



# Tips for Effective Blended Learning for Computer Science Education

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## ABSTRACT

Blended learning is the combination of in-person teaching and online activities. For example, combining face-to-face lectures/tutorials with online videos and assessments. With the adoption of non-traditional, not fully on-campus courses, such as degree and graduate apprenticeships in the UK, CPD, re/upskilling, and alternative teaching methods being required due to the pandemic, many different teaching strategies have been explored. Blended learning is one of these strategies and has proven popular for both universities and students.

Based on experience, we present tips for blended learning within the teaching of computer science.

## CCS CONCEPTS

• **Social and professional topics** → **Computing education**; • **Applied computing** → *Education*; *Interactive learning environments*.

## KEYWORDS

blended learning, flipped classroom, peer instruction

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## 1 INTRODUCTION

The introduction of non-traditional, not fully on-campus courses, led to the requirement for an alternative approach to delivery. For example, in Scotland, Graduate Apprenticeships are accredited work-based learning programmes that lead to the attainment of a university degree and a professionally recognised qualification in parallel. Due to the students being in employment while simultaneously attending university, these programmes require an alternative approach to teaching compared to traditional degrees. At Strathclyde, blended learning was the chosen approach, which combines "face-to-face and online activities in a seamless and complementary flow of learning" (HEA)[3]. This approach was also

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applied to our undergraduate and postgraduate degree programmes during the pandemic.

Blended learning originated from the open and distance education movements. The exact blend is dependent on various factors, such as the subject, the needs of the learner, technical capabilities of both the learners and instructors, and the technologies available. An example blend could be to ask students to watch videos and/or complete some reading in their own time on the simpler topics in a class and focusing on the more complex topics in face-to-face classes.

Why use blended learning? It provides the flexibility to cater to students on these non-traditional programmes. It also provides more opportunities for interaction beyond the lecture theatre, through the use of forums and messaging apps/chat services. This is also more inclusive as it encourages and gives opportunities for more students to participate. In addition, by moving some content online larger class sizes that may exceed lecture theatre capacity can be handled. Finally, by moving simpler concepts to videos or other online content it allows face-to-face classes to focus on the more complex topics which are harder to understand.

This paper presents tips for implementing blended learning in computer science education based on experiences of running programmes using this method.

## 2 TEACHING AND ASSESSMENT

When designing classes using blended learning, one of the initial decisions is what to put online and what to run in person.

As an example, online activities could include:

- Videos
- Reading
- Forum Discussions
- Quizzes

Whereas in-person activities could include:

- Tutorials
- Practical exercises

It should be noted that the above in-person activities could be run online but the chosen classification is due to experience of what has been more effective. For example, tutorials could be run on Zoom using breakout rooms to encourage discussion. However, we found it wasn't as effective as running the same activities in person, as it didn't encourage as much interaction.

## 3 TIPS FOR BLENDED LEARNING

The following tips are based on our experience of running various programmes which make use of blended learning and also from running the workshop Effective Blended Learning Practices for Computer Science Education at Computing Education Practice 2023

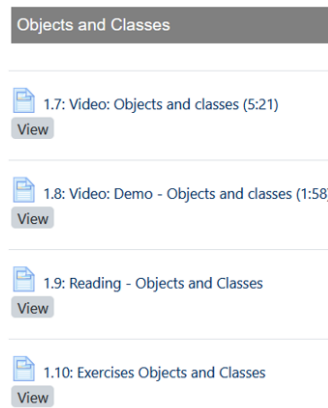


Figure 1: Example Class Page

(CEP 23). This workshop included a facilitated discussion where other educators who use blended learning shared their tips and experiences.

#### Tips:

- Class pages should be well-organised - it's important students can easily find the content they're looking for to help them with revision. Naming slides Lecture 1, Lecture 2, etc., with no other context, makes it difficult to find specific topics. When teaching students about programming the importance of meaningful names and well-structured code is stressed. The same rules should be followed when designing our class pages. For example, Figure 1 shows a fragment of a class page from one of our introductory Java programming classes.
- Don't lose the sense of community - moving online can sometimes lose the sense of community offered by in-person classes. Therefore, it's important students have other methods of communicating. Mattermost or other chat platforms have proven popular with our students. However, forums, Zoom breakout rooms and collaborative work can also be effective.
- Monitor learning analytics - it's easier to notice students who are disengaged with in-person classes due to attendance records or noticing low attendance in class. However, for self-led online activities it can be easier to miss these students until coursework is submitted or exams are marked. Therefore, it's important engagement with Virtual Learning Environments (VLEs) is monitored so timely additional support can be offered to students who are disengaged and/or struggling.
- Face-to-face activities must be interactive and as valuable and engaging as possible - from ours and other educators' experiences, as well as student feedback, the biggest tip is that any activities which are face-to-face must be interactive and as valuable and engaging as possible. If a lecture just involves explaining concepts to the students without asking the students any questions or giving them small problems to solve/exercises to complete then it would probably be better covered in a video.

We've found that the two most effective techniques that meet the requirements of interactive, valuable and engaging as possible are flipped classrooms [1] and peer instruction [2, 4].

### 3.1 Flipped Classroom

Flipped Classrooms [1] involve students completing work at home before working on questions and/or problems in face-to-face classes. The work to be completed at home should be low effort to encourage students to complete it, such as watching short videos.

An example from one of our software engineering classes is students are asked to watch videos and complete readings on the syntax of class diagrams. Then in class focus is on the more complex aspect of accurately drawing an appropriate class diagram when given a problem statement.

### 3.2 Peer Instruction

Peer Instruction [2, 4]<sup>1</sup> involves the following steps:

- (1) Ask a challenging question
- (2) The students answer individually - we use an online voting system
- (3) Responses are reviewed
- (4) Students work in groups to discuss their answers
- (5) Students resubmit answers
- (6) Responses are reviewed again which are then used to decide how to proceed, e.g., move on or give further explanation and ask the question again

An example from one of our software engineering classes is students are given JUnit test examples and asked if they are good tests. For example, we provide a Java method and a set of JUnit tests and ask them to determine if the tests fully test the method. This gives the opportunity to both discover and correct any misunderstandings as well as help students gain a deeper understanding of testing.

## 4 CONCLUSIONS

In conclusion, blended learning has proven effective and popular with our students. We presented some tips for blended learning. However, the most important one is that face-to-face activities must be interactive and as valuable and engaging as possible.

## ACKNOWLEDGMENTS

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<sup>1</sup>In the original definition of peer instruction [4], it was being used in a flipped approach. However, this method can be effectively used with or without flipping the classroom.