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ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rpra20

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To cite this article: Jordan Allison (2023) Factors for enabling effective student learning within English colleges: the case of computing, PRACTICE, 5:2, 128-143, DOI: 10.1080/25783858.2023.2198143

To link to this article: https://doi.org/10.1080/25783858.2023.2198143

Published online: 03 Apr 2023.

PRACTICE
2023, VOL. 5, NO. 2, 128–143
https://doi.org/10.1080/25783858.2023.2198143

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Factors for enabling effective student learning within English colleges: the case of computing

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ABSTRACT

The development of computing as a subject area and the skills gaps present in society has placed an increased emphasis on the teaching of computing and what practices enable effective student learning. Within England, colleges have been described as pivotal in addressing these skills gaps, but there is a lack of computing education research within a college setting. This paper therefore aims to answer the following research question: How are computing educators within English colleges enabling effective student learning for computing? Through conducting 24 semi-structured interviews with computing educators from 13 English colleges, six themes were identified which include having staff who care, building a positive relationship with students, developing student soft skills, challenging current practice, putting an emphasis on students, and other teaching tips. This paper augments findings of good practice that have been found in other educational settings such as the use of unplugged activities, flipped learning, and pair programming, but in the unique context of teaching computing within English colleges. Furthermore, this paper more explicitly contributes to knowledge and practice through detailing how a focus on student needs is deemed more important for enabling effective student learning for computing than the choice of curriculum or available resources.

ARTICLE HISTORY
Received 9 February 2023
Accepted 29 March 2023

KEYWORDS
Computing education; computing pedagogy; further education; student learning and development

Introduction

A survey of computing practitioners and researchers regarding computing education research found the top questions they want answering relate to student behaviour, student understanding and pedagogy (Denny *et al.* 2019). Furthermore, the constant development of curriculum change present for computing related courses gives precedence to an increased focus on how to teach effectively (Sentance and Csizmadia 2015), while it has been suggested a renewed focus on pedagogy for teaching computer science should be embraced (Davenport *et al.* 2016). This focus has further been emphasised since COVID-19 due to the challenges this has posed to computer science practitioners (Crick *et al.* 2020). Biggs (2003) has described how teaching itself is a catalyst for learning, and with the increased importance of computing for society, the importance of pedagogy

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for computing should not be understated as it significantly influences student outcomes (Passey 2017, Webb *et al.* 2017, Yadav and Berges 2019).

In March 2022, the British Computer Society published their landscape review of Computing Qualifications in the UK (British Computer Society 2022). The review indicated the growing appreciation amongst policy makers and employers for the role of computing qualifications but emphasised how the supply of qualified and trained teachers for these qualifications is a challenge for all four nations of the UK (British Computer Society 2022). The further education (FE) sector within England has been identified as being the part of the English education sector which should be at the forefront of providing education and skills training (Augar *et al.* 2019, HM Treasury 2020), with colleges being described as pivotal in addressing the computing skills gap which exists in society (House of Lords 2015, Independent Commission on the College of the Future 2020, Sinclair *et al.* 2021). In this context, colleges are institutions which primarily, although not exclusively, focus on compulsory education for students aged 16–18 (Snelson and Deyes 2016).

Recent initiatives have now been introduced for the FE sector to address the teacher recruitment concern, such as bursaries for FE teachers from 2021–2022, including for computing as a subject area (Department for Education 2021a). However, this does not address years of sector-wide neglect, nor does it make up for the shortfall in computing teachers within the UK (Brown *et al.* 2014, The Royal Society 2017, Moller and Crick 2018), and for colleges in particular (Association of Colleges 2018). Nevertheless, to improve the quality of computing provision, other initiatives have been proposed. For instance, the Skills and Post-16 Education Bill outlines how the UK government policy objective is to ensure FE provision is aligned to local needs (Department for Education 2021b), through initiatives such as 'The Skills Accelerator' that will help shape post-16 technical education and training through working with employers and colleges (Department for Education 2021b). Recent studies have shown progress regarding these attempts at collaboration. For example, James Relly and Laczik (2021) explain that despite the recruitment problems in FE, there is good practice occurring between colleges and employers, such as in their study about apprenticeship provision. However, apprenticeship courses are just one type of qualification taught by colleges, so it is not clear what leads to effective student learning for computing across college provision.

Despite the renewed focus on colleges to address computing skills gaps, they suffer from many challenges and continuous change (Norris and Adam 2017, Orr 2020, Misselke 2022, Allison 2023), with devolved responsibility of ever-changing policy interpretation leading to within-college tensions between departments (Dalby and Noyes 2018). Furthermore, there is a reported shortage of research for the FE sector overall (Augar *et al.* 2019, Ofsted 2019, Smothers *et al.* 2021), while research that does focus on the FE sector in the context of computing education has identified many challenges. For instance, Allison (2020) identified that computing educators within colleges suffer from a lack of time, resource issues, a lack of knowledge, staffing and finance issues, and a lack of understanding from senior leadership. Although these issues may initially appear common for all subjects, they are more profound for computing teachers due to the increased need for updating hardware and software (The Royal Society 2017), a more frequent need to up-skill than other teachers due to rapid changes in technology (Friend *et al.* 2022), and a smaller pool of computing teachers entering the profession (Moller and Crick 2018). Therefore, Allison (2020) recommends future research should investigate how to address these issues. This provides an emphasis to discover the techniques used within colleges for computing education in respect to what helps enable effective student learning. By establishing what is good practice, this can then be shared more widely to ensure more effective teaching and learning environments for computing education. Besides, the British Computer Society suggests there should be regular reviews to assess computing qualifications and what works (British Computer Society 2022), while existing literature has indicated future research should explore the relative value of different approaches used for computing teaching (Varvara *et al.* 2015, Derrick *et al.* 2016, Crick 2017, Webb *et al.* 2017). Therefore, this paper aims to address the following research question:

> How are computing educators within English colleges enabling effective student learning for computing?

To answer this research question, this paper will present the findings from the analysis of 24 semi-structured interviews with computing educators across 13 colleges within England, where six themes were created. These themes will be presented with supporting interview quotes and contextualised to existing literature where applicable.

Materials and methods

Data collection method

A qualitative research method was employed where semi-structured interviews were conducted with 24 employees across 13 colleges in England. Semi-structured interviews were the chosen data collection technique as they have been used when conducting research with colleges (Edgington 2013, Broad 2015, Hill and James 2017, Allison 2020), and due to their ability to gain rich detailed insights and to further investigate interviewee responses (Cohen *et al.* 2018). This was important as the focus of the research was to establish practitioner perspectives on what helps enable effective student learning for computing. Observations were considered, but it was deemed more beneficial to establish a more general overview of practitioner perspectives regarding teaching practice before further research could probe further into observing actual teaching practice within colleges.

Sampling

Interviewees were targeted by identifying publicly available contact email addresses available from college websites of those who were deemed relevant to the study, in addition to some known contacts. While many of those who were contacted were not able to participate, 24 individuals agreed to be interviewed who had a role involving teaching computing and/or managing a computing department. Although all related to the teaching of computing, the individuals interviewed had a wide range of roles and teaching experience. For example, some taught academic qualifications such as A-Level Computer Science, some taught more vocational qualifications such as BTEC level 3 Computing, and some taught the relatively newer T-Level qualifications (see Pearson

Education Limited (2020). It should be noted the focus of the research was not to ascertain explicit differences between courses, but what commonalities there were for enabling effective student learning for computing in colleges across the multiple courses offered.

Anonymity, confidentiality, and informed consent

Due to this research involving human subjects, the research project proposal was reviewed by the authors' faculty research lead to deem whether it required formal approval by their university ethics committee. However, due to not dealing with any vulnerable participants, this was not required, and the project was approved subject to following research ethics guidelines of good practice. All interview participants were provided with an informed consent form and participation information sheet prior to the interview which dealt with issues such as confidentiality and use of data, where interview participants were required to sign and return the form before the interview. For those who failed to oblige to this request, verbal informed consent was obtained before the interviews commenced on the day.

Interview structure

Interviews were conducted virtually and predominantly via Microsoft Teams, with all interviewees asked what practices they implement to overcome any challenges they face in teaching, what helps enable effective student learning, and whether there were any 'good practices' when it comes to teaching computing and related courses. Interviews were recorded, transcribed, and then transcripts were added to NVivo software to aid the data analysis process.

Data analysis

Interview data was coded using thematic analysis under the guidelines of Braun and Clarke (2013) to identify patterns across interview data. This involved generating initial codes of anything deemed relevant, followed by creating categories, searching for themes, reviewing themes, and defining and naming themes. It should be noted that the created themes are subjective as they are based on researcher interpretation. Therefore, to enhance the research reliability and credibility, interviewee excerpts will be provided for each theme as illustrative examples of how interview data led to the creation of themes (Cohen *et al*. 2018). Overall, a variety of themes were created through the analysis of interview data, and while six main themes are outlined in this paper, it should be disclosed that these interviews were conducted as part of a larger study of computing education within colleges (Allison 2022). This included the investigation of factors such as choosing curricula, but due to the vast nature of data assimilated through qualitative research, this paper focuses solely on pedagogy and factors enabling effective student learning. The six themes created were as follows:

- Staff who care

- Build a positive relationship with students
- Develop student soft skills
- Challenge current practice
- Put emphasis on students
- Other teaching tips

Results

Staff who care

A key finding from the analysis of interview data was that to help achieve positive student outcomes, colleges require staff who care about the students and the subject area, as this way, teachers will take action to ensure students succeed. Helping students and seeing their success was described as a satisfying and rewarding experience, with one lecturer explaining how this is one of the main reasons they are in the profession:

> I don't do it for the hours, I don't do it for the pay. I don't do it as everyone keeps thinking for the holiday. I do it because like the students need somebody who is caring and passionate about the subject [Interviewee 3].

The mention of 'passion' was cited by other interviewees in the context of the desire for helping students, and for technology and computing. Having passionate teachers has been hallmarked as a key aspect of good vocational pedagogy (Lucas *et al.* 2012), and some interviewees explained how if you do not have the passion for helping young people and the subject matter, then you are in the wrong profession. Interviewee 20 for instance, discussed how you need to be enthusiastic about technology for success as a computing teacher, because otherwise the students will likely find the subject boring, which can lead to a lack of engagement and poorer student outcomes. Those with a head of department style role indicated how passion for the subject was a trait they want within their teams. For instance, Interviewee 6 discussed how they can purchase new hardware or upgrade equipment, but having the right teachers is what will influence whether a student will stay on the course. They stated:

> So I think if someone's coming in new, I'd be saying, you know, you need, if you are doing web [development], I want to see that you are doing web [development] outside of the classroom, you, you know, you have a genuine passion for web [development] [Interviewee 6].

Being passionate about the subject helps to ensure teachers are keeping up with sector developments, and therefore more readily allows them to bring new ideas and topics into the classroom. Similarly, one lecturer discussed how they enjoy teaching because they can work in partnership with students and learn from them as well:

> So I absolutely love this job [teaching]. And one of the reasons is because you can pass you can, you can work and the study of the same time, you can learn. And IT and computing, you can learn from students as well, because computing is changing every day, quickly growing up, and [they] can capture all the information so, and very often I teach I learned from students, this is brilliant, it's absolutely amazing. When you, when you teach a young people, and when you see when they got started with passion in computing, this is the best place [Interviewee 4].

Having lecturers with the passion and knowledge for helping students, for teaching, and for technology is likely to be an influencing factor for positive student outcomes.

Build a positive relationship with students

Interviewees discussed the importance of understanding students' needs, being honest and transparent with them, to work in partnership with them and to build a positive relationship with students, as this leads to a more productive teaching and learning environment. By building a positive relationship with students and understanding their prior knowledge, abilities, preferred ways of learning, and expectations, teachers can adapt their teaching context to be more appropriate for those learners (Biggs 2003). For example, Interviewee 19 stated:

> You have to get on their [students] level, you have to, you have to understand why that student individually wants to do that course, and where they want to progress to... And as soon as you gain like their trust, you can you can basically get them to do pretty much whatever you want within the classroom environment [Interviewee 19].

The emphasis of understanding students was deemed more important than the teaching of the subject itself by some interviewees with comments such as:

> The computing side of it is not the biggest part of this job. Yeah, it's a very minor part of the role. The, the students are central [Interviewee 10].

A students' prior knowledge can influence the difficulties they face and the misconceptions they have (Qian and Lehman 2017), and so if there is not an effective relationship where the teacher understands this, then students may continue to have problems. For example, Interviewee 18 commented:

> Having the technology and the skills to understand technology is a, is a, is an important part of it. But it's not the essential part of it, I think, being able to understand learners, how to communicate, and how to identify, really, and be able to be proactive when they've got a problem, how to intercept that and help them. So I think really having those sort of skills and be able to plan your lessons effectively, is really important [Interviewee 18].

To build a positive relationship with students, some interviewees discussed the concept of working in partnership with students as opposed to trying to be too much of a teacher. The concept of partnership in education has been comprehensively explored by some authors who suggest partnership can engage and empower students, and is an effective approach for more authentic student engagement and transformational learning experiences (Healey *et al.* 2014). It can be understood as staff and students working together to foster learning and enhance teaching (Healey *et al.* 2014), but this is easier said than done. Some interviewees mentioned how in some cases, students may know more than they do. However, this was not deemed to be an issue as it means extra knowledge and discussion is brought into the teaching environment, where the teacher can act as a facilitator to the learning, in a constructivism approach to learning, where teachers could be seen as mediators assisting students in constructing their own knowledge (Armoni 2011). Having this student-centred approach was seen as beneficial to both parties, with one head of department explaining:

> I think as soon as I stop treating them, like students and I'm their teacher, and I started being, I'm a, I'm a senior producer and you are my production team. It completely changed the way my philosophy about how I approach teaching when, and actually made the relation with students that much better [Interviewee 9].

Through working in partnership with students and understanding their needs, curriculum content and suitability of resources can be tailored more effectively, and students are more likely to ask for help and be engaged in lessons. This is irrespective of what infrastructure and resources each college has, but instead using what they have available to foster the best teaching and learning environment for their student cohort. Much like existing literature which explores the differences between novice and experienced teachers, where novices may fear straying from lesson plans, but more experienced teachers may show more interactivity with students (Liberman *et al.* 2012), some indications of this were found through the interviews. Observations could verify this more effectively, but lecturers with more teaching experience seemed to have a more relaxed view on their approaches to teaching, and encouraged more interactivity, and hence, were able to build more positive student relationships. However, irrespective of whether a teacher is novice or experienced, selecting the most appropriate teaching and learning activities can be a complex decision (Varvara *et al.* 2015), as it is context dependent based on the specific student cohort, and so good teaching requires a good knowledge of learners (Yadav *et al.* 2016).

Develop student soft skills

Many interviewees discussed the development of students' 'soft skills', which refers to those skills considered important in employment such as communication, teamwork, leadership, and work ethic (Shadbolt 2016). Soft skills do not include skills such as programming ability as these are more technical skills. Significantly, like some existing studies concerning cyber security professionals (Jones *et al.* 2018), interviewees cited the development of soft skills as just as important, if not more so, than the technical skills being taught on computing courses. For example, Interviewee 7 explained:

> Developing those [soft] skills is important outside of so making sure the student is becoming developed rather than just teaching them the thing, which is what a lot of people in this space [computing and technology] develop. They think the content is first and foremost, and then forget that we teach kids though. Kids need help [Interviewee 7].

This concept of ensuring students are developed goes beyond the typical dissemination of knowledge associated with outdated teaching practices (Shulman 1986). To effectively develop student soft skills appropriate for the workplace in the computing and technology sector, teachers must understand policy changes, local context, employment options, and general changes within the sector (McCrone *et al.* 2015, Passey 2017). One lecturer stated how developing soft skills is 'the biggest part of the teaching job'. [Interviewee 10], while another lecturer explained how they are not teaching students content, but instead 'teaching people how to learn' [Interviewee 24]. This concept of teaching students how to learn was cited by other interviewees too, as it prepares students for an ever-changing digital world, helps develop a mindset of finding things out for themselves, and develops resilience; an attribute found to support learning and progression for computer science undergraduates (Prickett *et al.* 2020). Interviewee 23 expressed one way they develop student soft skills, and their reasoning for doing so:

> We've been in every single [e-sports] tournament and the whole point of the tournament is to grow, or to get students to improve their soft skills, communication to work resilience, problem solving... So getting students to sort of build those softer skills and communication, teamwork, networking with their peers, we find really useful [Interviewee 23].

This sample of interviewees have revealed the development of student soft skills is important, but curriculum constraints and typical ways of teaching can sometimes hinder progress. Hence, some interviewees described the ways in which they try to overcome this by challenging current practice.

Challenge current practice

Building upon the theme of developing student soft skills, this theme outlines how interviewees were challenging the usual ways of doing things. Interviewees from one college highlighted how they have implemented a large practical student project to help develop their computing students. Interviewee 9 discussed this project in detail explaining how it works for their students studying their Games Design module:

> I say literally, you know, you've got to turn around, we've got a full board game, 3D printed pieces, all cards, all counters, rule books, you know, game art, 20 minute presentation, 25 minutes making a documentary, four social media platforms. I want you know, the entire campus sorted out, I want full catering, run a mini bar here, the venue presented, question and answer, everything set up, and they look at me like I'm absolutely having a laugh. And you know what that is, I think that is my favourite module on the course, it's that one where I get a whole bunch of 16 year olds that literally are still wiping the placenta off themselves. And say in nine days time, you're going to be launching a full product... that I think is the thing that turns them from 16 year old kids into FE students [Interviewee 9].

For such a comprehensive project, this college had to condense their traditional teaching patterns by compacting their curriculum to allow for this two-week project. It was described as causing challenges for the teaching team, but the staff and students enjoyed working on the project, with students benefiting greatly. This example of challenging current practice shows how full college support can lead to the creation of new models for student success. Trying new things and taking risks was commended by other interviewees too. One head of department explained that without risks, teaching will get boring and won't improve. They stated:

> Look, don't be afraid to take risks. Yeah, it might not work right? But if you haven't tried it how do you know?'... if someone comes in and said it didn't work at least I know they've tried. Yeah, if you say 'well, that will always work' it becomes really stale [Interviewee 6].

However, to take risks you need to have the right staff who are willing to do so, and a college culture which is supportive of taking such risks. Hence, challenging current practice is intrinsically linked to the culture and senior leadership support within the college.

Put emphasis on students

One pedagogical approach cited by many interviewees was to put an emphasis on students. Some interviewees referred to the constructivist teaching approach of using a flipped classroom, which has been shown to increased student performance (Bradford *et al.* 2014). For example, Interviewee 17 explained:

> I've got videos and notes, and they've [student] got textbooks and it's, do all the learning at home, come into the classroom we'll do the consolidation and assessments in the classroom environment itself. And I found that's been really beneficial. . .they can take as long as they need, they're not relying on on my pace of delivery in order to get that understanding, come into the classroom, give them a little mini sort of pop quiz, very quickly work out who has understood and how much they've understood. And then you can tackle the, the specifics very, very easily [Interviewee 17].

However, not all teachers have had success using a flipped classroom approach, with existing literature highlighting how flipped learning can be challenging for students and educators (Cook and Babon 2017). Interviewee 16 explained how they have tried to get students to prepare in advance for in class sessions, but students do not always comply. This could be due to the student expectations or the link between the in class and out of class activities which is a key factor for success in a flipped classroom approach (Healey *et al.* 2014). Equally, some students may have disliked the approach as they cannot passively receive information (Berrett 2012). Interviewee 15 took a different approach to put an emphasis on students. Instead of using the flipped classroom as a compulsory part of teaching, they provided an opportunity for students in a less structured way:

> I went out and bought, bought a introductory Arduino box, gave those and said 'there yours, just play with them'. There's no work set, but go home and play with them. And for about half of them, it sort of that got them over the step. . . within a day, I had one of them and it's all plugged together an LCD and have his name scrolling as a marquee across it, somebody else had built some traffic lights, somebody else had built a reaction testing, mostly from from online tutorials, but the idea that they they go away, find out stuff. And then when they didn't, when they got stuck in the run, sit there, sit there and ask me, they'd go online and start to solve their own problems [Interviewee 15].

By allowing students to be creative and learn things themselves, this put the emphasis on them if they want to learn. Further, as noted by Interviewee 15, students started to solve their own problems, instead of asking for help, which coincides with the importance of teaching students how to learn for themselves as highlighted in 'develop student soft skills'.

Other teaching tips

This theme could be described as a collection of other pedagogical approaches that do not 'fit' within the other themes, but to neglect mentioning them would be to neglect sharing other pedagogical best practice for computing. This is particularly important as the English FE sector is one where the development of generic teaching skills has been more of a focus than specialist pedagogy, leading to a perception of being less challenging (Misselke 2022). Some interviewees referred to the importance of a classroom set-up, with open plan computing labs with a large boardroom table in the centre being cited as preferable. Similarly, it was discussed how it is important to pull students away from the computer in a classroom setting when explaining concepts and theory, while a centre boardroom style table can help minimise distractions from a computer.

> I think it's interesting with computing, because if you're not careful, we end up lecturing the back of people's heads [Interviewee 14].

These findings support existing literature in the context of schools that support using unplugged activities (Sentance and Csizmadia 2017, Nijenhuis-Voogt *et al*. 2021), which is where activities are designed for learning computing topics through kinaesthetic learning activities that emphasise understanding concepts without the need for tools or programming (Webb *et al*. 2017). While using unplugged activities can help address potential resource issues (The Royal Society 2017), it can require some imagination on what is appropriate which supports the assertion of having the right staff.

Some interviewees mentioned what worked best when teaching programming. One practice referred to the contextualisation of learning to other subject areas, which can help students see the value in what they are learning, and is a pedagogical strategy cited in existing literature (Sentance and Csizmadia 2017). One interviewee stated how python skills could be developed alongside other key subject areas such as maths and English:

> Strong linkage between what they're doing in maths, and then maybe doing Python to back that up [Interviewee 4].

In addition to programming crossovers with other subjects, some interviewees discussed how they try and make computing topics more engaging and 'real' by using their previous industry experience to make concepts and topics more relevant, and this has been found to be especially important in topic areas such as algorithms (Nijenhuis-Voogt *et al*. 2021). However, as is the case with the teaching of algorithms and programming, scaffolding has been documented as a key component of effective pedagogy (Hanley *et al*. 2018, Hamer and Smith 2021). Scaffolding can be provided to students through the provision of practical exercises with the opportunity for good quality formative feedback (Davenport *et al*. 2016). In some papers, this pedagogical strategy refers to how teachers can help students understand program code, with teachers emphasising good practice where they give students part of a program to extend, and programs to debug (Sentance and Csizmadia 2017). Some interviewees discussed this exact concept:

> What I do is I give them it's a, you know, a program that is working. And what I mean, we're using, we're just using pycharm here. And using the debugger, so I put a breakpoint on and start to monitor the code. So. So like with that, I will get a you know, if, if their code is there, I will ask them to go through it and look, you know, what's happening at that particular stage, by then take a look at what the variables are set to and stuff like that [Interviewee 2].

Getting students to debug others code as much as possible can help address issues such as insecurity amongst learners (Davenport *et al*. 2016) and inaccurate mental models of programming concepts (Qian and Lehman 2017). In the case of the interviewees, it was discussed how scaffolding programming tasks led to students learning how to identify errors and by seeing other versions of writing a program, they could learn more effective means of writing code. This finding augments existing literature by supporting the use of peer mentors, paired programming (Sentance and Csizmadia 2017), and peer support

(Davenport *et al.* 2016), with some interviewees explaining how creating group working strategies such as pairing students who have mixed abilities can help form a more prosperous teaching and learning environment.

Several pedagogical strategies were used by interviewees which are mentioned in existing literature but using a variety of strategies is most effective due to the variety of students and contextual factors that can influence the teaching and learning environment. However, what was commonly cited by interviewees but less so in existing literature was the extent of how teachers need to focus on the needs of the students, and understanding them more effectively, as opposed to focusing on specific topics or software.

Discussion

Existing studies which consider English education regarding computing typically focus on schools, while the FE sector has been neglected as a topic of research (Augar *et al.* 2019, Ofsted 2019, Smothers *et al.* 2021) and politically, with the sector being subject to continuous change (Burnell 2017, Norris and Adam 2017, Misselke 2022, Allison 2023) and a lack of funding (Orr 2020, Department for Education 2021c). However, colleges have been highlighted as crucial for addressing computing skills gaps (House of Lords 2015, Augar *et al.* 2019, HM Treasury 2020, Department for Education 2021c), while existing literature has indicated further research should take place which explores the different approaches used for computing teaching (Varvara *et al.* 2015, Davenport *et al.* 2016, Derrick *et al.* 2016, Crick 2017, Webb *et al.* 2017, Denny *et al.* 2019). This research provides an important contribution to knowledge by detailing how colleges are approaching the teaching of their computing students, and presents findings to the research question of 'How are computing educators within English colleges enabling effective student learning for computing?'

Contribution to current work

The 2022 British Computer Society (BCS) landscape review of computing qualifications indicates how a key aim of the BCS Curriculum and Assessment Committee is to help teachers understand how they should teach computing (British Computer Society 2022). The findings of this paper directly address this aim in the context of colleges as part of the FE sector and contributes to existing work on the pedagogical methods used to enable effective student learning. For example, this paper builds upon the findings of pedagogical good practice that has been highlighted for computing education in schools, such as the use of unplugged activities (Nijenhuis-Voogt *et al.* 2021), and giving students programs to debug and paired programming (Sentance and Csizmadia 2015, 2017).

The findings of this paper support the development of student resilience (Prickett *et al.* 2020) and soft skills as indicated by the Shadbolt review (Shadbolt 2016), and from cyber security professionals (Jones *et al.* 2018), but uniquely details this from the perspective of computing educators. Additionally, this paper reinforces existing findings regarding how the use of flipped learning can improve the performance of computing students as shown by Bradford *et al.* (2014), but also augments the findings of existing literature from other subject areas but in the context of computing, where it was found flipped learning can be a challenge for both educators and students (Cook and Babon 2017). This research supports studies such as those by Liberman *et al.* (2012) regarding how experienced teachers show more interactivity with students, but more uniquely highlights the importance of building a positive relationship with computing students in colleges, whereas existing literature has discussed this in other educational settings or more generally across all subject areas (Healey *et al.* 2014). Similarly, this work supports the assertion identified by Morris (2018) who found that those FE colleges who have been categorised by education regulators to be 'outstanding' were those who tended to have a more collaborative relationship between teachers and learners. Overall, this research provides the important contribution to knowledge on how focusing on student needs as opposed to the curriculum or other factors is one of the most important aspects in enabling effective student learning for computing.

Implications for practice

Due to the resource-intensive nature of computing as a subject area (The Royal Society 2017), there is often a focus on infrastructure, resources, and equipment when it comes to improving computing education (Gal-Ezer and Stephenson 2014, Department for Digital Culture Media and Sport 2017). However, there seems to be an increasingly forgotten element, which is the focus on learners. Interviewees highlighted the importance of focusing on the students and developing them as learners, as opposed to rigorously delivering a specification, or a specific topic. Hence, understanding student needs, and working with them, as opposed to disseminating knowledge was identified as a key factor for enabling student learning, irrespective of what curricula was being taught, or programming language or software used. Colleges have learners with a wide variety of different backgrounds and characteristics, and this can cause pedagogical challenges (Lucas *et al.* 2012, Varvara *et al.* 2015, Qian and Lehman 2017, Webb *et al.* 2017, Greatbatch and Tate 2018). Therefore, as an implication for practice, educational institutions need to ensure they employ staff who care about the students' development, and educators build a positive relationship with students and take steps to understand their needs as a learner, as this is required for good teaching (Yadav *et al.* 2016).

The next implication for practice is the recognition that students on college courses will be studying to become employable for jobs that may not currently exist (Passey 2017, Ester *et al.* 2020), while existing studies have reported concerns with the employability of students due to their lack of soft skills (Department for Business Innovation and Skills 2016, Davenport *et al.* 2019, Scepanovic 2019). Therefore, there should be an increased focus on the development of students 'soft skills' such as communication, problem solving, and developing the ability to learn new things quickly that will be important longer term. As part of this, putting the emphasis on students such as using flipped learning activities and getting students to experiment with equipment may be preferred, especially if teachers have a lack of knowledge themselves; a commonly cited issue (Brown *et al.* 2014, Yadav *et al.* 2016, The Royal Society 2017, Webb *et al.* 2017, Ofsted 2019, Yadav and Berges 2019). This has historically been a problem within the FE sector, where for the recruitment of new teachers in particular, workplace skills are often assumed to be a basis of claims for expertise as an educator (Esmond and Wood 2017), but this is not always the case. Challenging conventional practice and taking risks in trying new teaching approaches which foster the development of soft skills such as group activities, large projects, and presentations can aid student development. Where possible, educators should include the use of unplugged activities as this can address potential resource issues (The Royal Society 2017) such as unreliable college infrastructure (Armstrong 2019), but it can also mean that students are away from the computer either engaging in discussion or developing their understanding of concepts with the teacher acting as a facilitator to learning. Hence, providing further opportunities for educators to gauge student understanding, and for students to develop communication skills.

Limitations and implications for future research

The findings of this paper provide a unique insight into the practices found to enable effective student learning for computing in colleges, but a key limitation is the sample size of interview participants. While interviews allowed for rich and detailed insights into computing education within colleges, the sample consisted of 24 interviewees across 13 colleges, and so the results of this study can not necessarily be generalised to other educational settings. Consequently, future research could investigate whether other computing educators find the practices identified in this paper as relevant and important in their own teaching contexts. However, it is believed these practices could be applied in many other educational settings regarding the teaching of computing.

With the lack of existing literature concerning computing pedagogy in FE settings, it could be argued the research question of this paper is relatively broad. However, this paper outlines important factors for enabling effective student learning for computing such as building positive student relationships, putting the emphasis on students, and developing soft skills. Now these factors have been outlined, future research could be more direct in investigating what good practices exist for explicitly achieving these goals.

Disclosure statement

No potential conflict of interest was reported by the author.

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References

Allison, J. (2020) “The system’s holding me back: challenges of teaching computing in further education.” In 2020 International Conference on Computational Science and Computational Intelligence (CSCI), 929–933. IEEE. DOI: 10.1109/CSCI51800.2020.00173

Allison, J. (2022) Stakeholder Perceptions Regarding Level 3 `Digital Skills’ Teaching: A Qualitative Case Study of Colleges in South West England [Doctoral dissertation, University of Gloucestershire]. University of Gloucestershire Research Repository. https://eprints.glos.ac.uk/11847/

Allison, J., 2023. Fragmentation or focus? The precarious nature of initial teacher training within the English further education sector. *Practice*, 1–14. doi:10.1080/25783858.2023.2177559.

Armoni, M., 2011. Looking at secondary teacher preparation through the lens of computer science. *ACM Transactions on computing education*, 11 (4), 1–38. doi:10.1145/2048931.2048934.

Armstrong, E.J., 2019. Maximising motivators for technology-enhanced learning for further education teachers: moving beyond the early adopters in a time of austerity. *Research in learning technology*, 27 (0). doi:10.25304/rlt.v27.2032.

Association of Colleges, 2018. *AoC college workforce survey 2017: summary of findings*. London: Association of Colleges.
Augar, P., *et al*., 2019. *Review of post-18 education and funding*. London: Department for Education.
Berrett, D., 2012. How 'flipping' the classroom can improve the traditional lecture. *The chronicle of higher education*, 12 (19), 1–14.
Biggs, J., 2003. Aligning teaching for constructing learning. *Higher education academy*, 1 (4), 1–4.
Bradford, M., Muntean, C., and Pathak, P. (2014) "An analysis of flip-classroom pedagogy in first year undergraduate mathematics for computing." In IEEE Proceedings - Frontiers in Education Conference, FIE, Madrid, Spain. IEEE, 1–5.
Braun, V. and Clarke, V., 2013. *Successful qualitative research: a practical guide for beginners*. London: SAGE Publications.
British Computer Society. (2022) BCS landscape review: computing qualifications in the UK. Technical Report. Swindon: British Computer Society.
Broad, J.H., 2015. So many worlds, so much to do: identifying barriers to engagement with continued professional development for teachers in the further education and training sector. *London review of education*, 13 (1), 16–30. doi:10.18546/LRE.13.1.03.
Brown, N.C.C., *et al*., 2014. Restart: the resurgence of computer science in UK schools. *ACM Transactions on computing education*, 14 (2), 1–22. doi:10.1145/2602484.
Burnell, I., 2017. Teaching and learning in further education: the ofsted factor. *Journal of further and higher education*, 41 (2), 227–237. doi:10.1080/0309877X.2015.1117599.
Cohen, L., Manion, L., and Morrison, K., 2018. *Research methods in education*. 8th ed. Abingdon: Routledge.
Cook, B.R. and Babon, A., 2017. Active learning through online quizzes: better learning and less (busy) work. *Journal of geography in higher education*, 41 (1), 24–38. doi:10.1080/03098265.2016.1185772.
Crick, T. (2017) Computing education: an overview of research in the field. Technical Report. London: Royal Society.
Crick, T., *et al*. (2020) "The Impact of COVID-19 and "emergency remote teaching" on the UK computer science education community." In United Kingdom & Ireland Computing Education Research conference. (UKICER '20), New York, New York, USA, 31–37. ACM.
Dalby, D. and Noyes, A., 2018. Mathematics education policy enactment in england's further education colleges. *Journal of vocational education & training*, 70 (4), 564–580. doi:10.1080/13636820.2018.1462245.
Davenport, J.H., *et al*. (2016) "Innovative pedagogical practices in the craft of computing." In 2016 International Conference on Learning and Teaching in Computing and Engineering (LaTICE), Mumbai, India. IEEE, 115–119.
Davenport, J.H., *et al*. (2019) "The institute of coding: addressing the UK digital skills crisis." In Proceedings of the 3rd Conference on Computing Education Practice - CEP '19, Durham, 1–4. ACM.
Denny, P., *et al*. (2019) "Research this! Questions that computing educators most want computing education researchers to answer." In Proceedings of the 2019 ACM Conference on International Computing Education Research - ICER '19, New York, New York, USA, 259–267. ACM Press.
Department for Business Innovation and Skills, 2016. *Computer science graduate employability: qualitative interviews with graduates*. London: Department for Business, Innovation and Skills.
Department for Digital Culture Media and Sport. (2017) UK Digital Strategy 2017. London: Department for Digital Culture Media and Sport
Department for Education, 2021a. *Further education (FE) initial teacher education (ITE) bursaries funding manual*. London: Department for Education.
Department for Education, 2021b. *Skills and post-16 education Bill - policy summary notes*. London: Department for Education.
Department for Education, 2021c. *Skills for jobs: lifelong learning for opportunity and growth*. London: Department for Education.

Derrick, J., Laurillard, D., and Doel, M., 2016. *Building digital skills in the further education sector*. London: Government Office for Science.
Edgington, U., 2013. Performativity and affectivity: lesson observations in england's further education colleges'. *Management in education*, 27 (4), 138–145. doi:10.1177/0892020613485533.
Esmond, B. and Wood, H., 2017. More morphostasis than morphogenesis? The 'dual professionalism' of English further education workshop tutors. *Journal of vocational education & training*, 69 (2), 229–245. doi:10.1080/13636820.2017.1309568.
Ester, V.L., *et al*., 2020. Determinants of 21st-Century skills and 21st-Century digital skills for workers: a systematic literature review. *Sage open*, 10 (1), 1–14. doi:10.1177/2158244019900176.
Friend, M., *et al.* (2022) "Trends in CS teacher professional development." In Proceedings of the 53rd ACM Technical Symposium on Computer Science Education, Vol. 1, New York, NY, USA, 390–396. ACM.
Gal-Ezer, J. and Stephenson, C., 2014. A tale of two countries: successes and challenges in K-12 computer science education in Israel and the United States. *ACM Transactions on computing education*, 14 (2), 1–18. doi:10.1145/2602483.
Greatbatch, D. and Tate, S., 2018. *Teaching, leadership and governance in further education*. London: Department for Education.
Hamer, J. and Smith, J., 2021. *Online and blended delivery in further education: a literature review into pedagogy, including digital forms of assessment*. London: Department for Education.
Hanley, P., *et al*., 2018. *Literature review of subject-specialist pedagogy*. London: Gatsby Charitable Foundation.
Healey, M., Flint, A., and Harrington, K., 2014. *Engagement through partnership: students as partners in learning and teaching in higher education*. York: Higher Education Academy.
Hill, R. and James, C., 2017. An analysis of the role and responsibilities of chairs of further education college and sixth-form college governing bodies in england. *Educational management administration & leadership*, 45 (1), 57–76. doi:10.1177/1741143215587310.
HM Treasury, 2020. *Budget 2020 delivering on our promises to the British people*. London: HM Treasury.
House of Lords. (2015) Make or break: the UK's digital future. digital skills committee report. London: The Stationery Office Limited.
Independent Commission on the College of the Future. (2020) The college of the future: the UK-wide final report. London: College Commission.
James Relly, S. and Laczik, A., 2021. Apprenticeship, employer engagement and vocational formation: a process of collaboration. *Journal of education and work*, 35 (1), 1–15. doi:10.1080/13639080.2021.1983524.
Jones, K.S., Siami Namin, A., and Armstrong, M.E., 2018. The core cyber defense knowledge, skills, and abilities that cybersecurity students should learn in school: results from interviews with cybersecurity professionals. *ACM transactions on computing education*, 18 (3), 12. doi:10.1145/3152893.
Liberman, N., Ben-David Kolikant, Y., and Beeri, C., 2012. 'regressed expert' as a new state in teachers' professional development: lessons from computer science teachers' adjustments to substantial changes in the curriculum. *Computer science education*, 22 (3), 257–283. doi:10.1080/08993408.2012.721663.
Lucas, B., Spencer, E., and Claxton, G., 2012. *How to teach vocational education: a theory of vocational pedagogy*. London: City & Guilds Centre for Skills Development.
McCrone, T., *et al*., 2015. *A review of technical education*. Slough: NFER.
Misselke, L., 2022. What will T levels change? The portrayal of technical and vocational education in England: tensions in policy, and a conundrum for lecturers. *Journal of vocational education & training*, 74 (4), 708. doi:10.1080/13636820.2022.2118948.
Moller, F. and Crick, T., 2018. A university-based model for supporting computer science curriculum reform. *Journal of computers in education*, 5 (4), 415–434. doi:10.1007/s40692-018-0117-x.

Morris, T.H., 2018. Vocational education of young adults in England: a systemic analysis of teaching–learning transactions that facilitate self-directed learning. *Journal of vocational education & training*, 70 (4), 619–643. doi:10.1080/13636820.2018.1463280.

Nijenhuis-Voogt, J., *et al.*, 2021. Teaching algorithms in upper secondary education: a study of teachers' pedagogical content knowledge. *Computer science education*, 1–33. doi:10.1080/08993408.2021.1935554.

Norris, E. and Adam, R., 2017. *All change: why Britain is so prone to policy reinvention and what can be done about it*. London: Institute for Government.

Ofsted, 2019. *Education inspection framework: overview of research*. London: Ofsted.

Orr, K., 2020. A future for the further education sector in England. *Journal of education and work*, 33 (7–8), 507–514. doi:10.1080/13639080.2020.1852507.

Passey, D., 2017. Computer science (CS) in the compulsory education curriculum: implications for future research. *Education and information technologies*, 22 (2), 421–443. doi:10.1007/s10639-016-9475-z.

Pearson Education Limited, 2020. *T level digital: digital production, design and development specification*. London: Institute for Apprenticeships and Technical Education.

Prickett, T., *et al.* (2020) "Resilience and effective learning in first-year undergraduate computer science." In Proceedings of the 2020 ACM Conference on Innovation and Technology in Computer Science Education, Norway, 19–25. ACM.

Qian, Y. and Lehman, J., 2017. Students' misconceptions and other difficulties in introductory programming: a literature review. *ACM Transactions on computing education*, 18 (1), 1–24. doi:10.1145/3077618.

The Royal Society, 2017. *After the reboot: the state of computing education in UK schools and colleges*. London: Royal Society.

Scepanovic, S. (2019) "The fourth industrial revolution and education." In 2019 8th Mediterranean Conference on Embedded Computing (MECO), Budva, Montenegro, 1–4. IEEE.

Sentance, S. and Csizmadia, A., (2015). Teachers' perspectives on successful strategies for teaching Computing in school. In *IFIP TC3 Working Conference*, Vilnius, Lithuania. IFIP, 243–252.

Sentance, S. and Csizmadia, A., 2017. Computing in the curriculum: challenges and strategies from a teacher's perspective. *Education and Information Technologies*, 22 (2), 469–495. doi:10.1007/s10639-016-9482-0.

Shadbolt, N., 2016. *Shadbolt review of computer sciences degree accreditation and graduate employability*. London: Department for Business, Innovation and Skills.

Shulman, L.S., 1986. Those who understand: knowledge growth in teaching. *Educational researcher*, 15 (2), 4–14. doi:10.3102/0013189X015002004.

Sinclair, J., Kriskova, A., and Aho, A.M., 2021. Innovation in ICT course provision: meeting stakeholders' needs. *In:* L Uden, and D Liberona, Eds. *Learning technology for education challenges. LTEC 2021*. Vol. 1428. Cham: Springer, 197–207.

Smothers, N., *et al.*, 2021. (Re)conceptualising effective teaching in further education: an exploratory study. *Journal of further and higher education*, 46 (5), 1–16. doi:10.1080/0309877X.2021.1986622.

Snelson, S. and Deyes, K., 2016. *Understanding the further education market in England*. London: Department for Business, Innovation and Skills.

Varvara, G., Giannakos, M.N., and Chorianopoulos, K. (2015) "Computing education in K-12 schools: a review of the literature." In 2015 IEEE Global Engineering Education Conference (EDUCON), Tallinn, Estonia, 543–551. IEEE.

Webb, M., *et al.*, 2017. Computer science in K-12 school curricula of the 21st century: why, what and when? *Education and information technologies*, 22 (2), 445–468. doi:10.1007/s10639-016-9493-x.

Yadav, A., *et al.*, 2016. Expanding computer science education in schools: understanding teacher experiences and challenges. *Computer science education*, 26 (4), 235–254. doi:10.1080/08993408.2016.1257418.

Yadav, A. and Berges, M., 2019. Computer science pedagogical content knowledge: characterizing teacher performance. *ACM Transactions on computing education*, 19 (3), 1–24. doi:10.1145/3303770.