Estimating Student Workload During the Learning Design of Online Courses: Creating a Student Workload Calculator

Nicola Beer
Lancaster University, Lancaster,
n.beer@lancaster.ac.uk

Abstract: UK university students are expected to undertake 10 hours of work for each Credit Accumulation and Transfer Scheme (CATS) credit. With face-to-face learning, this is relatively easy to quantify as *x* hours of contact time and the remainder made up of independent study. For online and distance learning, this is more complex. Study materials are provided for students to work through independently, but unlike face-to-face where the class ends after an hour or two, online students could continue working indefinitely. Some students will inevitably take longer than others to complete tasks, and it is therefore more difficult to ensure student workload in online courses is proportionate to the credits awarded.

This paper provides a means to calculate student workload in online courses via a workload calculator, derived from a review of the literature and available at http://bit.ly/postgradworkload. It uses Laurillard's (2009, 2013) conversational framework activity types to categorise online course materials into task types, and provides a means of estimating the time it would take an average student to complete each task, for use in informing the design of online courses. For those task types that cannot be accurately estimated it is recommended to provide guidance on how long a student should spend on the task within the learning materials.

Keywords: Student workload, Online learning, Distance learning, Learning design.

Introduction

Background and context

Most higher education institutions in the UK use Credit Accumulation and Transfer Scheme (CATS) credits as a means of quantifying and recognizing learning. A specific credit value is awarded to a student upon completion of a unit of study, reflecting both the amount and depth of learning undertaken. Credits are accumulated by the learner towards the total credit required for a qualification (e.g. a Bachelor's or Master's degree). Whilst credit is awarded based on the successful achievement of learning outcomes, notional hours of learning are used as a guideline to estimate how long a student should be studying for each credit. In the UK, one credit represents ten notional hours of learning (QAA, 2018).

These notional study hours represent both directed learning and independent study. For courses delivered face-to-face, it is common for institutions to provide students with guidance on how they will be spending this time, with a set amount of contact hours (lectures, seminars, labs, study skills sessions, field work etc.) and the remainder spent on independent study (The University of Edinburgh, 2018; The University of Manchester, 2017; Warwick University, 2014). This provides students with a clearly structured workload. For online students it is more difficult to quantify their study time. Simultaneously, the ability to quantify study hours is of critical importance to these students who have most likely opted to study online for the promise of flexible part-time study (Park, 2017; Romero & Barberà, 2011). As workload issues are considered one of the highest causes for student dropouts on online courses (Bawa, 2016; Travers, 2016; Whitelock, Thorpe & Galley, 2015) try to prepare students; equipping them with information about required study time and helping them fit this in to their lives (Coventry University, 2018; Open University, 2018). Therefore, when designing online learning, a balance must be struck between ensuring the learning outcomes are met and providing an appropriate workload. What is therefore needed is an understanding of what students are actually doing when they study online, and how long it takes them.

Calculating student workload

It is possible to retrospectively model students' workload and how they spent their time on a course, either by asking them to record their actions or by using learning analytics.

Learning analytics tell us how students interact with their course. This can include when they access services, submit assignments or log on to university systems (Sclater, Peasgood, & Mullan, 2016). When applied to a course that is delivered wholly online, learning analytics can tell us how long students spend on their course or on specific pages, and whether they leave the page to search for external resources. This enables us to estimate how long students are spending on tasks, although you can never be certain of how long they are actually engaged whilst the course page is open on their device (Toetenel & Rienties, 2016).

Unfortunately, learning analytics can be time-consuming to utilize and are available during or after a course has run. If they demonstrate a need to adjust workload then a review cycle is required in order to make the necessary changes, requiring a significant time commitment from course creators. Using learning analytics as the sole measure of students' workload effectively makes the first students on a course the 'guinea pigs', impacting their learning experience.

Alternatively, workload can be assessed by asking students to record what they are doing and how long it takes (Nosair & Hamdy, 2017; Ruiz-Gallardo et al 2011). This can provide useful detail about timings, supplemented by qualitative feedback, and, as it is self- reported, the data should provide an accurate representation of how students are spending their time. These studies provide much smaller data sets than learning analytics, and they have their own limitations. Researchers note that students are not always reliable reporters of their own actions due to forgetfulness or perhaps a fear of disclosing how they are really spending their time (Garg et al., 1992; Ruiz-Gallardo et al., 2011). In common with learning analytics, this method is also retrospective.

Neither of these methods can be used during learning design. Of more practical use would be a method of calculating workload on a course whilst it is being produced.

Workload calculators do exist, but they are largely based on face-to-face teaching models (Barre & Esarey, 2016). They cover a limited range of tasks, leaving them unable to estimate times for completing problem-based tasks that online students undertake independently (Nosair & Hamdy, 2017). Where online workload tools have been developed, they are proprietary tools that are not in the public domain (Whitelock et al., 2015). This paper uses existing research to create a student workload estimation tool, addressing the following research questions:

Research questions

1. What are the discrete task types that make up a programme of online learning materials?
2. What is the estimated or average time for a student to complete each learning task, based on current research?

Method

This study is based on a literature review consisting of two parts:

1. An examination of online learning design methodologies to identify a classification of task types carried out by online students.
2. A review of the literature on student behaviour with a view to deducing an average 'time to complete' figure for each of the task types identified above.

The timings established in answer to RQ2 are used to create a workload estimation tool. This tool enables the user to estimate time required for each discrete activity or task on an online course.

Learning design and task types

Learning Design

Learning design can be defined as the purposeful creation of learning materials, experiences or lessons, guided by pedagogical principles, in order to meet specific learning outcomes (Toetenel & Rienties, 2016). It is aimed at supporting the process of learning, rather than teaching, and therefore the learning outcomes are key for guiding an appropriate design, where the learning activities chosen suit the type of outcome desired (Gagné, 2005). Online learning design refers specifically to the design of those learning activities that are delivered online.

Activity types and tasks

If learning design is the process of planning what learners *do* to learn, then it is not surprising that practical support for learning design tends to focus on enabling designers to explore the use of a range of activities (Conole & Fill, 2005; Manton, Balch, & Masterman, 2009; Sharples, 2018; UCL, 2018). Laurillard's conversational theory of learning (Laurillard, 2009, 2013) has been influential in informing a number of these learning design toolkits (Beetham & Sharpe, 2007). The conversational framework takes a holistic view of how students learn, interrogating key learning theories to provide a single framework. A practical application of the framework identifies six learning activity types that describe the ways in which students learn, which are frequently adopted as a means of planning a learning experience in which the student engages with a range of appropriate activities (Sharples, 2018; The Open University, 2018; UCL, 2018). The learning activity types are described in Table 1.

Table 1: Learning activity types (Laurillard & Kennedy, 2016)

Acquisition	Learner takes in information but is not required to do anything with it. Tasks include • Reading • Watching a video • Listening to audio
Discussion	Learner asks questions of others, or answers them. They exchange ideas and arguments to construct knowledge.
Investigation	Learner carries out their own inquiry, requiring them to come up with their own question(s), search for information to answer it, and evaluate their findings. Tasks include: • Conducting an experiment • Searching for resources
Practice	Learner has a task goal requiring them to generate an action, respond to feedback on that action, and try again to get nearer to their goal. Tasks include: • Writing • Quizzes
Production	Learners produce something that the teacher evaluates. This could include: • Writing • Presentation • Another artefact e.g. poster or video
Collaboration	Learners work together on a project to produce a shared output. This is different to discussion as the production of a shared output requires learners to negotiate their position until they agree. These outputs will be similar to those of Production activities.

Calculating time on task

Beetham & Sharpe (2007) distinguish between activities, which are engaged in *by* learners, and tasks, which are required *of* learners to scaffold their engagement in the activity. Learners complete a task or series of tasks that holistically contribute to their activity, and these are derived and quantified for each activity type in the following section.

Acquisition

Reading

Reading speed has been reasonably well researched and can be justifiably quantified. Rayner et al's (2016) systematic analysis concluded that for all people, reading rates are variable depending on the difficulty of the text and the purpose of reading. In creating their own workload tool, Barre & Esarey (2016) conducted a thorough review that identified three levels (Table 2) and three types (Table 3) of reading.

Table 2 Text difficulty

No new concepts	No new vocabulary, reader is able to quickly understand meaning using only their background knowledge.
Some new concepts	May be some new vocabulary, reader will need to check or infer meaning for some concepts.
Many new concepts	A lot of new vocabulary, reader is unable to immediately understand most of the ideas expressed.

Table 3 Reading purpose

Survey	To grasp main ideas
Understand	To understand the meaning of each sentence
Engage	To critically analyse

Studies of college students have shown that under normal conditions, reading a text with no new concepts with the purpose of understanding has a range of between 100-400 words per minute (wpm) (Carver, 1982; Chambers, 1992; Rayner et al., 2016). Where the material is more difficult, this falls to around 200 wpm (Barre & Esarey, 2016; Carver, 1982) and for engagement, rates fall to as low as 50 wpm (Barre & Esarey, 2016). Given more challenging reading material and purpose, the agreement across studies stabilizes (Rayner et al., 2016), suggesting that more accurate time estimates are possible for more complex reading tasks.
Barre & Esarey (2016) provided a breakdown of reading rates for all levels of text difficulty and purpose (Table 4).

Table 4 Reading rates

Reading purpose	**Text difficulty**	**Words per minute**
Survey	No new concepts	500
	Some new concepts	350
	Many new concepts	250
Understand	No new concepts	250
	Some new concepts	180
	Many new concepts	130
Engage	No new concepts	130
	Some new concepts	90
	Many new concepts	65

It should be noted that Barre and Esarey's rates are based on reading print, whereas online students will most likely be engaging with texts on a screen. Some studies demonstrate the impact of screen fatigue, screen position, and lack of tactile function leads to slower reading rates (Dillon, 1992; Kurniawan & Zaphiris, 2001). However, whilst a meta-analysis of comparative papers on reading on screen versus on paper (Kong, Seo, & Zhai, 2018) found that there was evidence for a slight variation, a 2016 review (Köpper, Mayr, & Buchner, 2016) found there was more evidence to show that reading times are equivalent for on-screen and paper. For the purposes of the workload tool, students have been allowed longer reading times (Table 5 Online reading rates). In order to maximize usability of the workload tool, and in line with other workload calculation methods (Chambers, 1992; The Open University, 2018) the number of categories has been reduced to just one difficulty level for each reading purpose.

Table 5 Online reading rates

Reading purpose	**Words per minute**
Survey	300
Understand	130
Engage	70

Watching and listening

Research on the use of media in education tells us the ideal length of videos to maximize student engagement (Brame, 2016; Giannakos, Chorianopoulos, & Chrisochoides, 2015; Kim et al., 2014), and examines students viewing patterns (Conglei Shi et al., 2015; Geri et al., 2015; Giannakos et al., 2015; O'Callaghan, Neumann, Jones, & Creed, 2017). However, there is a lack of research into the time students spend interacting with media and how that compares to the media duration.

A number of studies have identified successful viewing habits, finding that students who watched videos in full, repeated viewings, interacted with video (rewinding/skipping sections), and/or timed their viewings to occur during assessment periods achieved better results than those who didn't (Geri et al., 2015; Giannakos et al., 2015; Kim et al., 2014). None of these studies reported how long those successful students were spending on these tasks, but it is reasonable to assume that this kind of interaction is time-consuming and likely to take longer than the media duration. In deference to this, an initial figure of twice the media duration is suggested, accepting that it may need to be adjusted in response to testing.

Investigation

Investigative activities can be broadly categorized into two types of task (Laurillard, 2013; The Open University, 2018):

- Searching for and evaluating information
- Conducting experiments or collecting data

Research on how students search for and evaluate information tends to focus on how information seeking behavior manifests (Kelly & Sugimoto, 2013), i.e. what people do when they search (Vassilakaki & Johnson, 2015), how many search terms they try (Liu, Liu, Cole, Belkin, & Zhang, 2012), what they click on (Werner, Mandl, & Womser-Hacker, 2016), and how they feel about the process (Kelly & Sugimoto, 2013) rather than how long it takes them. Time is considered as an indicator of search success (Saastamoinen & Järvelin, 2018; Savolainen, 2006), and as a constraint (Crescenzi, 2014), yet time to search and what would be a 'good' time for a successful search is a current gap. Only one study (Borlund, Dreier, & Byström, 2012) was found that reported how long students spent on search tasks. The results can be found in Table 6, showing a marked difference in both the minimum and maximum times to complete tasks and a large disparity in time taken depending on the perceived difficulty of the task. At the 'quick' end of the scale is *verificative* tasks, which simply require the student to check a fact or find a named resource e.g. locating an article in the online library.

Taking almost twice as long are searches for *conscious* and *muddled topical* information needs. Conscious topical requires the student to search for information about a topic they know well. For example, a lawyer searching for relevant case law for an upcoming trial. With a muddled topical need, the user is looking for information about a topic they do not know well. For example, a student tasked with researching the topic of their first module.

Table 6 Time spent searching, measured in hours : minutes : seconds. (Adapted from Borlund et al)

Types of info needs	Min.	Median	Max.	Mean	Sd.
Verificative	00:01:25	00:03:52	00:15:37	00:05:36	00:04:07
Conscious topical	00:05:37	00:16:12	00:28:27	00:14:18	00:06:57
Muddled topical	00:05:02	00:16:38	00:28:30	00:17:17	00:06:02

The timings provided by Borlund et al. (2012) provide a useful indication of workload, however they do not tell us what an average student's experience will be. It is not possible in all cases to determine the type of search task and whether it will be the same for all students. We also know that searching is highly iterative (Kelly & Sugimoto, 2013) and there is high propensity for distractions (Greifeneder, 2016). Even within lab conditions, the difference between minimum and maximum search times is too great to provide a reasonable average. For these types of searches, the recommendation is that the learning designer suggests a reasonable time period, commensurate with the task and students' perceived pre-existing knowledge. This timing should be included in the learning materials to enable the student to plan their workload.

It is however possible to easily identify a verificative search task, and excepting the outlier at 15:37 (caused by one student not knowing how to access their university's library), the timings reported by Borlund et al. (2012)

are within a reasonable deviation. The suggestion is to use the median figure, rounded to the nearest minute, providing a figure of four minutes for a verificative search task.

For tasks that require students to perform experiments or collect data the recommendation is again for the learning designer to make a reasonable suggestion as to the time that should be allocated and signpost this to the learner, in recognition of the wide variety of tasks that could be included here.

Practice

The two most common practice tasks in online learning are:

- Formative writing
- Quizzes

(Toetenel & Rienties, 2016)
Formative writing is discussed under 'Production'.

Quizzes

In calculating how much time to allocate students for quizzes, it is common for guides aimed at teachers to provide advice such as:
"To determine how much time the student will need to take the test use the following:

- 30 seconds per true-false item
- 60 seconds per multiple choice item
- 120 seconds per short answer item
- 10-15 minutes per essay question
- 5 to 10 minutes to review the work
- Or, allow triple the amount of time it takes you to complete the exam."

(Clay, 2001).

The suggested timings in such guides times vary from 30 secs per question (University of Central Florida, 2018) to 60-90secs per question (Salkind, 2006). These figures are not supported by sources and do not seem to take into account differences between recall and application questions.

Schneid et al's (2014) study of the use of multiple choice quizzes (MCQ) in medical schools suggest that the design of questions impacts the time required to answer them, with the number of distractors being a key indicator of time. They found it takes an average of 36 seconds to answer a three-option MCQ, and 41 seconds to answer a four-option MCQ. This is supported by Vegada et al. (2016), who suggest an extra 6 seconds is needed for each extra option on an MCQ question.

Allowing for MCQs with five-option questions and time for students to review their responses, 60 seconds per question provides an adequate estimation. This aligns with guidance provided to students at some institutions (Gareis & Grant, 2015; Nottingham Trent University, n.d.).

Production

Writing

Writing is one of the most difficult things to calculate a time for because there are so many different types of writing (Barre & Esarey, 2016). Nevertheless, Torrance et al.'s (2000) study attempted to quantify it by gathering information from 715 students about their writing habits. This data was expanded on by Barre & Esarey (2016) in their workload tool.
Further timings for writing have also been informally provided to the author by Coventry University's Centre for Academic Writing. These timings, recorded in Table 7, are based on experience rather than backed by formal research, yet they provide very similar estimates. Due to their ease of application to an online course, these are the preferred figures for the workload calculator.

Table 7 Time to write: from CAW

Writing	Opinion or thought (e.g. comment/discussion)	100 words = 20 minutes 200 words = 40 minutes
Writing	Formative	500 words =10 hours 1500 words =30 hours
Writing	Summative	500 words = 11 hrs 40 1500 words = 36 hours 2000 words = 48 hours

Discussion

Discussion is very difficult to quantify, largely because students behave very differently in discussion activities, depending on their knowledge of the topic and their personal preferences for engagement with online discussions (Curtis & Lawson, 2001).

In order to engage in discussion fully, a student needs to understand the topic being discussed, formulate and post an initial response, read their peers' writings and comments, and formulate responses to them (Macia & Garcia, 2016). Given the complexity of this task, it could borrow from both reading and writing in estimating timings. However, this somewhat formulaic approach doesn't allow for the complexities of dynamic online discussion. As with several of the complex tasks, a better approach is for the designer to suggest an appropriate amount of time for students to engage with the discussion, bearing in mind the topic at hand.

Collaboration

Collaboration is essentially production, with the added element of organisational and time management skills that go along with working in a team.

Group work generally takes longer as students need to negotiate their position and reach a consensus before producing their output and reassess and review each other's work before submission (Laurillard 2016).

Further research is required to understand the workload involved in collaborative tasks, so as a starting point it is recommended to use the figure for production and double it. This will need assessing for accuracy as the workload tool is tested.

Additional tasks

Given that some online courses may include some synchronous activity, a final task classification has been included to allow for a full calculation of study time. Synchronous activities such as online tutorials have a set time limit so there is no need to estimate their duration and they therefore have their own category in the calculator.

Discussion and conclusion

Having identified the amount of time students can be expected to spend on different tasks as they learn online, the data is compiled into a usable format for calculating student workload.

The basic workload calculator spreadsheet is supported by an information sheet detailing the time allowances by task type. Users will need to use the guidance sheet to calculate time for each task and add it to the spreadsheet which then calculates a total workload time for the course.

Application of the calculator

Although the calculation tool has been produced with the aim of estimating workload on UK postgraduate courses delivered online via the FutureLearn platform, its usability is far wider than this. The use of the conversational framework activity types to derive online tasks was explicitly selected for its applicability to any model of online course design and use of any platform. It could apply to any level of learning, including MOOCs, although educators may want to tweak the suggested figures based on their knowledge of their student cohort, for example if the course is not being delivered in students' first language. Additionally, the literature review into time on tasks revealed that there is no explicit difference between whether a task is completed online or face-to-face: the difference lies in the lack of facilitation and therefore explicit structure provided to online students. Accordingly, the workload estimation figures could equally be applied to a face-to-face situations, supporting educators in planning their teaching. On the other hand, for online students this tool provides an estimate of how long a task *should* take and is therefore accompanied by a strong recommendation that this is communicated to the student to allow them to plan their time.

Using the calculator to aid design

The calculator should be used to monitor workload during design, but also as a prompt to help manage student expectations. Knowing that "students spend too much time on almost all activities, leading to a general overload" (Ruiz-Gallardo et al., 2011) certain tasks (as indicated in the guidance) should be accompanied by a recommendation to students to spend roughly *x* amount of time on it, i.e. 'Spend up to one hour researching and provide a summary of your findings in the forum'.

Limitations and further research

As Bowyer (2012) identified:

"Designing a model of student workload is fraught with difficulty because there are so many factors to take into account. Some factors cannot easily be quantified and even with those that can, it is then difficult to assess the relationships between these factors and how much they influence workload."

This tool is a pragmatic solution to a complex problem, accepting that it is possible only to cater for the 'average' student, and that this may be different from course to course (e.g. a course may not be in a student's first language). Even accounting for this, there were some notable gaps in the research, with student time on task being under-researched, for both face-to-face and online students. It would appear that there has been an over reliance in using the set time of classroom sessions to monitor workload, rather than assessing how long is actually needed in order for students to adequately engage with a task. Going forward, the calculator needs to be tested for accuracy and usability, which could be achieved using a combination of learning analytics and student-reported timings. Such a study could have the dual purpose of checking the reliability of the workload model and also filling in some of the gaps in research on how long students spend completing tasks. This could impact both online and traditional face-to face models of teaching.

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