embedded in a vocationally relevant way and not just as a 'bolt on' session to be delivered along side vocational qualifications.

Dissemination strategy

To produce research without a means of sharing the findings and narrative of discovery would be a huge shame so it is anticipated to share our findings and champion the benefits of making embedded subjects vocationally relevant. The aim is to share the findings and project over a range of platforms including and not limited to:

Sharing findings and the project in CPD staff development festival and Research Workshops.

Sharing and discussing findings at ETF Annual Research Conference (London, 2019).

Sharing findings with managers and Senior management team within college to highlight the importance of vocationally relevant embedding of maths.

Encourage other colleagues to explore research in their own practice through a new internal working group.

Final thoughts:

The spark that started this research came from some small discoveries and it gathered pace as we found out more, we now have even more growth to our thinking established by this project and look forward to exploring more. Looking in depth how we can provide learners with the best possible skills set to help them gain employment in the 21st Century. We hope that the journey will be lengthy, complex and interesting but that it will also be of great use to the future workers of tomorrow; a capable, flexible and adaptable workforce with the skills to develop and grow with the changes that happen around them.

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Appendices

Figure 1.1

Field Notes – Maths Specialist Tutor

The research observations

We started by banning the word "Maths", this was not mentioned in any of the lessons or briefs.

Students had an initial apprehension for the written text and instructions – some saying "oooh, I've got to read!!"

Using the computers to present the information allowed the work to be presented individually and took away the 'us versus them' traditional teacher-at-the-front relationship. Students were immediately engaged, they were looking through the work, talking to each other about the topic and asking each other for advice and often comparing their chosen dream salary.

The students were excited to see how much money they can make. "Ooh that's very interesting"

Students spent time listing dream items like living in a flat, having a nice car, having money to meet friends down the pub etc. They then completed their dream salary based on the lifestyle they'd love.

Whilst calculating their dream salary by month one student said: "I'm actually doing maths!" They were surprised by the fact that they had completed a maths calculation, correctly. The maths involved was basic number concepts such as addition, multiplication and division.

From previous activities, students already knew which website to use to find equipment hire. The students identified the best value for money options independently. They realised that a camera was either £125.00 per day or £500 per week. They worked out that by hiring the camera for a week (7 days) they could save £375.00. "Wow, it should have been £875!" "It's much cheaper to get it for a week".

I also observed the following conversation whilst students were calculating their invoices:

M: "It's all adding up."

B: "Are you using a calculator or doing that in your head?"

M: "In my head."

B: "How?"

M: *shows method*

B: "Thanks, I didn't know that… *(Calculates total correctly)."*

Some students wanted the best equipment and were happy to not earn as much money because "the equipment is better". They were showing reasoning skills and offered arguments for and against the types of equipment when discussing their choices.

At the end of one of the sessions, the students were asked: “how did you feel it went?”. Some student’s responses included:

- “The maths is easier than I thought.”
- “I usually can’t do maths, but did it today.”
- “This is great; it gives me a better idea of what to look for.”
- “I’d have to learn some parts separately.”
- “The maths is better to link with the work.”
- “It all makes sense, which is unusual for maths.”

Summary

The maths concepts naturally arose.

The students were engaged and helped each other.

The tutors were only asked for guidance if all the students couldn’t help, for example, some didn’t know what £35,000 looked like when written down.

The lessons worked because the students had a basic understanding of maths concepts.

Figure 1.2

Field Notes – Vocational (Photography/Art & Design) Tutor

Context

The sessions were highlighted as employability workshops rather than maths; the focus being on the kinds of skills identified by employers as essential for success in the workplace. With these particular subject area students’ the focus was on freelance skills that could be transferable to employed status taking the content into the vocationally relevant arena for their specialism and for general employability.

The (maths) sessions were delivered over 4 weeks and embedded into 3 hour sessions within 6 weeks for CPD and employability. The way this was done the students didn’t see any huge deviation from ‘normal’ all but one learner from the group [20 learners] happy to take part in the research after it was explained and a statement of ethics read to the student group.

The research observations

- It was clear that the students in the group had taken the project on with a surprising level of enthusiasm with the exception of one learner who chose not to take part. He later told me it was because he was prioritising his work for applying to university.
- Almost all of the students were able to discuss the developments to their ability and confidence.

- I was surprised to hear little in terms of negativity with the only focus being on them wanting more of this kind of workshop, more depth and more support with the maths. Despite the want for more help they were all able to problem solve and work together to find solutions and appeared to be taking the path of least resistance.
- Beyond the sessions the students kept talking about the project and how it could be used more and how they would have liked it to start sooner in the year.
- There were times I felt that leaving the students to problem solve themselves was difficult, but they were able to keep going and find solutions, sometimes it took a while to achieve.
- Once learners observed themselves that they were doing maths and successfully they showed a celebratory attitude to being able to 'do it' and 'get it right'
- Almost all of the students needed reassurance that they were doing the right thing, perhaps introducing a checking phase in future projects could help to support this need.

Summary

The workshops appeared to be well received and the student feedback was very useful to give considerations for the future. More depth and detail along with a more specific set of instructions may be more useful for lower level learners.

Once learners were able to see the vocational relevance and the impact it could have on them gaining employment they appeared to show a motivation that was surprisingly positive.

The students felt it a struggle but all that took part were able to produce a worthy outcome and grasp the task in hand.

The prospects for adding a wider skills base to a much larger project in future would perhaps be a good consideration based on the feedback from learners.

Figure 1.3

Student A - Responses to questions set to guide

Do you have any thoughts and feelings about the "how much are you worth?" task

- I found this task very helpful to the reality of money in the industry of working as a photographer.

Do you value the link the task had to employability?

- I do value it because it is an eye opener for any career that I would take in the future.

Is there anything we could have done to make the task more engaging?

- Personally, I don't think that there is anything more to do, I just think doing more of these tasks would be beneficial.

Would you appreciate further tasks to address issues like this in the future?

- Yes, I find that tasks like these will help me or someone else with the reality of earning money in any career that they take. And I feel it kind of prepares us for what the real world is like.

Do you feel applying maths to a context that is real world useful is more relevant than Textbook examples?

- I feel doing it this way is so much better than textbook examples because applying maths helps us to prepare ourselves to the future of working full time and how to handle money etc. I think textbooks are out dated and not really relevant with now a day careers.

Student B – Free comments about the workshop

- I found the "How much are you worth task?" really educational and has influenced the way I should present myself to others. The task given showed me exactly how much I am worth as an individual and how much I should be charging to live a comfortable life.
- To make the task more engaging, I'd suggest a clear explanation of exactly what was expected as I think that took the longest for us to grasp but once we got it that class was smooth running. I would appreciate further tasks addressing this issue as I think it has given me more life skills and has helped my understanding of what I should be expecting of myself. I found that practical side of this task more helpful than reading it out of a textbook as it gave me a clear understanding of what is expected.

Student C – Responses to questions set to guide

What the students thought about the project workshops.

Using a random selection of students present for the workshops that looked at the how much are you worth project. They were asked to tell us about their own experience, in two instances they struggled to know what to write about so we gave them some starting points from which to discuss and place their responses in context. These questions were still designed to give and promote open answers. In all cases the feedback was gathered in line with BERA guidelines and the students have been anonymised for the feedback.

Do you have any thoughts and feelings about the "how much are you worth?" task?

- I found this task quite interesting as it gave me an insight into how much it takes to be a full-time photographer and the amount of attention to detail it takes in order to be somewhat successful.

Do you value the link the task had to employability?

- Again, I think that the link the task had to real world work was really insightful as it did open my eyes to what it takes to work in this type of business and how consuming jobs could be.

Is there anything we could have done to make this task more engaging?

- I think that to make this task more engaging, a possible workshop of some sort would've have made all the information I took on board sink in more, showing us what it takes to work in a professional way and using the skills we learnt to some extent.

Would you appreciate further tasks to address issues like this in the future?

- Yes, I feel like we need to learn real world skills like this as it allows us to realise what skills we need to further ourselves as creative people.

Do you feel applying maths to a context that is real world useful is more relevant than textbook example?

- I feel that the maths side of this task made us understand what it takes to complete a real-world situation and how to budget yourself as well as how to manage a task like this, rather than some textbook situation.

Summary

All of the learners in this feedback and feedback taken during the class in note form indicated that they found the project worthwhile and engaging, they clearly saw the maths element as a secondary factor and employability skills as the main focus.

It was interesting to see that Student C felt that the workshop was not a "workshop" at all (perhaps because we called it a task) and indicated they would like it to be more in depth and more workshop like; this would be an interesting development area for the future of this project.

We intentionally left the learners to find their way in the task with minimal intervention as described in our rational for the workshop; this was to prove that teaching staff did not have to be maths experts and that given time students can navigate a problem themselves. This is very clear in the

feedback from student B who said they would have liked more instruction but also identified that they managed anyway. Perhaps this can be considered when developing further project work with a little more detail but the same ethos to problem solving for the students.

Student A saw a clear impact on vocational areas and employability and was able to see clear links between their chosen career pathway and the content of the work

Fig 1.4

Pdf file of the workshop materials used in some of the sessions.

How much pres.pdf