

**Using the Pomodoro Technique® to help undergraduate students better manage technology-based multitasking during independent study:
A design-based research investigation**

Salman Ahmed Usman, BSc (Hons), MSc, PGCert (LTHE)

April 2020

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

Department of Educational Research,
Lancaster University, UK

This thesis results entirely from my own work and has not been offered previously for any other degree or diploma.

Word count: 62,840

Signature 

Abstract

The issue of student multitasking is debated often in higher education, for example when discussing whether ‘digital native’ students can naturally multitask when using technology. Yet some students do continue to struggle with multitasking, especially when undertaking self-directed study using digital devices, and there have been few empirical investigations into how to support those students.

In this thesis, I seek to investigate the effectiveness of a popular time management technique, the Pomodoro Technique® (PT), in helping students better manage technology-based multitasking during independent study. To this end, I describe a design-based research investigation comprising four cycles/iterations, dedicated in turn to understanding the reasons students multitask (cycle 1), exploring and refining the use of the technique (cycles 2-3) and following the use of the refined technique by students over two months (cycle 4). Participants were twelve undergraduate students at a UK university who self-identified as struggling with multitasking. Data collection included participant diary records and periodic interviews.

Findings reveal that participants’ reasons for multitasking were varied. Most participants found the PT® helpful for addressing their multitasking. However, there was little consensus on how the PT® helped participants or which aspects were helpful, with the same aspects (e.g. ticking timer, deferring potential interruptions) identified as helpful or ineffective by different

participants. The effectiveness of the technique was also impacted by contextual factors such as assessment deadlines and uncondusive study environments. Overall, it seems important that students allow enough time to get used to the technique, and that they reflect on and modify how they use the technique to suit their context under appropriate guidance.

The thesis contributes to the literature on student multitasking in higher education. It presents one of the first evidenced-based investigations of managing multitasking (and one of the first formal evaluation of the PT® in an academic context). The findings highlight previously overlooked reasons for student multitasking, such as the convergent use of online platforms for both study and non-study-related activities, and emphasise that technology and non-technology-based reasons for multitasking can be closely related. The thesis also argues that scholars working on student multitasking should be aware of issues highlighted in other areas of literature, such as in studies of self-efficacy and human visual processing.

Acknowledgements

In the name of Allah (God), the most gracious and the most merciful. It is verily with His will and mercy that this work has been accomplished.

Words cannot adequately express my gratitude to my supervisors, Dr Brett Bligh and the late Dr Steve Dempster, for their interest in, and invaluable guidance on my work. I have benefitted immensely from their knowledge and insight. I am especially grateful to them for keeping me on track, for the continuous encouragement, and prompt feedback on my work.

I would like to give heartfelt thanks to my family and relatives, especially my parents, my wife, my daughter, and my sister, for their endless support, encouragement, love and patience.

My sincere thanks to academic staff on the E-Research and Technology Enhanced Learning doctoral program for their guidance and support through this doctoral journey, and to Ms Alice Jesmont for administrative support.

Thank you to my thesis examiners, Prof Don Passey and Dr Jennie Winter, for their interest in my work and insightful feedback.

I would like to thank peers on the E-Research and Technology Enhanced Learning doctoral programme, and colleagues, especially Dr Barry Avery, for their continuous support and encouragement throughout my doctoral studies.

Last, but not least, I would like to express my special gratitude to my research participants for sharing their experiences, and to the staff at the research site for facilitating data collection.

Table of contents

Abstract	iii
Acknowledgements.....	v
Table of contents	vi
List of figures.....	xv
List of tables	xv
Chapter 1 - Introduction	1
1.1 Introduction	1
1.2 Defining multitasking	2
1.3 Policy context.....	8
1.4 Personal motivation	13
1.5 Practice context	14
1.6 Research context and locating the project	16
1.7 Thesis overview.....	19
Chapter 2 - Literature Review	21
2.1 Introduction	21
2.1.1 Locating the project – ‘Digital Natives’ and multitasking	21
2.1.2 Conduct of literature search	25
2.2 Reasons for multitasking.....	27
2.2.1 Technology access and design	27
2.2.2 Motivation.....	28
2.2.3 Self-efficacy	29
2.2.4 Out of habit.....	30
2.2.5 Time pressure.....	31
2.2.6 Desire for sociability.....	31
2.2.7 Personality traits	31
2.2.8 Psychological problems and social difficulties.....	33
2.2.9 Addiction	34
2.2.10 Others	34
2.3 Strategies for managing multitasking	35

2.3.1 Maintenance of boundaries between study and non-study-related activities	36
2.3.2 Multitasking awareness and usage tracking	38
2.3.3 Time pressure.....	38
2.3.4 Technology breaks	39
2.3.5 Reminder for not multitasking.....	39
2.3.6 To-do lists and prioritising tasks	39
2.3.7 Self-observation and self-reflection.....	40
2.3.8 Mindful breathing	40
2.3.9 Others.....	41
2.4 Limitations in current research.....	41
2.4.1 Reasons for multitasking.....	41
2.4.1.1 Conceptions of multitasking	42
2.4.1.2 Self-report and participant memory	42
2.4.1.3 Non-natural settings	43
2.4.1.4 Lack of participant’s own experiences and voices	44
2.4.1.5 Not sufficiently longitudinal.....	45
2.4.2 Strategies for managing multitasking	45
2.4.2.1 Lack of evidence for effectiveness	45
2.4.2.2 Methodological shortcomings	46
2.4.2.3 Limited practical value	47
2.5 Implications for study	48
2.5.1 Conceptualisation of multitasking	48
2.5.2 Evidenced-based strategies for managing multitasking	48
2.5.3 Methodological rigour	49
2.6 Conclusion.....	50
Chapter 3 – The Pomodoro Technique®	52
3.1 Introduction	52
3.2 The Pomodoro Technique® explained.....	53
3.2.1 Dealing with and recording interruptions.....	56
3.2.2 Variation from the original technique	58
3.3 Reasons for selecting the Pomodoro Technique®	60
3.3.1 Alignment with recommendations from literature	61
3.3.2 Alignment with practice.....	61

3.3.3 Alternative strategies considered as interventions	62
3.4 Existing evaluation of the Pomodoro Technique®	63
3.4.1 Research limitations.....	68
3.4.1.1 Lack of research in multitasking in academic contexts.....	68
3.4.1.2 Methodological shortcomings	69
3.5 Summary	70
Chapter 4 – Research Design.....	72
4.1 Introduction	72
4.2 Ontological and epistemological position.....	73
4.2 Methodology.....	74
4.2.1 Overview	74
4.2.2 Choosing Design-Based Research as a methodology.....	75
4.2.2.1 Role of theory in a DBR study	76
4.2.3 Applying the methodology.....	77
4.2.3.1 Research site	77
4.2.3.2 Research participants.....	78
4.2.3.3 ‘Insider’ research.....	79
4.2.3.4 Designing the DBR study	81
4.3 Data collection methods	86
4.3.1 Participant diaries	86
4.3.2 Diary reflection using usage logging software/apps.....	88
4.3.3 Interviews.....	90
4.4 Data analysis	92
4.5 Research ethics	96
4.6 Strengths and weaknesses of the research design	98
Chapter 5: Data Presentation.....	102
5.1 Introduction	102
5.2 DBR cycle 1 – Participants’ experiences of and strategies for managing multitasking ...	103
5.2.1 Introduction to DBR cycle 1	103
5.2.2 Reasons for multitasking.....	104
5.2.2.1 Self-efficacy and/or motivation	106
5.2.2.2 Study environment	107

5.2.2.3 Technology for study-related activities	107
5.2.2.4 The need for a break.....	108
5.2.2.5 Pleasure and mood regulation.....	109
5.2.2.6 Ease of multitasking	109
5.2.2.7 Feeling ‘confident’.....	110
5.2.2.8 Activity type	110
5.2.3 Reasons for not multitasking	110
5.2.3.1 Exam or assignment deadlines.....	111
5.2.3.2 Interest in study-related task.....	111
5.2.3.3 Lack of interruption.....	111
5.2.3.4 Guilt.....	111
5.2.3.5 Hawthorne effect	112
5.2.3.6 Technique to manage multitasking.....	112
5.2.3.7 Activity type	112
5.2.4 Existing strategies to manage multitasking	112
5.3 DBR cycle 2 – Evaluation of the Pomodoro Technique® after use for the first time.....	113
5.3.1 Introduction to DBR cycle 2	113
5.3.2 Design of intervention	114
5.3.2.1 Minimising interruptions before commencing pomodoro	114
5.3.2.2 Review and reflection on to-do-today sheet	115
5.3.3 How participants used/adapted the Pomodoro Technique®?	115
5.3.4 Reasons for multitasking.....	117
5.3.4.1 Study environment	118
5.3.4.2 Non-study-related thoughts	119
5.3.4.3 Technology for study-related activities	119
5.3.5 Participants’ experience of the Pomodoro Technique®	119
5.3.5.1 Activity inventory and to-do-today sheets	119
5.3.5.2 Pomodoro timer.....	121
5.3.5.3 Recording a successful pomodoro	122
5.3.5.4 Deferring potential interruptions	122
5.3.5.5 Voiding pomodoro and recording interruptions.....	123
5.3.5.6 Duration of pomodoro and breaks	123
5.3.5.7 Refinements to the Pomodoro Technique®	125
5.3.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking	126

5.3.5.9 Misconceptions about the Pomodoro Technique®	131
5.3.5.10 Instructions for the Pomodoro Technique®	132
5.3.6 Reflections.....	132
5.4 DBR cycle 3 – Evaluation of the Pomodoro Technique® after use for the second time ..	133
5.4.1 Introduction	133
5.4.2 Design of the intervention	133
5.4.2.1 Removing the distinction between internal and external interruptions	133
5.4.2.2 Computer-based alternatives to kitchen/egg timer	134
5.4.2.3 Digital copy of activity inventory and to-do-today sheets.....	134
5.4.2.4 Adjusting pomodoro duration	134
5.4.2.5 Adjusting duration of breaks.....	134
5.4.2.6 Not ending the pomodoro abruptly.....	134
5.4.2.7 Returning to study after a shorter or longer break	135
5.4.2.8 Dealing with distractions	135
5.4.3 How participants used/adapted the Pomodoro Technique®?	136
5.4.4 Reasons for multitasking.....	137
5.4.4.1 Study environment	138
5.4.4.2 Technology for study-related activities	138
5.4.5 Participants’ experience of the Pomodoro Technique®	139
5.4.5.1 Activity inventory and to-do-today sheet	139
5.4.5.2 Pomodoro timer.....	140
5.4.5.3 Recording a successful pomodoro	140
5.4.5.4 Deferring potential interruptions	141
5.4.5.5 Voiding a pomodoro and recording interruptions.....	141
5.4.5.6 Duration of pomodoro and breaks	141
5.4.5.7 Refinements to the Pomodoro Technique®	142
5.4.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking	143
5.4.5.9 Misconceptions about the Pomodoro Technique®	145
5.4.6 Reflections.....	145
5.5 DBR cycle 4 – Evaluation of the Pomodoro Technique® after use for an extended time period.....	146
5.5.1 Introduction	146
5.5.2 Design of the intervention	146
5.5.2.1 Computer-based alternatives to kitchen/egg timer	147

5.5.2.2 Dealing with distractions	147
5.5.3 How participants used/adapted the Pomodoro Technique®?	147
5.5.4 Reasons for multitasking.....	149
5.5.4.1 Study environment	150
5.5.4.2 Self-efficacy and/or motivation	150
5.5.4.3 Technology for study-related activities	151
5.5.5 Participants' experience of the Pomodoro Technique®	151
5.5.5.1 Activity inventory and to-do-today sheet.....	151
5.5.5.2 Pomodoro timer.....	152
5.5.5.3 Recording a successful pomodoro	153
5.5.5.4 Deferring potential interruptions	153
5.5.5.5 Voiding a pomodoro and recording interruptions.....	154
5.5.5.6 Duration of pomodoro and breaks	154
5.5.5.7 Refinements to the Pomodoro Technique®	155
5.5.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking	157
5.5.5.9 Misconceptions about the Pomodoro Technique®	160
5.5.6 Reflections.....	160
5.5.6.1 Activity inventory sheet	161
5.5.6.2 To-do-today sheet.....	162
5.5.6.3 Adjusting duration of pomodoro and breaks.....	162
5.5.6.4 Using the PT® in groups	162
5.5.6.5 PT® instruction manual.....	162

Chapter 6: Data Analysis.....164

6.1 Introduction	164
6.2 Reasons for multitasking.....	164
6.3 Reasons for multitasking and the Pomodoro Technique®	165
6.3.1 Reasons for multitasking that may be addressed by use of the Pomodoro Technique®	165
6.3.1.1 Absence of a break.....	168
6.3.1.2 Pleasure and mood regulation.....	169
6.3.1.3 Switch from study to non-study-related conversation.....	170
6.3.1.4 Feeling 'confident'	170
6.3.1.5 Ease of multitasking	171

6.3.1.6 Technology for study-related activities	172
6.3.1.7 To check if contacted by peers	172
6.3.1.8 Activity type	173
6.3.1.9 Study environment	173
6.3.2 Reasons for multitasking that may not be addressed by use of the Pomodoro Technique®	174
6.3.2.1 Notifications for non-study-related activities	174
6.3.2.2 Study environment	175
6.3.2.3 Self-efficacy and/or motivation	177
6.3.2.4 Technology for study-related activities	178
6.3.2.5 Out of habit	179
6.3.2.6 Getting reminded of a non-study-related activity	179
6.3.2.7 Absence of deadline/time pressure	180
6.3.2.8 Peer expectations	180
6.3.2.9 Non-study-related thoughts	181
6.4 Effectiveness of different aspects of the Pomodoro Technique®	182
6.4.1 Activity inventory and to-do-today sheet	182
6.4.2 Pomodoro timer	183
6.4.3 Recording a successful pomodoro	183
6.4.4 Deferring potential interruptions	183
6.4.5 Voiding a pomodoro and recording interruptions	184
6.4.6 Duration of pomodoro and breaks between pomodoros	184
6.4.7 Refinements to the technique	185
6.5 Factors governing the effectiveness of the Pomodoro Technique®	186
6.5.1 Assessment deadlines	187
6.5.2 Convergence of platform for study and non-study-related activities	188
6.5.3 Conducive environment for study	189
6.5.4 Participants' affective state	189
6.5.5 Participants not adhering to rules of the PT®	191
6.5.6 Allowing time to get used to the PT®	192
6.5.7 Group study	193
6.5.8 Adapting the Pomodoro Technique® to suit one's needs	193
6.5.9 Keeping the technique and instructions simple and accessible	194
6.5.10 The 'getting to study' challenge	195

6.5.11 Other advantages of the PT [®]	196
6.6 Summary	197
Chapter 7 - Discussion	203
7.1 Introduction	203
7.2 How might the use of the PT [®] help better manage technology-based multitasking during independent study?	203
7.2.1 Contribution of different aspects of the PT [®] in enabling participants to manage multitasking.....	204
7.2.2 Contextual factors governing the effectiveness of the PT [®] in managing multitasking	206
7.3 Contributions to the literature on reasons for multitasking.....	209
7.3.1 Points of commonality with existing literature.....	209
7.3.2 Findings in the literature that did not appear in my findings	211
7.3.3 Findings of this research that were not reported in the literature	211
7.3.3.1 Convergence of platform for study and non-study-related activities	211
7.3.3.2 Multitasking is not technology-based only	213
7.3.3.3 Convergence of non-study-related activities on a phone.....	216
7.3.3.4 Nature of study-related task.....	217
7.4 Contributions to the research on strategies for managing multitasking.....	218
7.5 Contributions to evaluation of the Pomodoro Technique [®]	223
7.6 Conclusion.....	228
Chapter 8 - Conclusion.....	230
8.1 Introduction	230
8.2 Research objective	230
8.3 Research findings	231
8.4 Limitations.....	238
8.5 Contribution to new knowledge	239
8.6 Implications for policy.....	241
8.7 Implications for practice	244
8.8 Implications for future research	247
8.8.1 Conceptions of multitasking	247
8.8.2 Research design	248

8.8.3 Research contexts	248
8.8.4 Reasons for multitasking.....	248
8.8.5 Strategies for managing multitasking	250
8.8.6 Multitasking and assessment outcomes.....	252
References	253
Appendix 1 – Participation information sheet and informed consent form	271
Appendix 2 – Interview guide	278

List of figures

FIGURE	PAGE
FIGURE 3.1 ACTIVITY INVENTORY SHEET	53
FIGURE 3.2 TO-DO-TODAY SHEET	54
FIGURE 3.3 POMODORO TIMER	55
FIGURE 4.1 PARTICIPATION SUMMARY	85
FIGURE 8.1 REASONS FOR MULTITASKING FOUND BY THIS STUDY AND THOSE REPORTED IN THE LITERATURE	232
FIGURE 8.2 FRAMEWORK ON USING THE PT® TO SUPPORT UNDERGRADUATE STUDENTS BETTER MANAGE TECHNOLOGY-BASED MULTITASKING DURNG INDEPENDENT STUDY	237

List of tables

TABLE	PAGE
TABLE 4.1 DATA COLLECTION SCHEDULE	84
TABLE 4.2 SUMMARY OF DATA COLLECTION METHODS AND RESEARCH SUB-QUESTIONS THEY ADDRESSED	86
TABLE 4.3 FIRST ROW OF THE PARTICIPANT DIARY	88
TABLE 5.1 NUMBER OF DAYS DIARY WAS KEPT, TOTAL NUMBER OF STUDY SLOTS, AND NUMBER OF STUDY SLOTS INVOLVING MULTITASKING IN DBR CYCLE 1	104
TABLE 5.2 REASONS FOR PARTICIPANTS' MULTITASKING IN DBR CYCLE 1	105
TABLE 5.3 NUMBER OF DAYS PT® WAS USED, TOTAL NUMBER OF STUDY SLOTS, AND NUMBER OF STUDY SLOTS INVOLVING MULTITASKING IN DBR CYCLE 2	116
TABLE 5.4 REASONS FOR PARTICIPANTS' MULTITASKING/VOIDING POMODOROS IN DBR CYCLE 2	118
TABLE 5.5 FACTORS BEHIND MULTITASKING IDENTIFIED BY PARTICIPANTS AND MEASURES TAKEN BY THEM TO ADDRESS THESE DURING DBR CYCLE 2	126
TABLE 5.6 NUMBER OF DAYS PT® WAS USED, TOTAL NUMBER OF STUDY SLOTS, AND NUMBER OF STUDY SLOTS INVOLVING MULTITASKING IN DBR CYCLE 3	136
TABLE 5.7 REASONS BEHIND PARTICIPANTS' MULTITASKING/VOIDING POMODOROS DURING DBR CYCLE 3	138
TABLE 5.8 DURATION IN MONTHS FOR WHICH PARTICIPANTS USED THE PT® IN DBR CYCLE 4	147
TABLE 5.9 REASONS FOR MULTITASKING/VOIDING POMODOROS DURING DBR CYCLE 4	149
TABLE 6.1 REASONS FOR MULTITASKING ACROSS FOUR DBR CYCLES	166
TABLE 6.2 REASONS FOR MULTITASKING UNDER THE CATEGORY 'STUDY ENVIRONMENT'	167
TABLE 6.3 REASONS FOR MULTITASKING UNDER THE CATEGORY 'TECHNOLOGY FOR STUDY-RELATED ACTIVITIES'	167
Table 8.1 VARIANCES TO THE PT® BY INDIVIDUAL PARTICIPANTS ACROSS DBR CYLES 2, 3 AND 4	234

Chapter 1- Introduction

1.1 Introduction

The use of internet and smartphones has become widely prevalent in the United Kingdom (UK), especially amongst 16-24 year olds which is the typical age range for undergraduate university students. According to a study by Ofcom (2017), 95% of the 16-24 year olds had internet access at home with most using smart telephones (owned by 96%) to get online. Although the majority of their use comprise leisure activities, digital devices and the internet are increasingly being used by 16-24 year olds and especially university students for educational and study-related purposes (Ofcom 2017, Newman et al. 2018, UCISA 2018). Similar patterns can be seen in several other countries: for example Australia and New Zealand (Beetham et al. 2018), Canada (Canadian Digital Learning Research Association 2018) and the United States of America (USA) (Allen et al. 2016).

The increase in the use of digital devices and the internet for both study and non-study-related activities has prompted research on student behaviour and impact of technology. A wide range of studies in different research settings have reached similar findings: when pursuing study-related activities using digital devices and the internet, students are multitasking between study and non-study-related activities during independent study (Junco and Cotten 2011, Junco and Cotten 2012, Moreno et al. 2012, Yeykelis et al. 2014, Judd 2013, 2015). Yet, as I illustrate in section 2.1.1, research investigating the impact of

multitasking has found it to be associated negatively with task performance and assessment outcomes.

As I will be outlining later in this chapter, although the challenges arising from multitasking are recognised by media and some influential organisations related to educational technology, there is no government policy currently in place to address the challenge. Furthermore, the focus of research on multitasking to date is skewed towards the impact of multitasking on learning and academic performance (e.g. Song et al. 2013, Lau 2017). As I will be illustrating in section 2.4.2.1, there is almost no research on supporting students to effectively manage multitasking during independent study. Although some higher education institutions in the UK provide advice on managing multitasking, it is not evidence-informed. Given the increased importance of independent study within the contemporary university student experience (for a discussion in relation to blended learning, see Bowyer and Chambers 2017), I consider it vitally important that research is carried out on how students can be provided with evidence-based advice on effectively managing multitasking in relation to their study-related activities carried out digitally during that independent study.

1.2 Defining multitasking

Student multitasking has been referred to by a variety of other terminologies which include task switching, media multitasking, procrastination and distraction. Therefore, I believe that it is important to start by clarifying how I perceive and define multitasking.

Dzubak (2008:1) defines multitasking as 'engagement in individual and discrete tasks that are performed in succession'. Dzubak argues that multitasking entails multiple tasks being performed sequentially and in quick succession (also referred to as sequential multitasking by Rosen et al. 2013a) rather than at the same time. Cardoso-Leite et al. (2016) on the other hand term this as task switching and instead consider multitasking to be an instance where two stimuli are presented at the same time, e.g. an auditory and visual stimuli (also referred to as concurrent multitasking by Rosen et al. 2013a). Judd (2013) considers task switching as switching to a task without returning to the previous task with multitasking involving returning to the previous task. Yet another conception of task switching reported by Darmoul et al. (2015) entails being able to switch attention from one task to another in a planned manner during an assigned period. Switching attention from one task to another in an unplanned manner is considered interruption and both task switching (i.e. planned) and interruption (i.e. unplanned) together form multitasking. Sanbonmatsu et al. (2013) view multitasking as the concurrent performance of tasks with distinct goals involving unique stimuli, mental transformation, and response outputs. Among these varying perspectives and conceptions of multitasking, I present my conception of the term multitasking below.

As I illustrate in section 2.1.1, multitasking in its literal meaning, i.e. performing two tasks at once, is not humanly possible unless for tasks that are automated (such as making a cup of coffee whilst listening to radio). This conception of

multitasking will not be appropriate for research in educational contexts as educational tasks are not usually automated and require cognitive resources.

I take the view that in academic contexts switching between study and non-study-related activities is a switch between two tasks with distinct goals. This aligns closely with the definition of multitasking by Sanbonmatsu et al. (2013). My stance is also supported by analysis by Aagaard (2019) of research on multitasking which found that what is under study in this research is not a quantitative enumeration of tasks but behaviour that pulls attention away from the educational tasks (i.e. distinction between on and off-task activity).

Students use multiple stimuli and media for the completion of a goal/task. For example, a student who is completing an assignment may be using, and switching between, a word processor on a computer to type-in the assignment, reading an e-book on a web browser, searching for relevant research papers on a web search engine, contacting friends on an instant messaging app on their smart phone for assignment related queries, and using an audio player and headphones to ward off external noise. As all these activities, media and stimuli are aiding in attainment of a single goal, i.e. assignment completion, switching between them should not be considered multitasking. In addition, some of the media may be consumed and stimuli presented concurrently, e.g. typing in Microsoft (MS) Word whilst listening to an audio player, whereas other media is consumed sequentially, e.g. reading an e-book followed by going through a journal article.

However, the moment the student uses either these or other media or stimuli for a goal other than completion of the assignment, then they have engaged in multitasking. For example, in the midst of assignment completion, if the audio player is used to play a track that, instead of enabling the student to focus, distracts them so that they only listen to it, then they have multitasked. Similarly, students have multitasked if they decide to go to an online shopping website to shop for clothes when searching for papers relevant to the coursework.

Can multitasking be both planned and unplanned as reported by Darmoul et al. (2015)? I take the view that multitasking will always be unplanned. For instance, if a student planned to switch to a non-study-related activity (e.g. as a break) after half an hour then that will not be considered multitasking: instead, I consider it to be simply switching to a different task as planned. However, if a student switched to a non-study-related task before the assigned time (e.g. half an hour) either due to an internal urge or an external interruption then it will be considered multitasking.

How would then one classify switching behaviour where a student did not designate a schedule for study-related tasks? I posit that this relates to an individual student's perceptions about and value of the task they switch to. If a student finds that switching to a non-study-related task was valuable to the study-related goal (e.g. a refreshing break) then this will not be considered multitasking. However, if a student perceives that switching to a non-study-related activity/task (or even a different study-related activity with a different

goal) was detrimental to their study-related task or was undesirable (e.g. spending too much time on instant messaging with friends leaving little time for study-related task) then this will be considered multitasking. This also resolves the question of whether not returning to a task after switching to another task constitutes multitasking: if a person switches to a non-study-related task unplanned or considers the switch not desirable, then this will be considered multitasking regardless of whether they return to the study-related task or not.

To sum up the above discussion, I consider multitasking to be a switch between tasks where a task is identified by a distinct goal. To complete a task, students can employ multiple concurrent stimuli, communicate with other people, and switch between various mediums, devices, and applications as long as it is considered contributing to the same goal, i.e. the task.

Multitasking only occurs when students switch to another task with a different goal, either unplanned or if they ascribe a negative value to the switching behaviour. This includes switching to a non-study-related activity without returning to the original study-related task. This conception of multitasking is similar to the terminology 'off-task behaviour' used by Bolkan and Griffin (2017). However, I will use the term multitasking as it is more widely used in literature. Furthermore, although the focus of this study is technology-based multitasking, this study is in-situ (as explained in chapter 4) and therefore considers multitasking within media, between media, and between media and human beings (Wallis 2010), in order to understand a participant's multitasking behaviour.

Multitasking has also been termed in the literature as media multitasking (e.g. Foehr 2006), enforced/involuntary and volitional multitasking (Lee and Han 2014), cyber-slacking (Flanigan and Kiewra 2018) and cyber-loafing (Yılmaz and Yurdugül 2018).

Switching between study and non-study-related activities has also been discussed in the context of procrastination, which has been defined as ‘the act of needlessly delaying tasks to the point of having subjective discomfort’ (Solomon and Rothblum 1984:503). This means that students may have the intention to perform an academic activity within a desired timeframe, but fail to motivate themselves to do so (Senécal et al. 2003). According to another definition, procrastination entails the voluntary delay in the intended course of action despite expecting to be worse off for the delay (Steel 2007). Based on the aforementioned definitions, I take the view that multitasking is one of the enablers or facilitators of procrastination. However, students may not always engage in multitasking due to the desire to procrastinate.

The terms multitasking and distraction have been used interchangeably in literature. The Cambridge Dictionary (n.d.) defines distraction as ‘the state of being very bored or annoyed’ or ‘something that prevents someone from giving their attention to something else’. As mentioned above, Aagaard (2019) argues that as the focus of research in multitasking is on a distinction between on-task and off-task activity, this makes multitasking functionally equivalent to distraction and therefore the term media multitasking should be replaced with the term digital distraction. I take the view that distraction might be the cause

of multitasking, but all multitasking may not be due to distraction. For example, whereas being interrupted by notification for a mobile text might cause one to become distracted and thus form a reason for multitasking, a person actively interrupting their study-related task to chat with a friend online may not be distracted but has still undertaken multitasking.

1.3 Policy context

Despite the research evidence (mentioned in the Introduction and considered in greater detail in section 2.1.1), it is regrettably the case that national policies on digital skills often omit the issue of multitasking. The digital strategy by the UK government stresses the need and the aim for everyone in the UK to have basic digital skills (Department for Digital, Culture, Media and Sport 2017). The government's priority of digital literacy development appears to have an impact – supporting the development of digital literacy skills or digital capability was one of the top driving factors in the development of Technology Enhanced Learning (TEL) by UK higher and further education institutions (UCISA 2018). However, the government's digital strategy does not specify what those skills comprise and whether the government considers management of multitasking as part of it. The UK House of Lords select committee report (Select Committee on Digital Skills 2015) does include a digital skills specification and yet management of multitasking is not included there. The UK digital skills task force, an independent body, provides recommendations for 'nurturing' digital skills and identifies three 'tiers' of skills namely digital citizen, digital worker, and digital maker (UK Digital Skills Task Force 2014). The report does not provide details on what it considers digital literacy or what skills are encompassed in these categories.

The recognition of the challenge of multitasking is reflected in some frameworks for digital competencies, and has been categorised as part of 'digital wellbeing'. The European Commission digital competency framework, for example, includes the competency to be able to 'avoid health-risks related with the use of technology in terms of threats to physical and psychological wellbeing' (Ferrari 2013). The framework provides the ability to 'manage the distracting aspects of working/living digitally' as an example of this competency. Similarly Jisc, a UK-based digital services and solutions organisation, has produced a digital capability framework that outlines six broad categories of digital capabilities that are required to 'thrive in a digital environment' (Jisc 2018). Of these, the category 'digital identity and wellbeing' includes the capability to 'manage digital workload, overload and distraction'. Specifically, it expects a digital learner to 'recognise that digital information and media can cause distraction, overload and stress, and disconnect when necessary' (Jisc n.d:1).

Jisc's digital capability framework appears to be influential – 39% of the respondents to the TEL survey of UK higher and further education institutions said that the framework was found useful in planning TEL at their institution (UCISA 2018). Jisc also provides case studies from UK further and higher education institutions detailing how they are supporting staff and students to develop digital capabilities (Jisc 2018).

In practice, however, most of the institutions who have adopted Jisc's digital capability framework have limited their development of digital skills provision

to internet safety and maintaining privacy online. Examples include Anglia Ruskin University's online course '5 Days of Digital Literacy' based on the Digital Literacy Framework (Anglia Ruskin University 2016), UCL's digital skills course development programme (UCL 2018), and Open University's online course 'Digital literacy: succeeding in a digital world (The Open University n.d.). The University of Brighton's student digital literacy framework (University of Brighton n.d.) overlooked managing multitasking or online distraction. Since the commencement of this PhD project, a few institutions have incorporated advice on management of multitasking and/or digital distraction in their resources on academic skills (e.g. Lancaster University n.d., Staffordshire University 2018). However, it is not clear whether the advice is evidence-informed. I also found two programmes which are embedded in the curriculum and specifically support students in managing multitasking (Bast 2016), developing healthy use of technology (Levy 2016).

UCISA, an influential UK body for 'digital practitioners within education', periodically runs a digital capabilities survey that examines institutional drivers and approaches to developing digital capabilities in the UK. The survey asks respondents how they are supporting and monitoring digital wellbeing of their students (Fielding et al. 2019). However, the survey does not specify what it means by wellbeing and does not ascertain whether students are provided support in managing multitasking.

My organisation, a UK higher education institution, does not use Jisc's digital capability framework. In fact, digital literacy, let alone digital wellbeing, is

missing from its teaching and learning strategy. The organisation's digital strategy focuses on development of a digital infrastructure comprising hardware and software; the development of staff and students' digital capabilities does not form a part of it.

Jisc has produced a version of its digital capabilities framework for learning technologists, advising them how they could contribute to the development of digital capabilities at their organisation. Part of the framework expects learning technologists to contribute to the 'development of plans and policies in support of digital wellbeing' and to raise 'awareness of the personal benefits and risks of digital ways of working' (Jisc n.d:2). The version has been produced in collaboration with the influential UK body on learning technology, the Association of Learning Technology (ALT), via which, the framework has also been mapped to Certified Membership of the Association of Learning Technology (CMALT), which is an accreditation scheme for learning technologists.

Technology-based multitasking and the associated 'digital distraction' has been widely covered in the media with stories mainly involving coverage of research findings. Examples include multitasking negatively impacting memory (Richtel 2011), linked to less grey matter (NBC News 2014), and negatively impacting student assessment outcomes (Zimmerman 2013). Some news articles have provided advice on dealing with multitasking and distractions (e.g. Griffey 2018, Davis 2019). News stories have also revolved around banning of digital devices from classrooms (e.g. Bociurkiw 2018,

Berdik 2018). In short, the media has alerted to the proliferation and negative impact of multitasking, and offered solutions. Although there are reports for banning devices during class, I have not found examples of advocacy for changes to curriculum where students are provided guidance on managing multitasking during independent study.

It can be seen from the above paragraphs that although the challenge of multitasking is acknowledged at some level of policy, in practice it is not being addressed neither at my (as detailed further in section 1.5) nor other HE institutions. Although interventions have been made, mainly by schools, to address the issue, this has been limited to the classroom (e.g. banning devices).

As briefly mentioned in section 1.1 and discussed in detail in section 2.1.1, the inability to effectively manage multitasking can have adverse consequences for student well-being and assessment outcomes. Yet, students are not being provided with evidenced-informed guidance on managing multitasking during independent study. This study provides insights into the kinds of help that students require, explores in-depth one way in which practitioners in HE might provide that help, and suggests how they can embed this help in their existing support for students. Therefore, this work should be of interest to educators, curriculum designers, senior managers, policymakers, learning technologists and members of staff involved in student support services.

1.4 Personal motivation

A few years back I had the opportunity to deliver lectures and facilitate workshops on a creative technology course at my university. During my laboratory-based workshops I observed students frequently switching between their workshop activities (based on multimedia tools) and leisure activities (e.g. social media, video sharing websites). Similarly, during my lectures I observed a few students engaged with their phones and pursuing non-study-related activities on their laptops. I was surprised to witness this because I had designed my lectures and workshops keeping in view best practice in teaching and learning, with emphasis on active learning, student engagement and motivation. However, the lectures and workshops were clearly not engaging and motivating for those students who chose to pursue non-study-related activities. My discussion with other lecturers revealed that this was a commonly-observed phenomenon. This piqued my interest in exploring the area of multitasking.

As I began to read research on multitasking, I found how widely prevalent multitasking was and how it adversely impacted student learning and assessment outcomes (as reported in sections 1.1 and 2.1.1). In view of this, I was surprised that there was scant research on how students could effectively manage multitasking. When I commenced this research, there was no higher education institution, including my own, that provided advice and guidance to students on managing multitasking (as mentioned in section 1.3, although since commencement of my PhD a few institutions have begun to provide at least some advice on managing digital distractions as part of study skills).

As a learning technologist whose remit is to support teaching staff in harnessing affordances offered by technology to facilitate education, I felt obliged to find potential solutions to the challenges posed by technology in the form of multitasking. This, coupled with my pragmatist worldview that is concerned with action and change, compelled me to explore the phenomenon through undertaking this PhD study.

1.5 Practice context

I am a learning technologist for a STEM faculty of a post-92 higher education institution¹ in the UK. My preliminary research for this thesis began by investigating if students at my institution and in particular my faculty were provided any support in assisting them in managing multitasking. I started with examining the topics covered in modules on academic or study skills which are offered as part of all courses offered by my faculty. The content of these modules includes skills such as academic writing, presentations, note taking, revision and Curriculum Vitae (CV) writing. Effective management of multitasking was not found to be covered by these modules.

The faculty also runs a study skills centre that aims to provide students support outside of the classroom on the aforementioned study skills. The main focus of the centre is to provide support on academic writing, finding and referencing information, examination revision and mathematics skills.

Although no workshops are offered on managing multitasking, the centre's

¹ Former polytechnics granted university status in 1992

online presence on the Virtual Learning Environment (VLE) provides link to an external resource on time management.

The external resource offers tips on managing 'procrastination and distraction' but none of these cover managing multitasking involving digital devices. An activity in the resource invites users to identify distractions and encourages them to think how they will be managing these without offering any feedback on whether these user-proposed solutions will be effective or not. This activity is futile because, as reported in the literature review (chapter 2) and later corroborated by findings of this research (chapter 5), although students employ strategies for managing multitasking, they either do not find them effective or evidence on their effectiveness is missing.

Other faculties and university departments such as the library and IT services also do not provide any support to students on managing multitasking. I reported in section 1.3 that my organisation has a digital strategy, but it does not encompass development of staff and students' digital capabilities. Despite this, a digital literacy programme was run between 2016-2018 but was limited to staff and student training on a new operating system and software tools. Therefore, it appears that modules on study skills and the associated support department cover several skills but overlook a fundamental one, i.e. how to study effectively without multitasking.

I reported in section 1.3 that Jisc's digital capabilities framework for learning technologists expects them to support digital wellbeing. Reflecting on my own

practice and that of the learning technologist community in UK higher education, I realised that our work centres around enabling academic staff to harness the affordances offered by technology to facilitate teaching. As enthusiastic proponents of technology-facilitated education, we have missed the challenges posed by technology to students and consequently providing them with adequate guidance and support. Only after commencing work on the thesis, I came across one blog (Hole 2016) that provides advice on the use of digital tools to maintain focus and prevent multitasking.

I intend to use the findings of this study to raise awareness in my organisation about the challenge of multitasking and the need to support students in meeting this challenge. To this end, I intend to advocate for institutional strategy on digital capabilities and liaise with the academic support centre at my organisation to offer evidenced-based advice to students on how they can manage multitasking.

1.6 Research context and locating the project

When considering the issue of multitasking in an educational context it is difficult to escape the discourses of the 'digital native'/'Net Gen' argument and digital literacies, where it is argued that people born after 1982 are 'automatically' proficient in the use of technology, including the ability to multitask, because they grew up using ubiquitous technology (e.g. Prensky 2011). As I will go on to explain in chapter 2, scrutiny of the scholarship suggests that the so-called 'digital natives' are certainly *not* 'accustomed' to, or have the 'ability' for, multitasking as is being claimed – 'Net Gen' students are not only impacted negatively by multitasking but are also unable to effectively manage multitasking. Indeed the 'digital native'/'Net Gen' argument

has been widely challenged in the literature (cf. Jones and Healing 2010) with the focus largely on whether the students are or are not better multitaskers than those in earlier generations.

Yet, despite the prevalence of multitasking amongst students and its negative impact on their assessment outcomes, there is paucity of research in how students can be *supported in effectively managing multitasking*, which I intend to redress. In light of this aim, there are three areas of scholarship in which I will locate my thesis with the intention of both informing this project and contributing to the literature, which I will expand on in chapters 2 and 3.

The first area of scholarship covers ascertaining factors that contribute to student multitasking, while the second area of scholarship concerns existing strategies students employ to manage multitasking. These areas of scholarships have been chosen because in order to find how students can be supported to manage multitasking and inform the development of an intervention, it is first important to investigate and analyse what leads students to multitasking and what existing strategies are available for them to effectively manage it (Kononova and Chiang 2015).

The third area of scholarship involves the existing evaluation of and research in the effectiveness of the Pomodoro Technique® (PT), a popular time management technique. The PT® has been employed as an intervention in this study to facilitate participants (students) to manage multitasking. The PT® is a time management technique developed by Francesco Cirillo which aims

to 'help individuals and teams manage time effectively' (Cirillo Consulting GMBH 2013). The PT[®] is a registered trademark by Francesco Cirillo. Authorisation was sought (and received) by the author to write about this technique in this thesis. However, this thesis is not affiliated with, associated with, or endorsed by the PT[®] or Francesco Cirillo. Further details about the PT[®] have been provided in chapter 3.

I approach this research through a pragmatist paradigm (Creswell 2014). My aim is not to merely observe the world (i.e. examine students' multitasking) but to intervene (i.e. to support students in managing multitasking and to draw conclusions from doing so). My ontological position guides the choice of methodology for this study which is Design-Based Research (DBR) (Anderson and Shattuck 2012). The research is conducted at a university based in the UK and all research participants are students of various undergraduate programmes of that university, who self-identify as struggling with multitasking.

The research questions defining this study are:

R.Q.1 How might the use of the Pomodoro Technique[®] (PT) help previously struggling undergraduate students better manage technology-based multitasking when undertaking independent study in a higher education setting?

R.Q.1.1 What reasons do students give for multitasking?

R.Q.1.2 Which reasons that students give for multitasking may be addressed by their use of the PT[®]?

R.Q.1.3 How effective do students find different aspects of the PT[®] in managing multitasking?

R.Q.1.4 What contextual factors govern the effectiveness of the PT[®] in a higher education setting?

1.7 Thesis overview

The following is an overview of the chapters in the remainder of this thesis:

Chapter 2 presents a review of relevant literature including students' experiences of multitasking and strategies for managing multitasking.

Chapter 3 introduces the readers to the PT[®] and existing research on evaluation of the technique.

Chapter 4 presents my ontological stance and epistemological position and introduces the research design, including details of DBR, data collection methods, participant recruitment and research ethics.

Chapter 5 presents data for this thesis and documents the four DBR cycles undertaken.

Chapter 6 presents an analysis of the research findings.

Chapter 7 contains the discussion of the findings of the research in relation to existing academic literature.

Chapter 8 concludes the thesis and includes a summary of research findings in terms of the research questions, reflections, and implications and suggestions for policy, practice and future work.

Chapter 2- Literature Review

2.1 Introduction

This chapter presents a review of the literature relating to my research. I begin by positioning the project within the discourse of ‘digital native’/‘Net Gen’ argument and digital literacies (section 2.1.1) and provide details of the conduct of the literature review (section 2.1.2). This is followed by a review of the literature that has been presented as two themes. The first theme explores the reasons students multitask (section 2.2). The second theme explores the strategies students employ to manage multitasking (section 2.3). The two themes have been included to serve the purpose of a literature review in a Design-Based Research (DBR) study, which is to ‘(a) help flesh out what is already known about the problem and (b) to guide the development of potential solutions’ (Herrington et al. 2007:6). I conclude the chapter by identifying limitations of and gaps in the literature relating to the two themes (section 2.4) and the potential contribution my research makes to the research area (section 2.5).

2.1.1 Locating the project – ‘Digital Natives’ and multitasking

I position the project within the discourse of the ‘digital native’/‘Net Gen’ argument and digital literacies. Prensky (2011) referred to people born after 1984 as ‘digital natives’ positing that as this generation grew up using ubiquitous technology, they think and process information differently and can be assumed to be proficient in the use of technology for learning. Related terms that have been coined include homo zappiens (Veen 2007) and Net

Generation or Net Gen (Oblinger and Oblinger 2005). Prensky (2011) and others advocate for pedagogical change to suit the learning requirements and preferences of 'digital natives'.

There has been a lot of debate about, and contestation of, the 'digital native' narrative, focusing on a range of aspects. My thesis aims to contribute to this debate by focussing on the multitasking issue. Proponents of the 'digital native' idea claim that the new breed of learners prefer (Prensky 2011), are accustomed to (Oblinger and Oblinger 2005) or have the ability (Veen 2007) to effectively multitask. Numerous studies have shown that the 'digital native'/'Net Gen' students indeed multitask between study and non-study-related activities in digitally rich settings (Junco and Cotten 2011, Junco and Cotten 2012, Moreno et al. 2012, Yeykelis et al. 2014, Judd 2013, 2015).

Yet research examining the impact of multitasking amongst 'digital native'/'Net Gen' students has found it to be negatively associated with assessment outcomes (Fulton et al. 2011, Junco and Cotten 2012, Song et al. 2013, Lau 2017, Felisoni and Godoi 2018), retention of less information (Lee et al. 2012), and requiring more time to achieve the same level of performance on an academic task (Bowman et al. 2010). Furthermore, several theories on human cognition point out that multitasking can be detrimental to academic performance and assessment outcomes. These theories include the cognitive theory of learning and information overload by Mayer and Moreno (2003), the limited capacity model proposed by Lang (2009), the threaded cognition theory by Salvucci and Taatgen (2008), and the Memory for Goal Theory by Altmann and Trafton (2002). In broad terms, these theories propose that

humans have limited capacity for cognitive processing and as a result when two tasks are similar, require complex problem representation, and/or need similar mental resources, one task must wait its turn as the required mental resource can only be used for a single task at a time.

In light of the above, study-related tasks are likely to be unique, non-repeatable, and require high mental cognition. In addition, when one switches from one study-related task to another, the new task needs to be activated more than the interrupted task. When the user switches back to the original task, it will also take additional time to reactivate the task and mentally remember its state before the switch, resulting in longer time to complete the task compared to if it were completed without interruption. Therefore multitasking delays the learning process and increases the time to complete the task. However, one may be able to perform 'automated' tasks, such as preparing coffee whilst listening to radio, as they are familiar and repeated, causing the brain to rewire and transferring them from high cognitive load to low cognitive load (Lin 2013).

In addition to the above, there are a growing number of empirical research studies (e.g. Kennedy et al. 2007, Jones and Healing 2010, Margaryan et al. 2011, Kennedy and Fox 2013, Yot-Domínguez and Marcelo 2017, Flanigan and Kiewra 2018) critical of the 'digital native' argument that have found that a) 'digital native'/'Net Gen' population is not homogeneous and exhibit varying degrees of technology usage as well as understanding of course requirements for technology use, and b) participants had a superficial understanding of new

technology and there was limited awareness and/or use of technology for optimising learning experiences and academic betterment. Thompson (2015) found that managing multitasking did not come naturally to their research participants but was something they managed consciously. Flanigan and Kiewra (2018) state that computer-based multitasking in fact represents a new means of continuation of an age-old student practice of switching to non-study-related activities during study. It is not surprising then that the founder of the 'digital native'/'immigrant' argument have begun to distance themselves from the concept (Prensky 2009).

It can be seen that the so-called 'digital natives' may not be 'accustomed' to or have the 'ability' for multitasking simply due to their generational position as is being claimed. In addition, they may not possess natural ability to exploit technology to ward off negative impact of multitasking. On the contrary, they are *invited* to multitask in their lives more than before and need help in managing it. It is in view of the adverse effects of multitasking on a student's learning and the growing evidence of the inability of the 'digital natives' to manage multitasking that managing multitasking is being recognised as a digital literacy skill that students must have. For instance, capabilities of a digital learner that have been specified by Jisc (n.d:1) include the ability to 'manage attention, engagement and motivation to learn in digital settings', 'recognise that digital information and media can cause distraction, overload and stress', and disconnect when necessary.

My research study heeds this call and aims to support students in the digital literacy of managing multitasking. The thesis does not approach the issue of multitasking with the assumption that the 'digital native'/'Net Gen' students are somehow 'better' at managing multitasking due to their generational position. Rather it aims to help them understand and manage their own multitasking and, in the process, derive evidence-informed practice.

2.1.2 Conduct of literature search

When I set out to search for literature, I was hoping to find literature investigating the 'digital native' argument, the impact of multitasking on students, the reasons students multitask, and their strategies for managing multitasking. I was interested in finding research carried out in the context of independent study rather than classroom contexts as that was the focus of my research and I assumed that multitasking in classroom settings might take rather different forms from that in independent study situations. I was also interested in finding out whether, and how, multitasking was positioned in the digital literacy discourse.

To this end, I used the following keywords: multitasking, 'digital distraction', cyberloafing, cyberslacking, 'digital literac* AND multitasking', 'digital literac* AND distraction', 'digital native' AND multitasking'. As can be seen from the list, the keywords were selected to capture all studies related to multitasking and other terms it has been referred by (e.g. digital distraction). The date and subject parameters were restricted between 2010 and 2020 (due to few search results, the date parameters of some keywords such as cyberslacking were changed from 2010 to 2005). The lower date parameter of 2010 was

selected because it was around this time that technology such as computers and personal technologies had begun to become widely prevalent among students (the first iPhone was launched in June 2007). The subject parameter was restricted to education as this research is situated in educational contexts. The Lancaster University library catalogue was used to search for literature.

I read the title and abstract of each item in the search results, and filtered the literature to include only those studies that appeared relevant to my research questions. For instance, as the focus of my research was multitasking during independent study (as discussed in section 1.1), I excluded studies that related to multitasking in classroom contexts (e.g. Bolkan and Griffin 2017, Yılmaz and Yurdugül 2018, Chen et al. 2020). I also followed references of the literature I read to ensure that any articles that may not have appeared in the literature search had not been missed (a 'snowballing' approach).

Following identification of relevant texts, I applied a holistic approach (Booth et al. 2012): reading the text in full, searching for data against a set of deductive codes (e.g. reason for multitasking, strategies for multitasking) and copying passages in MS Word, organising them by deductive codes. I also maintained brief notes about methodology, research context, and strengths and weaknesses of literature. This was followed by comparing and contrasting texts and identifying patterns across the literature.

The review of literature led me to focus on two themes that are detailed in the rest of the chapter: reasons for multitasking (presented in section 2.2) and strategies for multitasking (presented in section 2.3).

2.2 Reasons for multitasking

As mentioned in section 2.1, the purpose of the literature review in a DBR study is to ascertain what is known already about the research problem as well as to guide the development of potential solutions. In view of this, it is important to first know what causes students to multitask before devising possible solutions. Therefore, this section presents my findings related to the theme 'reasons for multitasking'. At this stage, I restrict my discussion to establishing the key claims and points of focus in the literature. Limitations of research cited in this section will be covered later in section 2.4.1. Implications of the literature cited in this section for this research have been provided in section 2.5 of this study. In section 7.3 of this thesis, I discuss the congruence and departure of the findings of my study from the literature, therefore establishing my contribution to the scholarship.

The review of literature identified a range of reasons why students multitask.

2.2.1 Technology access and design

Several studies have reported that their research participants engaged in technology-based multitasking just because *they were able to due to easy access to technology*. This includes abundance of technology in their study area (Rosen et al. 2013a) and in bedrooms (Foehr 2006, Jeong and Fishbein 2007), access to unlimited or high speed internet (Baron, 2008, Zhang and Zhang, 2012), and wide prevalence of technology in general (Lin 2013,

Kononova and Chiang 2015). Kononova and Chiang (2015) who undertook a cross-cultural study of multitasking behaviour amongst USA and Taiwanese students found that technology adoption can reduce cross-cultural difference in multitasking.

Some researchers have asserted that computer-based gadgets are designed to encourage multitasking (Judd and Kennedy 2011, Zhang and Zhang 2012, Carrier et al. 2015). Examples cited to support this assertion are multiple tab facility in web browsers, the ability to run several programs and run multiple 'windows' simultaneously, icons on smartphones that represent ways to connect with others. Hyperlinked information tends to attract users from one link to another (Greenfield 2011, Murray et al. 2020). In addition, digital device features such as beep or vibration (when a message arrives), reminders, follow-ups and alerts provide stimuli that grabs a user's attention and directs their processing resources to engage in a new task in addition to a current task (Carrier et al. 2015). These notifications have been found to be the cause of multitasking by Rosen et al. (2013a), Levy (2016), Le Roux and Parry (2019), Deng (2020), and Murray et al. (2020). Zhang and Zhang (2012) found that students multitasked due to convenience, easiness, and instantness.

2.2.2 Motivation

Song et al. (2013) and Calderwood et al. (2014) found a *correlation between multitasking and motivation* – students would multitask less if they were motivated by their study materials. Likewise, various studies found factors that reflect a *lack of motivation* such as boredom (Baron 2008, Adler and Benbunan-Fich 2013, Rosen et al. 2013a, Hwang et al. 2014, Levy 2016, Kim

et al. 2017, Le Roux and Parry (2019), Deng 2020), lack of fulfilment (Le Roux and Parry 2019), and irrelevance of the task at hand (Lin 2013) as reasons for multitasking. Adler and Benbunan-Fich (2013) reported that those who had negative feelings emerging due to the task chose to interrupt their activity more often than those with positive feelings.

Some research studies have compared participants' motivation for study with that for non-study-related activities. For instance Yeykelis et al. (2014) who measured participants' moment-to-moment motivational changes through a wrist sensor found that physiological arousal levels (measured by skin conductance response) increased when switching from work to 'entertainment' tasks but decreased vice-versa. Based on these findings, the authors hypothesised that high levels of arousal for 'entertainment' tasks may be due to high motivational relevance of these tasks over work tasks where the former were likely to be experienced more positively than the latter. Similarly, Zamanzadeh (2016) explored whether media multitasking affects mood and arousal. The results suggested that multitasking with both non-social and social media led to higher arousal.

2.2.3 Self-efficacy

Factors indicating *low self-efficacy* (i.e. belief in one's capabilities to organise and execute a task/activity) for study-related tasks were found to be indicators of multitasking. Adler and Benbunan-Fich (2013) reported that those who felt frustrated by the study-related task due to perceived hardship of the task, obstruction (e.g. stuck at a task), and exhaustion (all indicators of low self-efficacy) multitasked more than those with positive feelings towards tasks.

Obstruction was reported as one of the reasons for multitasking by Whittaker et al. (2016) and Deng (2020), with the latter also reporting frustration as a cause.

Calderwood et al. (2014) and Kim et al. (2017) found *fatigue*, which impacts self-efficacy, to be one of the factors determining multitasking. Observing participants during a three-hour homework task, Calderwood et al. (2014) found that fatigue increased during the three hours whereas motivation for homework and positive affect decreased during this time period. Fatigue can compromise one's ability to regulate goal-directed perceptual and motor processes (van der Linde et al. 2003).

Contrary to the above, however, some participants of Thompson (2015) reported that they liked to multitask when self-efficacy for a task was high (subjects were 'easier') and avoided it when self-efficacy for a task was low (subjects were 'challenging'). Some participants of Deng (2020) also reported 'easy tasks' or the end of a task getting within sight, prompting multitasking.

2.2.4 Out of habit

Wang and Tchernev (2012) found *habitual needs* to be a predictor of multitasking which not only increase multitasking but are also satisfied by multitasking. Similarly, Zhang and Zhang (2012), Hwang et al. (2014), Levy (2016), Kim et al. (2017), Le Roux and Parry (2019) and Deng (2020) also reported unconscious, habitual use of non-task-related activities as reasons for multitasking.

2.2.5 Time pressure

Time pressure was reported to be a factor impacting multitasking albeit in contrasting ways. Baron (2008), Judd and Kennedy (2011) and Hwang et al. (2014) reported that time constraint pressurised students to juggle more tasks within limited time spans. On the other hand, Wu and Xie (2018) in their experimental setting found that imposing time pressure on study-related online search tasks 'significantly' reduced multitasking. Similarly, participants of Kim et al. (2017), Le Roux and Parry (2019), Deng (2020) and Murrey et al. (2020) reported that they were prone to giving-in to external and self-interruptions when relaxed and not under pressure, and did not multitask when pressed for time.

2.2.6 Desire for sociability

Some research studies found a person's *desire for sociability* and the need to keep in touch with other people as a predictor of multitasking (Zhang et al. 2013, Hwang et al. 2014, Kononova and Chiang 2015, Kim et al. 2017). Rosen et al. (2013a) found that those who texted more in general were easily distracted to another task, leading the authors to argue that this may be due to the need for emotional gratification from social media and texting. Zhang and Zhang (2012) found that being alone significantly increased multitasking. Participants of Kim et al. (2017) preferred contacting peers even during intensive tasks and worried about the inability to be contacted by peers if smartphone or notifications from its various applications were switched off.

2.2.7 Personality traits

Some research studies have explored the link between *personality traits* and multitasking. Wang and Tchernev (2012) found that participants with higher

neuroticism (i.e. the tendency to experience distress (McCrae and John 1992)) were more likely to engage in multitasking whereas no link was found between extraversion (which covers traits like being dominant, talkative, social, and warm (McCrae and John 1992)) and multitasking. Sanbonmatsu et al. (2013) found impulsivity traits to be associated with high levels of multitasking where impulsivity is 'a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions' (Barratt and Patton 1983). Duff et al. (2010) found 'creative personality' (e.g. asking questions that no one asks) to be a predictor of multitasking in both college students and the general population.

Several studies (Foehr 2006, Jeong and Fishbein 2007, Chang, 2012, Duff et al. 2014, Sanbonmatsu et al. 2013) have found *sensation-seeking* as a predictor of students' multitasking behaviour. Sensation-seeking has been defined as 'one's need for varied, novel, and complex sensations and experiences and the willingness to take physical, social, legal, and financial risks for the sake of such experience' (Zuckerman 1994). Jeong and Fishbein (2007) mention that high sensation seekers have a strong need for varied, novel and complex experiences.

Polychronicity has been defined as an individual's preference for doing several tasks simultaneously and the belief that this is the best way to perform tasks (Konig et al. 2005). Polychronicity has been found to be a predictor of multitasking by an unpublished doctoral research study (Chang 2012) and a cross-cultural study of multitasking between USA and Taiwanese students

(Kononova and Chiang 2015). Contrary to Kononova and Chiang's initial assumption that people in 'polychromic cultures' such as Taiwan are more likely to multitask than 'monochromic cultures' such as the USA, people in the latter country were found to be more polychromic and reported greater degrees of multitasking.

2.2.8 Psychological problems and social difficulties

Caplan and High (2011), in a review of literature on online social interaction and problematic internet use, report that people with *psychological problems and social and interpersonal difficulties* (e.g. loneliness, social anxiety) are more drawn to online social interaction than those without these difficulties, and are more likely to be engaged in compulsive internet use i.e. the inability to control or regulate one's online behaviour. The authors also found that those showing symptoms of compulsive internet use access internet to regulate their mood (i.e. alleviate states such as anxiety, loneliness or depression) or due to obsessive thought patterns involving the internet use (e.g. 'when I am offline, I cannot stop thinking about what is happening online'). It is likely that students encountering aforementioned problems and difficulties are more likely to multitask during independent study.

Rosen et al. (2013b) in a study exploring the link between technology use and psychiatric disorders found that the majority of the younger generation reported being *anxious* at not being able to check text messages, phone calls and social networks. In addition, there was a causal link between extent to which one felt anxious about not checking social media and the frequency with which one accessed it. The anxiety students experienced could be the Fear of

Missing Out (FoMO), as reported by a participant of Le Roux and Parry (2019), which is the pervasive apprehension that one might be missing out from rewarding experiences others might be having and the desire to stay continually connected with what others are doing (Przybylski et al. 2013). Przybylski et al. found that FoMO was linked to seeking out social media.

2.2.9 Addiction

Kononova and Chiang (2015) found *internet addiction* to be positively related to multitasking. Carrier et al. (2015) also suggested that internet addiction could cause some students to multitask more than others. Young (1998) states that in order for one to be addicted, they must be a) engaging in pleasurable behaviour, b) demonstrate a pattern of excessive use, c) are negatively impacted in a major sphere of life, and d) display tolerance and withdrawal factors. Greenfield (2011) argues that the internet itself is inherently addictive in nature, which in turn can be a reason for some students to multitask.

2.2.10 Others

Some other reasons for multitasking reported in the literature include enjoyment and *the need to be entertained* whilst studying (Zhang and Zhang 2012, Hwang et al. 2014, Kononova and Chiang 2015, Levy 2016), *getting reminded* of a non-study-related task (Zhang and Zhang 2012), finding it *hard to focus* and to not switch attention to things not related to study (Lin 2013), a way to *reward* oneself after completing a portion of the task (Kim et al. 2017), disruption by *people* (Thompson 2015, Levy 2016), *waiting for their computer to respond* to an instruction, e.g. waiting for a web page to load (Zhang and

Zhang 2012, Levy 2016, Deng 2020), and *information seeking* (i.e. checking facts, resolving curiosity, gaining more information about products or services, looking up unfamiliar words or people) (Hwang et al. 2014).

Guinness et al. (2018) investigated the effectiveness of technology breaks at reducing multitasking and found that *breaks to use technology* reduced the frequency of multitasking during independent study. Jeong and Fishbein (2007) and Foehr (2006) found that females were more likely to engage in multitasking than males. Similarly, Duff et al. (2014) found *gender* to be a predictor of multitasking but only in the overall general population and not for some of the specific student populations that participated in the study.

2.3 Strategies for managing multitasking

As mentioned in section 2.1, the purpose of the literature review in a DBR study is to ascertain what is known already about the research problem as well as to guide the development of potential solutions. In view of this, it is important to get insights into strategies students employ or are advised to employ to deal with multitasking, what has worked and what has not, in order to inform a strategy to manage multitasking. Strategies for managing multitasking have also been referred to as strategies for self-regulated learning (Zimmerman 2002) and volition control (Corno 1989). However, the literature related to this research area is scant. This has also been reported by Carrier et al. (2015) in their review of literature on multitasking. Strategies students employ or are advised to employ to manage multitasking reported in the literature are listed below (ordered by importance to this research).

Research that explored its participants' management of multitasking either in

classroom contexts (e.g. Cho 2016) or in non-academic rather than self-directed independent study contexts (e.g. Bardhi et al. 2010, Robinson 2017) was not considered. Limitations of research cited in this section will be provided in section 2.4.2. Implications of the literature cited in this section for this research have been provided in section 2.5 of this study. In section 7.4 of this thesis, I discuss the congruence and departure of the findings of my study from the literature, therefore establishing my contribution to the scholarship.

2.3.1 Maintenance of boundaries between study and non-study-related activities

Participants of some research studies reported what Winter et al. (2010) describes as *maintaining 'boundaries' between study and non-study-related activities* as a strategy to manage multitasking. For instance, participants of Winter et al. associated study-related activities with MS Office applications and 'academic' software and non-study-related activities with personal e-mail accounts, Facebook, and other web 2.0 applications. Examples of boundary management include studying away from a computer/tablet/phone (Jones and Healing 2010, Winter et al. 2010, Park 2014, Kim et al. 2017, Le Roux and Parry 2019, Deng 2020, Murray et al. 2020), e.g. by printing learning materials (ibid), disabling notifications and alerts for non-study-related applications (Nash, 2014, Park 2014, Carrier et al. 2015, Levy 2016, Hartley et al. 2020), switching off applications/devices associated with non-study-related activities (Jones and Healing 2010, Winter et al. 2010, Nash 2014, Thompson 2015, Levy 2016, Deng 2020), flipping the phone facing down or covering the screen (Deng 2000), removing non-study-related applications completely for a certain period of time (Park 2014, Kim et al. 2017), setting designated times for using

these applications (Winter et al. 2010, Nash 2014), and setting aside time where phone use is restricted (Hartley et al. 2020). Over half of the research participants (n=10) of Winter et al. (2010) reported that they learnt more effectively when away from computing and communication technologies.

Carrier et al. (2015) advised on the use of *technology for boundary management*, e.g. tools that block non-study-related websites, adverts and banners in order to declutter study-related online reading. Thompson (2015) reported their participants making use of features within a social media website that makes it unavailable for a desired period of time. Patterson (2018) tested various features of a 'time-management' software with different groups of students on a Massive Open Online Course (MOOC). Group A could use the software's feature to block distracting websites for up to an hour whilst group B could use the software's feature to pre-commit a time limit on non-study-related websites, with these websites getting blocked once the limit was reached. Findings revealed that group B showed the most improvement in course performance which included the amount of time they spent on coursework, overall scores and MOOC completion rates. Group A (that were able to block distracting websites for up to an hour) also showed improvement in performance but this was much smaller than group B and was not found to be statistically significant. Nevertheless, managing boundaries with the aid of technology such as blocking tools have been found to reduce the amount of strength one needs to exert to exercise self-control, resulting in reducing the stress that arises from exercising self-control and empowering users to fully focus on the task (Kim et al. 2017).

2.3.2 Multitasking awareness and usage tracking

Participants of Hartley et al. (2020) reported using apps to monitor phone usage and track how much time is spent on various phone applications. Kim et al. (2016) and Whittaker et al. (2016) designed and tested computer-based applications that *made participants aware* of the time they spent on different programs on their computers. Evaluation of the applications revealed that participants on becoming aware of their use of non-study-related applications during study reduced its use. Likewise, participants of Murray et al. (2020), upon seeing high mobile usage statistics provided by a usage tracking app, expressed willingness to change their multitasking behaviour. The application by Whittaker et al. (2016) and a similar one by Rooksby et al. (2016) also raised awareness of the 'trouble websites' that participants frequently multitasked to. This prompted reflection in participants on how to avoid those websites during future study sessions. Similarly, results of a field study by Lottridge et al. (2012) that evaluated a web browser plugin which categorised websites as study and non-study-related and gave a summary to users of the proportion of time spent in each of the two categories, found that the *awareness of multitasking* by the browser plugin reduced multitasking amongst participants. However, Patterson (2018) who asked one group amongst their participants to use an application that alerted participants on their multitasking behaviour from time to time, found that it had a 'statistically indistinguishable' impact on students' multitasking behaviour.

2.3.3 Time pressure

Jones and Healing (2010) and Le Roux and Parry (2019) report some of their participants *deliberately choosing* to leave assessment-related activities *close*

to their deadline as they claimed to focus best under time pressure. Based on findings of their experimental study that those who performed the task under high time pressure had lower levels of multitasking, Wu and Xie (2017) recommended that students create 'mild *time pressure*' by setting time limits for tasks when studying on digital devices.

2.3.4 Technology breaks

Jones and Healing (2010), Park (2014) and Murray et al. (2020) reported students *employing pre-scheduled breaks* involving non-study-related activities based on technology. Guinness et al. (2018) investigated the impact of technology breaks at reducing multitasking and found it to reduce participants' multitasking behaviour.

2.3.5 Reminder for not multitasking

Asking others to remind one to remove distractions before study-related activities was one of the recommendations reported by Nash (2014) to manage multitasking. Whittaker et al. (2016) who designed and tested a computer application to make participants aware of the time they spent on different applications found that some participants got reminded not to multitask by merely seeing the application's interface on their computers.

2.3.6 To-do lists and prioritising tasks

Creating to-do lists, prioritising tasks and undertaking them accordingly was one of the strategies recommended for managing 'task switching' by Nash (2014). The 'establishing of intention' strategy that worked for some students of Levy (2016), whereby students decide what they are setting out to do as they go online, also has similar purpose and function as to-do lists.

2.3.7 Self-observation and self-reflection

Levy (2016) reported running a module that invited their students to reflect on their experience of using digital devices and apps. Students were provided with self-observation exercises which required them to focus on their breathing, posture and feelings/emotions when using digital devices and multitasking. This in turn enabled students to notice when they got distracted during task-at-hand and bring their attention back to it. Self-reflection on their behaviour, aided by recording the behaviour using data-logging software, enabled them to identify challenges in their current practice and how changes can be brought about.

Self-reflection was also exercised if confronted by urge to multitask during a task. Students would take a pause and reassess why they wished to switch and whether they should switch or not, in turn defusing the urge to multitask. Self-reflection on one's behaviour post-study to see how improvements could be made is also one of the strategies recommended for managing 'task switching' by Nash (2014).

2.3.8 Mindful breathing

Students of Levy (2016) were introduced to mindful breathing which required them to focus on their breathing for a few minutes and not let the mind wander. The purpose of this exercise was to train the mind to pay attention and not multitask. A breathing exercise before the start of a task was also reported to sustain focus.

2.3.9 Others

Some other strategies for managing multitasking reported in the literature include engaging in non-study-related activities first before starting study-related activities in order to focus (Park 2014), breaking larger tasks into smaller tasks for 'focusing attention' (Nash 2014), and setting rewards for oneself upon completion of tasks without multitasking (Nash 2014).

Kim et al. (2017) reported that a strategy to manage multitasking employed by some of their participants was to create temporal periods for focusing by 'making up their mind' that they needed to focus from a certain point to complete the required tasks. The strategy worked for students of Levy (2016) who employed it in combination with self-observation and self-reflection, described in the following section.

2.4 Limitations in current research

In this section I present the limitations pertaining to the two themes of literature presented above, namely reasons for multitasking and strategies for managing multitasking. Later in section 2.5, I report how my project aims to address the limitations presented in this section.

2.4.1 Reasons for multitasking

As reported in section 2.2, there is considerable research that has attempted to ascertain students' experience of multitasking. However, this research has the following limitations.

2.4.1.1 Conceptions of multitasking

Some of the studies on multitasking appear to conceive multitasking as a switch between mediums, even when these belong to the same task. For example, Hwang et al. (2014) and Lin (2013) considered background music or television (TV) for the purpose of focusing on study-related tasks as multitasking, whereas in my view this was not multitasking because it aided rather than hindered them in completing their tasks. In addition, the primary motive of investigating and exploring multitasking amongst students is due to its adverse impact on students' assessment outcomes. Therefore, it does not appear appropriate to focus on multitasking between mediums (e.g. Judd and Kennedy 2011 who considered switching between websites as multitasking) even when multiple mediums are being employed to achieve the same goals or tasks. Furthermore, a drawback of this view of multitasking is that it does not present an accurate picture of students' multitasking behaviour.

2.4.1.2 Self-report and participant memory

Much existing research investigating why students multitask employs self-report measures for data collection, with the exception of Judd and Kennedy (2011), Adler and Benbunan-Fich (2013), Yeykelis et al. (2014), Levy (2016), and Wu and Xie (2018) who used computer logs, Rosen et al. (2013a) who observed participants, Song et al. (2013) who used eye tracking technology, Calderwood et al. (2014) who used surveillance cameras, a head-mounted point-of-view video camera, and a mobile eye tracker, and Deng (2020) who used video-stimulated recall. This has drawbacks in terms of accuracy. For instance, Moreno et al. (2012) compared students' estimated hours per day using the internet and the actual use of the internet and found that students

have a limited ability to accurately estimate their internet use. Likewise, Brasel and Gips (2011) comparing video recording of participants' behaviour with their survey responses taken immediately after their behaviour, found that participants had little insight into their multitasking behaviour which was found to be habitual and unconscious. Zhang (2015) posits that self-reported measures of multitasking may be under-reported due to accuracy of a research participant's memory. Therefore, there is a need for thinking critically about how to elicit data on students' multitasking behaviour when engaged in study-related activities.

2.4.1.3 Non-natural settings

The majority of research in multitasking has been conducted in experimental environments rather than in participants' natural settings. Controlled experiments simplify educational settings comprising several interwoven components that in my view cannot be isolated. This results in loss of ecological validity and a distorted view of expected outcome of an intervention to manage multitasking as the variables and behaviours cannot be controlled (Brown 1992). For example, Adler and Benbunan-Fich (2013) created a multitasking environment for participants with a main task and five mini-tasks and observed multitasking behaviour between these tasks. In actuality, participants are unlikely to switch to those mini-tasks and instead are likely to visit websites, access programs, and check their phones. Similarly, Zamanzadeh (2016) asked participants to perform a questionnaire comprising Graduate Record Examination (an admission test for some graduate schools in Canada and the USA) questions as their primary task which students are unlikely to come across again. The activities for multitasking given by

Zamanzadeh to participants comprised a pre-selected audio, video, and activity on a micro-blogging website Twitter which participants may not find interesting. Therefore, they may not switch to it as frequently compared with if they were given the option to switch to, say, their phones. This is because switching between different devices (e.g. personal computer (PC), smartphones) is fairly common in real life settings (e.g. Kim et al. 2017).

Although Levy (2016) presented reasons for multitasking by their students, it was often not clear if students were reporting their experiences when performing study-related activities. For instance, students were asked to observe their own behaviour when performing and/or trying to focus on undertaking tasks such as email and texting, or any other primary task which did not need to be academic-related.

2.4.1.4 Lack of participant's own experiences and voices

The focus of existing research has been on quantitative data collection methods (with the exception of Baron (2008) who employed focus groups, Foehr (2012) and Levy (2016) who used diary recordings, and Adler and Benbunan-Fich (2013) who had open-ended questions in their online questionnaire). Survey questionnaires are used to elicit data with questions of a Likert-style type with scales ranging from four to nine points. Participants would be given various reasons for multitasking and asked how likely they were to engage in multitasking due to such reason. Even if the researchers had tried to make the list of reasons exhaustive, respondents may wish to add something not covered. In addition, one respondent's interpretation of the scale may be different from another – one's 'agree' may be another's 'strongly

agree'. Another limitation of these data collections methods is that there is no opportunity to ask and probe deeper into a participant's responses (Cohen et al. 2007).

2.4.1.5 Not sufficiently longitudinal

Most of the research has collected data at a single instance or for a brief amount of time. For instance, Rosen et al. (2013a) observed participants for fifteen minutes. The only examples of longer durations are Jugg and Kennedy (2011 – five months), Wang and Tchernev (2012 – four weeks), and Foehr (2006 – seven days). The advantage of longer data collection duration is that it is more likely to capture a varied range of activities and situations that a participant encounters.

2.4.2 Strategies for managing multitasking

The research pertaining to strategies that students employ to manage multitasking (reported in section 2.3) has the following limitations.

2.4.2.1 Lack of evidence for effectiveness

Although I have reported twelve different strategies that students use to manage multitasking, most studies (Jones and Healing 2010, Winter et al. 2010, Park 2014, Thompson 2015, Deng 2020, Hartley et al. 2020) did not report whether participants found those strategies effective or not. For instance, it is all well to close distracting applications before commencing study but what matters to some extent is whether participants subjectively find this strategy effective in managing multitasking or not. I also mentioned suggestions to manage multitasking by Nash (2014) whose paper is titled

'effective strategies for managing multitasking'. These suggestions were proposed by experts in the field of psychology but it is not clear whether these have been evaluated for their impact and effectiveness. Similarly, suggestions by Carrier et al. (2015) were not backed up by evidence. Although some strategies such as the use of technology for boundary management (Patterson 2018), awareness of multitasking behaviour (Kim et al. 2016, Lottridge et al. 2016, Rooksby 2016, Whittaker et al. 2016), time pressure (Wu and Xie 2017), technology breaks (Guinness et al. 2018), creating a temporal period for focusing and to-do lists in conjunction with self-observation, self-reflection and mindful breathing (Levy 2016), were evaluated for their effectiveness to manage multitasking, all of this evidence-based research was published after the Pomodoro Technique (PT)[®] was selected as an intervention and data on its use were collected for this research (i.e. between October 2015 and June 2016).

2.4.2.2 Methodological shortcomings

The research cited in section 2.3 also suffers from methodological weaknesses. Firstly, with the exception of Rooksby (2016), Levy (2016) and Deng (2020), research studies only took into account one device e.g. computer/laptop (Kim et al. 2016, Lottridge et al. 2016, Whittaker et al. 2016) or a computer application, e.g. course website for a MOOC (Patterson 2018), when evaluating effectiveness of a technology-based tool such as a website blocker. These research studies did not consider the possibility that participants may multitask to other devices, such as their smartphone, or applications during study-related activities. Similarly, Park (2014) only focused on how participants adapted to multitasking on tablet devices and did not take

into account participants' natural study environments which are likely to include many other digital devices. Guinness et al. (2018) and Wu and Xie (2018) who respectively investigated the impact of technology breaks and time pressure on participants' multitasking behaviour employed an experimental task rather than study the impact of the intervention in participants' natural settings.

Research investigating effectiveness of strategies students employ for multitasking were not sufficiently longitudinal, except for Kim et al. (2016) and Patterson (2018) who monitored participant behaviour for eight and nine weeks respectively. The durations of other studies were fifteen minutes (Wu and Xie 2018), sixty minutes (Guinness et al. 2018, Deng 2020), four days (Whittaker et al. 2016), two weeks (Lottridge et al. 2016), three weeks (Kim et al. 2017) and four weeks (Rooksby 2016). Although Levy (2016) reported a number of strategies that were found effective by their students, what was not reported was the duration for which students used these strategies and consequently whether these were effective when employed for a long duration of time. In addition, it was not clear from the student responses and experiences presented as evidence for effectiveness whether they used the strategies during study-related activities or as part of general use of technology.

2.4.2.3 Limited practical value

Four research studies (Jones and Healing 2010, Winter et al. 2010, Park 2014, Kim et al. 2017) reported studying away from computing and communication technologies as a strategy to manage multitasking. There are

many cases where stepping away from computing and communication technologies is not practical. Examples include preference of technology amongst 16-24 year olds, emphasis on delivery of content online, the use of digital tools to produce coursework, and the use of collaborative tools to foster learning (as mentioned in section 1.1).

2.5 Implications for study

The review of literature has the following implications for this research study.

2.5.1 Conceptualisation of multitasking

I reported how several studies adopted an application/device-based rather than a task/goal-based conception of multitasking. As I have argued in chapter 1, switching between different applications or media should not be considered multitasking as long as they are contributing to the same goal. I believe that adopting a task/goal-based conception of multitasking (as mentioned in section 1.2) will address one of the limitations of earlier studies and help in determining a more accurate picture of the multitasking phenomenon and the reasons behind it.

2.5.2 Evidenced-based strategies for managing multitasking

As I have demonstrated in this chapter, there is a lack of evidence-informed advice on ways multitasking can be managed effectively (and at the time this research commenced that evidence-base was even smaller, although as mentioned a small number of studies have contributed some evidence very recently). Although suggestions for managing multitasking are in abundance, these have not been supported by evidence for their effectiveness. Pintrich (2003) notes that there has not been much research on the strategies and

tactics students employ to monitor, control and regulate their motivation or behaviour. Furthermore, as reported by Winter et al. (2010) and Park (2014), although students do employ strategies to manage multitasking, most of them have not done so effectively and still resort to multitasking.

As far as I am aware, this research is one of the first of its kind that explores the effectiveness of a strategy, i.e. the Pomodoro Technique (PT)[®] (see chapter 3 for details) to help students manage multitasking between study and non-study-related activities when working on digital devices during independent study. As I will illustrate in chapter 3, there has been no formal evaluation of the PT[®] for managing multitasking in an academic setting and this research aims to address this gap. As mentioned earlier, Kononova and Chiang (2015) posit that in order to develop strategies to manage multitasking, an understanding is required on what causes it. In view of this, this is the only research of its kind that first attempts to understand the circumstances that lead the research subjects to multitasking and any strategies they already employ to this end, and uses this information to tailor the strategy (i.e. the PT[®]) for them.

2.5.3 Methodological rigour

I highlighted in section 2.4 how most of the research conducted in the domain of multitasking and strategies to manage it used only limited data collection methods for investigating it. These include emphasis on quantitative rather than qualitative or mixed data collection methods, not being sufficiently longitudinal, the use of experimental and non-natural settings, and reliance on self-report measures for data collection (however, some research published

during or after data collection for this thesis does address one or more of the above limitations). An example is the emergence of multiple devices (e.g. laptops, smartphone) that students possess and multitask between, and one needs to consider all the different devices and environments that can potentially contribute to multitasking.

This study addresses these limitations by employing qualitative (interviews) and quantitative data collection methods (data logging tools, multitasking diaries, records of use of the PT[®]) in a participant's natural setting (i.e. day-to-day study-related activities) to ensure that the data are accurate and rich with thick descriptions. In my view, interviews will provide the researcher with the opportunity to press for complete answers and elicit responses about complex and deep issues thereby allowing for greater depth than other data collection methods (Cohen et al. 2007). Details of these methods have been provided in chapter 4. In addition, I have evaluated the PT[®] for nearly one academic year in order to see how participants adapt to it and to ensure that it has been tested for varied contexts, conditions, circumstances and tasks.

2.6 Conclusion

Proponents of the 'digital native' discourse claim that the so-called 'digital native'/'Net Gen' generation are automatically accustomed to multitasking successfully simply due to their generational position. This has not been the case, as I have illustrated how students not only sometimes get negatively impacted by multitasking but are also not of aware how to manage it.

However, I have highlighted in this chapter the lack of evidence-based advice

for managing multitasking. This thesis aims to address this gap in the literature and evaluate a strategy to manage multitasking (i.e. the PT®).

For this research, which aims to help students manage multitasking between study and non-study-related activities, it is important to first know their experience of multitasking and what causes them to multitask. This is because an analysis of what leads students to multitasking can help develop strategies to deal with it (Kononova and Chiang 2015). Although there is considerable research investigating the reasons why students multitask, an application/device-based conception of multitasking (rather than task/goal-based) is typically coupled with only restricted methods employed to collect data. My research aims to address these limitations and inform the strategy for multitasking by a more accurate understanding of participants' multitasking behaviour.

The next chapter introduces readers to the strategy for managing multitasking selected for this study, i.e. the Pomodoro Technique®.

Chapter 3 – The Pomodoro Technique®

3.1 Introduction

This project has employed the Pomodoro Technique® (PT) as an intervention to enable research participants to manage multitasking. This chapter introduces the readers to the technique (section 3.2), the reasons why it has been selected as the basis of an intervention to manage multitasking (section 3.3), and existing research on effectiveness of the PT® (section 3.4). The PT® has been developed by and is a registered trademark of Francesco Cirillo. Authorisation was sought (and received) by the author to write about this technique in this thesis. However, this thesis is not affiliated with, associated with, or endorsed by the Pomodoro Technique® or Francesco Cirillo.

As explained earlier in section 1.6, the current project is conceived as a work of Design-Based Research (DBR) in which I work in collaboration with my participants to design a strategy that enables them to better manage multitasking. The design or intervention in the DBR needs to be grounded in existing research or sound theory in order to ensure that it is not overly speculative (Edelson 2006). However, the ‘theory’ in DBR (as explained in section 4.2.2.1) is an ‘initial set of conjectures’ that are ‘intended to guide the generation, selection, and assessment of design alternatives’ (Penuel 2014). Therefore, for this research, the initial conjecture is the PT® which is refined in light of participant feedback and experience over three cycles (as I am going to explain in chapter 4).



Figure 3.3 Pomodoro timer (photo by author)

'X' next to its entry in the to-do-today sheet. A pomodoro cannot be interrupted so the 'X' denotes uninterrupted work for twenty-five minutes on an activity. If users multitasked during a pomodoro due to an interruption, the pomodoro is void and users cannot resume it after the interruption is finished (information on dealing with and recording interruptions is provided below). They need to re-do the entire twenty-five minutes of the pomodoro.

Step 5: After four consecutive pomodoros, i.e. three slots of twenty-five minutes each followed by a five-minute break plus a fourth slot of twenty-five minutes, users are required to take a longer fifteen/thirty-minute break if they wish to continue with study-related tasks.

Step 6: Users work on a task, pomodoro after pomodoro, until it is complete. Once the current task/activity has been completed, users move on to the next

task on their to-do-today sheet, then the next, and so on. Users can undertake a pomodoro for a later task before an earlier task has completed.

Step 7: At the end of day, users check off all the tasks/activities that they have completed from the activity inventory sheet and add any new tasks that they came across that day. Activities in the to-do-today sheet that are still in progress or have not been started can be continued on another day.

3.2.1 Dealing with and recording interruptions

As a pomodoro cannot be interrupted, the PT[®] provides users with advice on how to deal with interruptions and record them should they occur.

Interruptions are classified as external and internal interruptions. Examples of external interruptions include receiving a phone call or a text message, being interrupted by a friend or family member or getting distracted by an advertisement or recommended content on a website one is visiting for study-related activity. Internal interruptions are those that come from users themselves, e.g. the urge to get something to eat or drink, make a non-study-related call or text, or check non-study-related social media activities.

If someone (e.g. friend or family member) or something (e.g. incoming phone call) tries to interrupt a pomodoro, users are advised to strive to delay the interruption in the minimum time possible. For instance, dealing with an interruption by friend/family member might entail politely informing them that one is in midst of a pomodoro and will contact them, depending on the urgency, after the pomodoro ends. Once the interruption has been deferred, users write it as a new non-study-related activity (e.g. call my mum after the

pomodoro ends, check the YouTube video on the recommendations bar tomorrow) either in the to-do-today sheet if it is urgent or in the activity inventory sheet if it is not urgent. Users are also required to put a dash (-) on the to-do-today sheet at the place where they record their pomodoros. Dealing with an external interruption in this way as quickly as possible does not void the pomodoro and users can resume their study-related activity.

If users encounter a potential internal interruption (e.g. an internal urge to check updates on a non-study-related website), they are required to defer it by writing it as a new non-study-related activity (e.g. check social media website) either in the to-do-today sheet if it is urgent or in the activity inventory sheet if it is not urgent. Users are also required to put an apostrophe (') in the to-do-today sheet at the place where they record their pomodoros (as opposed to a dash (-) for an external interruption).

If the internal or external interruption cannot be delayed/deferred, either because participants gave in to temptation or something really urgent came up, then the pomodoro is void. When participants return back to the study-related activity, they do not record an X. Instead, they record an "I-int" or "I-ext" respectively for an internal or an external interruption along with detail of the cause of interruption. As previously mentioned, participants cannot resume the previous pomodoro and are required to re-do the entire twenty-five minutes of it again.

I have categorised the aforementioned steps of the PT[®] into the following aspects:

- Activity inventory and to-do-today sheet
- Pomodoro timer
- Recording a successful pomodoro
- Deferring potential interruptions
- Voiding pomodoros and recording interruptions
- Duration of pomodoros and breaks

The categorisation has been carried out in the interest of readability of participant feedback on the PT[®]. Later in the thesis, in chapters 5 and 6, I will report participant feedback on the PT[®] under the above categories of aspects of the technique.

3.2.2 Variation from the original technique

I varied the technique slightly from the original technique. The changes with reasons for doing so are as follows.

Cirillo (2013), the author of the PT[®], has presented it as a time management technique which can be used in all contexts including study and work.

Therefore, the author instructs users to note down in the activity inventory and to-do-today sheets the 'list of things to do during the day' (Cirillo 2013). As I used the PT[®] in assisting students in their study-related activities, I modified the technique instructions and activity inventory sheets accordingly. For instance, in the modified version used in this study, participants were asked to note down the study and non-study-related tasks planned for a week/day

separately in the activity inventory and to-do-today sheet. Further, as the purpose of using the technique was to help participants manage multitasking between study and non-study-related activities, they were asked to undertake only the study-related tasks in pomodoros.

In the original technique, an interrupted pomodoro is recorded the same way as a potential interruption, i.e. either with a dash (-) or an apostrophe (').

Instead, I asked my participants to record internal and external interruptions with an I^{-int} and I^{-ext} respectively. I also asked participants to include a small note of what interrupted the pomodoro. As explained in chapter 1, one of the purposes of the research was to determine reasons students multitask.

Therefore, distinguishing potential interruptions from actual interruptions (i.e. multitasking) and determining the cause of those interruptions, would generate data for this research. As another purpose of this research was to determine how the technique could help participants better manage multitasking, the record was also expected to help inform improvements to the technique in light of participant feedback and experiences.

Cirillo (2013) has also prescribed some additional steps to the technique which were not included in the instructions to the participants due to the following reasons. Firstly, with the exception of one step (maintaining a record sheet), all other steps were introduced by Cirillo as enhancements once participants 'begin to master the technique'. Secondly, some of these steps did not contribute to the purpose of using the technique for this research, i.e., enabling participants to manage multitasking behaviour. These included

estimating the number of pomodoros an activity requires and tallying it with the actual time it took to complete pomodoros so that future tasks can be fitted within a day; and maintaining a 'record sheet' of completed pomodoros to determine effort spent on a task/activity and whether similar future activities can be completed more efficiently. In addition, in case of the latter instruction, a record of activity was kept using the activity inventory and to-do-today sheet which could be used for reflection. Thirdly, inclusion of some of these steps would have made the technique complicated and not easy-to-follow. These include spending the first three to five minutes of each pomodoro to repeat what has been learnt since the beginning of the activity; spending the last three to five minutes of a pomodoro to review progress on task during the pomodoro; and setting up a timetable that separates work and free time and aids in pinpointing most productive time for certain types of task (as mentioned in section 5.3.2.2, the element of review and reflection on one's activities/behaviour was introduced following participants' experience and feedback of the technique).

3.3 Reasons for selecting the Pomodoro Technique®

The selection of the PT® as an intervention for this research was guided by its alignment with existing practice and recommendations for managing multitasking in the literature and my own practice. I also present alternative strategies for influencing behaviour that were considered but not selected.

3.3.1 Alignment with recommendations from literature

I reported in section 2.3 about strategies for managing multitasking either employed by students or recommended in the literature. Although these strategies were not evaluated for their impact and effectiveness, a number of these align with different aspects of the PT[®] (NB: A few strategies for managing multitasking reported in the literature review chapter have been evaluated but these were published either during or after the data collection phase of the study (i.e. Oct 2015 – June 2016). These existing practice/suggestions include creating a to-do list containing deadlines for goals and prioritising tasks accordingly, breaking larger tasks into smaller tasks, giving oneself rewards for task completion (Nash 2014), and employing pre-scheduled breaks involving non-study-related activities based on technology (Jones and Healing 2010, Park 2014).

Therefore, one of the reasons for selecting the PT[®] as intervention for the study was alignment of some of its aspects with existing practice or recommendations.

3.3.2 Alignment with practice

As I explained in section 1.5, I work as a learning technologist at a UK HE. My role is primarily staff-support rather than student-facing which means that I do not have direct contact with students. This meant that I was limited by the nature of interventions I could employ for this research. For instance, Katz et al. (2014) suggest that programmes to help students reduce procrastination (a concept related to multitasking) should aim at both improving their self-efficacy

as well as internalising motivation. However, when I looked at proposed interventions for increasing self-efficacy (e.g. opportunities for peer observation – Schunk 2012) and motivation (e.g. providing students with a rationale as to why the academic task/activity or a way of behaviour is important or relevant to them – Reeve and Jang 2006), these could only be administered by the lecturers or those who design teaching and curriculum.

In view of the above, a technique such as the PT[®] which students could administer themselves addressed the above limitation. I reported in section 1.5 that the study skills centre at my institution currently does not offer advice to students in managing multitasking. A technique like the PT[®] could easily be incorporated in the provision of the centre in the form of workshops delivered by me, compared with an intervention that requires involvement of teachers and curriculum designers.

3.3.3 Alternative strategies considered as interventions

The PT[®] was chosen out of several other techniques for altering behaviour. These include Don't break the chain (see Trapani 2007), Getting things done (see Allen 2001), and Zen to Done (see Babuata 2012). Although these techniques share some commonality with the PT[®], they do not include one or more aspects that are part of the PT[®]. The aspects that are part of the PT[®] and are missing in the other techniques include advice on how to manage interruptions/distractions, providing incentive to complete tasks, and penalty for multitasking during a study-related task.

Apart from the behaviour altering techniques, there are several blocking apps that also appear in search results for managing distractions (e.g. Hole 2016). These apps were not considered as interventions initially (as I will explain later in chapter 5, they were introduced as part of refinement to the PT[®]). This is because the PT[®] requires participants to employ skills such as prioritising, self-discipline, etc., whereas employing the blocking apps would not facilitate the development and use of these important skills. Furthermore, if participants used blocking apps alongside PT[®], it would have been harder to determine whether a successful intervention has been due to PT[®], the blocking apps, or a combination of both.

3.4 Existing evaluation of the Pomodoro Technique[®]

In this section, I present research pertaining to existing evaluation of the PT[®]. Limitations of research cited in this section will be covered in section 3.4.1.

A search for the string “pomodoro technique” on google.co.uk gives just over seven hundred thousand search results (as of December 2020). This indicates the popularity of the technique. Blog posts and articles on the PT[®] report of their authors’ personal views and experiences of the technique. Comments include the technique being rigid due to the requirement of the pomodoro to be of twenty-five minute duration rather than flexible duration (Dziubinski 2015, LightsAndCandy 2016, Vardy n.d.), and not suitable for a) group work (Martini 2014), b) a work environment where it is not always possible to avoid interruptions (Dziubinski 2015, Roche, 2018), and c) some types of tasks such as those which involve creative thinking where interruption after twenty-five minutes may impede creativity or interrupt flow/train of thought (Dziubinski

2015, LightsAndCandy 2016, Roche 2018). Martini (2014) observed that people who use the PT[®] do not follow its rules such as not voiding pomodoros, not maintaining the activity inventory sheet, and not taking a break after a pomodoro ends.

However, scholarly investigation of the technique has so far been rather modest in scale. I searched for the term 'pomodoro technique' in Lancaster university library catalogue, ERIC, and Google Scholar without setting any date parameters. I found that there has not been much published research on evaluation of the PT[®]. For instance, Bast (2016) provides 'time management and personal productivity' tips to his students which includes the PT[®] but no evaluation of its effectiveness has been provided. Similarly, Luo (2020) introduced the PT[®] to participants of a Massive Online Open Course (MOOC) on study skills in order to enable them to 'tackle procrastination', a concept related to multitasking (as I stated in section 1.2, I consider multitasking to be one of the enablers or facilitators of procrastination, though students may not always engage in multitasking due to the desire to procrastinate). Although student evaluation reported reduction in distraction while studying, it was not stated what the contribution of the PT[®] was towards the change in participant behaviour amongst the many other study skills introduced by the course.

Several studies reported development and evaluation of tools based on the PT[®]. One such tool was developed by Almalki et al. (2020) with the aim to help students manage time and 'decrease procrastination'. If the tool sensed that students were getting distracted, it gave them a warning. The tool was

used by fifteen graduate students for four weeks. In a post-study questionnaire, eleven of fifteen participants said that the tool helped them manage time. However, details of how the tool and the various aspects of the PT[®] contributed to the change in behaviour were not provided. Participants also provided feedback on various aspects of the tool and how they used the tool. These included requiring the twenty-five-minute duration of the pomodoro to be extended (n=1), not taking the shorter five-minute break between the first two pomodoros (n=1), timer found to be distracting (n=4), and time of the break found to be restricting (n=2).

Other examples of tools based on the PT[®] were reported by Kim et al. (2017), Feng et al. (2019) and Tseng et al. (2019). Feng et al. (2019) developed a mobile application based on the PT[®], which enabled users to set goals and tasks, set a timer on the application, and record completed pomodoros. The purpose of the application was to increase productivity and concentration. However, the focus of the evaluation of the study was the application's user interface design. The evaluation revealed that the application met participants' 'concentration needs' but did not provide any details on the role of the PT[®] in helping them achieve this.

The mobile/computer applications developed and evaluated by Kim et al. (2017) and Tseng et al. (2019) blocked access to distracting websites/applications. The only aspect of the PT[®] these applications incorporated was enabling users to block desired applications for duration of a pomodoro i.e., twenty-five minutes. The evaluation of the applications did not

seek to determine the efficacy of timeboxing 'distraction-free' slots for twenty-five minutes.

Adcroft (2018) in an unpublished dissertation attempted to investigate the impact of introducing mindfulness and the PT[®] to school pupils aged 10 to 11 years. The author found no support for benefits of the PT[®] or mindfulness in enabling participants to self-regulate their learning, which they attributed to insufficient participant responses for 'trend analysis'.

Other uses and evaluation of the PT[®] reported in the literature have only been in the field of software development. Gobbo et al. (2007) report of practitioners' experience of use of the PT[®] in a programming summer school and to facilitate development of education-related software. Gobbo and Vaccari (2008) and Wang et al. (2010) report of application of the PT[®] in agile software development with the latter exploring the use of the technique in teams located in different geographical locations. The purpose of using the technique in all these studies was to increase 'productivity', with Wang et al. (2010) also using the technique for estimating and tracking the effort various software development tasks involved.

All the research mentioned in the above paragraph reported positive outcomes of using the PT[®] which included increased productivity, although none of these clearly defined what they meant by 'productivity' and its enhancement. Other benefits reported included increasing quality of working life (Gobbo et al. 2007), increasing the balance between team productivity and

maintaining individual satisfaction (Gobbo and Vaccari 2008), making the software development process more transparent by way of tracking the effort expended on tasks, giving working rhythm to and increasing cohesion in teams, and shared breaks motivating team members to return to work on tasks deemed not 'cool' (Wang et al. 2010). Wang et al. also reported that some interruptions during a pomodoro were considered 'acceptable' which included assisting a team member in project-related work if they were facing challenges. This was because interrupting one's work to help a team member out was considered more worthwhile than letting them waste a pomodoro's duration of time trying to resolve the challenge themselves. A number of aforementioned advantages of the PT[®] appear to contribute to the user's wellbeing, which is useful to consider in my context as managing multitasking and distractions has been considered a wellbeing issue in frameworks for digital capabilities (reported in section 1.3).

The author of the PT[®] Francesco Cirillo also makes some claims about benefits of his technique. These are that the PT[®]: a) helps in 'working with time, instead of against it'; b) eliminates burnout; c) improves management of distractions (which I am mainly interested in); d) boosts motivation; e) creates a better work life balance; and f) helps determine time an activity requires to complete (Cirillo Consulting GmbH n.d.). The author claims that the five-minute break between pomodoros allows one to assimilate what has been learned in the previous pomodoro and reinvigorates one for the subsequent pomodoro (Cirillo 2013). The potential distractions one records during the

pomodoro, the author claims, do not appear as appealing or urgent when the pomodoro finishes (ibid).

3.4.1 Research limitations

The aforementioned research pertaining to the PT[®] has the following limitations.

3.4.1.1 Lack of research in multitasking in academic contexts

I was keen to look out for research that investigated impact of the PT[®] in order to manage multitasking and which was conducted in an academic setting. As illustrated above, there is limited evaluation of the PT[®] in general let alone in education (As mentioned in section 3.2.2, the author of the PT[®] designed it to be used in any context and not specifically education). Further, there was no research study whose primary focus was to investigate the effectiveness of the PT[®] in managing multitasking. However, other studies conducted at the same time as the one reported here investigated the effectiveness of the PT[®] in addressing behaviours related to multitasking. The limitations of these studies are reported below.

Adcroft (2018) explored the impact of the PT[®] and mindfulness in self-regulation but could not draw any conclusions due to insufficient participant responses. Luo (2020) found that introducing the PT[®] to their participants to 'tackle procrastination' resulted in distraction while studying, but it was not stated what the contribution of the PT[®] was towards the change in participant behaviour amongst the many other study skills introduced by the course.

Feng et al. (2019) developed a mobile application based on the PT[®] with the purpose of increasing productivity and concentration. Although the participants reported that the application met their 'concentration needs', no details were provided on the role of the PT[®] in helping them achieve this. Similarly, although the tool by Almalki et al. (2020) helped the majority of participants in managing their time and decreasing procrastination, it lacked the details on how the different aspects of the PT[®] contributed to the change in behaviour. However, as mentioned in section 3.4, participant perceptions of and feedback on some aspects of the PT[®] were reported by Almalki et al. (2020).

Kim et al. (2017) and Tseng et al. (2019) explored the impact of computer/mobile applications that blocked distracting websites/apps on participants' multitasking behaviour, the only aspect of the PT[®] the applications incorporated was to block distracting applications for the duration of a pomodoro, i.e. twenty-five minutes. The focus of evaluation of these studies was to explore the efficacy of blocking distracting websites/applications, and additionally, in the study of Tseng et al. (2019), to prevent participants from returning to distracting websites after they returned from a physical break. Both the studies were silent on the role of the only aspect of the PT[®] it had incorporated, which was timeboxing 'distraction-free' slots for twenty-five minutes. Only Wang et al. (2010) made a mention of protection from interruptions as one of the advantages of the technique.

3.4.1.2 Methodological shortcomings

None of the research that has evaluated the PT[®] (Gobbo et al. 2007, Gobbo and Vaccari 2008, Wang et al. 2010) has explicitly stated research methods

employed to collect data and to evaluate the technique. For instance, in research by Gobbo and Vaccari (2008) it is not clear if benefits stated are predicted or following an evaluation of the technique. The reported findings appear to be observations, anecdotal feedback and reflections. Similarly, Gobbo et al. (2007) who used the technique in a programming summer school did not provide any detail on how the evaluation was carried out, only reporting that students were found to have started applying the technique in their individual work and study.

I have listed some of the benefits of the technique claimed by PT[®]'s author in Cirillo (2013) earlier in this section. However, the author does not provide evidence in support of the assertions. I also reported critique of the technique by blog posts and articles by Martini (2014), Dziubinski (2015), LightsAndCandy (2016), Roche (2018) and Vardy (n.d.). These appear to be opinion pieces which have not been supported by evidence from a formal evaluation.

3.5 Summary

In this chapter, I introduced the PT[®], provided justification for its selection as the intervention for this study, and presented existing evaluation of the technique. It was found that there was limited evaluation of the PT[®] in general, let alone in the domain of education. The existing research has either not provided details on research methodology or has not supported claims and findings about the technique with evidence from a formal evaluation. Furthermore, there was no research study whose primary focus was to investigate the effectiveness of the PT[®] in managing multitasking. Therefore,

to my knowledge, this is one of the first research study that provides formal evaluation of the PT[®] in managing multitasking in an educational setting.

In the next chapter, I present the research design, detailing how the research questions for this study have been explored through design-based methodology and how findings from the review of the literature have informed the methodological approaches adopted for this study.

Chapter 4 – Research Design

4.1 Introduction

In this chapter, I set out my empirical approach to exploring the phenomenon of multitasking and evaluating the Pomodoro Technique® (PT). In the introduction chapter, I discussed my personal interest in the phenomenon of multitasking between study and non-study-related activities, triggered by my revelation that multitasking adversely impacts students' assessment outcomes. Therefore, this study aims to evaluate effectiveness of the PT® in helping students manage multitasking.

It will be helpful for the reader to recall the research questions from which the study proceeded, since they guided the research design that is documented in this chapter. The research questions are as follows:

R.Q.1 How might the use of the Pomodoro Technique® (PT) help previously struggling undergraduate students better manage technology-based multitasking when undertaking independent study in a higher education setting?

RQ1.1 What reasons do students give for multitasking?

RQ1.2 Which reasons that students give for multitasking may be addressed by their use of the PT®?

RQ1.3 How effective do students find different aspects of the PT® in managing multitasking?

RQ1.4 What contextual factors govern the effectiveness of the PT® in a higher education setting?

I begin this chapter by setting out my ontological and epistemological position which is rooted in pragmatism. I then describe the research methodology adopted for this study and justify the reasons for its selection. This is followed by description of how the methodology is applied in terms of research site, participation selection and recruitment, and overall design of the study, whilst also highlighting the issues around insider research. I then present the data collection methods employed for this study and how these were developed. Next, I detail my approach to the analysis of data. To ensure that the ethical approach is understood in relation to the empirical strategy, the section on research ethics is situated towards the end of the chapter. I conclude the chapter by presenting strengths and weaknesses of the research design.

4.2 Ontological and epistemological position

My ontological and epistemological position is grounded in pragmatism where the approach to the nature of reality and how that nature is uncovered is determined by ‘what is useful, is practical, and “works”’ (Creswell, 2013:37) rather than being concerned with claims to truth.

Pragmatism is therefore concerned with action and change. According to John Dewey, one of the primary philosophers associated with pragmatism, actions are guided by purpose and knowledge and not carried out for their own sake (1931). In addition, it is an action and its consequence that form the meaning of an idea or a concept (Goldkuhl 2012).

In view of the above, pragmatism is appropriate as a basis for research approaches that aim to intervene into the world and not merely observe the world (ibid). Therefore, pragmatism is a suitable paradigm for this research as its aim is not only to identify reasons behind students' multitasking behaviour but also to ascertain what works in enabling students to effectively manage multitasking. Although pragmatism acknowledges that research is situated in context (e.g. social, historical, political), it is not committed to any one system of philosophy or reality (Creswell 2013). Therefore, valid knowledge to be examined and evaluated for this research study includes that which is objective (i.e. what the researcher observes in analysis) as well as subjective (i.e. what participants state that they think and feel).

4.2 Methodology

4.2.1 Overview

The methodology adopted for this research is Design-Based Research (DBR), an emergent approach described by Anderson and Shattuck (2012) as:

'a methodology designed by and for educators that seeks to increase the impact, transfer, and translation of education research into improved practice. In addition, it stresses the need for theory building and the development of design principles that guide, inform, and improve both practice and research in educational contexts.' (p. 16)

The researcher manages the DBR process in collaboration with participants, with interventions designed, implemented, evaluated and refined through

multiple cycles, leading to development of practical design principles, patterns, and/or grounded theorising that can be useful to practitioners and educational designers (Wang and Hannafin 2005, Anderson and Shattuck 2012, Alghamdi and Li 2013).

4.2.2 Choosing Design-Based Research as a methodology

My alignment with pragmatist ontology and epistemology (set out in section 4.2) leads me to believe that it is simply not enough to identify what causes students to multitask (although doing so might well be a useful prerequisite), but that instead it is desirable to actively intervene to identify what works with regard to enabling them to manage multitasking. DBR aligns well with my thesis objectives which are not simply to find what causes students to multitask but to intervene in their world and work in collaboration with participants in determining useful, practical knowledge on how they can successfully manage multitasking. DBR also enables me to select appropriate methods which address limitations in existing research on multitasking as illustrated in section 2.4.1 (e.g. not situated in context, not sufficiently longitudinal). Details of these methods can be found in section 4.3.

I also considered another methodology grounded in pragmatist paradigm, Action Research (AR), which shares many similarities with DBR. However, the primary difference between DBR and AR is that the latter does not primarily involve supporting the practice of other people. Kemmis and McTaggart (1992:21–2) assert that AR is ‘research by particular people on their own work, to help them improve what they do, including how they work with and for others’. DBR is more relevant to this research as the aim is to look at how

research participants effectively manage multitasking and not about improving an aspect of my own practice. In addition, there is no emphasis on constructing theory, models, or principles to inform future design initiatives in action research (Reeves 2000), something which forms the key output of a DBR study and which align with my aspirations of this work.

4.2.2.1 Role of theory in a DBR study

The role and use of theory in DBR is different from the way the term ‘theory’ is used by other researchers. Penuel (2014) describes this distinction as follows:

‘Learning scientists have described the theories they seek to develop as local instructional theories focused on how to support the accomplishment of specific, targeted learning goals (Cobb, Confrey, et al., 2003). These local instructional theories focus on such diverse learning goals as developing students’ understandings of statistical variation (Cobb, McClain, & Gravenmeijer, 2003), the cycling of carbon through Earth’s systems (Mohan, Chen, & Anderson, 2009), and structure–function relationships in complex biological systems (Hmelo-Silver, Marathe, & Liu, 2007)...These examples illustrate the ways that theories in learning sciences differ from theories developed by such figures as Piaget and Vygotsky, which attempt to give accounts of basic processes of learning and development and define methodologies for investigating them (see also diSessa & Cobb, 2004)’ (p. 99).

In view of the above, PT[®] is a theory from this learning sciences perspective as it supports the accomplishment of a learning goal, i.e. managing

multitasking during study-related activities. The theory in DBR is essentially an 'initial set of conjectures' that are 'intended to guide the generation, selection, and assessment of design alternatives' (ibid). Therefore, PT[®], as originally proposed by its author and specifically the way in which I have codified it in section 3.2.2, forms that initial set of conjectures that are refined in light of participant feedback and experiences over several DBR iterations.

4.2.3 Applying the methodology

4.2.3.1 Research site

A DBR study is situated in a real educational setting (The Design-Based Research Collective 2003) and this research was conducted at a post-92 higher education institution in the UK where I work as a learning technologist for the STEM faculty. The site was chosen primarily because I intend to use findings of this study to deliver workshops on managing multitasking at my institution. Therefore, the highly contextualised findings of this study are likely to be more relevant to future workshops when the research is based at my institution.

As this research was instigated in light of adverse impact of multitasking on students' assessment outcomes, it was appropriate to conduct the research in a post-92 university (former polytechnics granted university status in 1992) where students are more likely to be from non-traditional backgrounds and have lower entry qualifications (Boliver 2015), are more likely to drop-out (Department for Children, Education, Lifelong Learning and Skills 2009), and hence are more likely to require academic support. In addition, the university used in this research is representative of a typical post-92 university and

therefore findings are likely to be applicable to many university contexts (of the 103 public universities in England, UK, 69 are post-92 (Council for the Defence of British Universities 2019)). Convenience also played a role in selection of the research site as it was easier to recruit and access participants from my own institution.

4.2.3.2 Research participants

There is no prescribed figure in literature for the ideal number of participants for a DBR study. However, I set out to recruit ten-twelve participants which is in line with the sample size range (i.e. between ten to sixty) reported for qualitative studies (Baker and Edwards 2012). This number was chosen keeping in view my intent to revisit each participant multiple times to see how their narrative regarding multitasking unfolded over time, and the time available for carrying out multiple interviews in each cycle of the DBR study, and transcribing and analysing these interviews. Considering that the purpose of a DBR research is to find solutions in collaboration with, and that work for, its participants, the number of participants is not determined by statistical requirements as it is for some other research approaches.

I recruited participants from STEM disciplines at my university. The focus on STEM students was due to convenience as I work for the STEM faculty and enjoy the goodwill of staff to allow me to make an announcement inviting students to be involved in the research in their lectures (nineteen different cohorts) and send reminder emails to them on my behalf. Of the twenty-four who attended a briefing about the study, twelve eventually volunteered to join the study. Six participants were from Pharmacy, two from Chemistry, two from

Biomedical Science, and one each from Medical Biochemistry and Software Engineering courses. Nine participants were in their second and three participants were in their third year of study. All participants who were in their third year were enrolled in a four-year course. For ethical reasons and to satisfy inclusivity, I did not gather specific demographic data. However, based on my experience, the population was likely to be 10 females and 2 males, all under the age of 25 years, and 11 participants having a black and minority ethnic (BME) heritage and 1 participant having white heritage (though there is no way to support this with evidence from individuals since I did not ask participants such demographic questions as part of the data generation process).

In DBR cycle 2, I introduced all participants to the PT[®] in-person and provided them a kitchen/egg timer and printouts of instructions, the activity inventory sheet and the to-do-today sheet.

4.2.3.3 'Insider' research

As my student participants were enrolled at the same institution where I work, I could potentially be classed as an 'insider researcher' (Mercer 2007), i.e. one who is conducting research at their place of work. However, my role is staff rather than student-facing so I neither knew the students before they participated in the study nor did I teach them. Therefore, I find myself on a 'continuum' of the insider/outsider end-points (Anderson and Jones 2000), rather than at one end of the scale.

Mercer provides a summary of the debate around issues that being an insider and outsider researcher can pose to the validity of research and to issues of 'bias'. The points of this debate include whether insider or outsider researchers are more likely to a) achieve an 'objective' account of human interaction, b) alter the research process, and c) build rapport and credibility with participants, in turn getting richer data from participants.

In my view, most of the concerns and issues that form the insider/outsider debate do not apply to my research context. The purpose of my research is to determine the effectiveness of the PT[®] in helping students manage multitasking. It is not to research an aspect of my organisation's processes, systems or culture. Therefore, my knowledge of my organisation and me not being a 'neutral outsider' does not, in my view, have a bearing on the findings. Similarly, I was not researching a particular group, e.g. gender/ethnicity whose experience I needed to share in order to understand the phenomenon under investigation. In my view, the fact that I am to some extent also an 'outsider' makes it less likely for participants to feel pressurised to participate in the study or to not withdraw from it, and more likely to feel not being judged on sharing information about their multitasking behaviour. However, I do acknowledge some of the advantages being on the insider/outsider continuum afforded me. The 'insider' aspect of my position as a researcher made it easier to recruit and access participants as well as understand participant responses around academic culture and environment. It also made it easier for me to meet repeatedly with the participants over the longitudinal period of the research study.

I believe that my position as an 'outsider' in the senses outlined above also addresses the power imbalance my position as a researcher and member of staff could have imbued on my relationship with participants. As stated above, participants are less likely to feel pressurised to participate in the study or to not withdraw from it as I do not teach them. Further, as mentioned in section 4.5, I reminded participants at numerous times during the data collection period that they could withdraw from the study at any time without any disadvantage and without providing a reason. I did not consider power imbalance in gender terms, although it is conceivable that some participants may have been impacted by it, I was not aware of this at any time.

4.2.3.4 Designing the DBR study

A DBR study commences with preliminary research which entails a review of literature, development of a conceptual or theoretical framework for the study, and accurate assessment of the local context (Cobb et al. 2003, Plomp 2007). To this end, I conducted a review of existing literature on reasons for multitasking (section 2.2) and strategies for multitasking (section 2.3) and identified its limitations. These limitations were used to inform the design of my research and in turn carry out an assessment of the local context, i.e. what causes participants of my research study to multitask between study and non-study-related activities. An appreciation of participants' contexts helped in refining the intervention for this research (i.e. the PT[®]) before it was introduced to participants (as mentioned in section 5.3.2).

The design of DBR interventions evolves through multiple cycles with iterative adjustments and improvements made to the intervention following evaluation

at each cycle (Design-Based Research Collective 2000, Anderson and Shattuck 2012). One aspect to consider for DBR studies is the maximum number of cycles or iterations of intervention required. Anderson and Shattuck (2012) report that half of the DBR studies they came across progressed through three or more iterations. Herrington et al. (2007) suggest that there should be two or more cycles of intervention. On the other hand, Levin and O'Donnell (1999) argue that interventions should be conducted for a 'long enough' period (a semester or a year) 'for them to "take" and permit the assessment of both the desired outcome... and any unwanted side effects' (p. 204).

In view of the above, my research design comprised four DBR cycles. The purpose of the first DBR cycle was to find reasons behind participants' multitasking and any existing strategies they employ to manage multitasking. Participants were required to keep a diary of their multitasking behaviour (detailed in section 4.3.1) for seven days. One week is the most commonly used time period for diary keeping and a duration longer than this may cause participant fatigue (Wiseman et al. 2005). Seven days is also likely to cover the varied range of activities and situations that a participant is going to encounter during the week.

The purpose of DBR cycles 2 and 3 was to evaluate participants' use of the PT[®] with adjustments made to the technique based on their experience and feedback after each evaluation. Participants were expected to use the technique for seven days in each of these cycles. This was followed by a third,

final evaluation in DBR cycle 4 where use of the PT[®] was assessed for a longer duration of time, which was a minimum of two months.

Participants were asked to use the PT[®] for seven days in DBR cycles 2 and 3 in view of the time available for data collection. This is illustrated using the data collection schedule presented in Table 4.3. As can be seen from the table, I could only recruit participants and subsequently collect data during term time which ran from the last week of September 2015 to the beginning of April 2016. Within this time, I had to make allowance for time required for four interviews, the preliminary analysis of the first three interviews in order to refine the technique, as well as introducing the technique to the participants. It was additionally impacted by participants' availability. For instance, as can be seen from Table 4.3, participants were introduced to the PT[®] for the first time in-person and asked to use it for seven days, between 16 and 29 November 2015, i.e. fourteen days. Ideally this phase should have taken eight days (first day for introducing the technique and the remaining seven for using the PT[®]). However, all participants were not available for receiving instructions for the PT[®] on the 16 November, resulting in this phase extending until 29 November 2015. This pushed back the project schedule. Similarly, in DBR cycle 3, participants were introduced to the refined PT[®] in DBR cycle 3 to use for seven days on 14 December 2015, but due to the Christmas break I could not take interviews until at least 10 January 2016. Although participants were free to use the technique after the required seven days, I only collected data for seven days as it had implications on time available for interviews and processing data.

Start and end date	Project activity
5 – 16 October 2015	Participant recruitment and induction
DBR cycle 1	
19 – 25 October 2015	Diary keeping for recording multitasking behaviour for seven days
26 October – 6 November 2015	First interview
DBR cycle 2	
7 – 15 November 2015	Preliminary interview analysis and PT [®] refinement
16 – 29 November 2015	Participants introduced to the PT [®] in-person for the first time and asked to use it for seven days
30 November – 8 December 2015	Second interview
DBR cycle 3	
9 December – 13 December 2015	Preliminary interview analysis and PT [®] refinement
14 December 2015 – 10 January 2016	Participants introduced to the refined PT [®] and asked to use it for a further seven days
11 – 22 January 2016	Third interview
DBR cycle 4	
23 – 31 January 2016	Preliminary interview analysis and PT [®] refinement
1 February 2016	Participants introduced to the refined PT [®] and asked to use it for at least 2 months
2 April – 17 June 2016	<p>Final interview</p> <p>Interview dates and duration of the use of PT[®] of each participant</p> <p>P10 – 2 April (2 months) P9 – 6 April (2 months) P6 – 8 April (2 months) P11 – 9 May (3 months) P1 – 30 May (4 months) P4 – 16 June (4.5 month) P2 – 17 June (4.5 months)</p>

Table 4.1 Data collection schedule

As can be seen from Table 4.1, the final interviews were also conducted when participants were available for the interview, which resulted in the differences in duration of use of the PT[®] in DBR cycle 4. In all, the maximum duration of the DBR study, taking into account time for evaluation, analysis and refinement of the technique was eight months.

Figure 4.1 presents the participation summary. As can be seen from the figure, the number of iterations varied between participants. Five participants withdrew from the study at various points. Of those who did not withdraw from the study (seven participants), the reason why some participants had four and the others three or two interviews was due to their availability for interviews. In total, I conducted thirty-four interviews between durations twenty and forty-five minutes.

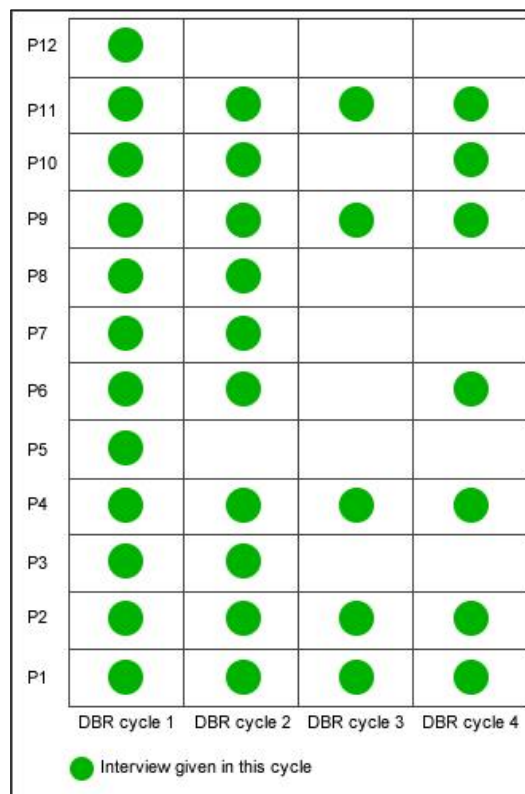


Figure 4.1 Participation summary (original work)

The resultant output of my DBR study, presented in chapter 5, comprises details of the refinements made to the technique, in what ways it has been effective in managing multitasking, its limitations, and recommendations for future refinements and implementation.

4.3 Data collection methods

With pragmatism as the underlying paradigm, DBR does not prescribe particular methods. It is the research purpose, and research questions to be addressed, that determine the selection of research methods for a DBR study (Reeves 2000, Goldkuhl 2012). Therefore, my research employs different methods during different phases of the study and these are selected based on my perceptions of their utility in relation to research questions. Table 4.2 presents a summary of the data collection methods and research objectives they addressed. Details of these methods including reasons for their selection are as follows.

Data collection method	DBR cycle	Research sub-questions addressed
Diary (multitasking behaviour)	1	RQ1.1
Diary (Activity inventory and to-do-today sheet)	2,3,4	RQ1.1, RQ1.2, RQ1.3, RQ1.4
Diary reflection using usage logging software/apps	1,2,3,4	RQ1.1
Interviews	1,2,3,4	RQ1.1, RQ1.2, RQ1.3, RQ1.4

Table 4.2 Summary of data collection methods and research sub-questions they addressed

4.3.1 Participant diaries

Participant diaries were employed to address the research sub-question RQ1.1. Diaries were complimentary to participant interviews in DBR cycle 1

where they were asked about their diary on multitasking behaviour. They were filled-in with the aid of usage logging software/apps listed in section 4.3.2.

The main purpose of employing this method was to minimise recall bias in reporting multitasking behaviour, compared with an interview or questionnaire (Bowling 2009). If a diary is maintained daily, participants are more likely to accurately recall their multitasking behaviour. Furthermore, participants are more likely to include sensitive or private information in their diaries that may not be obtained in interviews (Corti 1993). Although participants may not wish to disclose aspects of their multitasking behaviour, recording of that information in the diary can help participants accurately respond to questions. Diaries also provided a substitute for accurate observation in participants' natural settings (Elliott 1997), which was neither feasible nor possible for me.

The diaries were structured in the form of a pro-forma with the first row reproduced in Table 4.3. As can be seen from the table, the diary aims to capture participants' multitasking behaviour as well as situational factors such as the reason they multitasked. In line with my task-based conceptualisation of multitasking, participants were asked to record all devices and applications used to perform a study-related activity. As the study was in-situ, participants were asked to record both technology and non-technology-based multitasking (e.g. involving people). Participants were asked to record their multitasking behaviour for each *study slot* they undertook, where a study slot is a period of time intended for study purposes (there could be more than one study slot during a day).

Study slot	Where were you situated for the period of this study slot?	List all study-related activities you performed during this study slot and the devices and applications you used to perform this activity.	List all the non-study-related activities you switched to whilst performing study-related activities in this study slot. These activities might involve devices/technology or other people.	Specify approximate time spent on the non-study-related activities you listed in the previous column.	List any activities that involved both your study and non-study-related activities.
------------	--	--	---	---	---

Table 4.3 First row of the participant diary

Participants were asked to fill in the diary at the end of each day and not immediately after the end of a study session to ensure that diary keeping was not disruptive. The offer to be sent a daily reminder (in the form of e-mail or mobile text/SMS) for keeping the diary was made, but not availed by any participant.

The activity inventory sheet and to-do-today sheet (explained in section 3.2) which form part of the PT[®], also served a function similar to participant diaries. Participants were interviewed based on their activity inventory and to-do-today sheets during DBR cycles 2, 3 and 4. This helped in addressing all four research sub-questions of this study.

As detailed in the following section, participants were introduced to usage logging software apps to support diary reflection.

4.3.2 Diary reflection using usage logging software/apps

Usage logging software/apps were also employed to address the research sub-question RQ1.1. The software/apps were intended to help participants accurately record and recall their multitasking behaviour when filling in their

diaries. This is because it may not be possible to recall and record accurately detail of every study-related activity and non-study-related activity during a day, especially when participants were advised to fill in the diary at the end of each day. Therefore, logging software/apps were introduced to increase the validity of data added to the participant diaries. Yeykelis et al. (2014) report that usage logging software enhances the ecological validity of studies of computer task-switching by recording details that participants may not remember. As I discuss in section 4.5, I did not seek access to participant logs in order to maintain their privacy.

There was no single software/tool that could track user activity on a range of different devices/platforms. Therefore, participants were prescribed three free data logging software and apps (along with help guides) which are listed below:

- ActivTrak²: free software for Windows and MAC OS X that keeps a log of all activity on a personal computer.
- RescueTime³: is a mobile phone app for Android and Apple phones that keeps track of the total time spent on each app on a mobile phone.
- Google Web and App Activity⁴: a feature to keep history of web browsing activity on university computers, where students did not have administrative privileges to install ActivTrak.

² <https://activtrak.com/> (Accessed 10.9.15)

³ <https://www.rescuetime.com/> (Accessed 10.9.15)

⁴ <https://support.google.com/websearch/answer/54068> (Accessed 10.9.15)

4.3.3 Interviews

Participant interviews were employed to address all four research sub-questions of this study. Each DBR cycle included an interview with participants. Interviews were complemented by diaries in DBR cycle 1 and by activity inventory and to-do-today sheets in DBR cycles 2, 3 and 4.

The main purpose of employing interviews was to open up and explore participants' responses, seek clarity on what participants mean by their responses, and clarify questions to them if they appeared to not have understood them, thereby allowing for greater depth than other data collection methods (Cohen et al. 2007).

The interviews were semi-structured to enable me to respond to issues that emerged during the course of the interview (King and Horrocks 2010).

Therefore, I developed an 'interview guide' for my interviews that 'outlines the main topics the researcher would like to cover, but is flexible regarding the phrasing of questions and the order in which they are asked' (ibid:35). As DBR is exploratory, the interview questions were open-ended (Cohen et al. 2007) in accordance with advice by Herrington et al. (2007). I also tried to ensure that the questions were non-leading (King and Horrocks 2010).

The interview for DBR cycle 1 aimed at addressing research sub-question RQ1.1 and therefore asked participants about their multitasking behaviour as recorded in their diaries. Participants were also enquired about any existing strategies they employ to manage multitasking.

Interviews for DBR cycle 2 aimed at eliciting how participants used the PT[®] and their perceptions of it after using the technique for the first time for seven days, and addressed all research sub-questions. Interviews were based around the activity inventory and to-do-today sheets that participants completed whilst using the PT[®]. Participants were asked if they used various aspects of the technique and how they perceived it. They were asked about the number of pomodoros they undertook for each study slot, how many pomodoros they voided, and the reason for voiding pomodoros.

Participants were asked if the technique helped them in managing multitasking, whether they required any amendments to the technique, and whether they wished to use the technique in the future.

Interviews for DBR cycle 3 aimed at eliciting how participants used the PT[®] and their perceptions of it after using the technique for the second time, after it was refined in light of their experiences and feedback, for seven days. The interview addressed all research sub-questions. The guide for the third interview was the same as the one for the second interview. Additional questions were asked about the participant's perception and experiences of the refinements to the PT[®].

Interviews for DBR cycle 4 aimed at eliciting how participants used the PT[®] and their perceptions of using the technique for an extended period of time (e.g. two months), after it was refined in light of their experiences and feedback either after DBR cycle 2 or cycle 3 (as detailed in chapter 5, some

participants did not appear for interview in DBR cycle 3). The interview addressed all research sub-questions. Contrary to interviews for DBR cycles 2 and 3, participants were asked about overall perceptions of the technique after using it for a prolonged period of time rather than eliciting details of specific study slots. Questions were also asked about the participant's perception and experiences of the refinements to the PT[®] made after DBR cycle 2 (for those who said they could not attend interviews for DBR cycle 3) or cycle 3, and whether they intended to continue using the technique after the study.

The interview guide used in the four DBR cycles can be found in Appendix 2.

4.4 Data analysis

All thirty-four audio interviews were transcribed verbatim. Some brief supporting notes were also kept from interviews. For instance, I recorded any non-verbal communication and general impressions of note separately after the interview.

I only got the chance to transcribe and analyse interviews after the data collection phase had completed. Yet, I conducted a preliminary analysis of each interview before a subsequent interview with a participant in order to a) add refinements, if any, to the PT[®], and b) to clarify any aspects of the participant's response that I, on revisiting the interview, was not clear on or for which I needed further information. To this end, I employed a 'notes and quotes' approach whereby I listened to an entire interview before the

succeeding interview with a participant and made notes regarding the information that was of immediate interest to me.

DBR is underpinned by a pragmatic paradigm so a researcher should use 'whatever works' to analyse research data (Fraenkel and Wallen 2009:559). The approach I adopted to analyse data for this research was thematic analysis which is independent of theory and epistemology, thereby flexible enough to be applied across a range of paradigms including DBR (Braun and Clarke 2006). What is unique about thematic analysis is the acknowledgement that analysis happens at an intuitive level:

'it is through the process of immersion in data and considering connections and interconnections between codes, concepts and themes that an "aha" moment happens' (Savin-Baden and Major 2013:440).

Despite being widely used, there is no clear agreement on what constitutes thematic analysis and how one does it (Braun and Clarke 2006, Savin-Baden and Major, 2012). For this research, I followed the six-step guidelines to thematic analysis proposed by Braun and Clarke (2006) which are described below, along with an example of how I applied these.

1. *Familiarisation with data*: this involves the researcher immersing themselves in data in order to get familiar with the depth and breadth of the content. I developed some familiarity by a) listening to each interview before a subsequent interview, and b) transcribing each

interview after data collection was over. At the time of data analysis, I re-familiarised myself with interview data for each DBR cycle.

2. *Generating initial codes:* I generated the codes using the ATLAS.ti qualitative analysis tool by tagging and naming selections of text within a transcript (I tagged surrounding text in a code so that context was not lost). I coded data for one DBR cycle at a time. I coded the entire dataset, one transcript at a time, using an inductive approach where codes and themes are strongly linked to data and are not driven by the researcher's theoretical interest in the topic or a pre-existing coding frame (Patton 1990). For instance, a participant response to why they switched to a non-study-related activity whilst studying was given the code 'reason_for_multitasking'.
3. *Searching for themes:* involves sorting different codes into themes. A theme captures important information about data in relation to research questions (Braun and Clarke 2006). To this end, I analysed the different codes to see how they could combine to form a theme. Similar to coding, the themes were identified largely using an inductive approach. I considered codes that captured what is important to the overall research questions. Themes were created in MS Word rather than in ATLAS.ti.
4. *Reviewing themes:* involves the refinement of themes. To this end, I first read the extracts associated with each theme to check whether they were linked with each other. This resulted in either the creation of

new themes or some extracts, which I no longer found relevant, being discarded. Secondly, I re-read the entire data set to ascertain whether a) the themes were valid in relation to the entire data set, and b) there was room for coding additional data that had been missed in earlier coding stages.

5. *Defining and naming themes*: involves continuing to analyse and refine the themes, and giving them concise names. Refinement involves organising data extracts within a theme into a coherent and consistent account, determining whether a theme has sub-themes, identifying the story each theme tells, and considering how this story relates to a story of other themes and that of the overall data. This stage also involves defining the themes: i.e. paraphrasing contents of data extracts associated with a theme, its scope, and why they are of interest and relevance to the theme.
6. *Producing the report*: involves final analysis and writing-up of the findings, which have been presented in chapter 6.

This was not a step-wise process from one stage to another, rather I moved back and forth (especially between stages 3, 4 and 5) as required. In order to increase validity of the analysis, I discussed the codes and themes with a critical friend who is an academic working in higher education.

4.5 Research ethics

I sought ethical approval for the project from the university research ethics committee at Lancaster University as well as the relevant ethics committee at the host institution where I carried out my research. My research, which is non-funded, handled ethical considerations in light of the principles outlined in Lancaster University's ethical code of practice (Lancaster University 2009) in the following ways.

Informed consent was gained from the participants. To this end, in a face-to-face briefing, I clearly communicated to potential participants both verbally and through a written information sheet, the aims of the project, potential advantages and risks to them as a result of participation in the study, and that they could withdraw at any time without any disadvantage and providing a reason. Those who agreed to participate after the briefing were asked to provide signed consent. The participant information sheet and consent form can be found in Appendix 1. Following the interview for each DBR cycle, participants were asked whether they would like to continue with the study. No monetary reward was given to the participants.

I ensured that all information gained from participants was maintained in a strictly confidential manner. To this end, interview audio was encrypted and stored in Lancaster University's online data storage facility Box. A pseudonym was given to protect participant identity and any identifying information about them was removed from the transcriptions.

As findings of DBR study comprise in-depth and thick descriptions, this may increase chances of participants being identified (Brock-Utne 1996). To mitigate for this, I have kept the name of the host institution as well as information about participant gender and their course anonymous. Following completion of transcriptions and the assignment of pseudonyms, all personal data and interview audio were deleted. Interview transcripts will be stored for ten years to allow for publication in journals or conferences.

One key ethical consideration related to the use of software and apps that a) track participants' multitasking behaviour and b) can help them manage multitasking behaviour. This is because the tools and apps I found suitable for my study are hosted on servers outside the European Union and hence may not comply with the EU's data protection legislation. In view of this, the use of these tools was left optional and at the discretion of the participants. They were also informed, through a participation information sheet and induction, about the data protection consequence of using these software and apps. I also considered how best to get information on participants' multitasking activity yet maintain their privacy. To this end, I decided not to seek access to usage logs produced by tracking software. Instead, participants were advised to use the logs to complete their diaries and bring these diaries to the interview as aid memoirs of their multitasking behaviour. In addition, I decided not to gather names of non-study-related websites and apps to which participants multitask, instead asking them to classify them as study or non-study-related. This issue was discussed with Lancaster's research ethics committee and the approach derived from that discussion.

4.6 Strengths and weaknesses of the research design

As mentioned earlier in section 1.4, I embarked on this research due to witnessing the adverse impact of multitasking on students' assessment outcomes and lack of evidenced-based advice to effectively manage it. DBR aligns well with my pragmatist worldview that is concerned with action and change, enabling me to come up with solutions that address the needs and requirements of my participants. DBR also addresses criticism of educational research that argues that it may not account for 'influence of contexts, the emergent and complex nature of outcomes, and the incompleteness of knowledge about which factors are relevant for prediction' (Robinson 1998). DBR aims to address these challenges by being situated in a local context with the results used to assess, inform and improve practice in that context.

The design of this research addresses a number of limitations of earlier studies on multitasking and the PT[®] as highlighted in sections 2.4 and 3.4.1. Usage logging software and diaries were employed to improve accuracy of self-reported data. Participants reported their multitasking behaviour and experiences of the PT[®] in a natural study environment rather than experimental settings. The long duration of this research (eight months) is likely to test the PT[®] across a varied range of activities and situations that a participant encounters. The use of interviews rather than quantitative methods such as questionnaires enabled me to press for complete answers, open up and explore participants' responses, and clarify questions to them if they appeared to not have understood them, thereby allowing for greater depth than other data collection methods (Cohen et al. 2007).

Yet all research projects have weaknesses and limitations and this project is no exception. In the following paragraphs I highlight some of the limitations of research design.

As I struggled with recruiting participants for the study, it was not feasible for me to pilot (Cohen et al. 2007) the research questions. However, the interview questions were run past my supervisor and feedback received was incorporated. In addition, when I ran the first few interviews, I did not feel the need to change the interview guide because I was able to draw in-depth data from most participants without confusing them with my questions. Yet, although I tried to formulate the questions in a way that the meaning was abundantly clear to the participant, sometimes participants appeared confused due to the open-ended nature of the questions.

One of the measures proposed to increase both research validity and reliability is member-checking or respondent validation (Lincoln and Guba 1985). Although I availed the opportunity afforded by subsequent interviews for clarifying anything that I was not clear about in the previous interview, I did not refer to participants for checking the research findings. This was due to difficulty in getting in touch with participants as they had all graduated by the time I analysed the thesis findings. Verbrugge (1980) argues that post respondent-validation data becomes retrospective and actually may weaken the validity of findings.

Data should ideally be coded by multiple researchers and any resultant ambiguities should be resolved through discussion with them (Silverman 1993). This was not feasible in my research due to time constraints, though I discussed coding with a critical friend to validate its appropriateness.

Evidence arising from DBR has been criticised for trustworthiness due to lack of experimental control (e.g. Mayer 2003). I subscribe to the argument by Brown (1992) that control experiments are not possible in educational settings comprising several interwoven components that cannot be isolated.

Simplifying the setting would result in loss of ecological validity and a distorted view of expected outcome if an intervention is used in a technology-based learning environment where the variables or behaviours cannot be controlled. Therefore, the findings of DBR need to be described and understood as a system of interdependent elements.

Another criticism of DBR is that in absence of experimental control, it is not possible to attribute outcomes solely to an intervention when too many interdependent variables are at play (Levin and O'Donnell 1999). I believe that this criticism is not valid because the results of the DBR intervention are tied to the context it was applied to and do not seek generalisation. As Winn (2003:371) aptly sums up:

'I would prefer to have the detailed information... about how an intervention works, and the opportunity to fix it if it does not work, than

a statistically derived estimate of the probability that what I was observing was due to chance and not to the intervention.'

In the following chapter, I present findings from the four DBR cycles of this study.

Chapter 5: Data Presentation

5.1 Introduction

This chapter outlines the range of data generated by this research study. Presenting data in a relatively unmediated form prior to documenting the analysis is a mechanism of transparency about the nature of the data before analysis; it is undertaken to assist the reader to judge the robustness of research and transparencies concerning nature of the data before analysis (Trowler 2016). Of course, data cannot be presented in totally unmediated form, since that would be both difficult for readers to understand and would contravene word count restrictions. However, as this is a Design-Based Research (DBR) study comprising four cycles, it makes sense to document the data generated in each cycle. The structure of this chapter is therefore organised around these four cycles.

This chapter begins with the first cycle of DBR (section 5.2), which aimed at understanding the causes behind participants' multitasking and any existing strategies they employ to manage multitasking. The second DBR cycle (section 5.3) comprised refinement of the Pomodoro Technique (PT[®]) in light of information gathered in DBR cycle 1 before it was introduced to the participants, and evaluation of the participants' first experience of the PT[®] for the prescribed seven days. The third DBR cycle (section 5.4) comprised evaluation of the participants' experience of the PT[®], after its refinement in light of their feedback, for another seven days. The fourth and final DBR cycle (section 5.5) comprises evaluation of the PT[®] after its refinement in light of

feedback after the third cycle and/or for a longer duration of time. The structure of the section on the first DBR cycle is different from the remaining three cycles because of the difference in aims of the cycles. As data are presented by cycles, please also note that there are instances where experiences of one participant in a DBR cycle are echoed by another participant in a subsequent cycle. Readers are reminded that the time schedule for data collection has been provided in Table 4.1.

5.2 DBR cycle 1 – Participants’ experiences of and strategies for managing multitasking

5.2.1 Introduction to DBR cycle 1

The aim of the first DBR cycle was to elicit reasons participants multitask and any existing strategies they employed to manage multitasking. The findings from this cycle informed the design of intervention for multitasking. To this end, participants were asked to keep a diary of their multitasking behaviour for seven days and were invited to an interview in which they were asked about their diaries.

Twelve students participated in the first cycle. Participants were assigned codes P1, P2, P3 and so on, in the order they appeared for the interview.

Although participants were asked to keep a diary for seven days, the number of days this was kept varied and has been summarised in Table 5.1 below.

Table 5.1 also shows the number of study slots for each participant (ten participants had more than one study slot in a day), and the number of slots which involved multitasking. As can be seen from the table, all participants

reported multitasking to non-study-related activities during study-related activities (88 of 100 study slots).

Participant	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	
Days diary kept	7	7	3	7	4	5	5	3	5	4	3	8	Total
No. of study slots	13	12	4	13	6	7	6	3	9	5	14	8	100
No. of slots multitasked	11	12	3	13	6	6	4	3	9	5	8	8	88

Table 5.1 Number of days diary was kept, total number of study slots, and number of study slots involving multitasking in DBR cycle 1

To facilitate diary-keeping, participants were provided with information about mobile apps and computer software to record the phone/computer activity. However, only two participants chose to use these tools. Participants either recorded their diaries on the go or at the end of the day. Only P3 gave a reason for not using the tools stating that they were ‘not comfortable’ installing these tools on their devices.

5.2.2 Reasons for multitasking

Table 5.2 summarises the various reasons participants gave for multitasking along with their occurrence, for the days and study slots they kept the diary (mentioned in Table 5.1). The data presented in the table were obtained from participant interviews. Some of the rows in the table have a ✓ instead of a number. These instances represent general reasons participants cited for multitasking in their interview rather than being recorded against specific study slots in their diaries. Therefore, the rows with a ✓ have a >= symbol in the ‘total frequency’ column which signifies the minimum number of occurrences in the absence of definitive data.

	Occurrence												Total Frequency
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	
Notification (vibration, light, sound) for non-study-related activity	10	4	1	3	1	3	2	3	1	1		3	32
Study environment		1		11	✓	1		1		3	1	3	>=22
Self-efficacy and/or motivation	3	5	2	1		1			3	2	2		19
Technology for study-related activities		4		2	2	1	4	2					15
Need for 'break'				2					2		2	3	9
Pleasure and mood regulation		1	1						2		3	✓	>=8
Out of habit					5								5
Ease of multitasking	✓							✓	✓			✓	>=4
Getting reminded of a non-study-related task			1	1				1					3
Absence of deadline			✓							✓			>=2
Not able to study for long periods of time											✓	✓	>=2
Switch from study to non-study related conversation							1					1	2
Feeling 'confident'							1					1	2
Delay in webpages loading					2								2
To check if contacted by peers							✓						>=1
Peer expectation to respond to messages instantly	✓												>=1
Activity type					✓								>=1
Reason could not be determined from participant response	1												1

Table 5.2 Reasons for participants' multitasking in DBR cycle 1

Several of the reasons for multitasking listed in Table 5.2 are self-explanatory and in many cases relate directly to issues highlighted in the literature review.

However, some issues are worth unpacking further and these are considered in the following sub-sections.

5.2.2.1 Self-efficacy and/or motivation

The participants' affective state towards a task was reported to be one of the reasons for multitasking. These included finding the study task boring (P1, P2, P6, P9, P10) or 'overwhelming' (P2), the task causing a feeling of frustration (P1, P2, P4), encountering obstacles in the study-related task (P3, P9, P10, P11), tiredness (P1, P2, P11), having had 'enough of task' (P3), and revision material being 'too long' (P9). P4 reported that in general they were more likely to 'welcome distractions' around them when they were struggling with study-related tasks. In terms of the concepts highlighted earlier, all these reasons point to low motivation and/or low self-belief (self-efficacy). An example quote by P10:

'(when doing an assignment) it is when I would face a problem and I don't know how to do it and I kinda get bored and then just get my phone and turn to Facebook.'

Participants also shared aspects of their life that were not reported as reasons for multitasking but appeared to cause low self-efficacy and/or motivation for study-related tasks, thereby increasing likelihood of multitasking (as described in sections 2.2.2 and 2.2.3). These included unavoidable external interruptions by family members at home (P4), inability to attend some lectures due to work (P4), unfavourable timetable with six lectures crammed in one day (P1), lecture slides only comprising 'pictures and stuff' making these difficult to

revise (P1), finding it harder to revise lectures that were not audio-recorded (P1), lacking time for study due to working part-time (P4), long commuting journey to university (P4), and non-willingness to tell interrupting friends to contact later as opportunity to 'catch up' with them was already limited due to academic and work routine (P4).

5.2.2.2 Study environment

Aspects of the study environment were attributed as a contributing factor to multitasking. These included interruptions by friends and family members (P2, P4, P6, P8, P10, P11, P12), noise in the library (P4), the TV running in the background (P12), internet becoming unavailable (P4), and studying in bed causing tiredness making the participant more prone to taking a 'break' (P5), and delay in webpages loading (P5). In few of these cases, aspects of the study environment (e.g. noise, brief interruption by a friend) caused participants to lose focus and delve into non-study-related activity on their computer/phones.

5.2.2.3 Technology for study-related activities

Technology used for study-related activities contributed to multitasking in the following ways: non-study-related content being recommended next to a study-related video on the video-sharing website YouTube (P2, P4, P6), study-related conversation on messaging application delving into non-study-related conversation with either the same or a different person (P2, P7), when the web browser was opened to access study-related content, non-study-related 'tabs' from a previous browsing session opened which caused the participant to switch to them (P2, P7), the default web browser landing page

having links to non-study related content or activities (P8), and background music playlist used to aid study (e.g. jazz music) advancing to a distracting song (P7), and as a result losing focus when proceeding to replay/replace the track (P4, P5).

5.2.2.4 The need for a break

A few participants (P4, P9, P11, P12) stated the need to take a 'break' as the reason for multitasking. In other instances (P2, P5, P10) participants termed their multitasking activity a 'break' where the actual reason for multitasking was different, e.g.,

'I reached part of an assignment I didn't really understand so I thought I'll have a little break.' (P2)

The above instances were considered multitasking rather than breaks because a) the breaks were not planned and b) the participants considered and reported these as multitasking. On one occasion, P10 considered their 'break' for dinner as 'border line distraction' as they took more time than required for it.

Two participants (P11, P12) responses indirectly alluded to the need for break as a reason for multitasking. They reported that one of the reasons they multitasked during study-related tasks was due to inability to focus for long periods of time, e.g.,

'I can't focus for a long time and then my break is to go to my phone. So I was taking a break'. (P12)

5.2.2.5 Pleasure and mood regulation

Participants reported actively switching to non-study-related tasks 'to get entertained' (P9), 'momentarily for entertainment' (P11), 'to feel better' (P3, P11), or because they were feeling 'lonely' (P2). P12 reported that they were more likely to multitask when studying individually rather than in the company of others:

'(I multitask because)... may be I am alone and I want to see other people... if I am with people I don't think about my phone. I am more of a social learner.'

5.2.2.6 Ease of multitasking

P8 and P9 alluded that they would multitask to non-study-related activity just because of the ease in doing so:

'If I minimise assignment window even to check research paper I will just click on another tab and start doing something separate.' (P8)

'I think I revise better on textbook... because of distraction of laptop... it is easier to access stuff on laptop.' (P9)

Similarly P12 stated that they were more likely to multitask on a phone than a laptop due to the ease of doing so on the phone:

'On laptop I have to go to Facebook and sign-in... on my cell I just click on the app and I don't need to sign-in and it is very easy.'

P1 reported that often notification from one non-study-related application on the mobile phone led them to check updates from other non-study-related applications just because they were on the phone as well.

5.2.2.7 Feeling 'confident'

A couple of participants (P7, P11) reported to have multitasked because they felt confident in completing the task, e.g.,

'...because previously for two weeks I didn't study and now I started studying so I have a feeling that "I have started studying" and that is quite big so I got a bit overconfident and relaxed that I am studying. And then I tried to find ways to distract myself...' (P11)

5.2.2.8 Activity type

P5 alluded to being more likely to multitask when drafting assignments compared to other tasks such as searching for research papers on a database. The participant explained that their mind would 'drift' when thinking about what to write in an assignment, and as a result they would switch to social media.

5.2.3 Reasons for not multitasking

As can be seen from Table 5.1 there were five participants who did not multitask during twelve study slots between them. Participants reported reasons they did not multitask in certain study slots or in certain situations. I am reporting these below because in developing an understanding of why participants multitask it is also useful to know why they did not multitask.

5.2.3.1 Exam or assignment deadlines

There were eight instances between three participants (P3, P7, P11) where they did not multitask when working on an assignment because the deadline was close. When asked for a reason for not multitasking, P7 said that ‘there was no time’. P10, who had a negligible instance of multitasking for one slot compared to their other slots, explained the reason for this as follows:

‘...because the pressure was on. I really need to get this done. I got notifications but just ignored the notifications.’

5.2.3.2 Interest in study-related task

Two participants (P4, P11) alluded to interest in the study-related task as a reason for no or minimal multitasking. For example, P4 said that they did not multitask when ‘I read a topic that I enjoy, I really get into the topic and I do not know anything else around me’.

5.2.3.3 Lack of interruption

P7 reported on two instances where they did not multitask because friends situated close by did not interrupt and because they did not get a response back to their text message which was sent to a friend.

5.2.3.4 Guilt

P6 was ‘guilty’ that they wasted a lot of time earlier and did not multitask during one study slot to make up for the lost time.

5.2.3.5 Hawthorne effect

P1 said that they did not multitask in the first slot because they wanted to 'do good for this study' and for the interview.

5.2.3.6 Technique to manage multitasking

P11 was employing a technique similar to the PT[®] where the study slot was of an hour and a half in duration. Although the participant broke the rules and multitasked because they could not 'study for too long', the duration of multitasking was still negligible (two-three minutes) because the participant's goal was to follow the technique as closely as possible.

5.2.3.7 Activity type

Earlier I reported that P5 was more likely to multitask when drafting assignments. The participant added that they deliberately did not use social media when they were reading research articles because 'then I get too distracted... when I'm like looking at several things I can't remember which one is important which one is isn't'.

5.2.4 Existing strategies to manage multitasking

In order to inform the refinement of the PT[®] to suit participants' needs, they were also asked about any existing strategies they employed to minimise multitasking. Three participants (P6, P9, P12) said that they did not employ any strategies to manage multitasking. For those who did employ a strategy, the most popular of these related to a mobile phone which included switching off the phone, setting it to silent mode, or putting it upside down (P1, P3, P4, P5, P8, P10). Two participants endeavoured to work individually rather than in

groups as they found it distracting (P4, P8) and three used background music to blend out other noises (P5, P7) or because it 'relaxes' (P11).

Other strategies included placing a clock on the desk to 'visually see time' (P8), visit social media websites before commencing study-related activities 'so it doesn't interrupt coz I have already seen everything' (P3), having something to eat before studying (P3), telling oneself not to get distracted (P2), and using a technique similar to the PT[®] where practitioners work in slots of one hour and thirty minutes rather than twenty-five minutes followed by a five-minute break (P11).

Three participants (P1, P8, P11) explicitly said that the strategies they employed were not effective. For instance, P1 said that it is the phone that is the main source of distraction; however, trying to switch off or put it away has not helped. It should also be noted that some of the strategies that the participants shared were not aimed at preventing technology-based multitasking, e.g. studying individually rather than in a group and using music to blend out noise.

5.3 DBR cycle 2 – Evaluation of the Pomodoro Technique[®] after use for the first time

5.3.1 Introduction to DBR cycle 2

The second cycle of this DBR study comprised refining the intervention (i.e. the PT[®]), introducing it to participants, and the first evaluation of the PT[®].

Participants were asked to bring their activity inventory sheet and to-do-today

sheet to the interview. Ten of the initial twelve participants participated in this cycle. P5 and P12 withdrew from the study after the first cycle.

5.3.2 Design of intervention

Information provided in sections 5.2.2, 5.2.3 and 5.2.4 was used to inform the design/refinement of the intervention introduced to participants, i.e. the PT®.

Some aspects of participants' lives that appeared to cause low self-efficacy and/or motivation for study-related tasks (reported in section 5.2.2.1), thereby increasing likelihood of multitasking (as discussed in sections 2.2.2 and 2.2.3), could not be addressed as these were either beyond my control or remit (e.g. long commuting journey to university). However, some adjustments and suggestions could be made, as explained below.

5.3.2.1 Minimising interruptions before commencing pomodoro

As can be seen from Table 5.1, phone notifications and an uncondusive study environment were the reasons for multitasking that occurred most frequently. Therefore, participants were advised to minimise the risk of interruptions from these sources before commencing a pomodoro. This included logging out of non-study-related programs on the computer, temporarily switching off notifications for mobile apps, setting mobiles to silent, informing friends and family in advance about the PT® so that they either do not interrupt or are understanding if they inadvertently interrupt and are asked to be contacted after pomodoro, and choosing a place to study which had minimum risk of external interruption (e.g. the silent zone of the university library). Readers are reminded that although avoiding an uncondusive study environment did not address technology-related multitasking, it impacted (as detailed in section 5.2.2.2) participants' self-efficacy to study and a loss of focus due to

interruption prompted a few participants to multitask to non-study-related activities on their phone/computer.

5.3.2.2 Review and reflection on to-do-today sheet

Participants were asked to review their to-do-today sheets and identify factors that they thought contributed to multitasking (i.e. factors other than phone notifications and unconducive study environment that were specific to them).

Participants were asked to reflect on how these factors could be addressed before they started using the PT[®]. For example, P1 reported that their self-efficacy for revising lectures that were not audio-recorded was low, which made them more likely to multitask.

5.3.3 How participants used/adapted the Pomodoro Technique[®]?

Participants were recommended to use the PT[®] for seven days. Tables 5.3 and 5.4 present data from the interviews. Not all participants used the technique for seven days as can be seen from Table 5.3. No participant used the programs and applications recommended to record multitasking behaviour on a computer and mobile. P6 and P10 did not bring inventory and to-do-today sheets to the interview so they were asked general questions pertaining to their experience of using the PT[®]. It is for this reason that they have 'not available' (NA) or ✓ (denoting that some pomodoros were voided) corresponding to their entry in Table 5.3. Therefore, the rows with a ✓ have a > symbol in the 'total' column which signifies the minimum number of occurrences in absence of definitive data.

Participant	P1	P2	P3	P4	P6	P7	P8	P9	P10	P11	
No. of days PT [®] used	7	7	1	6	NA	6	7	2	NA	8	Total
Total study slots	7	7	2	6	NA	9	7	2	NA	8	> 48
No. of study slots where pomodoro was voided	2	5	0	3	✓	1	2	0	✓	0	> 13

Table 5.3 Number of days PT[®] was used, total number of study slots, and number of study slots involving multitasking in DBR cycle 2

All participants except P9, P10, and P11 reported that they maintained the activity inventory and to-do-today sheets. P11 said that they only used the to-do-today sheet. Of those who used the activity inventory sheet, P7 did not list non-study-related tasks on it. Except for P1 who did, it could not be determined if participants had divided tasks into sub-tasks. Most participants reported that it was deadlines that guided them in selection of study-related tasks for a day.

All participants except P3, P4 and P10 used the kitchen/egg timer. However, during the cycle four participants switched to a digital timer either completely (P2, P4, P7) or when studying in a public space such as a library (P1).

Participants also adapted the technique to suit their needs. This included merging two pomodoros together without taking a break where pressed for time (P4), shortening the duration of the five-minute break between pomodoros to three minutes (P4) or extending it to ten minutes (P8, P9), and extending the duration of longer breaks after pomodoros from thirty to sixty minutes (P7, P8, P9, P11).

Not all participants followed the two refinements to the study, i.e. minimising interruptions before commencing the pomodoro and identifying factors causing multitasking. Details can be found in section 5.3.5.7.

Activities undertaken during a shorter five-minute break included checking/responding to non-study-related messages on social media and instant messaging applications, snacking, stretching/light exercise, praying, and speaking to family members. Activities undertaken during a longer fifteen/thirty-minute break included snacking/lunch/dinner, speaking to family members, watching TV, praying, and checking/responding to non-study-related messages on social media.

5.3.4 Reasons for multitasking

Table 5.3 shows the number of study slots for which participants voided (by multitasking) at least one pomodoro. As can be seen from the table, only three participants (P3, P9, P11) did not engage in multitasking during pomodoros.

Table 5.4 summarises the various reasons participants gave for voiding pomodoros (i.e. multitasking) along with their occurrence, for the days and study slots they used the PT[®] (mentioned in Table 5.3). Once again, some columns have a ✓ instead of a number because these were general reasons participants cited for voiding pomodoros, rather than recorded against specific study slots in their to-do-today sheets. Therefore, the rows with a ✓ have a >= symbol in the 'total frequency' column which signifies the minimum number of occurrences in the absence of definitive data. Readers are reminded that some participants (e.g. P8) voided multiple pomodoros in a study slot. In

Reasons for multitasking/void pomodoros	Occurrence										Total Frequency	
	P1	P2	P3	P4	P6	P7	P8	P9	P10	P11		
Notifications for non-study-related activity		2	No pomodoro voided	1	✓			No pomodoro voided	✓		>=5	
Study environment		2		3	✓	1						>=6
Technology for study-related activities										✓		>=1
Out of habit					1				1			2
Getting reminded of a non-study-related task	2								2			4
Non-study-related thoughts						✓					✓	>=2
Reason could not be determined from participant response		1										1

Table 5.4 Reasons for participants' multitasking/voiding pomodoros in DBR cycle 2

addition, Table 5.4 states that although P11 reported non-study-related thoughts as a reason for multitasking, Table 5.3 states that they did not void any pomodoro. This is because non-study-related thoughts was identified as multitasking, but it did not void a pomodoro.

Some reasons for multitasking/voiding pomodoros listed in Table 5.4 are self-explanatory. Yet some additional comments do need to be made and are mentioned in the following sub-sections.

5.3.4.1 Study environment

Aspects of the study environment were attributed as a reason for voiding pomodoros. These included interruptions by friends, flatmates and family members (P2, P4, P6, P7) and the internet becoming unavailable (P4).

5.3.4.2 Non-study-related thoughts

Two participants (P6, P11) reported encountering distracting thoughts during pomodoros although they did not void pomodoros because of it. P6 referred to this as 'emotional distractions' such as 'thinking about someone in your head'.

5.3.4.3 Technology for study-related activities

P10 reported one instance where they voided a pomodoro by switching to non-study-related websites when searching for study-related websites.

5.3.5 Participants' experience of the Pomodoro Technique®

I will first report on participants' experiences of individual components of the technique followed by their perception of its effectiveness in managing multitasking.

5.3.5.1 Activity inventory and to-do-today sheets

Seven of ten participants used the activity inventory sheet. Many of those who maintained an activity inventory sheet had positive perceptions about it.

Participants P1 and P2 found it useful because it gave them a general idea of what study-related activities they needed to undertake. P3 and P4 found it a useful planning and organising tool which ensures that a task is not forgotten.

P8 said that while they 'really liked' the activity inventory sheet, the number of study-related tasks listed on it was 'a bit off-putting'. P11 did not find much utility in maintaining the activity inventory sheet whereas P9 said that they did not use the activity inventory sheet 'because of time'.

There were not many comments about the to-do-today sheet. P6 said that the to-do-today sheet enabled them to 'visualise' what they were doing and

served as a reminder for study-related tasks they would have forgotten otherwise. P11 who only maintained a to-do-today sheet rather than an activity inventory sheet said that seeing 'everything in front of what you have to do' in the to-do-today sheet made them feel 'quite organised' and a 'bit positive'.

As part of using the PT[®], participants were required to select tasks from the activity inventory sheet to undertake on a day. Five participants (P2, P3, P4, P9, P11) viewed this process positively. For instance, P3 said that the process helped them plan the day ahead whereas P4 reported that the process facilitated in prioritising tasks.

Two participants (P2, P8) found value in ticking completed tasks off the activity inventory sheet with P2 finding it a source of achievement. P4 said that because the activity inventory sheet was paper-based, maintaining it was challenging as one needed to carry it around all the time. P4 and P7 said that they would prefer a digital version of the activity inventory and to-do-today sheets.

Two participants shared their views on the use of the activity inventory sheet to list their non-study-related tasks. P8 said that listing non-study-related tasks enabled them to focus on study-related tasks for the day. P3 said that they did not feel the need to write down non-study-related tasks because they knew when they cannot or do not study.

5.3.5.2 Pomodoro timer

Of the ten participants, seven used the egg timer. Five participants who used an egg timer (P2, P7, P8, P9, P11) found ticks of the timer distracting:

‘...you kept thinking of tick and sometimes you try to put it off before it goes to buzz and so I kept looking at the egg timer.’ (P7)

P8 said that despite the timer ticks being loud and distracting, they found the tangible timer useful:

‘I can visually see... how much time is going and if there was not a timer I may have gotten up and may be not come back. I would look at the timer when I had the urge to get up for something else and I would see like maybe there are fifteen minutes left or even ten or five minutes and I would stay.’

The participant added that mobile or computer-based timers did not appear ‘serious’ and did not instil ‘commitment’ to the study-related task.

P1 and P4 did not have any issues with the timer but said that because of the ticks and the buzzer at the end of pomodoro, they could not use it when studying in the library. Due to timer sound being a distraction or too loud to be used in a public place, four participants switched to a digital timer either completely (P2, P4, P7) or when studying in a public space such as a library (P1).

5.3.5.3 Recording a successful pomodoro

Many participants reported positive conceptions of marking a completed pomodoro by an 'X'. It was reported to generate feelings of accomplishment (P1, P2), achievement (P4, P8), pride (P7, P11), motivation (P4, P7), goodness (P2), and satisfaction (P11):

'I felt like look at the time I have spent I am like so proud of myself... coz you think you never spent that much time studying and now you are...' (P7)

P9 did not mark pomodoros by 'X' because 'it is just effort'.

5.3.5.4 Deferring potential interruptions

Participants were asked about their perceptions of deferring potential internal and external interruptions to the end of a pomodoro. As discussed further in section 5.3.5.9, many participants did not have the correct conceptions about potential and actual interruptions and how to record these. However, two participants, P7 and P8, found this useful in managing multitasking:

'(noting down a potential interruption) helped me do what I was doing at the moment and then do them later when I have time... it felt like I have control.' (P7)

'...certain times I have internal interruptions but it is just something I can note down and go back to study... it does help me (focus) coz I feel like I know I will do it once I finish this one.' (P8)

P6 said that whilst they were able to defer computer-based distractions such as Facebook, the technique did not help them defer 'emotional distractions', for instance 'thinking about someone in your head'. P11 said a non-study-related thought during a pomodoro was 'interesting only in that moment', and not after the pomodoro had ended.

5.3.5.5 Voiding pomodoro and recording interruptions

There were not many responses on participants' perceptions of voiding a pomodoro and recording interruption. P2 said they were 'quite upset' when they had to void a pomodoro and it felt like a 'waste'. Similarly, P4 said that they were 'annoyed' at voiding a pomodoro and it felt like 'I was taking a step back and start again'. The participant added that brief interruptions (e.g. someone asking for mobile charger) that do not affect focus should not void pomodoros:

'...a lot of people would ask me questions like do you have a charger for example and that would be frustrating because I don't want to void a pomodoro so I will just say yes and then I will take out the charger and give it to them and then not continue the conversation.'

Participants P2 and P6 said that the prospect of voiding a pomodoro and starting again incentivised them not to pursue and/or entertain distractions during study-related activities.

5.3.5.6 Duration of pomodoro and breaks

Two participants (P2, P4) said they would prefer variable duration for pomodoros depending on the study-related task they were undertaking. For

instance, P2 and P4 would have liked longer duration respectively for mathematical calculations and examination revision. P6 wanted the duration of the pomodoro changed from twenty-five to thirty minutes. P8 said they were satisfied with the duration of the pomodoro on the whole though sometimes had the urge to work more than twenty-five minutes. Three participants, P4, P9 and P11, said that the duration of the pomodoro made it easier to defer an interruption for a short period of time, thereby preventing them from multitasking, e.g.,

‘...twenty-five minutes is not long to lose patience.’ (P11)

P2 and P11 had an unfavourable view of the requirement to end study-related tasks abruptly at the end of pomodoro, with the former calling it ‘restrictive’. Participant P2 revised lectures by listening to a few minutes of recording followed by making notes. If the pomodoro ended after the recording had been listened to but corresponding notes had not been made, then by the end of the five-minute break the participant would have forgotten what they listened to and had to listen-in again in the next pomodoro. P3 found the requirement to study in pomodoros ‘restrictive’ to the extent it deterred them from using the technique. The participant said they preferred to study continuously for long durations of time and taking a break would cause them to ‘just go off and do something else’.

Five participants failed to keep to the duration of shorter (P6, P8, P9) or longer breaks (P7, P9, P11) on one or more occasions. Participants also found the

duration of shorter break either not enough (e.g. P6 preferred a fifteen-minute shorter break) or more than enough (e.g. P4 preferred three minutes). There were also instances where participants (P1, P7, P8) did not return to study after a shorter or longer break even when they intended to. The reasons were lack of motivation for study-related tasks (P1, P7, P8), non-study-related activity being more 'engaging' than the study-related task (P7), and finding the study-related task 'daunting' (P8) or not understandable (P7).

P11 said that the five-minute breaks 'changes your mind and I feel a bit fresher when I go back to study'.

5.3.5.7 Refinements to the Pomodoro Technique®

5.3.5.7.1 *Minimising interruptions before commencing pomodoro*

All participants reported taking one or more steps to minimise interruptions prior to beginning a pomodoro (e.g. putting the phone on silent), as part of the refinement to the PT®. However, three participants (P2, P4, P10) did not switch their phone to silent mode for some slots which was one of the key reasons for multitasking. Not many participants shared their perceptions of utility or otherwise of this exercise. P2 said that they did not 'get as distracted as I usually do' due to steps they took to minimise interruptions.

5.3.5.7.2 *Review and reflection on to-do-today sheet*

As part of the refinement to the PT®, participants were asked to review and reflect on the to-do-today sheet in order to identify and address factors that caused multitasking. Factors identified and measures taken to address them have been summarised in Table 5.5.

Factors behind multitasking	Measures taken to address factors behind multitasking
Music to aid study switching to distracting music (P2, P4, P7)	Separate playlist for music to aid study was created (P2, P4, P7)
Non-study-related tabs opening when web browser starts (P2, P7)	Browser settings were changed to prevent non-study-related tabs from opening when web browser starts (P2, P7)
Low self-efficacy for revising lectures that weren't recorded (P1)	Lectures were audio-recorded (P1)
Study-related conversations during group work switching to non-study-related conversations (P1)	Factor not addressed as group work was not encountered again (P1)
Expectations of friend to respond to messages instantly (P1)	Factor not addressed as friend 'won't understand' (P1)

Table 5.5 Factors behind multitasking identified by participants and measures taken by them to address these during DBR cycle 2

The measures participants took were found to have helped them in managing multitasking. P3 said that reflections on the recording of interruptions was useful as 'it was showing me what was causing me to void a pomodoro and things I can try avoiding next time.'

5.3.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking

Participants were asked about the effectiveness of the PT® in helping them manage multitasking. Participants who found the technique helpful attributed to different reasons for its usefulness to them.

P6 said that with the PT® they were able to 'sort out my life' as it helped the participant *get organised*, mainly due to the activity inventory sheet. This was because the activity inventory sheet enabled them to remember the tasks they needed to undertake which otherwise would have been forgotten, and as a

result made them more likely to feel 'guilty' if those tasks were not pursued or could not be completed due to multitasking.

P2 said that they did not multitask like they previously used to due to *steps they took to minimise interruptions*.

The *prospect of voiding a pomodoro and starting anew* prevented three participants from multitasking and entertaining internal and external interruptions, e.g.,

'I don't want to start again so I put my phone on the side... so I know that if I touch my phone it's going to start all over again' (P6)

'If I am researching on the internet for an assignment and I know if I open a new tab and write hotmail.com then I have to eliminate that (pomodoro)... so that is why it motivates me.' (P8)

P7 said that *deferring potential interruptions* helped them 'lockdown' and 'focus on one thing until it is completed and then look at something else'.

Three participants, P4, P9 and P11 said that it was the duration of the pomodoro that made it easier to defer an interruption for a short period of time, thereby preventing them from multitasking, e.g.,

'...because of twenty-five-minute blocks I feel like "oh I can leave it till the end of twenty-five minutes and look at it afterwards and just focus for twenty-five minutes."' (P4)

P11 who was using a similar technique to PT[®] in DBR cycle 1 but where the duration of the study slot was one and a half hours rather than twenty-five minutes reported that one of the reasons they had no instances of multitasking in DBR cycle 2 was due to the *duration of the study slot*; it was difficult for the participant to focus in the earlier slots of an hour and a half.

Participants alluded to contribution of various factors that prevented them from multitasking. P1 and P11 said that one of the reasons they did not multitask was because of a looming *assignment or examination deadline*. P1 said that had it not been the deadline they would have been more likely to multitask to non-study-related tasks on the phone. P2 said that PT[®] 'helped' when the deadlines were very close and when it 'really matters'. When probed to explain the contribution of the PT[®] when the deadline would likely have prevented from multitasking regardless of the technique being used, P2 responded:

'(PT[®]) kina organises it... so when I try to do something at last minute without PT[®] it is very tiring because I am trying to do everything all at once... but because I have a pomodoro with little breaks in between it doesn't tire me up as much so it's more about organisation.... coz I have twenty-five minutes followed by a five-minute break then I don't have to think about anything for twenty-five minutes so I think it kind of helps in that way'.

Participant P3 said that they preferred working for long stretches of time where 'I do the whole thing and finish' rather than taking a break every twenty-five minutes. The participant added that the *break would in fact 'break the flow'* and cause them not to return to study.

Three participants said that participation in the study made them realise that multitasking during study was either not an issue (P3) or was addressed by the PT[®] (P7, P8); the real challenge was '*getting to study*', something the PT[®] did not help them with, e.g.,

'...the pomodoros help you stay focussed on what you are doing in that limited time. But getting to that destination of "I want to study" was the problem for me.' (P7)

'...(PT[®]) does not really help me to get to my desk to study. I think that is more my problem. However the PT[®] did help me, once I get started, to complete those twenty-five minutes. (P8)

P8 also reflected on reasons why they struggled to 'get to study' and listed various factors:

'I notice that if I have a daunting (study-related) task to do and I walk in and someone is watching TV I will be more inclined to sit down.'

'I feel like if I have been at work or uni and I go home in the evening I find it harder to study then just because I feel I have been doing so much in a day anyway... I am tired.'

On a related note, P7 reported struggling to get back to study after a break for a study-related task. The participant, who did not multitask between pomodoros, said that it was deadlines that made them 'get to study' and/or get back to study to attempt more pomodoros; when the deadline was far away they would either 'procrastinate' or do negligible pomodoros. Similarly, P11 said one of the reasons they studied for a duration of six hours on one occasion was because of an assessment, otherwise they would not have studied. Other factors such as assignment being 'interesting', and watching motivational video before pomodoros also helped participant P7 do more pomodoros than usual.

P10 voided nearly all of their pomodoros. When asked to reflect on why PT® failed to prevent them from multitasking, P10 said:

'..sometimes it is just the human thing that you feel lazy right? You just don't wanna do any work and let alone sticking to a pomodoro... you don't feel like studying.' (P10)

The participant also reported that the interview made them realise that they *did not follow the technique correctly*. The participant reflected that it might be for this reason they did not find the technique useful and that they needed to allow more time to get used to it.

P6 said that whilst they were able to defer computer-based multitasking such as switching to Facebook, the technique *did not help them defer 'emotional*

distractions'. P11 also reported struggling with distracting thoughts during pomodoros.

5.3.5.9 Misconceptions about the Pomodoro Technique[®]

During interviews, it emerged that all participants had either misinterpreted some aspect(s) of the technique or not followed it correctly. The most prevalent of these were participants not being clear about the difference between potential and actual interruptions and/or how to record them (P1, P4, P6, P8), the difference between internal and external interruption and/or how to record them (P1, P2, P3), and considering study-related activities as not study-related (e.g. organising folders, printing lecture notes) (P2, P4, P10).

Other misconceptions included considering certain activities not as multitasking (e.g. glancing at the phone to check who sent an incoming message was not considered multitasking but reading it was – P4), recording an 'X' after finishing a *task* and not a pomodoro (P1), study-related activities carried out daily not required to be entered in the activity inventory sheet (P3), not starting a new task if the preceding task finishes in the middle of the pomodoro (P4), that non-study-related tasks also need to be done in pomodoros (P7), and that one always had to work in a two-hour slot to complete four consecutive pomodoros (P11).

Most of the misconceptions were attributed in interviews to be as a result of not reading the instructions, with one participant (P1) admitting that they did not read them 'properly'.

5.3.5.10 Instructions for the Pomodoro Technique®

Feedback on instructions was also sought from participants. Six participants (P1, P4, P6, P8, P9, P11) said that instructions were clear. P2 said that instructions needed to be 'simpler' whereas P4 said that they did not like reading 'long texts'.

5.3.6 Reflections

As reported in section 5.3.5.7, no participant commented on the usefulness of the refinement 'minimising interruptions prior to pomodoro' except for P2 who found it helpful in managing multitasking. Nevertheless, I decided to retain it for DBR cycle 3 in the hope to get further feedback on its usefulness.

Four participants used the other refinement, i.e. reviewing and reflecting on the to-do-today sheet to identify and address factors that cause multitasking. As can be seen from Table 5.5, four participants came up with solutions to four of the five factors that caused multitasking. Therefore, I kept this refinement to the PT® as well.

Reflection on participants' experiences of other aspects of the PT® reported in section 5.3.5 reveal a number of challenges participants encountered when using the technique. These included having misconceptions about the technique, finding the egg timer noisy, struggling to resume study after shorter/longer breaks, finding the pomodoro durations and having to abruptly end pomodoro when its time ends, rigid or restrictive, finding the technique not helpful in dealing with 'emotional' distractions, and the technique not helping

with 'getting to study'. These challenges were the key ones I sought to address in DBR cycle 3.

5.4 DBR cycle 3 – Evaluation of the Pomodoro Technique® after use for the second time

5.4.1 Introduction

For the third cycle of DBR study, participants were asked to use the PT® again for seven days with the refinements presented in section 5.4.2. Five (P1, P2, P4, P9 and P11) of the remaining ten participants from cycle 2 participated in this cycle.

P3, P7 and P8 withdrew from the study after the second cycle. P6 and P10 did not appear for an interview for the third cycle but appeared for a final interview, the purpose of which was to evaluate the technique after prolonged use (i.e. two months).

5.4.2 Design of the intervention

Experiences from DBR cycle 2 were used to refine the intervention. Previous refinements listed in section 5.3.2 were retained. Participants' misconceptions of the technique were clarified and they were reminded that tasks needed to be broken down into sub-tasks. Details of new changes introduced in this DBR cycle are provided below.

5.4.2.1 Removing the distinction between internal and external interruptions

Participant feedback suggested that drawing this distinction when recording interruptions made the technique unnecessarily complicated. In addition, it

neither contributed to managing multitasking nor added any value to the quality of the data collected. So I asked participants to consider both internal and external interruptions simply as 'interruptions', and denote potential interruptions by ' and actual interruptions by I.

5.4.2.2 Computer-based alternatives to kitchen/egg timer

As the egg timer was perceived to be noisy, participants were informed of computer-based alternatives that were quieter.

5.4.2.3 Digital copy of activity inventory and to-do-today sheets

With difficulty in managing paper-based copies by two participants, they were provided with a digital copy of activity inventory and to-do-today sheets.

5.4.2.4 Adjusting pomodoro duration

Following feedback, participants were allowed to adjust the duration of the pomodoro according to the nature of the study-related tasks. However, they were advised to decide the duration before the start of the pomodoro. In addition, if a pomodoro was void, a pomodoro of a similar duration should be carried out in its place.

5.4.2.5 Adjusting duration of breaks

Participants were allowed to change the duration of the shorter break between pomodoros to what suited them.

5.4.2.6 Not ending the pomodoro abruptly

The previous requirement to abruptly end working when pomodoro time was up was waived in instances when leaving a task mid-way would require

participants to do some of the work again. An example is making lecture notes where the user has listened to part of the lecture recording and the time of the pomodoro ends before they can write corresponding notes.

5.4.2.7 Returning to study after a shorter or longer break

Many participants reported either extending shorter and longer breaks or not returning back to it. Therefore, participants were provided with tips to help them return to study after a shorter or longer break. For example, they were advised to set a timer for both shorter and longer breaks so that participants are reminded that break has finished and the next pomodoro has started. They were also advised to avoid those activities during shorter or longer breaks that are of duration longer than that of the break (e.g. watching an hour-long TV show during longer breaks) as it would risk the break getting extended more than the recommended duration.

5.4.2.8 Dealing with distractions

Participants were provided with the following tips to deal with distractions during study-related activities.

- If a technology is being used both for study and non-study-related activities (e.g. the use of instant messaging applications to ask study-related queries from course mates), then reserve this activity for the last pomodoro to avoid the risk of getting distracted to non-study-related activities on the platform and potentially not returning to study-related activity at all.
- Use applications for a mobile phone and computer or settings of mobile phones (e.g. 'flight mode') to automatically block access to non-study-

related activities during a pomodoro, and also to ensure that shorter breaks do not get extended from the required duration i.e. five minutes.

- If interruptions comprise non-study-related thoughts about a person or an event then put these in ‘unplanned and urgent’ on the to-do-today sheet in the manner ‘think about thought X after end of the pomodoro’.

5.4.3 How participants used/adapted the Pomodoro Technique®?

Table 5.6 shows the number of days the PT® was used by each participant, their total study slots and number of slots where at least one pomodoro was voided. As can be seen from the table, all participants except for P1 and P9 used the technique for the prescribed seven days or more. All participants except P9 brought the activity inventory and to-do-today sheets to the interview. Therefore, P9 has ‘not available’ (NA) or ✓ (denoting that pomodoros were voided) corresponding to their entry in Table 5.6.

Participant	P1	P2	P4	P9	P11	
No. of days the PT® was used	6	8	8	2	8	Total
Total study slots	9	8	8	NA	8	> 33
No. of study slots where pomodoro was voided	0	3	5	✓	2	> 10

Table 5.6 Number of days PT® was used, total number of study slots, and number of study slots involving multitasking in DBR cycle 3

All participants except for P9 and P11 maintained an activity inventory sheet. Except for P1 who used it, it could not be determined if participants used the to-do-today sheet. Similarly, it could not be determined if participants divided tasks into sub-tasks, except for P4 who did so. Only P11 used the quieter online timer. Other participants used timers and/or alarms on their phone (P1, P9) and tablets (P4). All participants took steps to minimise interruptions

before pomodoros. P1 on occasions did not record a pomodoro by an 'X' or took steps to minimise multitasking before commencing pomodoros.

Participants used varied durations for pomodoros (P1, P2, P4, P11) of up to forty-five minutes, and shorter breaks between pomodoros (P4, P9) as permitted to them after review of intervention. It could not be determined from participant responses whether they followed tips that were recommended to them to help them return to study after shorter or longer breaks. P11 used the tips recommended to them to prevent multitasking during pomodoros, especially for non-study-related thoughts. P4 did not void pomodoros if they thought that an interruption did not impact their focus (e.g. someone asking for a mobile charger).

Activities undertaken during shorter five-minute breaks included checking/responding to non-study-related messages on social media and instant messaging applications, speaking to family members/friends, snacking, and stretching/light exercise. Activities undertaken during longer fifteen/thirty-minute breaks included checking/responding to non-study-related messages on social media and instant messaging applications, and speaking to family members.

[5.4.4 Reasons for multitasking](#)

Table 5.6 shows the number of study slots for which participants voided (by multitasking) at least one pomodoro. As can be seen from this table, all participants engaged in multitasking during pomodoros. Table 5.7 summarises

the various reasons participants gave for voiding pomodoros (i.e. multitasking) along with its occurrence.

Reasons for multitasking/void pomodoros	Occurrence					Total Frequency
	P1	P2	P4	P9	P11	
Study environment			4			4
Technology for study-related activities		1		✓		>=2
Out of habit		1	1			2
Getting reminded of non-study-related task		1	1			2
Peer expectation to respond to messages instantly	✓					>=1
Non-study-related thoughts					2	2

Table 5.7 Reasons behind participants' multitasking/voiding pomodoros during DBR cycle 3

Some of the reasons for multitasking/voiding pomodoros listed in Table 5.7 are self-explanatory. However, some important observations are provided in sub-sections below.

5.4.4.1 Study environment

Aspects of the study environment were attributed to be a reason for voiding pomodoros by P4. Most of these were interruptions by family members and friends during study-related activities, and confusion about how to put their new phone into silent mode.

5.4.4.2 Technology for study-related activities

Technology used for study-related activities was attributed to be the cause of multitasking by two participants. P2 reported one instance where they voided pomodoro by switching to non-study-related websites when searching for study-related websites. P9 switched to non-study-related videos on the video-sharing website YouTube after seeing recommendations for them beside a

study-related video. P1 said that they would multitask during pomodoros on days when they were using the messaging app WhatsApp for study-related conversation with friends; checking the app for study-related messages would inadvertently lead exposure to non-study-related messages.

5.4.5 Participants' experience of the Pomodoro Technique®

I will first report on the participant's experience of individual components of the technique followed by their perception of its effectiveness in managing multitasking.

5.4.5.1 Activity inventory and to-do-today sheet

Two of five participants (P1, P2) maintained an activity inventory sheet whereas P4 kept an equivalent list of tasks and also put these in a calendar diary. P4 said that keeping a list of tasks in order of priority and breaking tasks down helps them in 'tackling' them. P2 found the activity inventory sheet 'really good and useful', and helpful in prioritising and 'planning stuff'. The participant said that making a list of study-related tasks provides a perspective on and serves as a reminder for what needs to be done, making them more likely to undertake tasks. If tasks are 'in the head' then one could 'cancel that anytime'.

P11 said that they did not maintain an activity inventory sheet because they remembered what they needed to do. P9 did not maintain activity inventory and to-do-today sheets because doing so was 'time consuming'.

P1, who used the to-do-today sheet, said they would prefer to record pomodoros on a phone rather than on a printed to-do-today sheet as it is easy to lose or forget to carry with oneself.

5.4.5.2 Pomodoro timer

P1 and P4 did not use the egg timer in this cycle. P1 said they did not use the egg timer because it was 'loud', although they did not report any issues with the sound of the egg timer in DBR cycle 2. Conversely, P2 said that ticks of the timer reminded them that they were in the middle of a pomodoro and prevented them from multitasking unconsciously to non-study-related activities.

P2 and P4 reiterated their views about the egg timer from DBR cycle 2 that the timer was suitable at home but not in public spaces such as the library due to it being noisy and loud. P2 said that they wanted a recommendation for a computer-based timer to have the ticking sound and end-of-pomodoro buzzer that could be listened to through headphones (online timers recommended to participants in DBR cycle 2 did not have a ticking sound). Having used the alarm on phone as a timer in this cycle, P9 said that they would now prefer to have a physical timer which was not noisy.

5.4.5.3 Recording a successful pomodoro

All participants marked successful pomodoros by an 'X' or equivalent and reiterated perceptions they had about this exercise in DBR cycle 2. P2 found it 'good' whereas P1 found it handy in keeping a record of 'what you have done'. P1, P3 and P11 said that recording a successful pomodoro brought a feeling of accomplishment, e.g.,

'I felt good coz it made me feel like I have accomplished something and that I had completed a task.' (P3)

5.4.5.4 Deferring potential interruptions

Only two participants shared their views on deferring potential internal and external interruptions to the end of a pomodoro. P4 said that telling frequently interrupting friends that they will be contacted after the pomodoro ends, especially when the nature of the interruption was short and outside of their control, was 'frustrating'. P4 chose not to void pomodoros when interruptions were brief and did not, in their view, impact concentration. P4 said that this adaptation made them more 'willing' to use the technique.

5.4.5.5 Voiding a pomodoro and recording interruptions

P2 and P4 said that they had feelings of frustration when they had to void the pomodoros. P4 said that this was particularly so when the interruption was external (e.g. friends or family interrupting) because there was 'nothing that I can do about it'. P9 said that voiding the pomodoro and restarting it made the technique 'quite hard'.

5.4.5.6 Duration of pomodoro and breaks

P11 said that twenty-five minutes was generally a suitable duration for a pomodoro and was 'a short time to get distracted'. However, the participant said that on some occasions it was disappointing to have to leave study-related tasks half-way when the pomodoro ends. Sometimes the participant had extended the pomodoro to complete the task.

P1 said that they struggled to keep to the duration of shorter five-minute breaks as they ended up spending more time on non-study-related activities on their phone.

5.4.5.7 Refinements to the Pomodoro Technique®

Participants did not share their perceptions about all refinements listed in section 5.4.2, with two choosing to defer their interview to the end of cycle 4. However, perceptions on and use of refinements to the PT® that participants did share are provided below.

5.4.5.7.1 Minimise interruptions before commencing pomodoro

All participants reported taking one or more steps to minimise interruptions prior to beginning of pomodoro (e.g. putting the phone on silent). P1 found that it was due to steps they took to minimise interruptions before a pomodoro which made them more likely to focus on study-related tasks.

5.4.5.7.2 Computer-based alternatives to kitchen/egg timer

P2 said that they wanted a computer-based timer with a ticking sound and a buzzer that they could use with headphones when studying in a library.

5.4.5.7.3 Digital copy of activity inventory and to-do-today sheets

P1 found it valuable to use the digital copy of activity inventory and to-do-today sheets as they said that it was easy to lose or forget carrying a paper-based copy.

5.4.5.7.4 Not ending the pomodoro abruptly

P11 extended the duration of pomodoros on some occasions to finish-off tasks that they did not wish to leave half way, and found this to be useful.

5.4.5.7.5 Dealing with distractions

No participant used the applications recommended to block distracting apps/websites. P1 reported that the applications did not suit their needs and that they would welcome an application that would turn off WIFI during times designated for pomodoros. P9 said that they wanted applications that blocked distracting content from websites that contained both study and non-study-related material (e.g. recommendations for non-study-related videos on YouTube). Advice to deal with distracting thoughts did not appear to help P11. The participant continued to have these thoughts and was not able to focus on the study-related task.

5.4.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking

Participants attributed different reasons for why and how the PT® was useful to them in managing multitasking.

P4 attributed success of the PT® in preventing them from multitasking down to a combination of *deferring interruptions* to avoid voiding the pomodoro, and the duration of the pomodoro:

‘...before if I was working and I remember oh let me check something on Instagram and I will do it and now I remember that I have to do it a couple of more minutes... just twenty-five minutes and then I can do whatever I need to’.

P11 said that the technique helped them in managing multitasking because *it enabled separate times for study and non-study-related activities*, with the prospect of voiding the pomodoro acting as an incentive not to multitask.

P1 said they had fewer interruptions this time round compared to the previous DBR cycle because they were *more motivated* to 'follow the technique'. The motivation arose from the fact that P1 had examinations, was lagging behind peers in examination revision and wanted to catch up, and could not 'afford to get distracted'. When asked about the contribution of the PT[®] in managing multitasking and whether recent examinations and peer pressure would have sufficed to prevent them from multitasking, P1 said that with the technique they were more likely to focus on study-related tasks due to steps taken to minimise interruptions (e.g. 'have the internet off') before a pomodoro.

P11 said that PT[®] had been useful despite examination pressure providing an incentive not to multitask because previously a close deadline would cause them to panic and not study at all, whereas PT[®] enabled them to *focus* and note down any urges to multitask as potential interruptions:

'...you know that you don't have to think about anything else when you are doing this cycle... just study... so it is kind of helping even when the deadlines are not close.'

P2 said that a reason the pomodoro technique worked better in this cycle compared with DBR cycle 2 was because '*I am used to it* and am doing it more'. P9 said that PT[®] did not facilitate in minimising multitasking because they 'did not follow it properly'.

5.4.5.9 Misconceptions about the Pomodoro Technique®

Participant interviews revealed continued misconceptions about the PT®. These included not being clear about the purpose and utility of noting down non-study-related tasks (P2), and that managing an external interruption (e.g. telling an interrupting person that they will be contacted after a pomodoro) does not void a pomodoro (P4).

5.4.6 Reflections

As can be seen from section 5.4.5.7, participants did not share their experiences of several refinements that were proposed to them for DBR cycle 3. Nevertheless, I decided to retain those refinements for DBR cycle 4 in hope to get further feedback on their usefulness.

Some of the refinements such as minimising interruptions before commencing a pomodoro, maintaining a digital copy of activity inventory and to-do-today sheets, and not ending the pomodoro abruptly were found useful by at least one participant. Other refinements such as computer-based timers, dealing with distracting thoughts, and tools for blocking distracting websites/apps were either not found useful or did not meet participants' requirements.

I found computer-based timers and some additional blocking apps that could meet participants' needs and these were included in refinements (see section 5.5.2). A request by P1 for a recommendation for a mobile app that could switch off mobile WIFI at designated times could not be met as I did not find a relevant application at the time (spring 2016). Similarly, I did not find an alternative solution to deal with distracting thoughts.

As reported earlier, P4 did not void pomodoros if they thought that an interruption did not impact their focus. I decided not to refine the technique to make allowance for such interruptions since doing so would make the technique complicated (and thus violate the lessons learnt after cycle 2).

5.5 DBR cycle 4 – Evaluation of the Pomodoro Technique® after use for an extended time period

5.5.1 Introduction

The fourth and final cycle of this DBR study aimed at evaluating the PT® for a longer duration of time, i.e. at least two months. The participants were expected to use the technique with refinements proposed to them after DBR cycles 2 and 3. Participants were not expected to bring activity inventory and to-do-today sheets to the interviews as the focus was on participants' experience of using the technique and perception on its effectiveness in managing multitasking.

Seven participants used the PT® for a longer duration. These were P1, P2, P4, P6, P9, P10 and P11. P6 and P10 did not appear for the third interview in DBR cycle 3 and gave a final interview for cycle 4.

5.5.2 Design of the intervention

Experiences from DBR cycle 3 were used to refine the intervention. Previous refinements listed in sections 5.3.2 and 5.4.2 were retained. Misconceptions that two participants had about the technique (reported in section 5.4.5.9) were clarified and all were reminded again that tasks needed to be broken

down into sub-tasks. Details of changes introduced in this DBR cycle are provided below.

5.5.2.1 Computer-based alternatives to kitchen/egg timer

In addition to existing recommendations for computer-based timers, participants were informed of another digital timer that had the ticking sound.

5.5.2.2 Dealing with distractions

In response to participants' feedback, further applications were recommended to participants to block distracting content and/or applications. These comprised web browser extensions that can be used to hide distracting content from websites being used for study-related activities (e.g. hiding recommendations for non-study-related videos on YouTube).

5.5.3 How participants used/adapted the Pomodoro Technique®?

Table 5.8 below shows durations for which participants used the technique.

Participant	P1	P2	P4	P6	P9	P10	P11
Duration (months)	4	4.5	4.5	2	2	2	3

Table 5.8 Duration in months for which participants used the PT® in DBR cycle 4

Participants adapted how they used the activity inventory and/or to-do-today sheets to suit their needs. This included keeping a 'list' of study-related activities on a separate piece of paper instead of the activity inventory and/or to-do-today sheet (P1, P4, P10), merging the activity inventory and to-do-today sheets so that all tasks are written, whether planned for a day or other days, on the to-do-today sheet (P2, P11), and recording non-study-related tasks on an electronic calendar (P4). P2 listed their non-study-related activities on the activity inventory sheet for the first time in the study.

Participants did not follow certain aspects of the PT[®]. This included not keeping the activity inventory and to-do-today sheet (P1), not voiding pomodoros upon interruption (P1), not recording a pomodoro by an 'X' because either the participant was 'used to the technique' (P1) or wrote start and end times of each pomodoro which was an indication of a successful pomodoro (P4), internal urge to check the phone during pomodoro not written down under potential interruption as participant would 'check it anyway' during breaks (P4), not dividing tasks into sub-tasks (P10), and not working in pomodoros and only using the to-do-today sheet (P6).

P11 reported that aside from recording a completed pomodoro by an 'X', they also used to write how much progress they made in their study-related task. This enabled the participant to gauge how productive their pomodoro was and strive for better levels of productivity for subsequent pomodoros.

Six participants availed refinements to the PT[®] suggested to them, most common being the duration of pomodoros and break. Duration of the pomodoro was extended in run up to and during examinations (P1 – duration spanning up to two hours), during 'productive' times of the day (P4), or depending on nature of the task (P2). The duration of the longer break was either increased to an hour (P11) or reduced to ten (P10) or fifteen minutes (P11) during examinations. The duration of the shorter break was extended on occasions (P2, P4, P6) or reduced to less than five minutes during times when the participant had 'loads of study' (P11) or near examinations (P6). Three participants (P2, P10, P11) said that during shorter breaks between

pomodoros they would avoid engaging in those non-study-related activities that would make it challenging to return to study after the break. P6 reported using the recommended app to block distracting apps during pomodoros.

Activities undertaken during shorter five-minute breaks included snacking, stretching/light exercise, speaking to family members, and listening to music.

Activities undertaken during longer fifteen/thirty-minute breaks included checking/responding to non-study-related messages on social media and instant messaging applications, watching TV, and snacking/lunch/dinner.

5.5.4 Reasons for multitasking

Table 5.9 summarises the various reasons participants gave for voiding pomodoros (i.e. multitasking) along with its occurrence. Entries in the table comprise of a ✓ (denoting that a reason for multitasking occurred at least once) instead of a number. This is because in DBR cycle 4 participants were not asked to keep a record of the precise number of instances they multitasked as was the case in DBR cycles 2 and 3. As can be seen from the table, except for P11, all participants voided pomodoros on at least one occasion.

Reasons for multitasking/void pomodoros	P1	P2	P4	P6	P9	P10	P11
Notifications for non-study-related activity	✓						No pomodoro voided
Study environment			✓		✓		
Self-efficacy and/or motivation	✓		✓				
Technology for study-related activities	✓						
Out of habit/not following the technique						✓	
Absence of deadline	✓			✓	✓		
Peer expectation to respond to messages instantly	✓	✓					

Table 5.9 Reasons for multitasking/voiding pomodoros during DBR cycle 4

Several reasons for multitasking/voiding pomodoros listed in Table 5.9 are self-explanatory, but some additional comments are provided in sub-sections following.

5.5.4.1 Study environment

Aspects of the study environment were attributed as reasons for multitasking. These included interruptions by family members (P4), unannounced visitors (P2) and calls on the home landline (P9).

5.5.4.2 Self-efficacy and/or motivation

Responses of two participants alluded to low self-efficacy and/or motivation for study-related activities as a reason for voiding pomodoros:

‘(more likely to void pomodoros) when I wouldn’t feel like studying so if there is an interruption or I have a phone call I would just go and pick it up... (I don’t feel like studying) when the subject is hard, the lecture I am doing is hard, or I feel like it’s too much content, so I interrupt and take a long break.’ (P1)

‘(voided pomodoros when) I just don’t want to focus on the topic... even though I knew I had that break I still couldn’t carry on because knowledge wasn’t going in, so I just knew that I had to end the pomodoro’ (P4)

5.5.4.3 Technology for study-related activities

P1 used the video-sharing website YouTube to watch study-related videos.

The participant said they often used to switch to non-study-related videos on the website following recommendations next to study-related video.

5.5.5 Participants' experience of the Pomodoro Technique®

I will first report on participants' experience of individual components of the technique followed by their perception of its effectiveness in managing multitasking.

5.5.5.1 Activity inventory and to-do-today sheet

Three participants found the activity inventory and/or to-do-today sheet 'useful' (P6, P11) and 'helpful' (P9). P11 said that without listing tasks in the to-do-today sheet they would have forgotten about them. P2 and P6 said that the to-do-today sheet enhanced their organisational skills.

Four participants found the reviewing and/or updating of the to-do-today sheet useful. Participants said that the exercise made them aware of their progress and what they needed to do in subsequent days (P2, P4, P9, P11) and helped determine the most productive times of the day for study-related activities, in turn informing planning for future slots (P4), e.g.,

'I feel like it has helped... because sometimes I feel like I have done a lot but maybe have been distracted three or four times during that time and taken half an hour breaks, but when I actually document it I know

how much I have actually revised and how much I should do better next time.’ (P4)

‘(reviewing the to-do-today sheet) was a good thing coz I won’t get carried away. I know that ok I did fifteen slides for the last pomodoro so I should be that quick for this one as well.’ (P11)

P2 and P11 only used the to-do-today sheet and did not use the activity inventory sheet. P2 said that it was difficult to think of all the weeks’ activities to enter in the activity inventory sheet. In contrast, the participant said they knew at the beginning of the day the study-related activities they needed to pursue and enter in the to-do-today sheet. P11 said the activity inventory sheet appeared a ‘waste of time’ because during the last cycle they were under ‘much pressure’ and had ‘too much to do’.

P2 used the activity inventory sheet to list non-study-related activities for the first time in this cycle. The participant said that this helped them identify time slots in which they could undertake study-related activities.

5.5.5.2 Pomodoro timer

Participant P2 said they preferred to use an egg timer when they were not in public places because the timer ticks reminded them that they were in a pomodoro and therefore unlikely to multitask. P9 reported using a ‘quiet’ stopwatch instead of the ‘noisy’ egg timer and found it ‘helpful’.

5.5.5.3 Recording a successful pomodoro

Participants P2, P4 and P9 reported that recording a successful pomodoro informed them of progress on study-related tasks and how much more needed to be done. P9 found recording of successful pomodoros 'rewarding', whereas it gave a sense of achievement to P4 and motivated them to do 'better' in future pomodoros by completing 'longer' pomodoros.

5.5.5.4 Deferring potential interruptions

P2 said that due to 'exam stress' they wanted to distract themselves with non-study-related activities but could not because of the pomodoro. Although this was 'frustrating', the participant found it useful at the same time. Similarly, P4, P6 and P9 also found deferring of potential interruptions helpful in managing multitasking. However, P6 added that once they started revising for examinations they did not need to defer interruptions, because due to pressure of the examinations 'I forgot about everything else'.

P11 said that they sometimes got reminded of essential non-study-related tasks during pomodoros. Writing them down in the to-do-today sheet during pomodoros ensured that they did not forget about them as well as retain concentration on the study-related task.

Advice to defer interruption by a peer was to tell them that they were in the middle of the pomodoro and would be contacted after it ended. However, P2 said that they did not find this advice practical because they felt doing so would entail explaining the entire technique to their interrupting peer.

5.5.5.5 Voiding a pomodoro and recording interruptions

Two participants (P4, P9) felt disappointed about voiding pomodoros since they had spent time on it. On the other hand, P2 said that they did not feel as frustrated with voiding pomodoros as before. P2 and P4 said that recording interruptions motivated them not to multitask in subsequent pomodoros.

P2 shared reflections on whether an interruption that is related to study (e.g. study-related query from a peer) would constitute multitasking or be considered part of the study-related activity. P2 termed this an interruption because 'it is taking me away from what I am doing right now'.

5.5.5.6 Duration of pomodoro and breaks

P11 said that the twenty-five minute duration of the pomodoro was too short to get distracted and made it easier to defer any potential interruption to the end of a pomodoro. In addition, the participant said that the duration of the pomodoro enabled them to 'get to study'. This is because the thought of studying for a longer period of time appeared daunting so the participant started with the intention of studying for just one twenty-five-minute pomodoro. Once the participant started the first pomodoro, following it with further pomodoros became easier.

P10 and P11 said that the break between pomodoros is refreshing for the brain and enables them to carry on pursuing and completing study-related tasks. In addition, P11 stated that the duration of pomodoros and breaks made them more efficient:

‘...it is kind of I don’t get bored because otherwise like previously I used to study for one and a half hour or two hours and eventually my efficiency used to decrease, and it is not good like you feel that you have studied for two hours and then you look at your progress and it isn’t that much.’

5.5.5.7 Refinements to the Pomodoro Technique®

Participants did not share their perceptions of several refinements mentioned in section 5.5.2. Perceptions on and use of refinements to the PT® that participants did share are provided below.

5.5.5.7.1 Minimise interruptions before commencing pomodoro.

P2 said that in the final cycle they did not need to take any steps to minimise interruptions before beginning the pomodoro. This was because they were revising for examinations during the last cycle, had ‘more pressure’ and were unlikely to attend to distractions.

5.5.5.7.2 Review and reflection on to-do-today sheet

P9 said that reviewing and reflecting on recording interruptions was ‘helpful’ as it demonstrated ‘how many times I go on internet and how much time I have wasted’. P2 reported that reflection on the to-do-today sheet provided insights on how interruptions could be minimised in the future.

5.5.5.7.3 Computer-based alternatives to kitchen/egg timer

Computer-based alternatives to the egg timer were reported to have worked ‘very well’ (P2), was ‘helpful’ (P9), and ‘quite nice’ (P10).

5.5.5.7.4 Adjusting pomodoro duration

P2 found the use of variable durations for pomodoros depending on the nature of the task 'quite helpful'. P9 and P10 did not find the twenty-five minute duration of the pomodoro adequate and extended it respectively to thirty and forty minutes.

5.5.5.7.5 Adjusting duration of breaks

P6, who in DBR cycle 2 wanted the shorter break to be extended to fifteen minutes, now reported that they would not require more than five minutes for a break. The participant said that for the most part, during the last cycle, they were revising for examinations and a fifteen-minute break was 'way too long' and a 'waste of time'. P6 said that a fifteen-minute break was requested due to 'procrastination and laziness' and was appropriate for term time when examinations were not near, for example when:

'... it's an assignment and it's not something you want to do... you feel like not wanting to do it but you must do it.'

Similarly, P9 extended the duration of shorter breaks because 'it's very challenging to get back after five minutes'. The participant attributed getting 'lazy' as the reason why they struggled to keep the shorter break to five minutes.

5.5.5.7.6 Dealing with distractions

Two participants said they did not need to employ the recommendations for dealing with distractions because the pressure of examinations ensured they

remained focused on study-related activities (the recommendations were for countering distracting thoughts (P11) and use of a mobile app to block distracting websites (P6)).

5.5.5.8 Effectiveness of the Pomodoro Technique® in managing multitasking

All participants of the last cycle said that the PT® helped them in managing multitasking. However, they attributed its effectiveness to varied aspects of the technique. These included ticks of the egg timer reminding the participant of the ongoing pomodoro and thereby not to multitask (P2), review of the to-do-today sheet providing reflections on how interruptions entertained on a day could be minimised in future (P2, P9), minimising interruptions before a pomodoro (P1), deferring potential interruptions during the pomodoro until it finishes (P4, P6, P9), duration of the pomodoro not long enough to be distracted and making it easier to defer any potential interruptions (P11), and breaks 'refreshing the brain' and preventing exhaustion leading to multitasking (P10). Here is an example of a participant's comment:

'(before using the PT®) if I wanted to check my phone, I'll tell myself "oh I am gonna check one message" and that will lead to another and something else and this way I missed maybe half an hour of revision. With this I feel like every time I have to void a pomodoro it kinda tells me "Oh for the next one I should do better, try to work on not getting distracted" and that way I feel like I have done more work in that time.'

(P4)

Participants said that factors other than the PT[®] also contributed to managing multitasking. P1 and P4 attributed a more *conducive environment to study* respectively at university and home in this cycle compared to previous cycles as a factor that minimised multitasking. P4, whose major source of multitasking was interruption from family members at home during previous cycles, reported that this was minimised in the last cycle. The participant said that their family had become familiar with rules of the PT[®] and therefore did not interrupt them during a pomodoro.

For participants P1, P6, P9, P10, and P11 *examinations and assessment deadlines* were factors that influenced multitasking. For instance, P6 said that close to examinations they did not need to defer any internal urge to multitask during pomodoros or use the recommended apps to block non-study-related apps during certain times. This was because this was 'serious time' with 'no option to have distraction'. Similarly, P10 said that in the absence of examinations they had 'so much time I can just do it the way I want and not be disciplined about it'. However, P1, P6 and P11 stressed that the PT[®] worked for them in the absence of a deadline and examinations as well. P11 also said that the distracting thoughts they used to encounter previously did not occur in this cycle because 'I had loads of things to do' in the run-up to the examination.

Whereas pressure of examinations caused some participants to avoid multitasking, P4 reported that they voided some pomodoros whilst revising for examinations. P4 did this due to *examination stress and low self-efficacy*

('knowledge wasn't going in') even when they knew that they will be able to have a break soon.

When asked about the contribution of the PT[®] in managing multitasking when examination pressure was stated to be incentive enough to focus, participants said that the technique still disciplined them by deferring interruptions at the end of a pomodoro (P9), informing the participant of the time they 'wasted' on non-study-related activities thereby stimulating reflection (P9), making the participant 'more responsible' with time and 'careful' for not losing it (P10), and replenishing cognitive resources through frequent breaks (P10).

P4 said that it was '*difficult to implement*' the PT[®] when working in groups.

They also said that the technique was not useful for carrying out study-related activities at their workplace because they would be 'dealing with other things at the same time'.

P4 reported that they wanted to void a pomodoro when lecture notes they were revising were 'long' and comprising 'quite a few pages'. However, this participant did not break tasks into sub-tasks as recommended by the PT[®]. P4's perceptions about voiding the pomodoro may have been different *had they followed the technique* and worked on smaller sub-tasks rather than a single long task.

P2 and P10 alluded that *one must allow time* to enable the PT[®] to help manage multitasking. Both participants initially voided pomodoros by

unconsciously multitasking to non-study-related activities. However, this improved over time as participants continued using the technique.

Furthermore, P2 said that they initially found ticks of the egg timer distracting but as they got used to the technique, they found the timer ticks as a reminder that they were in a pomodoro and could not multitask.

All seven participants who participated in the last cycle of this study said that they were satisfied with the PT[®] in the way they were using it and intended to use the technique in the future.

5.5.5.9 Misconceptions about the Pomodoro Technique[®]

P11 thought that the section 'unplanned and urgent' in the to-do-today sheet was only for tasks that were urgent and unplanned. In actuality, the purpose of the section was to note down any potential interruptions one came across during the pomodoros that needed to be deferred, no matter if they were actually urgent or not.

5.5.6 Reflections

After use of the PT[®] for two or three cycles including for prolonged periods of time, it can be seen that none of the participants used the technique as it was presented originally. Participants availed refinements that were introduced to the technique in response to their feedback and requirements. Participants also did not follow certain aspects of the technique, either because they did not find it useful or did not feel the need to after they got used to the technique. Examples included not keeping the activity inventory and/or to-do-today sheets, not using the activity inventory sheet to record non-study-related tasks, not dividing tasks into sub-tasks, not recording completed pomodoros,

not voiding pomodoros upon interruptions, not taking steps to minimise multitasking before a pomodoro, not recording an internal urge to multitask in the to-do-today sheet, and not working in pomodoros.

As can be seen from section 5.5.5.7, not sufficient data on participants' perceptions of some refinements to the PT[®] could be elicited. Some of the refinements such as computer-based alternatives to egg timers and adjusting breaks of pomodoros were found useful by participants. However, two participants reported not needing to undertake a few refinements because the pressure of examinations ensured that they did not multitask. On a related note, a couple of participants extended breaks between pomodoros (which was one of the requested refinements) due to 'procrastination' (P6) and laziness (P6, P9) suggesting the role of other factors in influencing the effectiveness of the PT[®] in managing multitasking (discussed in detail in chapter 6).

Going forward, I will keep many of the refinements in the PT[®] for my future studies after the PhD. Based on participants' experiences and misconceptions reported in section 5.5.5, I would introduce the following further refinements to the PT[®] after DBR cycle 4, which might form part of the technique used in the future.

5.5.6.1 Activity inventory sheet

The 'unplanned and urgent' portion of the to-do-today sheet will be renamed 'potential interruptions' to avoid misinterpretation.

5.5.6.2 To-do-today sheet

In order to assist users in ensuring that they take steps to minimise interruptions before commencing study (e.g. remember switching off notifications), a checklist can be included in the to-do-today sheet.

5.5.6.3 Adjusting duration of pomodoro and breaks

Duration of the pomodoro and breaks will respectively be kept at twenty-five and five minutes initially. Users will be advised to use these durations as a starting point and make adjustments if needed.

5.5.6.4 Using the PT[®] in groups

Guidance on how the technique can be used for group work/study will be included which entails the entire group working together in pomodoros – group members ensure that their mutual activities/conversations remain focused on the task during pomodoros and do not switch to non-study-related conversations/activities.

5.5.6.5 PT[®] instruction manual

Due to participants' misconceptions, a worked example of the PT[®] will be included as part of the guide on the technique. Due to preference by one participant, I will also provide the instructions in narrated video format besides text.

All participants did not follow some aspects of the PT[®] at all (rather than using them and not finding them useful). Therefore, in future, instructions for the PT[®] will include the rationale behind each component of the technique so that

users develop an appreciation for the different aspects of the technique and are more likely to try to use it. I did not include a rationale in instructions provided to the participants of this research study in order not to bias their experience of the technique.

The PT[®] instruction manual will also advise users to allow time to get used to the technique and/or realise its benefits. Examples include a) egg timer initially appearing noisy but reminding the user later not to multitask, b) users voiding pomodoros by multitasking unconsciously in the first few days before overcoming it, and c) family and/or friends requiring several reminders before they stop interrupting during pomodoros.

Having presented the four DBR cycles and participants' experiences of multitasking and the PT[®], the following chapter synthesises and analyses the data to answer the research sub-questions.

Chapter 6: Data Analysis

6.1 Introduction

This chapter provides an analysis of results presented in the previous chapter, Data Presentation, in light of the research sub-questions for this thesis. The purpose of this chapter is to synthesise the core findings that emerge from this study. These core arguments will be discussed in light of the literature in chapter 7. The structure of this chapter is guided by the research sub-questions. I first present the reasons students give for multitasking (section 6.2) and provide an analysis of which of these reasons may or may not be addressed by their use of the Pomodoro Technique® (PT) (section 6.3). This is followed by an analysis of the effectiveness of different aspects of the PT® in managing multitasking (section 6.3). Finally, I present the factors governing the effectiveness of the PT® in managing multitasking (section 6.4).

6.2 Reasons for multitasking

This section addresses the first research sub-question ‘What reasons do students give for multitasking?’ and presents key themes that emerge from analysis of the factors contributing to multitasking amongst participants during the course of the research study, both in the absence and presence of the PT®. Although five participants left the study after the first and second DBR cycle, which may have impact on the results, this section aims at analysis of general factors contributing to multitasking and not individual change in behaviour over time.

In Table 6.1, I combine the reasons participants multitasked for all four phases of the DBR study (separate tables for each phase are presented in chapter 5). Readers are reminded that a ✓ across a row in the table denotes that participants engaged in multitasking behaviour at least once as they did not provide a definitive number of instances for those reasons for multitasking. Two reasons for multitasking, namely 'study environment' and 'technology for study-related activities' (orange background in Table 6.1), are groups of reasons for multitasking that have been categorised together to make the table readable. Tables 6.2 and 6.3 respectively unpack the reasons for multitasking categorised under 'study environment' and 'technology for study-related activities' in Table 6.1. Reasons presented in Tables 6.1, 6.2 and 6.3 have been used as the basis for further analysis in section 6.3.

6.3 Reasons for multitasking and the Pomodoro Technique®

This section addresses the second research sub-question 'Which reasons that students give for multitasking may be addressed by their use of the Pomodoro Technique®?' To this end, section 6.3.1 presents an analysis of reasons for multitasking that may be addressed by the PT® whereas section 6.3.2 presents an analysis of reasons for multitasking that may not be addressed by the PT®.

6.3.1 Reasons for multitasking that may be addressed by use of the Pomodoro Technique®

As can be seen from Table 6.1, the reasons for multitasking within the green rectangle are those that were only reported during DBR cycle 1 when the PT® was not used (readers are reminded that two reasons for multitasking, namely

Study environment	DBR Cycle 1	DBR Cycle 2	DBR Cycle 3	DBR Cycle 4
Interruption by friend/family	P2, P4, P6, P8, P10, P11, P12	P2, P4, P6, P7	P4	P4
Noise in library	P4			
Internet becoming unavailable	P4	P4		
Phone not having silent mode			P4	
Call on home landline				P9
TV running in background	P12			
Studying in bed causing tiredness and making one more prone to taking a 'break'	P5			
Delay in webpages loading	P5			

Table 6.2 Reasons for multitasking under the category 'study environment'

Technology for study-related activities	DBR Cycle 1	DBR Cycle 2	DBR Cycle 3	DBR Cycle 4
Recommendation for non-study-related video next to study-related video on YouTube	P2, P4, P6		P9	P1
Music playlist used to aid study advancing to distracting music	P4, P5, P7			
Study-related conversation on messaging application delving into non-study-related conversation with either the same or different person	P2, P7		P1	
Non-study-related 'tabs' from previous browsing session appearing when participant switched to them	P2, P7			
Default web browser landing page having links to non-study-related content or activities	P8			
Switching to non-study-related websites when searching for study-related website		P10	P2	

Table 6.3 Reasons for multitasking under the category 'technology for study-related activities'

'study environment' and 'technology for study-related activities' (orange background in Table 6.1) appear to occur throughout the study. However, some of the reasons for multitasking that formed part of these two categories only occurred in DBR cycle 1, as can be seen from Tables 6.2 and 6.3). As these reasons for multitasking were only reported during DBR cycle 1 when the PT[®] was not being used, I analyse in the following paragraphs how these reasons for multitasking may have been addressed by use of the PT[®] and not

reported when the technique was used by participants (reasons for multitasking outside the green box were reported when participants used the PT[®] and likely were not addressed by the technique, as analysed in section 6.3.2).

6.3.1.1 Absence of a break

Two reasons for multitasking reported in DBR 1, 'need for break' and 'not able to study for long periods of time', were not reported to be a reason for multitasking in DBR cycles 2, 3, and 4 when participants used the PT[®]. As the PT[®] provides an opportunity for a break after every twenty-five minutes, it is possible that participants did not cite these reasons as a cause for multitasking in subsequent DBR cycles when they used the PT[®].

Table 6.1 shows that 'need for break' was explicitly reported as a possible reason for multitasking nine times. In addition to this, I identified forty-three additional study slots between eleven participants in DBR cycle 1 where the amount of time participants spent on multitasking was less than or equal to the duration of breaks participants would have had availed had they been using the PT[®] (if students were employing the PT[®], they would have had the following allowance for break: five minutes for a thirty minute slot, ten minutes for an hour, twenty minutes for two hours, fifty minutes for three hours, and an hour for a four hour study slot). So, it is possible that absence of a break was an implicit reason for multitasking as participants' cognitive abilities were depleted thereby impacting their self-efficacy for the task.

The limitation of the above analysis is that I do not know at what point in time during their study slot the participants multitasked. PT[®] requires participants to take a five-minute break after every twenty-five minutes. It is not known that participants took breaks at similar intervals. However, some participant responses corroborate with the finding of my analysis. For instance, P9 who engaged in multitasking activities for thirty-five minutes during a three-hour slot said that although they found the study-related task interesting, they switched to multitasking when they encountered something that was 'a bit hard', and in turn decided to go to social media and return to study later. This could be due to a participant's cognitive capacity being depleted due to absence of a break, thereby impacting their efficacy to deal with 'hard' aspects of the assignment and resulting in multitasking. It may also be the case that study-related tasks appeared harder than in actuality had the participant been looking at it with a fresh pair of eyes. Similarly, two other participants (P10, P11) reported that they could not focus on study-related activities for prolonged periods of time. Of the two, P10 on one occasion termed switching to non-study-related activity as a 'break'. On the other hand, P11, who was using a technique requiring focused study without multitasking for an hour and thirty minutes, multitasked or abandoned the slot altogether terming inability to focus 'for long' as a reason. In fact, in three instances, participants referred to their multitasking behaviour as a 'break'.

6.3.1.2 Pleasure and mood regulation

Participants reported actively switching to non-study-related tasks 'to get entertained' (P9), 'momentarily for entertainment' (P11), 'to feel better' (P3 and P11), because they were alone (P12), or felt 'lonely' (P2). This reflects a

low motivation for a task as well as need for a break. As the PT[®] provides users a break after every twenty-five minutes, participants would have possibly availed the breaks to seek pleasure and/or regulate their mood. This explanation is supported by the nature of activities participants undertook during breaks between pomodoros (reported in sections 5.3.3, 5.4.3 and 5.5.3) which included checking/responding to non-study-related messages on social media, snacking, stretching/light exercise, praying, and speaking to family members, all of which can lead to pleasure or 'to feel better'.

6.3.1.3 Switch from study to non-study-related conversation

Study-related face-to-face conversation with coursemates/friends extending to non-study-related conversation was one of the causes for multitasking. The two participants who reported this, P12 and P7, left the study after cycles 1 and 2 respectively and this might be the reason it was not reported again. Another possibility could be that the rest of the participants did not engage in group study, although there is no data to support this assertion.

6.3.1.4 Feeling 'confident'

Participants P7 and P11 reported to have multitasked because they felt confident in completing the task, e.g.,

'I was relaxed and confident in it. I can be easily distracted because, you know, anyway I am gonna do well and can afford to do it.' (P7)

This reason was not reported when participants were using the PT[®]. This may possibly be because even if participants felt the urge to multitask due to feeling confident, they would have been prevented from multitasking because

of the penalty of voiding pomodoro, as well as deferring the pomodoro by writing it down.

6.3.1.5 Ease of multitasking

Three participants alluded to being more likely to multitask either due to technology (P8, P9) or certain technology (e.g. on phones as compared to laptops) (P12) just because of the ease of doing so. For instance, P12 mentioned that they were less likely to multitask to the social networking website Facebook on a laptop compared to a phone because in the case of the former they were required to sign-in whereas in the case of the later they could access it easily via a mobile app without needing to sign-in. P1 reported that when accessing a mobile to check notifications from one non-study-related application, they would check updates from other non-study-related applications just because they were on the phone as well. 'Ease of multitasking' is likely to have not been reported by any participant when using the PT[®] because even if participants did experience the urge to multitask, they would have been prevented to act on it because the pomodoro could not be interrupted and that they would need to start all over again. Delaying interruptions were also aided by the fact that participants could defer them by noting them down and that they only needed to wait for a maximum of twenty-five minutes to act on the interruption, e.g.,

'...because of twenty-five-minute blocks I feel like "oh I can leave it till the end of twenty-five minutes and look at it afterwards and just focus for twenty-five minutes."' (P4)

6.3.1.6 Technology for study-related activities

Although ‘technology for study-related activities’ appears in Table 6.1 to be a reason for multitasking reported across all the four DBR cycles, some of the factors that comprise this category were not reported in subsequent cycles. As can be seen from Table 6.3, these included losing focus when proceeding to replay/replace background music to aid study (P4, P5, P7), non-study-related ‘tabs’ from a previous browsing session opening upon starting the web browser (P2, P7), and the default web browser landing page having links to non-study-related content/activities (P8). As part of the intervention (i.e. the PT[®]), participants were asked to reflect on the causes for multitasking and take steps to minimise/avoid them before commencing a pomodoro. It is for this reason that three participants did not report these factors in subsequent pomodoros. For instance, as can be seen from section 5.3.5.7.2 and specifically Table 5.5, P2 changed their browser setting so that non-study-related ‘tabs’ did not appear when the browser was started, whereas P4 created an automated playlist of music for study so that they did not have to interrupt their pomodoro to switch to a new track. Three participants who reported these reasons left the study after the first (P5) or second (P7, P8) DBR cycle and it is likely for this reason that the factors contributing to their multitasking in the first cycle were not reported in subsequent cycles.

6.3.1.7 To check if contacted by peers

P7 looked at their phone regularly just to see if a friend had sent a message. The participant who left the study after DBR cycle 2 did not report this reason again.

6.3.1.8 Activity type

P5 reported that they were more likely to multitask when drafting assignments compared to other tasks such as searching for research papers. The participant said that it was when they thought about what to write that their mind drifted and they switched to social media. P5 left the study after the first DBR cycle and this is why it could not be determined if the PT[®] would have been effective in addressing this reason.

6.3.1.9 Study environment

Although 'study environment' appears in Table 6.1 to be a reason for multitasking reported across all the four DBR cycles, some of the factors that formed this category were not reported in subsequent cycles. As can be seen from Table 6.2, these included noise in the library (P4), TV running in the background (P12) studying in bed causing tiredness and making one more prone to taking a 'break' (P5), and delay in webpages loading. Participants reported that interruptions such as noise in the library or family member switching on the television caused them to lose focus and delve into non-study-related activities on their computers/phones. As part of the intervention, participants were asked to reflect on the causes for multitasking and take steps to minimise/avoid them before commencing a pomodoro. P4 who encountered noise in the library aimed to study in the quiet zone of the library for DBR cycles 2, 3 and 4 and this could be the reason they did not report this reason in subsequent pomodoros. P5 and P12 left the study after DBR cycle 1 and it is likely for this reason that the factors that contributed to their multitasking in the first cycle were not reported in subsequent cycles.

6.3.2 Reasons for multitasking that may not be addressed by use of the Pomodoro Technique®

In this section, I present reasons for multitasking that were reported when participants used the PT® (those not enclosed by the green box in Table 6.1 – as mentioned previously some of the reasons for multitasking reported under ‘study environment’ and ‘technology for study-related activities’ respectively presented in Tables 6.2 and 6.3 only occurred in DBR cycle 1). As the reasons for multitasking presented in this section were reported when participants used the PT®, I provide in the following paragraphs an analysis of why the technique might not have been able to address those reasons. Where a reason for multitasking has not been reported in DBR cycle 4 (suggesting that the use of the PT® for longer duration might have addressed it), I have mentioned factors other than the technique that may have contributed to addressing those reasons.

6.3.2.1 Notifications for non-study-related activities

As can be seen from Table 6.1, almost all participants reported multitasking due to notifications for non-study-related activities (incoming message/call or phone vibrating) during DBR phase 1. Participants should not be multitasking due to this reason when using the PT® because as part of the steps undertaken to minimise interruptions before commencing a pomodoro they should have switched off the notifications. On the contrary, half of the participants who remained in the study for DBR cycle 2 multitasked (and voided pomodoros as a result) due to this reason. Notifications were not reported as a reason for multitasking in DBR cycle 3 but were reported by one participant (P1) in DBR cycle 4.

It can be seen that PT[®] appeared to have addressed this reason for multitasking for nearly half the participants in DBR cycle 2. As participants were using the technique for the first time, it might be the case that participants were getting used to the technique and forgot firstly, to switch off the notifications, and secondly, that they were in the middle of a pomodoro. By the end of the study, only P1 reported occasionally multitasking due to notifications because they forgot to put the phone on silent. One would expect that when someone (like P1) uses the technique for long durations of time, the process of undertaking steps to minimise multitasking before a pomodoro would become a habit. On the whole, PT[®] was able to address this cause of multitasking.

6.3.2.2 Study environment

In Table 6.1, lack of a conducive study environment is the second most frequently occurring reason for multitasking that was reported by participants when the PT[®] was used. Table 6.3 presents the breakdown of the factors that contributed to an unconducive study environment. As can be seen from the table, some of the factors contributing to the unconducive study environment only occurred when the PT[®] was not used and have been analysed in section 6.3.1.9. The remaining contributing factors were reported in DBR cycles 2, 3, and 4 (as well as DBR cycle 1). The PT[®] encourages users to reflect on the reasons they multitask and as a result avoid environments or situations that are not conducive to study in subsequent pomodoros. On the contrary, due to an unconducive study environment, four of ten participants multitasked in DBR cycle 2. This reduced to only one of five participants in DBR cycle 3 but increased to two in seven participants in DBR cycle 4.

Examining the factors causing an uncondusive study environment reveal that several of them were beyond participants' control such as internet becoming unavailable (P4), the phone not having a silent option (P4), a call on the home landline (P9) or not having a desk to study at home with studying in bed causing tiredness (P5). In some instances, participants revealed that loss of focus due to an external interruption caused them to pursue a non-study-related activity on their mobiles/computer. To address factors such as interruptions by friends and family and noise in the library, the PT[®] recommended participants to minimise interruptions (e.g. study in an environment that had the least chance of interruption such as a silent study zone in the library) and advise interrupting family members and/or friends that they will be contacted after the pomodoro. This advice helped most participants. P4 on the other hand struggled to minimise interruption from their family throughout the four DBR cycles stating that this was 'out of my control' and there was 'nothing that I can do about it'. This was because P4 studied mostly at home and did not have a dedicated space for them to study by themselves. Although by the end of the study the interruptions by the family had reduced as they got familiarised with PT[®]'s requirements, these were nevertheless unavoidable.

It can therefore be seen that some factors contributing to an uncondusive study environment, such as interruptions by friends and family, improved with time after participants took appropriate measures to address these. However, the PT[®] will not be able to help participants manage multitasking when interruptions are beyond participants' control to avoid, e.g., the internet

becoming unavailable, lack of a study desk at home (which might in turn cause tiredness).

6.3.2.3 Self-efficacy and/or motivation

As can be seen from Table 6.1, nine of twelve participants in DBR 1 reported their affective state as a reason for multitasking. They multitasked because the study-related task was boring (P1, P2, P6, P9, P10) or 'overwhelming' (P2), the task caused feelings of frustration (P1, P2, P4), encountering obstacles in study-related task (P3, P9, P10, P11), tiredness (P1, P2, P11), having had 'enough of task' (P3), and revision material being 'too long' (P9). All these reasons directly point to low motivation and/or low self-efficacy. No participant reported an affective state as a reason for multitasking in DBR cycles 2 and 3. However, two of seven participants in DBR cycle 4 reported their affective state as a reason for multitasking, e.g.,

'(more likely to void pomodoros) when I wouldn't feel like studying so if there is an interruption or I have a phone call I would just go and pick it up...' (P4)

(I don't feel like studying) when the subject is hard, the lecture I am doing is hard, or I feel like it's too much content, so I interrupt and take a long break.' (P1)

It can be seen that multitasking due to affective states, although not reported by most of the participants when using the PT[®], nevertheless took place for a couple of participants. Therefore, in light of the aforementioned quotes by

participants, it appears that different aspects of the PT[®] (e.g. reward for recording a successful pomodoro by an 'X', penalty for voiding pomodoro by having to do it again) were not able to influence those two participants' affective states.

6.3.2.4 Technology for study-related activities

Some of the study-related technology that was a reason for multitasking were covered in section 6.3.1.6 as they were only reported in DBR cycle 1 when the PT[®] was not used. Other aspects of study-related technology that caused multitasking when participants used the PT[®] were non-study-related content being recommended next to a study-related video on the video-sharing website YouTube (P1, P9), switching to non-study-related websites when searching for study-related websites (P2, P10), and study-related conversations with peers/friends on the messaging app WhatsApp leading to non-study-related conversation with the same or different people (Table 6.3). These reasons were provided by one of ten participants in DBR cycle 2, two of five participants in DBR cycle 3, and one of seven participants in DBR cycle 4. The PT[®], at least on paper, addresses these reasons by enabling participants to defer potential interruptions (e.g. urge to click on recommendation for non-study-related video, or a non-study-related website appearing in search results) by noting them down and continuing with the pomodoro. However, it might be the case that the PT[®] was not useful in preventing participants from multitasking, at least in DBR cycles 2 and 3, as they were still getting used to the technique. The one participant who reported voiding pomodoros by not deferring technology-based interruptions even after prolonged use in DBR cycle 4, either a) did not follow the technique, or b) the penalty of voiding

pomodoro by having to do it again and/or the reward for completing a pomodoro by marking it with an 'X' was not an incentive to prevent them from multitasking.

6.3.2.5 Out of habit

Multitasking out of habit was reported by one participant during DBR cycle 1 who did not continue participation after this. However, as can be seen from Table 6.1, two of ten participants in DBR cycle 2, two of five participants in DBR cycle 3, and one of seven participants in DBR cycle 4 reported multitasking out of habit as a reason for voiding pomodoros. It is likely that participants reported this reason for multitasking in DBR cycles 2 and 3 because they were getting used to the PT[®]. Only one participant (P10) reported this reason for multitasking after prolonged use of the technique. Therefore, apparently the PT[®] was not able to address this reason for multitasking even after prolonged use by one participant. However, P10 reported that they voided pomodoros by multitasking unintentionally only initially during the last cycle when they were still getting used to the technique. This suggests that allowing time to get used to the technique can address this reason for multitasking (discussed further in section 6.5.6).

6.3.2.6 Getting reminded of a non-study-related activity

Three of twelve participants multitasked in DBR cycle 1 when they remembered they needed to undertake a non-study-related activity (Table 6.1). On paper, this reason for multitasking should have been addressed by the PT[®] as it requires users to create a list of non-study-related activities and plan study slots, keeping in view those activities so that they do not interrupt

during study-related activities. However, two of ten participants in DBR cycle 2 and two of five participants in DBR cycle 3 multitasked because they got reminded of non-study-related tasks that could not be delayed. This is likely because participants did not maintain a list of non-study-related tasks and/or planned their slots accordingly. Participants were reminded of the reason and value behind noting down non-study-related tasks after DBR cycle 3. P2 reported in their final evaluation that noting down non-study-related activities helped them to identify time slots in which they could undertake study-related activities. It is possibly because of the reminder that no other participant reported this reason in the final evaluation. This suggests that adhering to rules of the PT[®] can impact whether it helps participants tackle this reason for multitasking (discussed further in section 6.5.5).

6.3.2.7 Absence of deadline/time pressure

The absence of a deadline was a reason for multitasking reported by two participants (P3, P10) in DBR cycle 1. When participants used the PT[®], it was only reported as a reason for multitasking in DBR cycle 4 where three participants (P1, P6, P9) reported that they were more likely to void pomodoros in the absence of an immediate deadline. Therefore, it appears that the PT[®] was not effective in preventing some participants from multitasking in the absence of deadline pressure.

6.3.2.8 Peer expectations

Peer expectation to respond to their messages sent via messaging applications as soon as possible was a reason for multitasking both in the absence and use of the PT[®] for P1 (Table 6.1). P2 also reported in DBR cycle

4 that during examination revision they felt obliged to promptly respond to course mates' messages. Both participants said that it was not possible to defer the response to the end of the pomodoro, e.g.,

'...one of my friend I have to reply on time... my day would be ruined if I don't and I wouldn't be able to study after that' (P1)

It appears that participants' social needs outweighed the incentive of marking the pomodoro by an 'X' and the penalty of voiding the pomodoro.

6.3.2.9 Non-study-related thoughts

Two participants (P6, P11) reported encountering non-study-related thoughts during pomodoros. As can be seen from Table 6.1, this reason was not reported in DBR cycle 1. Both participants did not void pomodoros because of these thoughts. The PT[®] is quiet about the issue. Nevertheless, participants were advised on deferring non-study-related thoughts during pomodoros by writing them down as tasks to be done, e.g. 'think about thought X after pomodoro'.

During DBR cycle 4 this reason was not reported by both P6 and P11.

Whereas P11 did not find advice on deferring non-study-related thoughts useful, both they and P6 reported that due to examination pressure they were too focused on study-related tasks during DBR cycle 4 to entertain any non-study-related thoughts. Therefore, it appears that on its own, the PT[®] did not help participants address this reason for multitasking.

6.4 Effectiveness of different aspects of the Pomodoro Technique®

This section addresses the research sub-question ‘How effective do students find different aspects of the Pomodoro Technique® in managing multitasking?’

The section has been structured according to different aspects of the PT® previously presented in section 3.2.1, with the exception of refinements to the PT® which were presented in sections 5.3.2, 5.4.2 and 5.5.2. These aspects are namely activity inventory and to-do-today sheet, pomodoro timer, recording a successful pomodoro, deferring potential interruptions, voiding pomodoros and recording interruptions, duration of pomodoros and breaks. As mentioned in section 3.2.1, the categorisation of the PT® into distinct ‘aspects’ has been carried out in the interest of readability of participant feedback on the PT®. The order of appearance of these aspects follows the order in which they were listed in section 3.2.1.

6.4.1 Activity inventory and to-do-today sheet

In DBR cycle 1, three participants had to interrupt study-related activities as they were reminded of or were interrupted by urgent non-study-related activities that could not be delayed. After using the PT®, two participants (P2, P8) reported that listing non-study-related tasks on activity inventory and to-do-today sheets helped them schedule study slots that avoided times where they were required to undertake non-study-related activities. This lowered the possibility of interruptions during study and enabled them to focus on the study-related tasks for the day.

6.4.2 Pomodoro timer

A couple of participants reported that the pomodoro timer prevented them from multitasking during pomodoros. For P8 the tangible timer in front of them was a visual reminder whereas for P2 the ticks of the timer was an aural reminder that they were not supposed to multitask during pomodoros.

6.4.3 Recording a successful pomodoro

No participant explicitly attributed the recording of a successful pomodoro by an 'X' or equivalent as a contributing factor in managing multitasking.

However, participants associated recording of pomodoros with conceptions that allude to increase in motivation and potentially incentivising them not to multitask (the link between motivation and multitasking is discussed in section 2.2.2). These conceptions include feelings of accomplishment (P1, P2, P3, P11), achievement (P4, P8), pride (P7, P11), goodness (P2), motivation (P4, P7), reward (P9), and satisfaction (P11).

6.4.4 Deferring potential interruptions

Six participants (P2, P4, P7, P8, P9, P11) reported that the PT[®] was effective in managing multitasking because potential interruptions were deferred to the end of a pomodoro by noting them down in an 'unplanned and urgent' section of the to-do-today sheet. This in turn enabled them to retain 'focus' on the study-related task (P8, P11), stay 'in control' (P7), and undertake 'as much revision' as they could (P2). On occasion, the potential interruptions were not leisure activities but important non-study-related tasks the participant needed to pursue. Noting them down in the to-do-today sheet not only enabled the participant to focus on the study-related task but also served as a reminder for the non-study-related task which otherwise would have been forgotten. P11

reported that a distracting thought only appeared 'interesting' during pomodoros and not after it had ended. This implies that deferring interruptions prevents multitasking in situations when a participant has relatively low motivation for a study-related task compared to that for a potential interruption.

6.4.5 Voiding a pomodoro and recording interruptions

The prospect of voiding a pomodoro and re-doing it was an incentive and a source of motivation not to multitask during a pomodoro for five participants (P2, P3, P8, P10, P11), e.g.,

'I don't want to start again so I put my phone on the side... so I know that if I touch my phone it's going to start all over again' (P6)

6.4.6 Duration of pomodoro and breaks between pomodoros

Three participants (P4, P9, P11) reported that the short duration of a pomodoro made it easy to defer any interruption or urge to multitask to the end of the pomodoro. The short duration of twenty-five minutes was not 'long to lose patience' (P11) when one wanted to pursue a non-study-related task during a pomodoro.

As I discussed in section 6.3.1.1, participants may have multitasked during the first DBR cycle, when the PT[®] was not being used, because they were not taking adequate breaks. This assertion is supported by the fact that four participants cited 'need for break' as a reason for multitasking during cycle 1. In contrast, no participant reported that they had to void a pomodoro due to 'need for a break' when they used the PT[®] in cycles 2, 3 and 4. In addition, a participant (P11) was following a technique similar to the PT[®] in the first cycle

which required them to work in slots of 1 hour and 30 minutes without taking a break. This always caused the participant to multitask because they 'couldn't concentrate that long'. Furthermore, two participants (P10, P11) reported the break to be refreshing which may increase their self-efficacy to study. Similarly, two participants (P2, P3) found that breaks prevented exhaustion and tiredness which could prevent self-efficacy for study to decrease. Breaks may also have given participants the opportunity for pleasure and regulating their mood, which was cited as a reason for multitasking during DBR cycle 1 but not in cycles 2, 3 and 4 when participants used the PT[®].

6.4.7 Refinements to the technique

This section presents an analysis of how different refinements to the PT[®], introduced in response to participants' feedback and requirements over various DBR cycles, contributed to managing multitasking. Three participants (P1, P2, P11) reported that steps taken to minimise multitasking before a pomodoro (e.g. putting phone on silent, studying in an environment devoid of external interruptions) contributed in minimising multitasking. Given that notifications for non-study-related activities on phone/computers and interruptions by friends and family were reported to be major reasons for multitasking, it is not surprising that steps taken to minimise these distractions would have helped participants in managing multitasking.

Review and reflection on to-do-today sheets resulted in six participants (P1, P2, P3, P4, P7, P9) identifying some of the factors that caused multitasking. This enabled participants to take measures to address (e.g. recording lectures

to improve self-efficacy for revising them) or avoid these factors thereby helping them reduce multitasking.

Of the remaining refinements which could potentially contribute to managing multitasking, participants either did not use them or provided much feedback (as reported in sections 5.3.5.7, 5.4.5.7 and 5.5.5.7). These refinements included tips on dealing with distractions, adjusting duration of pomodoros and breaks, and reserving the use of technology used both for study and non-study-related activities for the last few pomodoros.

Readers are reminded that some of the refinements were introduced to facilitate participants' use of the technique and the purpose was not to manage multitasking. These refinements included computer-based alternatives to the egg timer, a digital copy of activity inventory and to-do-today sheets, not ending the pomodoro abruptly, removing the distinction between internal and external interruptions, and tips for returning to study after a shorter or longer break (e.g. use of a timer for breaks, avoiding activities that extend the risk of breaks).

6.5 Factors governing the effectiveness of the Pomodoro Technique[®]

This section addresses the research sub-question 'What contextual factors govern the effectiveness of the PT[®] in a higher education setting?' The factors governing effectiveness of the PT[®] arose from thematic analysis (details in section 4.4) of participant responses. Analysis of their responses reveal that there was no consensus amongst participants on how the technique helped or

did not help them in managing multitasking. The effectiveness of the PT® in enabling participants to manage multitasking was governed by a combination of factors. Details of these factors are provided below.

6.5.1 Assessment deadlines

Five participants (P1, P6, P9, P10, P11) reported that they did not engage in multitasking when the deadline for their study-related task was close. Two participants said that the technique was more useful when the deadline was not close, with one participant (P6) reporting that they did not need the technique during examinations because examination pressure was suffice to prevent multitasking. On the other hand, three participants said that it was because of examinations that they decided to use the technique.

Therefore, I asked participants, as reported in chapter 5, to what extent was the contribution of the PT® in preventing multitasking in the presence of factors like a looming deadline for a study-related task an incentive alone in preventing multitasking. Participants attributed effectiveness of the PT® during examination period to different aspects of the PT®. These included steps taken to minimise multitasking before a pomodoro (P1), duration of the technique short enough for one to delay the urge to multitask until after the pomodoro (P11), providing 'organisation' and enabling one to focus on one task at a time instead of doing 'everything all at once' (P2), a record of voided pomodoros and interruptions providing reflections on improving future pomodoros (P9), the provision to defer potential interruptions during pomodoros by writing them down (P9, P11), and breaks between pomodoros replenishing cognitive resources, the absence of which would have

'exhausted' (P10) or 'tired' (P2) the participants. Note that one of the reasons for the technique's effectiveness, i.e. providing 'organisation', is not related to managing multitasking but indicates that participants may use the technique for advantages other than managing multitasking.

6.5.2 Convergence of platform for study and non-study-related activities

Several participants used the same technological platform for study and non-study-related activities (e.g. web search engines, video-sharing websites, instant messaging tools). As a result, a number of times when participants used these platforms for study-related activities, they multitasked to non-study-related activities on the same platform due to exposure to it. Participants appeared to not follow the rules of the PT[®] which requires them to defer potential interruption by writing them down in the to-do-today sheet. However, those with already low motivation and/or self-efficacy for study are more likely to resist the urge to pursue non-study-related tasks. Furthermore, the refinement to the technique that participants minimise interruptions from non-study-related environments before commencing a pomodoro was given under the assumption that users will have separate spaces for study and non-study-related activities. However, convergence of study and non-study-related environments, especially the web search engines which can give search results for both study and non-study-related websites, increases the risk of exposure to non-study-related activities when studying. Hence, any attempt to compartmentalise study-related environments from non-study-related activities will not be of much utility, in turn impacting the effectiveness of the PT[®] in managing multitasking.

6.5.3 Conducive environment for study

Analysis of the reasons participants multitasked when using the PT[®] (i.e. voiding pomodoros, presented in Table 6.1) indicate how factors such as a conducive environment for study contributes to the effectiveness of the technique in managing multitasking. Eight participants, on occasion, had to void pomodoros because of interruptions by friends/family or external noise. P4 also stated that they could not use the technique to study in spare time at their workplace due to frequent interruptions. In fact, participants P1 and P4 reported that they were only able to manage multitasking for some study slots due to a conducive environment to study.

6.5.4 Participants' affective state

I highlighted in section 6.3.2.3 that when using the PT[®] participants switched to non-study-related activities due to low motivation, low self-efficacy as well as high self-efficacy. In this section, I present aspects of the PT[®] which appeared to increase participants' motivation and/or self-efficacy as well as factors that influenced participants' self-efficacy and motivation, in turn impacting their multitasking behaviour.

There were several aspects of the PT[®] (analysed in section 6.4) which appeared to increase participants' motivation and/or self-efficacy, thereby making it less likely they would multitask. These included breaking of tasks into sub-tasks helping in 'tackling them' (P4), ticking completed tasks off the activity inventory sheet giving a source of 'achievement' (P2), the recording of a pomodoro generating feelings of accomplishment (P1, P2, P3, P11), achievement (P4, P8), pride (P7, P11), goodness (P2), motivation (P4, P7),

reward (P9), and satisfaction (P11), breaks between pomodoros found to be refreshing (P11), and the prospect of voiding a pomodoro and re-doing it.

Participants' affective states were also cited as a reason why they either extended the break or did not return to study-related activities either after the shorter five-minute or longer fifteen/thirty-minute break, even when they intended to continue study-related activities. The reasons cited by participants such as not feeling motivated for the study-related task (P7, P8), absence of deadline (P7, P8), finding study-related tasks 'daunting' (P8), laziness and procrastination (P6, P9), all point to low motivation and self-efficacy for study-related tasks.

Teaching quality appeared to influence a participant's motivation and self-efficacy in ways that could lead them to multitasking. Examples included lecture notes not being revision-friendly ('only pictures and stuff and no text' – P1) and having an unfavourable timetable (for example, having six lectures delivered in a day – P2). Other factors impacting participants' motivation and self-efficacy that could lead them to multitasking included not being able to attend lectures or devote adequate time to study-related activities due to work commitments, and long commuting distance between home and university. Just like the lack of a conducive environment to study described in section 6.5.3, these factors could not be addressed through the PT®.

There were instances where participants could have deferred interruptions to the end of a pomodoro but chose not to. Examples of multitasking behaviour

resulting from these interruptions included entertaining notifications for non-study-related activities, the need to respond to messages by peers instantly, responding to non-study-related messages when an instant messaging tool is used for study-related messaging, and clicking on recommendations for non-study-related videos when watching study-related videos on a video-sharing platform. A possible reason for this could be that participants were getting used to the technique (especially in DBR cycles 2 and 3). However, several of the aforementioned examples of multitasking were also reported in DBR cycle 4 (e.g. the need to respond to messages of peers instantly) by the time when participants had been using the technique for some time. This suggests that the penalty of voiding a pomodoro (by having to do it again) and the reward for completing a pomodoro (by marking it with an 'X') was not an incentive enough for participants to not multitask. Conversely, as reported in section 6.4.5, the prospect of voiding a pomodoro and re-doing it was an incentive and a source of motivation not to multitask for five participants during several instances.

Therefore, it appears that there were some interruptions for which participants' motivation was greater than the motivation arising from the penalty of voiding a pomodoro and the reward for completing a pomodoro. For instance, as reported in section 6.3.2.8, P1 said that they had to respond to a friend's message instantly else their 'day would be ruined'.

6.5.5 Participants not adhering to rules of the PT®

In some instances, participants voided pomodoros or did not benefit from the technique because they did not adhere to the rules of the technique. For

instance, three participants did not take steps to minimise interruptions before pomodoros such as switching off notifications for non-study-related activities (e.g. sound or vibration from the phone - P2, P4, P10). Four participants (P1, P2, P4, P8) voided pomodoros as they got reminded of urgent non-study-related tasks. This could have been prevented had participants, as per the technique's instructions, written down all their study and non-study-related tasks in the to-do-today sheet and planned their study slots accordingly. Two participants (P4, P10) did not break larger tasks into sub-tasks as recommended by the PT[®]. As a result, study-related tasks appeared to be daunting which reduced participants' self-efficacy, with one of the participants (P4) wishing to multitask during pomodoros as a result. A couple of the participants even admitted that the PT[®] was not as beneficial in managing multitasking as expected because they did not follow it 'properly' (P9)/'correctly' (P10).

6.5.6 Allowing time to get used to the PT[®]

Users may need to give some time to get used to the PT[®] before they can enjoy its positive impact. For instance, five participants voided pomodoros because they multitasked unintentionally or unconsciously out of habit. As participants used the technique for extended periods of time in DBR cycle 4, this reason for multitasking/voiding pomodoros was only reported by P10. However, P10 reported that they voided pomodoros by multitasking unintentionally only initially during the last cycle when they were still getting used to the technique. Similarly, interruptions by family members of participant P4 had reduced by DBR cycle 4 as their family got familiarised with the PT[®]'s requirements.

Participant P2 explicitly stated that their multitasking behaviour improved as they got used to the technique. The participant also said that they initially found the ticks of the egg timer distracting but after prolonged use not only got used to the timer but also the ticks served as a reminder that they were in a pomodoro and were not supposed to multitask.

6.5.7 Group study

PT[®] was reported to be not useful for studying in groups. One participant (P4) was of the view that while they could ensure that they do not get distracted, there was no guarantee that other group members would not and that would have an impact on their 'learning'.

6.5.8 Adapting the Pomodoro Technique[®] to suit one's needs

After use of the PT[®] for two or three cycles including for prolonged periods of time, it can be seen that none of the participants used the technique as it was presented originally. Therefore, a factor contributing to the effectiveness of the PT[®] to manage multitasking and/or making it easier to use was that this research incorporated changes to the technique in response to participants' experiences and feedback. Examples of adaptations, as reported in chapter 5, included removing the distinction between internal and external interruptions, use of computer-based timers instead of an egg timer, use of online rather than paper-based activity inventory and to-do-today sheets, varying the duration of pomodoros and breaks, completing the task rather than abruptly ending the pomodoro, and dealing with 'emotional distractions' such as thoughts about a person or an event.

Six participants introduced changes of their own in order to suit their needs and preferences. Examples included merging the activity inventory and to-do-

today sheets (P2, P11), variations in the way activity inventory and/or to-do-today sheets were maintained (P1, P4, P10), using their own timers instead of those recommended to them (P1, P4, P9), and making notes on progress made on study-related activity when recording completed pomodoros (P11). Six participants also did not follow certain aspects of the technique either because they did not find it useful or did not feel the need to after they got used to the technique. Examples included not keeping the activity inventory and/or to-do-today sheets (P1, P6, P9, P10, P11), not dividing tasks into sub-tasks (P4), not recording completed pomodoros (P1), not voiding pomodoros upon interruptions at all times (P1) or, in the case of one participant, when the interruption was viewed as not impacting their focus (P4), not recording an internal urge to multitask in the to-do-today sheet (P4), and not working in pomodoros (P6). The above examples do not include instances where participants reported not following the rules but did not state the reason for doing so.

[6.5.9 Keeping the technique and instructions simple and accessible](#)

As reported in sections 5.3.5.9, 5.4.5.9 and 5.5.5.9, nearly all participants reported misconceptions about the technique. Although this was in part due to some participants not reading the instructions, there were aspects of the technique that made it unnecessarily complicated. Examples included distinguishing between and recording internal and external interruptions separately and terminology such as ‘unplanned and urgent’ for recording potential interruptions that caused confusion. In addition, instructions for the PT[®] were perceived to be text-heavy and lengthy. Unnecessary complications in the technique and the way the instructions were presented have likely

contributed to its uptake in the correct way. I have presented proposals for making instructions for the PT[®] more useful for users in section 5.5.6.5.

6.5.10 The 'getting to study' challenge

As reported in chapter 5, three participants realised that the challenge they faced was not multitasking during study-related activities but not having enough motivation to 'get to study'. The participants who faced the challenge of 'getting to study' left the study as they found that the PT[®] did not help them with this. This is understandable as the purpose of introducing the PT[®] was to prevent participants from multitasking and not as a tool to motivate them to study. However, three participants pointed to various aspects of the technique helping them to study. These included listing tasks stated on the to-do-today sheet serving as a reminder and a motivation to study (P2, P6), and the short duration of a pomodoro making study appear less daunting (P11) – the participant would start with the intention of studying only for twenty-five minutes which would set up momentum for study thus resulting in pursuing additional pomodoros.

Even when participants had enough motivation to start study-related activities, six of them reported struggling to return to study after a break between pomodoros or not undertaking as many pomodoros as intended or needed. So even if participants did not multitask during pomodoros, there were instances when they were not studying for the desired or intended number of hours. In addition, the less number of pomodoros a participant undertakes, the less likely would they have encountered a situation where they had to deal with an interruption. There is not much benefit in getting a student not to multitask

during a pomodoro when they are not undertaking the desired number of pomodoros; one twenty-five-minute uninterrupted pomodoro for an entire day when the participant had the time to complete, e.g. six, is not fulfilling the spirit behind undertaking this study which was to facilitate students in managing multitasking so that it does not negatively impact their assessment outcomes.

As mentioned in sections 6.5.3 and 6.5.4 respectively, an uncondusive environment to study and factors influencing participants' affective states (e.g. inability to attend some lectures due to work) appeared to be some of the reasons why participants struggled to return to study after a break, or did not undertake as many pomodoros as intended. As these reasons were beyond the control of both the participant and researcher, the PT[®] would not have been of help anyway. On the other, hand it was assessment deadlines that, in a number of instances, motivated participants to study or undertake more pomodoros than they normally would.

6.5.11 Other advantages of the PT[®]

Aside from helping in managing multitasking, participants also reported other benefits of using the PT[®]. These included helping participants 'get to study' (P6, P11 – mentioned in section 6.5.10), planning and organisation (P2, P3, P4, P6, P11), an activity inventory/to-do-today sheet serving as a reminder for study-related tasks which would have been forgotten otherwise (P2, P6, P11), prioritising tasks (P2, P4), informing of the actual rather than perceived effort on task (P4), informing of progress made on tasks and how much more needed to be done (P1, P2, P4, P9, P11), and identifying 'productive' times of the day (P4). These benefits of the PT[®] other than helping to manage

multitasking may have positively impacted participants' perceptions and adoption of the technique, and contributed to their motivation for study-related activities.

6.6 Summary

In this chapter, I attempted to address four research sub-questions of this thesis, details of which are provided below.

What reasons do students give for multitasking?

Participants gave a wide range of different reasons for multitasking as presented in Tables 6.1, 6.2 and 6.3. These included technology-based reasons (such as notifications for non-study-related activities), non-technology-based reasons (such as interruptions by family and friends), and low self-efficacy and/or motivation. In some instances, loss of focus due to a non-technology-based reason caused participants to pursue a non-study-related activity on their mobiles/computer.

Some of the reasons for multitasking were not reported when the participants used the PT[®], whereas others either persisted or were reported only when participants used the PT[®]. This leads to the second research sub-question:

Which reasons that students give for multitasking may be addressed by their use of the PT[®]?

Some of the reasons for multitasking were only reported during DBR cycle 1 and not during cycles 2, 3 and 4 when participants used the PT[®]. I provided

an analysis on how these reasons may have been addressed by the PT[®] and were not reported when the technique was used. Examples included the need for breaks and not being able to study for long periods of time (as the PT[®] provided breaks between pomodoros), pleasure and mood regulation (which was met by pursuing appropriate non-study-related activities during breaks between pomodoros), and ease of multitasking (participants prevented from multitasking due to short duration of the pomodoro and consequences of voiding the pomodoros). It may also be the case that some of the reasons reported in DBR cycle 1 were not reported when the PT[®] was used because participants who mentioned these left the study after cycles 1 or 2. Examples included studying in bed making one tired and more prone to taking 'breaks', multitasking being dependent on the type of activity one is undertaking, and face-to-face study-related conversation switching to non-study-related conversation.

I also provided an analysis of how some of the reasons for multitasking either persisted or were reported only when participants used the PT[®], and why the technique was not able to prevent them. Reasons such as multitasking out of habit were reported during the early days of the use of the PT[®] but were not reported when participants had used the technique for a prolonged period of time and became familiar with it. Reasons for multitasking such as 'notifications for non-study-related activities', 'getting reminded of a non-study-related activity', and convergence of platforms for study and non-study-related activities (e.g. recommendations for non-study-related videos next to study-related videos) were likely to have occurred because either participants did

not follow the technique or different aspects of the technique (e.g. penalty for voiding and reward for completing a pomodoro) were not an incentive enough for participants not to multitask. Reasons for multitasking such as an uncondusive environment for study (e.g. interruptions by family/friends) were beyond participants' control so the PT[®] would not have been of help in countering them. The technique failed to prevent some participants from multitasking in the face of expectations from peers to respond to messages as soon as possible during study-related activities (n=2), as well as when assessment deadlines were not close (n=3). The PT[®], on occasions, was not able to help two participants with multitasking resulting from low self-efficacy and/or motivation (which in some instances was influenced by several external factors).

How effective do students find different aspects of the PT[®] in managing multitasking?

Almost all the different aspects of the PT[®] (with the exception of 'recording a successful pomodoro' and most of the refinements to the technique) were reported by one or more participants to have contributed in managing multitasking. Although recording of a successful pomodoro was not explicitly attributed to managing multitasking, participants' conceptions of it suggested that it nevertheless increased their motivation, thereby potentially incentivising them not to multitask. Participants' conceptions of most of the refinements introduced to the PT[®] were not elicited, which is a limitation of this study. However, the refinement 'minimising interruptions before commencing pomodoro' helped participants in managing multitasking.

What contextual factors govern the effectiveness of the PT[®] in a higher education setting?

My analysis found a range of factors that govern the effectiveness of the PT[®] in managing multitasking. A key contributing factor to the effectiveness of the PT[®] in helping participants manage multitasking and/or making it easier to use was that refinements were made to it in response to participants' experiences and feedback. Most importantly, there was no consensus on how the technique helped participants manage multitasking with participants finding different aspects of the technique helpful in their contexts.

PT[®] was not as effective for a few participants because they did not adhere to its rules. In contrast, seven participants were more receptive to using the technique only when they decided to amend or not follow some of its rules (e.g. not voiding pomodoros on interruptions that were perceived not to impact one's focus, merging activity inventory and to-do-today sheets).

Convergence of study and non-study-related platforms (e.g. recommendations for non-study-related videos next to study-related video) may impact effectiveness of the PT[®]. Although the PT[®] requires participants to defer potential interruptions (e.g. recommendations for non-study-related videos), participants with low-self-efficacy or motivation may struggle. In addition, the refinement to the technique pertaining to minimising risk of interruptions before commencing a pomodoro may not work when study and non-study-related activities share the same platform with the latter competing for a user's

attention (e.g. recommendation for a non-study-related video next to a study-related video).

Participants' affective states impacted their use of the PT[®] in different ways. Several aspects of the PT[®] appeared to increase participants' motivation and/or self-efficacy thereby making it less likely they would multitask. Several other external factors appeared to impact participants' affective states for a study-related task (e.g. dissatisfaction with teaching quality). It was also partly due to their affective states that participants did not follow the technique correctly, e.g. returning to study after a shorter or longer break.

The PT[®] was not found to be useful in managing reasons for multitasking that were beyond participants' control, e.g. interruptions by friends/family. The technique was also not perceived to be useful for studying in groups as other group members may not follow the technique.

It was found that users should allow time to get used to the PT[®] before they could accrue its benefits. On a different note, unnecessary complications in the technique and the way instructions were presented (e.g. lack of worked examples) in the user guide seemingly impacted the technique's conceptions, adoption and effectiveness.

Three participants left the study mid-way stating that their challenge was not multitasking during study-related activities but to 'get to study'. On the other hand, a few participants reported that it was aspects of the PT[®] such as

activity inventory/to-do-today sheets and duration of pomodoros that made them 'get to study'. Participants also reported other advantages of the PT[®] apart from helping in 'getting to study', e.g. organisation and planning, which may have positively impacted their perceptions and adoption of the technique. For some participants, it was assessment deadlines that motivated them to 'get to study'. When enquired if a looming assessment deadline could have sufficed to ensure focus and prevent multitasking, five participants attributed several aspects of the PT[®] (e.g. deferring potential interruptions during pomodoros by writing them down) that contributed in managing multitasking.

The next chapter discusses the analysis presented in this chapter to answer the main research question i.e. 'how might the use of the PT[®] help previously struggling undergraduate students better manage technology-based multitasking when undertaking independent study in a higher education setting?'.

Chapter 7- Discussion

7.1 Introduction

The previous chapter addressed the research sub-questions. In this chapter, I draw together an answer to the overarching research question (section 7.2). I then relate the findings of this thesis to the three areas of literature introduced in chapters 2 (literature review) and 3 (The Pomodoro Technique® (PT)), discussing their congruence and departure, and therefore establishing my contribution to the scholarship. The three areas of literature I reviewed in chapters 2 and 3 were 'reasons for multitasking' (section 2.2), 'strategies for managing multitasking' (section 2.3), and 'evaluation of the PT®' (section 3.4).

7.2 How might the use of the PT® help better manage technology-based multitasking during independent study?

In this section I answer the main research question of this study, i.e. 'How might the use of the PT® help previously struggling undergraduate students better manage technology-based multitasking when undertaking independent study in a higher education setting?'

To address the research question, I first gained an understanding of the context of my research, i.e. the reasons my participants engaged in multitasking. As detailed in section 6.2, when participants were engaged in independent study using technology, they not only multitasked due to technology-based reasons (such as notifications for non-study-related activities on mobiles) but also due to non-technology-based reasons (such as

interruptions by family and friends, non-study-related thoughts). In some instances, loss of focus due to a non-technology-based reason caused participants to pursue a non-study-related activity on their mobiles/computer. Participants' affective states (self-efficacy and motivation) was also a contributory factor to their multitasking.

When answering the research question I not only report on how different constituent aspects of the PT[®] contributed in enabling participants to manage multitasking but also look at different contextual factors that govern the effectiveness of the PT[®] in managing multitasking.

All participants who used the technique until the end of the study reported that they found that it helped in managing multitasking, and all of them intended to use it in the future. However, there was no consensus amongst participants on *how* the technique helped them in managing multitasking, with participants finding different aspects of the technique useful. In addition, the effectiveness of the technique in helping participants manage multitasking was found to be governed by a number of contextual factors.

7.2.1 Contribution of different aspects of the PT[®] in enabling participants to manage multitasking

As detailed in section 6.4, different participants found different aspects of the technique useful in enabling them to manage multitasking. The different aspects of the PT[®] helped participants in managing multitasking in the following ways:

Listing non-study-related tasks on the activity inventory and to-do-today sheets helped two participants schedule study slots that avoided times where they were required to undertake non-study-related activities, in turn lowering the possibility of interruption from those activities. The pomodoro kitchen/egg timer served either as a visual or aural reminder (through ticks) that one was in the middle of a pomodoro and was not supposed to multitask.

Noting down potential interruptions (e.g. urge to check social media activity) in the to-do-today sheet and resuming study-related activity helped in deferring them. The prospect of voiding a pomodoro and re-doing it served as an incentive not to multitask. The duration of the pomodoro made it easier to defer potential interruptions. Breaks between pomodoros and activities pursued during these appeared to have addressed the 'need for break', 'not able to study for long periods of time', and 'pleasure and mood regulation' reasons for multitasking.

Taking measures to minimise interruptions before commencing study-related activities (a refinement introduced to the technique) appeared to reduce multitasking, especially those associated with notifications for non-study-related activities from phones, or study environments rife with external interruptions such as interruptions by friends. Review and reflection on records of multitasking and interruptions in the to-do-today sheets (a refinement introduced to the technique) resulted in participants identifying some of the factors contributing to their multitasking and so enabled them to take measures to address those.

7.2.2 Contextual factors governing the effectiveness of the PT[®] in managing multitasking

As detailed in section 6.5, my analysis of participant data found a range of factors governing the effectiveness of the PT[®] in managing multitasking, which are summarised here:

None of the participants used the technique in its original form. Refinements were introduced in light of participants' experiences and feedback. In addition to the above, as detailed further in section 6.5.8, for six participants the technique was only useful when they introduced changes of their own to suit their needs (P1, P2, P4, P9, P10, P11) and/or chose not to follow some of the rules (P1, P4, P6, P9, P10, P11). Examples included merging activity inventory and to-do-today sheets (P2, P11) and not voiding pomodoros when the interruption was viewed as not impacting their focus (P4).

Six participants (P1, P2, P4, P8, P9, P10), on some occasions, did not appear to benefit from the technique as they did not appear to adhere to the technique's rules. As detailed further in section 6.5.5, these rules are not the same as those referred to in the previous point, which participants did not follow because they did not find these useful. Reasons for multitasking such as 'notifications for non-study-related activities', 'getting reminded of a non-study-related activity' and 'convergence of platform for study and non-study-related activities' (e.g. recommendations for non-study-related videos next to study-related videos) appeared to persist where participants did not follow the technique.

Participants needed to allow time to get used to the PT[®] before they were able to accrue its benefits. Examples included allowing time to: avoid multitasking due to 'out of habit', get familiar with ticking sound of the pomodoro timer, and allow family members to be accustomed to the rule of the pomodoro not to be interrupted.

One of the refinements to the PT[®] required participants to minimise the risk of interruption before commencing study. However, this was a futile effort for some participants, especially when platforms for study and non-study-related activities converged (e.g. mobile communication apps used for both study and non-study-related conversation).

The PT[®] appeared not useful in managing reasons for multitasking that were beyond the learner's control, e.g. interruptions by friends/family. The technique was not useful in managing multitasking when working in groups. The technique appeared to be not helpful in deferring non-study-related thoughts.

Several aspects of the PT[®] (e.g. recording of successful pomodoros) appeared to increase participants' motivation and/or self-efficacy thereby making it less likely they would multitask. There were some interruptions for which participants' motivation was greater than the motivation arising from the penalty of voiding a pomodoro and the reward for completing a pomodoro (e.g. multitasking due to peer expectations). It was also found that participants' self-efficacy and motivation was determined by several factors

(e.g. managing work and study, dissatisfaction with teaching quality as detailed further in section 6.5.4). This in turn impacted how effectively the technique was used (e.g. not returning to study after a shorter or longer break). The PT[®] did not appear to have an impact on participant behaviour in the presence of these factors.

For some participants, the PT[®] was not required when assessment deadlines were close, as time pressure sufficed for them to prevent multitasking. For others, it was the assessment deadline that motivated them to 'get to study' and use the PT[®]. Unnecessary complications in the PT[®] and the way instructions were presented impacted the technique's conceptions, adoption and effectiveness.

Perceived advantages of the PT[®] other than helping in managing multitasking (e.g. helping in 'getting to study', organisation and planning) positively impacted perceptions and adoption of the technique for some participants. On the other hand, three other participants stopped using the PT[®] as their challenge was not multitasking but 'getting to study'.

Some of the reasons for multitasking that were only reported in DBR cycle 1 may not have been reported when the PT[®] was used, not because the technique addressed them but because participants who mentioned these left the study in cycle 1 or 2. Nevertheless, to support students struggling with multitasking using the PT[®] will involve having an appreciation of their context and an ongoing conversation with them about how they are using the PT[®],

which aspects they are finding useful, and how it could be tailored to suit their needs. The technique may not always be effective in enabling its users to manage multitasking by itself, and may have to rely on contextual factors to have the desired outcome.

7.3 Contributions to the literature on reasons for multitasking

The literature presents a wide range of reasons students multitask during study-related activities. However, as highlighted in section 2.4, my concerns about many of the studies were around conceptions of multitasking employed and limited the data collection methods for investigating it. These included adopting an application/device-based conception of multitasking (rather than task/goal-based) and methods employed to collect data (i.e. self-reporting data, non-natural settings, a focus on quantitative rather than qualitative or mixed data collection methods, and a data collection period not sufficiently longitudinal).

7.3.1 Points of commonality with existing literature

A few of the reasons why my participants multitasked are in congruence with findings from previous studies. For example, as mentioned in section 6.3.2.3, participants reported reasons for multitasking that point to low motivation and/or self-efficacy (e.g. study-related tasks being 'boring' or causing frustration). This is in line with research, discussed in sections 2.2.2 and 2.2.3, that found low motivation (Baron 2008, Adler and Benbunan-Fich 2013, Rosen et al. 2013a, Hwang et al. 2014, Calderwood et al. 2014, Levy 2016, Kim et al. 2017, Le Roux and Parry 2019, Deng 2020) and self-efficacy (Adler and

Benbunan-Fich 2013, Calderwood et al. 2014, Whittaker et al. 2016, Kim et al. 2017, Deng 2020) for study-related tasks as a reason for multitasking. Conversely, both my participants (as reported in section 6.3.1.4) and other research (Thompson 2015, Deng 2020) found high self-efficacy for study-related tasks (e.g. feeling 'confident') as a reason for multitasking as well. Another example of congruence is that four of my participants alluded that they were more likely to multitask due to wide prevalence, easiness and instantness of technology (as reported in section 6.3.1.5), which corroborates with findings (reported in section 2.2.1) from Jeong and Fishbein (2007), Zhang and Zhang (2012), Lin (2013), and Kononova and Chiang (2015).

Similar points of congruence can be found regarding the reasons related to acting out of habit (Wang and Tchernev 2012, Zhang and Zhang 2012, Hwang et al. 2014, Levy 2016, Kim et al. 2017, Le Roux and Parry 2019, Deng 2020), seeking entertainment/enjoyment and mood regulation (Zhang and Zhang 2012, Hwang et al. 2014, Kononova and Chiang 2015, Levy 2016), notifications (e.g. phone vibration) for non-study-related activities on digital devices (Rosen et al. 2013a, Carrier et al. 2015, Levy 2016, Le Roux and Parry 2019, Deng 2020, Murray et al. 2020), absence of deadline or time pressure (Kim et al. 2017, Wu and Xie 2017, Le Roux and Parry 2019, Deng 2020), doing something else while waiting for the computer to respond (Zhang and Zhang 2012, Levy 2016, Deng 2020), absence of or need for breaks (Guinness et al. 2018), and getting reminded of non-study-related activities (Zhang and Zhang 2012).

7.3.2 Findings in the literature that did not appear in my findings

Some contributory factors to multitasking that have been reported extensively in literature were not reported by my participants. The most note-worthy of these are psychological problems and social difficulties (section 2.2.8), addiction (section 2.2.9), and personality traits (reported in section 2.2.7) that include aspects such as polychronicity, neuroticism, sensation-seeking and impulsivity. In section 2.2.6, I reported that desire for sociability and the need to keep in touch with other people have been found to be a predictor of multitasking (Zhang et al. 2013, Hwang et al. 2014, Kononova and Chiang 2015, Kim et al. 2017). On the other hand, some of the reasons my participants multitasked that were related to other people, i.e. to check if they had been contacted on the phone by others or because they felt obliged to respond timely to peers, are not in my view the same as desire for sociability and the need to keep in touch with others.

7.3.3 Findings of this research that were not reported in the literature

Additionally, I unpacked some aspects of the multitasking phenomenon which have either not been reported in literature before or not in sufficient depth.

These themes are presented below.

7.3.3.1 Convergence of platform for study and non-study-related activities

I found the convergence of technologies for study and non-study-related spaces to be a contributing factor for multitasking, i.e. participants are more likely to multitask just because the same platform provides access to both study and non-study-related activities (reported in sections 6.3.1.6 and 6.3.2.4). Examples reported by participants included switching to non-study-

related content being recommended next to a study-related video on a video-sharing website (YouTube), study-related search on a search engine giving non-study-related search results, non-study-related 'tabs' from previous browsing sessions being opened when a web browser was switched on, a background music track being used to aid study advancing to a distracting song, and study-related messaging on messaging services (e.g. WhatsApp) resulting in conversations delving into non-study-related conversation with either the same person or a different person. In most of these instances participants appeared to have switched to non-study-related tasks when they received stimuli and not because they actively pursued non-study-related activities. It can be deduced from the above that participants would not have engaged in multitasking in these instances if platforms for study and non-study-related activities were different, e.g. separate messaging services were used for study and non-study-related conversations.

Although none of the research studies exploring students' experience of multitasking has reported the convergence of study and non-study-related platforms as a contributing factor for multitasking, studies in some *other* areas of literature do report this phenomenon. Hillstrom and Chai (2006), for example, present a review of findings of what distracts visual attention and report on the following contributing factors: a) distinctiveness of stimuli; b) the intention and motivation of the user; c) memory for previous encounters with similar displays; and d) the perceptual organisation of displays. It can be argued that recommendations for non-study-related videos next to study-related video, search results for non-study-related content amongst study-

related content, and non-study-related messages amongst study-related messages, are all distinct stimuli that are organised next to study-related content. If the stimuli are familiar and participants' memory of it is pleasurable and/or it is important to them, participants will pursue the stimuli especially when their motivation for it is greater than that for study-related activity.

My findings also lend some support from findings of a study tracking the digital experiences of 37,000 high school and university students in the UK and abroad which found that 23% of HE learners reported getting 'easily distracted' when digital tools were used in their course (Newman et al. 2018). However, unlike my findings, Newman et al. do not provide details of how and why the use of digital tools results in distraction.

The implication of this finding is that scholars interested in student multitasking need to be better aware of this convergence between study and non-study-related spaces, and might benefit from making links with other areas of research that already consider such issues (Hillstrom and Chai's (2008) work, for example, is located in the scholarship on human visual processing).

Another implication of this finding is that the use of those tools that are usually used by students for non-study-related activities (e.g. social media) should be carefully considered in education.

[7.3.3.2 Multitasking is not technology-based only](#)

As I reported in section 2.2, the literature on multitasking focuses on multitasking that is technology-based. The only exception was Thompson (2015) where a participant reported that it was people rather than technology

that was the main source of distraction for them. In fact, a number of studies explicitly state that the focus of their studies is technology-based multitasking or media multitasking. Although the focus of my research was to determine reasons students multitask between study and non-study-related activities when working on digital devices, my findings differ from the literature in that my participants' multitasking was technology as well as non-technology-based – the two could not always be separated, with non-technology-based multitasking frequently influencing technology-based multitasking. Further, unlike earlier research that only found disruption by people and noise as a source for multitasking (Thompson 2015, Levy 2016) my findings also unpacked other aspects of non-technology-based multitasking. These included study-related face-to-face conversation with coursemates/friends extending to non-study-related conversation (section 6.3.1.3) and non-study-related thoughts (section 6.3.2.9) that occupied some participants' minds during study-related activities.

What makes it important to uncover non-technology-based factors for multitasking is the frequency of its occurrence - as can be seen from section 6.2 and specifically Table 6.1, an uncondusive study environment was the second most-cited reason for multitasking by participants when not using the PT® and the main reason why participants multitasked during a pomodoro when using the PT®. In addition, as reported in sections 6.3.1.9 and 6.3.2.2, I found that some participants switched to technology-based multitasking due to non-technology-based multitasking, e.g. a physical interruption by a friend/family member causing a participant to 'lose focus' or break their 'flow',

and as a result switching to a non-study-related activity on their phone (non-study-related activities on the phone, whether they involved family members and friends, were considered technology-based multitasking).

As reported in section 6.3.2.9, it emerged from responses of two participants that even when they were not switching to a non-study-related activity, they were not focusing on a study-related task due to non-study-related thoughts, e.g. about a person or an event. Non-study-related thoughts as a reason for multitasking have not been widely reported in other research on multitasking in academic settings. Although some students of Levy (2016) did report their mind 'wandering' during their primary tasks, it was not always clear if the setting was academic-related (e.g. Levy's students observed their own behaviour when performing and/or trying to focus on undertaking tasks such as email/texting). One partial exception is the work of Deng (2020), who observes in passing a participant alluding to their mind wandering, which was a result of ignoring notifications on their phone, leading them to think what those notifications were about. However, Deng did not explore this issue further. One might argue that non-study-related thoughts may not be considered as multitasking by other studies. However, I have considered them as multitasking for the following reasons: firstly, non-study-related thoughts are off-task behaviour which match my conception of multitasking. Secondly, non-study-related thoughts can hijack executive control for its own attainment in turn impeding performance of executive function task (Marien et al. 2012). So even if a student is not multitasking to a tangible non-study-related activity, they are not focusing on the task. This in turn defeats the spirit with which this

research was pursued in the first place, i.e. to help students overcome the negative impact of multitasking. At this point, one may also question the difference between internal interruptions (e.g. an internal urge to access social media) and non-study-related thoughts. In my view the former are thoughts that can result in 'tangible' multitasking, whereas the latter only consumes the executive control and does not result in 'tangible' multitasking; though such issues are beyond the direct remit of this project, they would seem to warrant further investigation.

The implication of this finding is that technology forms one aspect of multitasking during study-related activities and in some instances non-technology-based multitasking can influence technology-based multitasking. Therefore, any strategy to help students manage multitasking should take into account both technology and non-technology-based multitasking.

7.3.3.3 Convergence of non-study-related activities on a phone

One participant reported that if they multitasked to a non-study-related application on a phone, they were likely to check updates for other non-study-related applications as well. No other study on students' experience on multitasking has uncovered the convergence of non-study-related activities on a phone as a contributing factor to multitasking. However, this aspect of multitasking appears reasonable in light of findings by Ofcom (2017) which report that 16-24 year olds (the demographic group of my participants) have their leisure/non-study-related activities converging on the phone, including accessing content, gaming, instant messaging and social networking. As this

reason for multitasking was not reported in experiences of other participants, these are of interest and hence further study is warranted.

7.3.3.4 Nature of study-related task

My research is the first of its kind to report the nature of the study-related task as a contributing factor for multitasking, although this was reported by one participant only. The participant said that they were more likely to multitask when drafting assignments compared with when they were searching for research papers. The participant said that this was because their mind was more likely to 'drift' when they had to think about what to write in the assignment.

Although earlier literature did not report this factor as a reason for multitasking, the participant's behaviour could be explained through other areas of literature on motivation and self-efficacy. Participants' motivation and self-efficacy vary from task to task (Bandura 1997, Schunk 2012) and hence it may be the case that a participant's self-efficacy for tasks involving having to think and write original text is lower than that of searching for research papers, making them more likely to multitask when engaged in the former rather than the latter. Furthermore, one is more likely to experience obstruction when having to draft an assignment requiring creative thinking compared with searching for research papers, and this obstruction, resulting in reduction in self-efficacy, is more likely to lead one to multitask (Adler and Benbunan-Fich 2013). Nevertheless, this reason for multitasking is of interest because it was reported by one participant only, and further study is required to explore this.

7.4 Contributions to the research on strategies for managing multitasking

As the strategy for managing multitasking evaluated for this research was the PT[®], this section will compare my findings of the evaluation of the technique with literature pertaining to strategies for managing multitasking (section 2.3) as well as evaluation of the PT[®] (section 3.4).

In the review of literature in chapter 2 and specifically in section 2.4.2.1, I reported that there was a dearth of evidence-based advice on ways multitasking can be managed effectively during independent study. This is especially significant because the majority of study time for a UK university student is expected to be self-managed – for a 15 credits module in the first year, a student is expected to spend, per week, roughly 2-3 hours on taught study, 4-5 hours on self-managed directed study (including preparatory and assessment tasks), and 3-4 hours on self-managed independent study (University of Hertfordshire 2016). Besides lack of evidence for effectiveness, I also pointed out methodological shortcomings (section 2.4.2.2) and the limited practical value (section 2.4.2.3) of some of the research involving formal evaluations of strategies for managing multitasking. In section 3.4.1, I also highlighted the lack of evaluation of the PT[®] in managing multitasking in academic contexts.

This primary contribution of this research study is that it is one of the first of its kind that explores the effectiveness of a strategy (i.e. the PT[®]) to help students manage multitasking between study and non-study-related activities

during independent study when working on computer-based devices. In addition, the technique has been refined in light of participant feedback and requirements as well as being evaluated for a long duration to ensure it was tested for a range of situations and circumstances.

Due to lack of evidenced-based strategies for managing multitasking as well as evaluation of the PT[®], there is not much congruence between previous literature and my findings (presented in section 7.2) on how the PT[®] might as a strategy to better help students in managing technology-based multitasking when undertaking independent study. The only points of congruence are with the literature reported in sections 2.3.2 and 2.3.5. In section 2.3.2, I presented evaluation of computer applications and web-plugins (Kim et al. 2016, Lottridge et al. 2016, Rooksby 2016, Whittaker et al. 2016) that informed users of their multitasking behaviour and patterns, in turn prompting them to reflect on how to avoid a repeat of the behaviour in the future. Although participants of my study did not employ a computer application to track their computer usage during pomodoros, the findings of my study are similar to the literature in that review of and reflection on voided pomodoros and interruptions helped some participants to identify and take measures to minimise multitasking in future pomodoros (reported in section 6.4.7). Of the former research studies, Whittaker et al. (2016) reported that some participants were reminded not to multitask merely by seeing the interface of the study (section 2.3.5). My findings reported in section 6.4.2 are similar to these in that some participants were reminded not to multitask either by just seeing the timer or by hearing the ticks of the timer.

A further contribution of this study is that it verified some of the strategies for managing multitasking reported in the literature (section 2.3) that also formed part of the PT[®] but for which evidence of their effectiveness in managing multitasking was not provided. These strategies for managing multitasking include taking measures to minimise multitasking before commencing study such as maintaining boundaries between study and non-study-related activities (Winter et al. 2010, Nash 2014), employing pre-scheduled breaks involving non-study-related activities (Jones and Healing 2010, Park 2014, Murray et al. 2020), and setting rewards for oneself for not multitasking (ibid) (although some students of Levy (2016) did report maintaining of boundaries between study and non-study-related activities useful in managing multitasking, it was not clear if the strategy was used in academic settings).

A suggestion to manage multitasking by Nash (2014) was to break larger tasks into smaller tasks. Although my participants did not report this to be a factor contributing to manage multitasking, it was suggested that breaking larger tasks into smaller tasks increased self-efficacy for the study-related task (section 6.5.4) making it more unlikely that they would multitask.

The study also verifies some of the claims on the effectiveness of various aspects of the PT[®] in the literature as well as wider discourse (e.g. blogs) (reported in section 3.4) that were not backed up by evidence. These claims about aspects of the PT[®] included deferring potential interruptions by writing them down (Cirillo 2013, Babuata 2015), the prospect of voiding an interruption serving as an incentive not to multitask (Cirillo 2013), the record of

interruptions serving as a basis for reflection on how to minimise interruptions in future pomodoros (ibid), and the inability of the PT[®] to be effective in preventing multitasking when the environment for study or work is unconducive (Dziubinski 2015, Roche 2018).

In the following paragraphs, I discuss how some of my findings pertaining to the effectiveness of the PT[®] as a strategy to manage multitasking relate to and/or are explained by other areas of literature.

In section 6.4.6, I provided an analysis of how breaks between pomodoros appeared to be one of the factors that governed the effectiveness of the PT[®] in preventing participants from multitasking. My analysis is supported by findings from Rosen et al. (2012) who report that in-class trials allowing one-minute technology breaks followed by a fifteen-minute study period boosted students' attention and improved their learning. 'Technology breaks' can aid in removing internal and external distractions, they explained, because they allow students opportunities to control an internal urge to obsess over what they might be missing out. Similarly, Patry et al. (2007), who used self-determination theory to investigate how students use leisure activities to cope with difficult tasks, reported that incorporating leisure activities in the overall study plan generated positive feelings, restored depleted resources, and helped study participants cope with and regulate demanding tasks and manage time effectively.

In section 6.4.4, I reported deferring of potential interruptions by writing them down as one of the aspects of the PT[®] contributing to its effectiveness in

managing multitasking. This is supported by findings of McFarlane (2002) who explored the effectiveness of negotiating interruptions in user interface design. McFarlane presented thirty undergraduate students with experimental conditions implementing four methods of coordinating interruptions. These were immediate (participants were interrupted with a new task directly regardless of the state of the primary task), negotiated (participants were given notification of availability of a secondary task and given control over when they would like to handle it), mediated (the software program calculated participants' workload on primary tasks and presented an interrupted task when workload was low), and scheduled (interruptions were presented according to a prearranged schedule). Of the four experimental scenarios, participants performed best in the task where the user interface design allowed them to negotiate interrupting tasks.

In section 6.5.4, I reported that participants alluded to some aspects of the PT[®] increasing their motivation and/or self-efficacy which in turn could prevent multitasking. These included breaking down tasks into smaller sub-tasks and marking a successful pomodoro by an 'X'. These findings are supported by research that has explored the relationship between goal achievement and rewards with motivation and self-efficacy. Dividing a goal into sub-goals increases the proximity of sub-goals, makes them explicit and making it easier to judge progress towards them, and provides immediate guidance for performance. This in turn increases the motivation and/or self-efficacy to achieve these sub-goals (Bandura and Schunk 1981, Schunk 1985, Steel and König 2006). Eight participants reported that marking successful pomodoros

by an 'X' was found rewarding and motivating and generated feelings of accomplishment. Rewards when linked with students' accomplishments have been found to increase motivation (Schunk 1984, Bandura 1986).

I reported in section 6.5.4 that a limitation of the PT[®] was that it was unable to address some of the factors that resulted in low self-efficacy and motivation for study-related activities such as teaching quality and delivery which in turn made participants more likely to multitask. This corroborates with findings of research related to multitasking in face-to-face and online classes which report that multitasking during class (Bolkan and Griffin 2017) and lack of participation in activities of an online course (Xie et al. 2006) was a function of instructor's teaching and the experiences of boredom it produced.

The convergence of my findings with other areas of literature suggests that scholars working on strategies for managing multitasking should consider scholarship in these other areas (McFarlane's (2002) work, for instance, is located in user interface design whereas research by Bandura and Schunk (1981), Schunk (1984) and Bandura (1986) is located in the field of self-efficacy and motivation).

7.5 Contributions to evaluation of the Pomodoro Technique[®]

Findings from evaluation of the PT[®] that relate to managing multitasking have been discussed already in section 7.4. This section therefore discusses those findings from the evaluation of the PT[®] that are about the broader use of the technique itself, rather than its effectiveness in managing multitasking.

In section 3.4.1, I highlighted a lack of evaluation of the PT[®] in managing multitasking in academic contexts. Furthermore, none of the research evaluating the PT[®] explicitly stated research methods employed to collect data and to evaluate the technique. The only exception is the study by Almalki (2020) (reported in section 3.4), which was published after the data collection period of this study had ended, and evaluated a tool based on the PT[®] that was developed with the aim of reducing procrastination amongst students. The contribution of this research in the evaluation of the PT[®] is that it is one of the first research that has evaluated the technique in academic contexts, explicitly stating the evaluation methodology, and determining how the technique is used for a prolonged period of time, capturing different situations and circumstances.

In view of the above, there were few evidenced-based findings in the literature that had a congruence with findings of this study. These include participants preferring to adjust the duration of pomodoros and breaks (section 6.5.8), and merging pomodoros (section 5.3.3), which were all reported by participants of Almalki (2020). However, a further contribution of this study is that it verifies some of the claims about the PT[®] - in the literature and the broader discourse such as blogs (as reported in section 3.4) - that were not previously backed up by evaluatory evidence. For instance, Martini (2014) notes that many practitioners of the PT[®] violate a number of its rules (e.g. not taking a break after a pomodoro ends, not voiding pomodoros). Findings of this research study similarly reveal that participants did not follow the rules of the technique (section 6.5.5).

Likewise, some discourse on the PT[®] claims that the requirement to abruptly end pomodoro breaks the 'flow' or 'momentum' (Vardy n.d., Dziubinski 2015, Roche 2018). For similar reasons, a few of my research participants also reported continuing, or wishing to continue, to work on study-related tasks even after the pomodoro ended (as reported in section 5.4.2.6, not ending the pomodoro abruptly was incorporated as a rule in the PT[®] following participant feedback).

Other claims about the PT[®] made by Cirillo (2013) were also verified by this study. These included ticks of the pomodoro timer being annoying initially and requiring time for users to get used to (section 6.5.6), egg/kitchen timers not suitable for shared study spaces (sections 5.3.5.2 and 5.4.5.2), not returning to study after the shorter or longer break when the intention was to study further (sections 5.3.5.6 and 5.4.5.6), and some potential interruptions only interesting or urgent during the pomodoro and losing their appeal once the pomodoro ended (section 5.3.5.4).

One claim about the PT[®], however, diverged from my findings. The author of the PT[®] claims that the ideal duration of the pomodoro is twenty to thirty-five minutes, with forty minutes as the maximum upper limit (Cirillo 2013). My findings differ in that duration of pomodoros that participants reported worked for them routinely ranged from twenty-five minutes to forty-five minutes (section 5.4.3), with one participant reporting positively on combining two pomodoros on occasions (section 5.3.3).

Some of my findings were not reported by either other literature or the wider discourse about the PT[®]. These included the activity inventory sheet (section 5.3.5.8) and duration of pomodoro (section 5.5.5.6) helping in 'getting to study', the terminology 'unplanned and urgent' in the activity inventory sheet (section 5.5.5.9) and making the distinction between internal and external interruption causing confusion (section 5.3.5.9), the activity inventory sheet helping in planning and organising study-related activities (section 5.3.5.8), and seeing the list of all tasks in the inventory sheet that one needed to undertake as 'off-putting' (section 5.3.5.1).

In the following paragraphs, I discuss how some of my findings pertaining to the evaluation of the PT[®] relate to and/or are explained by other areas of literature.

I reported in section 6.5.10 how the activity inventory sheet served as a reminder for study-related tasks for two participants making it more likely that they would be undertaking it. This corroborates with findings of Schunk (1985), who explored relationship between goal setting and self-efficacy, that setting goals for oneself (which is what the activity inventory sheet entails) brought increased commitments to complete the tasks associated with the goals.

I reported in section 6.5.11 that recording the number of completed tasks and any multitasking made participants aware of their progress, and review of the to-do-today sheet at the end of the day enabled one participant to identify

'productive' times of the day. This corroborates with advantages of the 'un-schedule', similar to the PT[®]'s activity inventory and to-do-today sheets: Burka and Yuen (2008) posit that one of the ways the un-schedule helps one achieve goals is by enabling self-monitoring of how time is actually managed and spent.

In section 5.5.5.7.5, I mentioned that one participant who earlier requested extending the duration of the shorter five-minute break between pomodoros to fifteen minutes later said that this was a 'waste of time' during examination lead-up times. When probed if this was not a 'waste of time' outside of the examination period, the participant said that they wanted longer breaks due to 'procrastination and laziness' and because they were not motivated by the study-related task. So the break was not being used to replenish cognitive resources but for procrastination and task avoidance purposes. This behaviour seems to resonate with the assertion of Patry et al. (2007) that too much time devoted to leisure activities can be a means to avert tasks and goals and may hinder regulation of cognitive resources.

I reported in section 5.4.3 that one participant did not void pomodoros when they considered an interruption as not impacting their focus on study-related activities (e.g. quickly handing-over a mobile charger to a peer requesting it). This can be explained in my view by the concept of 'automaticity' (Just et al. 2008) where tasks which are familiar and repeated cause the brain to rewire and are transferred from high to low cognitive load, in turn letting a person do one task while focusing on the other task.

7.6 Conclusion

This is one of the first studies that have elicited evidence-based advice on how students can be supported in better managing multitasking when undertaking independent study. The study is also the first formal evaluation of the strategy employed for this study, i.e. the PT[®] in an academic context. It was found that supporting students struggling with multitasking using the PT[®] involves having an appreciation of their context and an ongoing conversation with them about how they are using the PT[®], which aspects they are finding useful, and how it could be tailored to suit their needs. Therefore, there was no consensus amongst the participants on how the technique was useful to them with different participants finding different aspects of the technique helpful. Further, the technique may not always be effective in enabling its users to manage multitasking by itself, and may have to rely on contextual factors to have the desired outcome, such as a study environment devoid of interruptions that they not always had control over, sources of motivation in the form of assessment deadlines, and the quality of teaching received.

The research uncovered a number of reasons for multitasking that were not reported by previous research on technology-based multitasking. For instance, multitasking between study and non-study-related activities was not always due to technology and external factors other than technology were a considerable contributor. This research study has also been the first to identify the various ways in which convergence of technology for study and non-study-related activities contributes to multitasking.

In each of the three areas of literature to which the findings of my study make a contribution, I report how these relate to or are explained by other areas of literature. Examples include multitasking due to convergence of study and non-study-related platforms explained by research in human visual processing, breaks between pomodoros as an effective strategy to manage multitasking supported by similar strategy used in-class as well as research employing self-determination theory to investigate the use of leisure to cope with difficult tasks, effectiveness of deferring of potential interruptions during pomodoros supported by research into coordinating and negotiating interruptions in user interface design, and possible contribution of breaking down of tasks into sub-tasks and marking successful pomodoros by an 'X' in reducing multitasking explained by research into relationship of goal achievement and rewards with motivation and self-efficacy. Convergence of my findings with those from other areas of literature indicate the need for scholars working on multitasking and strategies to manage it to draw more extensively on scholarship from other areas (the only exception is work by Calderwood et al. (2014) who investigated students' multitasking behaviour during independent, self-directed study through the lens of task motivation and self-efficacy).

In the following chapter, I conclude this thesis by providing a summary of the research findings, and reflect on limitations and broader implications of my work on policy, practice and future research.

Chapter 8- Conclusion

8.1 Introduction

In the concluding chapter I first remind the readers about the objective of my research, and how that objective was approached. I then summarise the findings of this study that I interpreted from the data and acknowledge some limitations of the work. Next, I outline my contribution to new knowledge. To close the chapter I discuss the implications for policy, practice and future research.

8.2 Research objective

The objective of this research was triggered by my recognition of the phenomenon of multitasking between study and non-study-related activities amongst students and its adverse impact on their assessment outcomes. The challenge of multitasking is not helped by the popularity of the 'digital native'/'Net Gen' argument which posits that the current generation of university students is automatically proficient in the use of technology, including an ability to multitask across technological devices, just because they grew up using ubiquitous technology. Reviewing the literature revealed a lack of evidenced-based advice for struggling students to better manage multitasking between study and non-study-related activities. The review also revealed shortcomings of existing research on multitasking with respect to conceptions of multitasking employed and limited data collection methods for investigating it.

In view of the above, my objective for this research was to evaluate the effectiveness of the Pomodoro Technique[®] (PT) in helping undergraduate students at a UK university better manage multitasking when undertaking independent study. The technique was selected as an intervention for this study due to its alignment with existing practice and recommendations for managing multitasking, as well as my own practice. In concordance with my ontology and epistemology, discussed in section 4.2, I employed design-based research (DBR) to achieve my research objectives. This involved gaining an appreciation of my research participants' contexts and what caused them to multitask, and having an ongoing conversation with them about how they used the PT[®], which aspects they found useful, and collaborating with them to tailor the technique to suit their needs. Data collected across four DBR cycles over eight months was presented in detail. From the analysis of these data I argue a number of key findings.

8.3 Research findings

Participants multitasked due to a range of reasons, as highlighted in Tables 6.1, 6.2 and 6.3. Although the focus of this research was technology-based multitasking, I also found non-technology-based reasons for multitasking (such as interruptions by family and friends, non-study-related thoughts), which in some instances caused participants to engage in technology-based multitasking. Other important reasons for multitasking included the convergence of study and non-study-related platforms, the convergence of non-study-related activities on a phone, and the nature of the study-related task. Reasons for multitasking found by this study as well as reported by the literature have been highlighted in Figure 8.1. The box 'factors impacting low

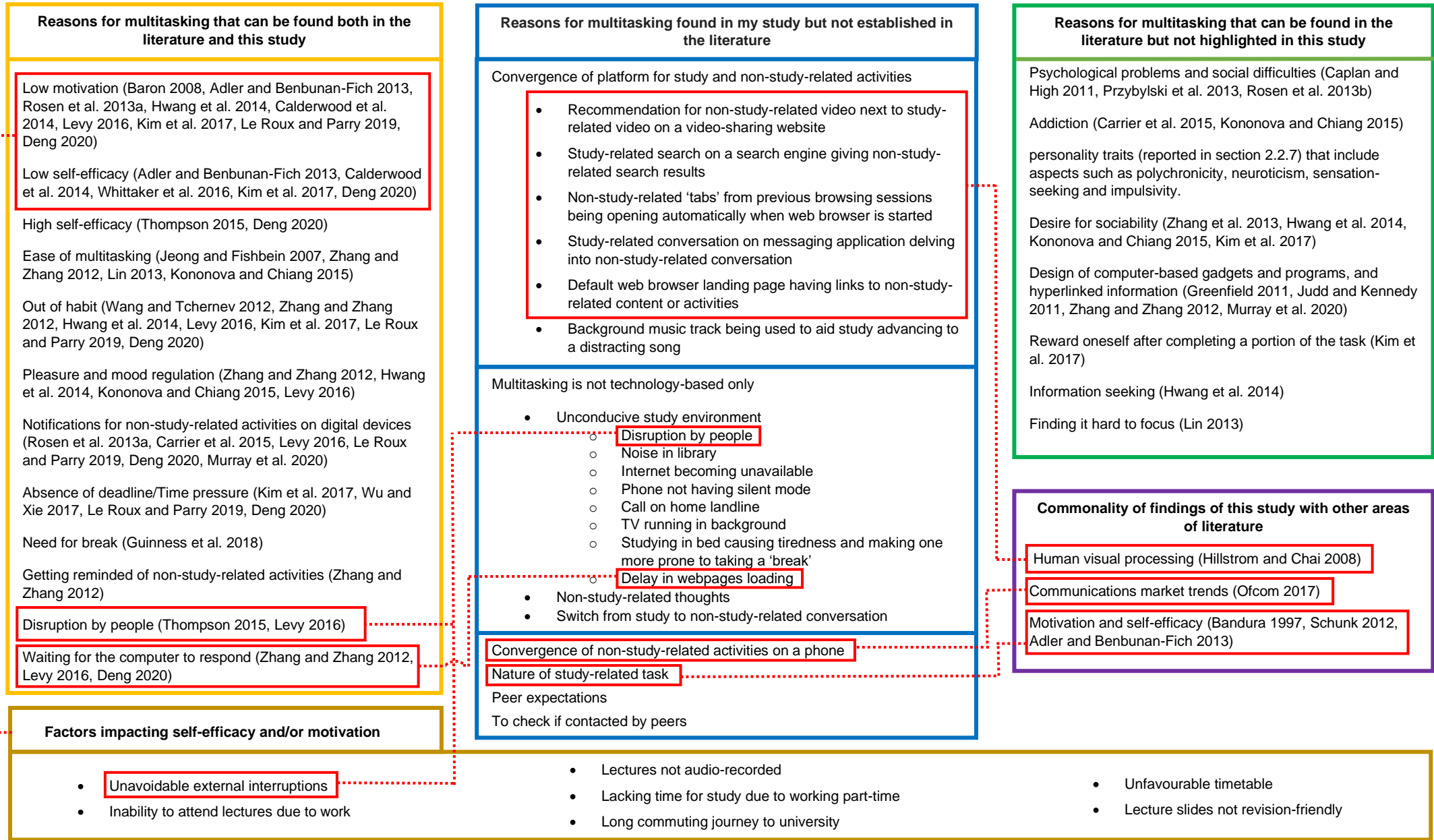


Figure 8.1 Reasons for multitasking found by this study and those reported in the literature (original work)

motivation and/or motivation' lists factors that were not reported to be the direct cause of multitasking, but appeared to influence participants' motivation and/or self-efficacy, thereby making them more likely to multitask.

The study commenced with twelve participants in DBR cycle 1. As can be seen from Figure 4.1, of these participants, ten attempted the PT[®] for the first time in DBR cycle 2, and seven participants remained till the final DBR cycle 4. Table 8.1 shows how individual study participants used the PT[®] in each DBR cycle (two of the twelve participants withdrew from the study after DBR cycle 1). The row for each participant shows how their use of the technique deviated from the technique instructions in terms of either not following the rules of the technique and/or introducing changes to the technique of their own. As stated in the sections 5.3.5.7, 5.4.5.7 and 5.5.5.7, readers are reminded that participants' experience of and feedback on several of the refinements introduced to the PT[®] could not be elicited, so if a participant appears to have not used a refinement, they may not have reported it but still availed of it. Participants who remained until the end of the study reported finding the PT[®] helpful in managing technology-based multitasking and intended to use the technique in the future. However, participants did not have consensus on how the technique helped them in managing multitasking. Different participants found different aspects of the technique useful in enabling them to manage multitasking. In addition, the technique helped some participants manage multitasking in some contexts but not others.

	DBR cycle 2	DBR cycle 3	DBR cycle 4
P1	▶Used digital timer in a public space	▶Used phone as timer ▶Interruptions not minimised occasionally ▶Completed pomodoro not recorded	▶Not following the template for AIS and TDTS ▶Not voiding pomodoros upon interruption ▶Completed pomodoro not recorded
P2	▶Interruptions not minimised occasionally ▶NSR tasks not listed in AIS ▶Used digital timer	▶NSR tasks not listed in AIS	▶Merging AIS and TDTS
P4	▶ Interruptions not minimised occasionally ▶Used digital timer ▶Not availing shorter break occasionally ▶Duration of shorter break reduced	▶Used tablet as timer ▶Pomodoro not voided if interruption not distracting	▶Not following the template for AIS and TDTS ▶Recording NSR tasks on electronic calendar ▶Recording start and end time of pomodoro ▶Not recording potential interruptions
P9	▶ AIS and TDTS not used ▶Duration of shorter break extended ▶Duration of longer break extended	▶AIS not used ▶Used phone as timer	▶Used stopwatch as timer
P11	▶AIS not used ▶Duration of longer break extended	▶AIS not used	▶Merging AIS and TDTS ▶Recording task progress with a pomodoro
P6	▶Interruptions not minimised occasionally	Did not appear for interview	▶Not working in pomodoros
P10	▶ Interruptions not minimised occasionally ▶AIS and TDTS not used ▶Timer not used	Did not appear for interview	▶Not following the template for AIS and TDTS ▶Not dividing tasks into sub-tasks
P3	▶Timer not used	Withdrew from study	
P7	▶ NSR tasks not listed in AIS ▶Used digital timer ▶Duration of longer break extended	Withdrew from study	
P8	▶Duration of shorter break extended ▶Duration of longer break extended	Withdrew from study	

AIS = Activity inventory sheet, TDTS = To-do-today sheet, NSR= Non-study-related

Table 8.1 Variances to the PT[®] by individual participants across DBR cycles 2, 3 and 4

The PT[®] appeared to have addressed some of the reasons for multitasking, e.g. absence of break, pleasure and mood regulation, ease of multitasking. Yet there were other reasons for multitasking that the PT[®] did not appear to have addressed, e.g. uncondusive environment for study, absence of deadline/time pressure, peer expectations.

Different aspects of the technique appeared to have contributed to addressing the reasons for multitasking. For instance, the 'need for break' appeared to be addressed by the PT[®]'s provision of breaks between pomodoros. Similarly, the duration of the pomodoro was short enough for some participants to wait until the break to pursue 'pleasure and mood regulation'. There was also evidence of different aspects of the technique appearing to increase participants' self-efficacy and motivation making it less likely that they would multitask. For example, recording of a completed pomodoro generated feelings of accomplishment and achievement which, in turn, increased their motivation for the task.

PT[®] may not have been able to address other reasons for multitasking due to a range of factors which included participants not following the technique, an uncondusive environment for study (e.g. interruptions by family/friends) which were beyond participants' control, lack of examination pressure, and convergence of study and non-study-related activities making it difficult to shut out distractions.

Participants' motivation and self-efficacy for study-related activities, which impacts their multitasking behaviour, appeared to be influenced by several factors which could have an impact on the effectiveness of the PT[®]. Examples of these factors included dissatisfaction with teaching quality, juggling work and study. Participants' affective states also impacted how effectively the technique was used (e.g. not returning to study after a shorter or longer break). Whereas for some participants PT[®] was not required when assessment deadlines were close, for some others it was the assessment deadline that motivated them to 'get to study' and use the PT[®].

A number of other contextual factors were found to have contributed to the effectiveness of the PT[®] in helping participants. These factors included the technique being amended in light of their experience and feedback and/or participants not following some of its rules, allowing time to get used to the PT[®] before accruing its benefits, the mode of study, i.e. individual or group, the way instructions were presented to participants, and the perceived advantages of the PT[®] other than helping in managing multitasking positively impacting perceptions and adoption of the technique.

Figure 8.2 presents a framework on using the PT[®] to support undergraduate students to better manage technology-based multitasking during independent study. The figure lists the reasons for multitasking that may be addressed by use of the PT[®] (discussed in section 6.3.1) and that may not be addressed by the technique (discussed in section 6.3.2). The coloured lines in the figure

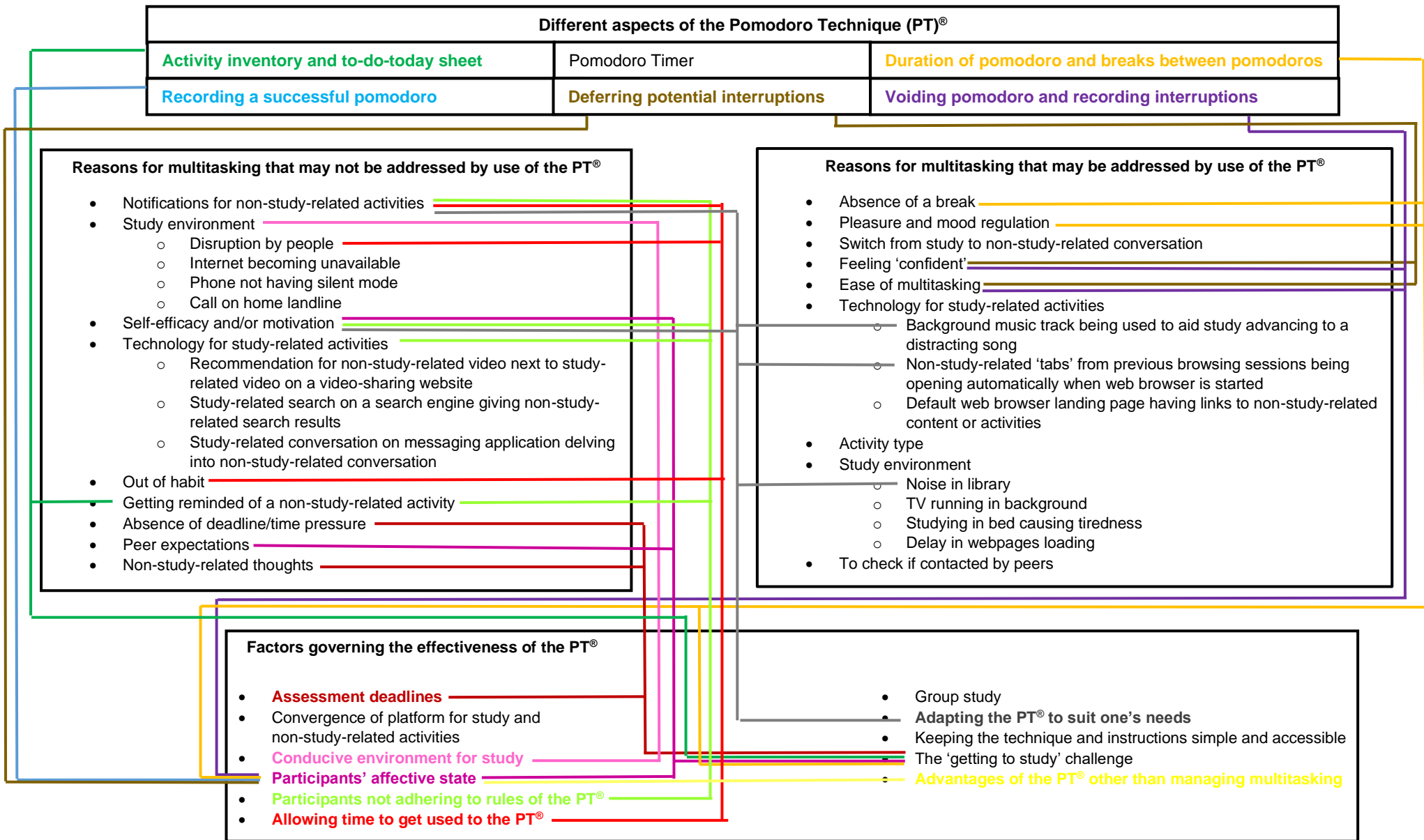


Figure 8.2 Framework on using the PT[®] to support undergraduate students better manage technology-based multitasking during independent study (original work)

depict connections between different aspects of the PT[®] and the reasons for multitasking (discussed in sections 6.3 and 6.4), and reasons for multitasking and the factors governing the effectiveness of the PT[®] (discussed in section 6.5).

8.4 Limitations

Certain aspects of the data collection may have impacted the validity of findings of this study. Data logging tools prescribed to participants to improve accuracy of participants' reporting of their multitasking behaviour and minimise recall bias were only used by one participant. Two participants did not bring diary or activity inventory/to-do-today sheets on to three interviews between them which may have impacted on the accuracy of reporting of data.

Nevertheless, this is still an approach worth pursuing as it provides data that contrasts well with the methods other studies on multitasking have used.

As mentioned in section 4.6, some of the prescribed measures for improving validity could not be followed. These included not piloting the interview questions prior to using them in the study (although they were discussed with my supervisor), coding data by multiple researchers (although they were discussed with a critical friend), and member-checking/respondent validation (although aspects of interviews not clear were re-visited with participants in subsequent interviews, the overall research findings could not be checked as participants had graduated by that time).

Participants' experience of and feedback on several of the refinements introduced to the PT[®] could not be elicited, which is another limitation of this study. A few participants did not follow the rules of the PT[®] (e.g. did not break a larger task into smaller sub-tasks) which may have impacted on the extent to which the technique was effective for them. Some of the reasons for multitasking (e.g. multitasking dependent on type of activity) were reported by participants who left the study after the first DBR cycle without using the technique. Therefore, it was not possible to determine if PT[®] could have addressed these reasons for multitasking or not. Another factor impacting the findings is of some participants not using the PT[®] for the prescribed number of days (e.g. in DBR cycle 2, P9 only used the technique for two days).

This research was conducted in a post-92 higher education institution in the UK with subject disciplines limited to life sciences, pharmacy, chemistry and computer science. Students from different disciplines might differ in their approaches to learning (Kember et al. 2008). Therefore, the results of my research study are limited to the narrow bounds described in this thesis. Nevertheless, I have provided rich contextual and methodological information to enable readers to make judgements about the potential transferability and applicability of the findings to other contexts.

8.5 Contribution to new knowledge

The primary contribution of my research study is that it is one of the first of its kind that evaluates the effectiveness of a strategy, i.e. the PT[®], to help students manage multitasking between study and non-study-related activities

when undertaking independent study on computer-based devices. The research is also the first formal evaluation of the PT[®] in an academic context. Findings of my study demonstrate ways in which the PT[®] is able to support students in managing multitasking and the contexts that govern its effectiveness. This is important because much of the literature remains concerned with whether 'digital native'/'Net Gen' students are better at multitasking than earlier generations (with much empirical evidence concluding that they are not), which has distracted attention from the need to provide support to students who struggle with the issue. Crucially, the findings demonstrated that a one-size-fits-all approach does not work – participants modified the technique in different ways for it to work for them.

A number of strategies for managing multitasking reported in the literature have not previously been backed up by evidence. Some of these strategies also form an aspect of the PT[®]. Thus, another contribution of this study is that it has verified claims made about the effectiveness of these strategies. These strategies for managing multitasking include taking measures to minimise interruptions before commencing study, such as maintaining boundaries between study and non-study-related activities, employing pre-scheduled breaks involving non-study-related activities, self-reflection on one's behaviour post-study to see how improvements could be made, and setting rewards for oneself for not multitasking.

The study also verifies some of the claims about the PT[®] in the literature and in the broader discourse such as blogs (reported in section 3.4) that were not backed up by evaluatory evidence, as detailed in section 7.5.

My research findings have also uncovered some reasons for students engaging in multitasking which have either not been reported in literature before or not in sufficient depth. These reasons include students multitasking due to use of the same digital platform for study and non-study-related activities, multitasking taking place due to technology-based as well as non-technology-based factors, convergence of non-study-related activities on a phone, and the nature of the study-related task. Of the above reasons, the finding that students multitask both due to technology and non-technology-based reasons is important because multitasking involving digital devices has been studied in isolation in the overwhelming majority of studies, whereas my findings show that non-technology-related multitasking also influences technology based-multitasking.

Another key contribution is the convergence of my findings with those from other areas of literature (e.g. human visual processing, affective states such as self-efficacy and motivation). This indicates the need for scholars working on multitasking and strategies to manage it to draw more extensively on scholarship from other areas.

8.6 Implications for policy

I highlighted in section 1.3 that the challenge of multitasking has not been acknowledged in the UK government digital strategy. Recognition of the issue of multitasking and support to address it in the government's digital strategy will have an impact on higher education institutions (HEIs) like my institution where management of multitasking does not feature in its digital and academic skills programmes and which in the past has shaped its policies in

light of government priorities. It will also encourage the allocation of more resources to the evaluation of what works and what does not work when supporting students in managing multitasking in a wide range of contexts.

Similarly, findings of this study imply that HEI policies on teaching and learning need to recognise the challenge of multitasking and accordingly offer provision on supporting students. The institutional teaching and learning policy is the appropriate policy to reconsider as it is this policy that addresses issues associated with multitasking that have been highlighted by this study, and which fall in the areas of student wellbeing, appropriate academic support, student assessment outcomes, and teaching quality. Section 8.7 provides details on how the PT® can be embedded within an HEI.

Although efforts to support students in better managing multitasking at a local level can be made, in my view the problem has to be recognised at a government level for the schools and higher education sector as well as technology companies to take notice and act. Government policy on multitasking is also vital because of the myths around the capabilities of the so-called 'digital native'/'Net Gen' generation which assume that they are adept at multitasking and do not struggle with it.

As mentioned in section 1.3, digital wellbeing forms part of the digital competency frameworks by organisations such as the European Commission and Jisc, with managing distractions as an example of this competency. This

study has demonstrated that some participants' experiences of managing multitasking has in turn helped them in their wellbeing, e.g.,

'(after recording a pomodoro) I felt like look at the time I have spent I am like so proud of myself... coz you think you never spent that much time studying and now you are...' (P7)

The findings therefore emphasise the importance of supporting students with managing multitasking when considering their wellbeing. UK HEIs should refer to Jisc's digital capabilities framework when devising their digital literacy provision, which acknowledges the multitasking issue. Further, digital wellbeing should not be limited to internet safety and maintaining privacy online as digital skills provision of many UK HEIs indicates (reported in section 1.3), but also incorporate evidenced-based advice on managing multitasking.

I mentioned in section 1.3 how Jisc's digital capabilities framework includes the capability to 'manage digital workload, overload and distraction'. However, the organisation's digital capabilities discovery tool⁵, which enables users to self-assess their digital capabilities, only asks if a user is confident in their ability to 'log off from emails, social media for periods of concentration'. As I have reported in my findings, managing multitasking is much more complex than logging off from devices (e.g. managing multitasking when the same platform, such as video-sharing website, is being used for study and non-

⁵ <https://digitalcapability.jisc.ac.uk/our-service/discovery-tool/> (Accessed: 1.11.19)

study-related activities) and in my view the tool needs to be adapted to encapsulate this complexity.

8.7 Implications for practice

I highlighted in section 1.3 that although the challenge of multitasking was recognised at some level of policy, institutional programmes on academic skills and digital literacies have not incorporated evidence-based advice on multitasking. HEIs should incorporate into their curricula evidence-based advice on managing multitasking, especially within modules where academic skills are already taught to students, and provision of student support services related to academic skills. To this end, the findings and recommendations of this study may be found useful by educators, curriculum designers, senior managers, policymakers, learning technologists and other members of staff involved in student support services. By demonstrating the advantages of the PT[®] and the conditions in which it works, it is hoped that there may be an increase in its incorporation in study skills curricula and propagation by educators, learning technologists and student support services.

The findings demonstrate that the PT[®] as a strategy for multitasking worked for participants when they used it over a long period of time, had the opportunity to work with a practitioner to reflect on their experiences and refine it to their needs. In addition, the refinements for the technique varied between participants. This implies that programs to help students manage multitasking should not be one-off events, but rather involve a continuous dialogue between practitioner and students, with the latter providing the opportunity to

reflect on their experiences and modify their strategies for multitasking accordingly.

As for implications for my own practice, I will advocate for the adoption of a digital literacy strategy based on Jisc's digital capabilities framework within my institution. I will liaise with my departmental management and academic skills centres to advocate provision of evidenced-based advice to students to help them better manage multitasking. To this end, I will offer workshops on the PT® to students in my faculty as part of the provision of the study skills centre, incorporating the refinements to the technique that resulted from the evaluation of the technique.

A finding of this study was the convergence of technological platforms for study and non-study-related activities when examining the reasons for multitasking. Students multitasked when stimuli for a non-study-related activity were presented next to a study-related activity, e.g. recommendations for non-study-related videos on the video-sharing website YouTube. I also reported that recording interrupted pomodoros was a source of reflection amongst participants on how they could avoid repeating their behaviour in future. Some participants also wanted features like the ability to switch off applications or internet at specified times to prevent them from spending more time on non-study-related activities than expected. This implies that technology companies can include features that enable users to: customise the interface of their programs and apps so that distracting aspects can be shut out, view a record of their activity, have greater control on how they receive notifications for new

activity on programs/applications, and allow them to set time limits on their use of the programs/websites and apps. Since work on this research commenced, big players in mobile technology such as Google and Apple are beginning to incorporate 'digital wellbeing' tools. These include a dashboard informing users of the time one is spending on the phone and specifically on which apps (Apple 2019, Google 2019), an app timer setting that limits usage of apps on phones (ibid), 'take a break' reminders on the video sharing/hosting website YouTube, and combining all YouTube notifications so they come once during the day (Google Developers 2018). These are steps in the right direction and other platform developers need to emulate this.

Academics and learning technologists in UK higher education are employing technologies used by students primarily for non-study-related activities for educational purposes (UCISA 2018). Examples includes lecturers publishing learning materials on video sharing websites (e.g. YouTube) and the use of social media websites (e.g. Facebook, Twitter) for classroom activities and for facilitating collaboration and group work. As convergence of platforms for study and non-study-related activities was found to be a reason for multitasking, the advocacy of the use of social media tools in education should be carefully considered when mobilised in practice settings.

A finding of this study was that students' self-efficacy and motivation, which influence multitasking behaviour, was shaped by a number of factors and the PT[®] was limited in altering student behaviour in presence of these factors. Examples of these factors included dissatisfaction with teaching quality,

commuting distance between home and university, and juggling work and study. Several UK HEIs including my own institution have been taking steps to address these factors which include teacher training qualifications for staff. Teaching quality and life contexts can impede any efforts to support students in better managing multitasking and hence HEIs should step up efforts to address these factors.

The thesis also demonstrates the feasibility of DBR and its usefulness for those wishing to adopt it as a research methodology for doctoral dissertations.

8.8 Implications for future research

In this section, I discuss the implications of this study's findings on future research in terms of conceptions of multitasking, research design, research contexts, reasons for multitasking, strategies for multitasking, and the link between multitasking and assessment outcomes.

8.8.1 Conceptions of multitasking

This research study uncovered that students not only multitasked when using technology environments but also due to non-technology-based factors.

Although the focus of this research was technology-based multitasking, I considered non-technology-based factors such as non-study-related thoughts, interruptions by friends/family, as well. This is because this research was pursued due to the negative impact of multitasking on student assessment outcomes. Therefore, those wishing to conduct research in the field of strategies for technology-based managing multitasking or digital distraction should take into account all reasons, whether these are technology or non-

technology-based. In addition, I believe that one of the reasons I captured a more in-depth and complex picture of the multitasking phenomenon is due to the conceptions of multitasking (i.e. off task behaviour) and approach for data collection (i.e. in-situ, longitudinal) I adopted for this study. Those wishing to conduct research in the field of multitasking should consider employing these conceptions of multitasking and approaches to data collection to get richer, in-depth understandings of the multitasking phenomenon.

8.8.2 Research design

Similar research in future can improve the research design to strengthen accuracy of data pertaining to students' multitasking behaviour. Means other than data logging tools to enable participants to recall their multitasking behaviour more accurately (e.g. the Experience Sampling Method employed by Moreno et al. (2012) which sends mobile text based surveys to participants several times a day) can be incorporated.

8.8.3 Research contexts

This research study was conducted in a post-92 higher education institution in the UK with limited subject areas. Future studies may extend this research to varied institutions, subject areas (including those related to design and arts) and even culture.

8.8.4 Reasons for multitasking

A couple of reasons for multitasking unpacked by my findings, namely convergence of non-study-related activities on their mobile phones and the

nature of study-related tasks, were experienced by one participant only. Future studies on multitasking can investigate these factors further.

Caplan and High (2011), in a review of literature on online social interaction and problematic internet use, reported that people with psychological problems and social and interpersonal difficulties (e.g. loneliness, social anxiety) are more drawn to online social interaction than those without these difficulties, and are more likely to be engaged in compulsive internet use, i.e. the inability to control or regulate one's online behaviour. This research did not aim to take account of such issues. This factor can be taken into account when investigating multitasking in future studies. Some research in multitasking has found factors such as age (Brasel and Gips 2011, Voorveld and van der Goot 2013, Carrier et al. 2009), gender (Schultz et al. 2003, Pilotta et al. 2004), and level of education (Rhee et al. 2006, Kang 2011) as predictors of multitasking, and these factors can also be considered in future investigations.

In section 7.3.3.2, I argued that two aspects of multitasking, internal interruptions and non-study-related thoughts, were different in that the former are thoughts that result in 'tangible' multitasking whereas the later only consume the executive control and do not result in 'tangible' multitasking. Future studies on multitasking can explore this issue further.

I reported in section 6.5.4 that participants' self-efficacy and motivation, which appears to influence their multitasking behaviour, was shaped by a

combination of different factors including dissatisfaction with teaching and teachers. Future research can explore the link between teaching quality, affective states and multitasking during independent study more closely.

8.8.5 Strategies for managing multitasking

There are a wide range of suggestions to increase students' motivation and self-efficacy that can only be administered by teachers (e.g. Reeve and Jang 2006, Schunk 2012). Future research could investigate if administering those proposals by teachers has an impact on students' multitasking as well as on the effectiveness of the PT[®] in managing multitasking.

After data collection of this study concluded, I came across exercises for managing attention and multitasking by Levy (2016). These include self-observation and mindful breathing exercises involving focus on one's breathing, posture and feelings/emotions when using digital devices and multitasking. Some of Levy's students appeared to find these strategies helpful in maintaining focus on technology-based tasks including warding off non-study-related thoughts (which PT[®] did not help with), although it was not clear if the strategies were used in academic or a general technology context. Nevertheless, I intend to incorporate these exercises in PT[®] for future studies with the view to exploring their contribution to managing multitasking.

As reported earlier in this thesis, I suggested the use of computer and phone-based 'blocking' tools to my participants to facilitate in minimising multitasking. These were used by only one participant and that too was quite limited. Future research into the PT[®] can evaluate its use in conjunction with 'blocking' tools.

When I introduced software tools for managing multitasking and apps for logging computer/mobile users to participants, I made them aware of the data protection implications of using these tools as it was not clear if these tools complied with the European Union's data protection regulations. Future studies can explore if data protection implications of using these tools deter them from using these.

A factor contributing to DBR cycle 4 participants benefiting from the PT[®] was the research process itself, i.e., working in collaboration with the researcher to reflect on the efficacy of the technique in managing multitasking, and refining it over time so that it works for them. However, no participant reported or acknowledged the contribution of the researcher, and reflections enabled by the interviews leading to refinements in the technique, in changing their multitasking behaviour. Therefore, future research can enquire about participant reflections on the contribution of the DBR process and the researcher in coming up with a workable solution for managing multitasking.

I reported in section 5.5.5.8 that a participant found the PT[®] 'difficult to implement' for group work. As mentioned in section 3.4, Wang et al. (2010) have evaluated the introduction of the PT[®] to a team of software developers working in a professional setting. Future research in PT[®] can investigate its impact by introducing it in academic settings to entire classes and encouraging students to employ it in group work, as opposed to independent study which was the focus of this work. This might be especially useful because friends/fellow students were reported by participants of this study to

be a reason for multitasking – Pintrich (2003) suggests that instead of causing distraction, students’ social goals could be harnessed in service of academic goals and using PT[®] in groups could be a way of linking social and academic goals and outcomes.

8.8.6 Multitasking and assessment outcomes

I mentioned in section 5.3.5.5 that a student did not view some of the interruptions impacting on their focus and/or performance, and voiding pomodoros due to those interruptions was found demotivating. Future research can investigate whether entertaining such interruptions during study-related activities could have an adverse impact on students’ assessment outcomes.

References

- Aagaard, J., 2019. Multitasking as distraction: A conceptual analysis of media multitasking research. *Theory & Psychology*, 29, pp. 87–99. <https://doi.org/10.1177/0959354318815766>
- Adcroft, S.K., 2018. Developing Self-regulated Learning with Time Management and Mindfulness Practice. Fordham University, New York, NY.
- Adler, R.F., Benbunan-Fich, R., 2013. Self-interruptions in discretionary multitasking. *Computers in Human Behavior*, 29, pp. 1441–1449. <https://doi.org/10.1016/j.chb.2013.01.040>
- Alghamdi, A.H., Li, L., 2013. Adapting Design-Based Research as a Research. *Methodology in Educational Settings*, 1, pp. 1-12.
- Allen, D., 2001. Getting Things Done. Penguin Books, London, England.
- Allen, I.E., Seaman, J., Poulin, R., Straut, T.T., 2016. Online Report Card - Tracking Online Education in the United States. Babson Survey Research Group, Babson Park, MA.
- Almalki, K., Alharbi, O., Aljohani, M., 2020, Anti-procrastination Online Tool for Graduate Students Based on the Pomodoro Technique. In: Learning and Collaboration Technologies. Human and Technology Ecosystems. Presented at International Conference on Human-Computer Interaction. Springer, Cham, pp. 133–144. https://doi.org/10.1007/978-3-030-50506-6_10
- Altmann, E.M., Trafton, J.G., 2002. Memory for goals: An activation-based model. *Cognitive Science*, 26, pp. 39–83.
- Anderson, G.L., Jones, F., 2000. Knowledge generation in educational administration from the inside out: the promise and perils of site-based, administrator research. *Educational Administration Quarterly*, 36, pp. 428–464.
- Anderson, T., Shattuck, J., 2012. Design-Based Research: A Decade of Progress in Education Research? *Educational Researcher*, 41, pp.16-25. <https://doi.org/10.3102/0013189X11428813>
- Anglia Ruskin University, 2016. About 5 Days of Digital Literacy [online]. Available at: <https://5daysofdigitalliteracy.com/about-5-days-of-digital-literacy/> (Accessed 5.6.19).
- Apple, 2019. Use Screen Time on your iPhone, iPad, or iPod touch [online]. Available at: <https://support.apple.com/en-gb/HT208982> (Accessed 8.5.19).

- Babuata, L., 2012. Zen To Done: The Ultimate Simple Productivity System [online]. Phatbits LLC. Available at: <https://www.amazon.co.uk/Zen-Done-Ultimate-Simple-Productivity/dp/1434103188> (Accessed 8.5.19)
- Baker, S.E., Edwards, R., 2012. How many qualitative interviews is enough? Discussion Paper. NCRM. (Unpublished)
- Bandura, A., 1997. Self-efficacy: The exercise of control. W. H. Freeman, Basingstoke.
- Bandura, A., 1986. Social Foundations of Thought and Action. Pearson, Englewood Cliffs, NJ.
- Bandura, A., Schunk, D.H., 1981. Cultivating Competence, Self-Efficacy, and Intrinsic Interest Through Proximal Self-Motivation. *Journal of Personality and Social Psychology*, 41, pp. 586–598.
- Bardhi, F., Rohm, A.J., Sultan, F., 2010. Tuning in and tuning out: media multitasking among young consumers. *Journal of Consumer Behaviour*, 9, pp. 316–332. <https://doi.org/10.1002/cb.320>
- Baron, N.S., 2008. Adjusting the Volume: Technology and Multitasking in Discourse Control, In: Katz, J.E. (Ed.), Handbook of Mobile Communication Studies. The MIT Press, Cambridge, MA, pp. 177–194. <https://doi.org/10.7551/mitpress/9780262113120.003.0014>
- Barratt E.S., Patton J.H., 1983. Impulsivity: Cognitive, behavioral, and psychophysiological correlates. In: Zuckerman M. (Ed.), Biological basis of sensation-seeking, impulsivity, and anxiety. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 77–116.
- Bast, F., 2016. Crux of time management for students. *Resonance*, 21, pp. 71–88. <https://doi.org/10.1007/s12045-016-0296-6>
- Beetham, H., Newman, T., Knight, S., 2018. Digital experience insights survey 2018: Findings from Australian and New Zealand university students. Jisc, Bristol, England.
- Berdik, C., 2018. To ban or not to ban: Teachers grapple with forcing students to disconnect from technology. Washington Post.
- Bloor, M., Wood, F., 2006. Keywords in Qualitative Methods: A Vocabulary of Research Concepts. Sage, London, England.
- Bociurkiw, M., 2018. French schools say “Non!” to cellphones [online]. CNN. Available at: <https://www.cnn.com/2018/09/03/opinions/france-smartphone-ban-opinion-bociurkiw/index.html> (Accessed 3.6.19).
- Boliver, V., 2015. Are there distinctive clusters of higher and lower status universities in the UK? *Oxford Review of Education*, 41, pp. 608–627. <https://doi.org/10.1080/03054985.2015.1082905>

- Bolkan, S., Griffin, D.J., 2017. Students' use of cell phones in class for off-task behaviors: the indirect impact of instructors' teaching behaviors through boredom and students' attitudes. *Communication Education*, 66, pp. 313–329. <https://doi.org/10.1080/03634523.2016.1241888>
- Booth, A., Papaioannou, D., Sutton, A., 2012. Systematic approaches to a successful literature review. Sage, Thousand Oaks, CA.
- Bowling, A., 2009. Research methods in health, 3rd ed. OU Press, Maidenhead, Berkshire.
- Bowman, L.L., Levine, L.E., Waite, B.M., Gendron, M., 2010. Can students really multitask? An experimental study of instant messaging while reading. *Computers & Education*, 54, pp. 927–931. <https://doi.org/10.1016/j.compedu.2009.09.024>
- Bowyer, J., Chambers, L., 2017. Evaluating blended learning: Bringing the elements together. *Research Matters: A Cambridge Assessment Publication*, 23, pp. 17–26.
- Brasel, S.A., Gips, J., 2011. Media Multitasking Behavior: Concurrent Television and Computer Usage. *Cyberpsychology, Behavior, and Social Networking*, 14, pp. 527–534. <https://doi.org/10.1089/cyber.2010.0350>
- Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, pp. 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brock-Utne, B., 1996. Reliability and validity in qualitative research within education in Africa. *International Review of Education*, 42, pp. 605–21.
- Brown, A.L., 1992. Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *The Journal of the Learning Sciences*, 2, pp. 141–178.
- Burka, J.B., Yuen, L.M., 2008. Procrastination: Why you do it, What to do about it now. Da Capo Press, Cambridge, MA.
- Calderwood, C., Ackerman, P.L., Conklin, E.M., 2014. What else do college students “do” while studying? An investigation of multitasking. *Computers & Education*, 75, pp. 19–29. <https://doi.org/10.1016/j.compedu.2014.02.004>
- Cambridge Dictionary, n.d. DISTRACTION | meaning in the Cambridge English Dictionary [online]. Available at: <https://dictionary.cambridge.org/dictionary/english/distraction> (Accessed 6.3.20).

- Canadian Digital Learning Research Association, 2018. Tracking Online and Distance Education in Canadian Universities and Colleges: 2018 [online]. Canadian Digital Learning Research Association. Available at: <https://eduq.info/xmlui/handle/11515/37136> (Accessed 6.3.20).
- Caplan, S.E., High, A.C., 2011. Online Social Interaction, Psychosocial Well-Being, and Problematic Internet Use, In: Young, K.S., de Abreu, C.N. (Eds.), *Internet Addiction: A Handbook and Guide to Evaluation and Treatment*. John Wiley & Sons, Inc., Hoboken, NJ, pp. 35–53. <https://doi.org/10.1002/9781118013991.ch3>
- Cardoso-Leite, P., Kludt, R., Vignola, G., Ma, W.J., Green, C.S., Bavelier, D., 2016. Technology consumption and cognitive control: Contrasting action video game experience with media multitasking. *Attention, Perception, & Psychophysics*, 78, pp. 218–241. <https://doi.org/10.3758/s13414-015-0988-0>
- Carrier, L.M., Cheever, N.A., Rose, L.D., Benitez, S., Chang, J., 2009. Multitasking across generations: Multitasking choices and difficulty ratings in three generations of Americans. *Computers in Human Behavior*, 25, pp. 483–489.
- Carrier, L.M., Rosen, L.D., Cheever, N.A., Lim, A.F., 2015. Causes, effects, and practicalities of everyday multitasking. *Developmental Review*, 35, pp. 64–78. <https://doi.org/10.1016/j.dr.2014.12.005>
- Chang, T., 2012. Predictors of multitasking behavior and the impact of multitasking on learning. Southern Illinois University, Carbondale, IL.
- Chen, L., Nath, R., Tang, Z., 2020. Understanding the determinants of digital distraction: An automatic thinking behavior perspective. *Computers in Human Behavior*, 104, pp. 1–11. <https://doi.org/10.1016/j.chb.2019.106195>
- Cho, V., 2016. Organizational problem solving around digital distraction. *Journal of Professional Capital and Community*, 1, pp. 145–158. <https://doi.org/10.1108/JPCC-11-2015-0009>
- Cirillo Consulting GMBH, 2013. Pomodoro® Trademark Guidelines | Cirillo Consulting GmbH [online]. Available at: <https://francescocirillo.com/pages/pomodoro-trademark-guidelines> (Accessed 9.10.19).
- Cirillo Consulting GmbH, n.d. The Pomodoro Technique® [online]. Available at: <https://francescocirillo.com/pages/pomodoro-technique> (Accessed 22.3.17).
- Cirillo, F., 2013. The Pomodoro Technique. FC Garage, Berlin, Germany.
- Cobb, P., Confrey, J., diSessa, A., Lehrer, R., Schauble, L., 2003. Design Experiments in Educational Research. *Educational Researcher*, 32, pp. 9-13. <https://doi.org/10.3102/0013189X032001009>

- Cohen, L., Manion, L., Morrison, K., 2007. *Research methods in education*, 6th ed. ed. Routledge, London.
- Corno, L., 1989. Self-Regulated Learning: A Volitional Analysis, In: Zimmerman, B.J., Schunk, D.H. (Eds.), *Self-Regulated Learning and Academic Achievement*. Springer Series in Cognitive Development. Springer, New York, NY.
- Corti, L., 1993. Using diaries in social research [online]. *Social Research Update*, 2. Available at: <http://repository.essex.ac.uk/24606/> (Accessed 23.3.20)
- Council for the Defence of British Universities, 2019. Higher education in England: Frequently Asked Questions [online]. Available at: <http://cdbu.org.uk/higher-education-in-england-frequently-asked-questions/> (accessed 14.02.2021)
- Creswell, J.W., 2013. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage, Thousand Oaks, CA.
- Darmoul, S., Ahmad, A., Ghaleb, M., Alkahtani, M., 2015. Interruption Management in Human Multitasking Environments. *IFAC-PapersOnLine*, 48, pp. 1179–1185. <https://doi.org/10.1016/j.ifacol.2015.06.244>
- Davis, K., 2019. Is digital minimalism the answer to our distracted lives? [online]. Fast Company. Available at: <https://www.fastcompany.com/90305328/is-digital-minimalism-the-answer-to-our-distracted-lives> (Accessed 5.6.19).
- Deci, E.L., Ryan, R.M., 2000. The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, 11, pp. 227–268.
- Department for Children, Education, Lifelong Learning and Skills, 2009. Student Withdrawal from Higher Education [online]. Available at: <https://dera.ioe.ac.uk/10860/1/090908hereviewen.pdf> (Accessed 21.11.19).
- Department for Digital, Culture, Media and Sport, 2017. UK Digital Strategy. Department for Digital, Culture, Media and Sport, London, England.
- Dewey, J., 1931. The development of American pragmatism. In: Dewey, J. (ed.), *Philosophy and Civilization*. G.P. Putnam's, New York, NY, pp. 13-35.
- Duff, B.R.-L., Yoon, G., Wang, Z., Anghelcev, G., 2014. Doing It All: An Exploratory Study of Predictors of Media Multitasking. *Journal of Interactive Advertising*, 14, pp. 11–23. <https://doi.org/10.1080/15252019.2014.884480>

- Dziubinski, M., 2015. Using the Pomodoro Technique with TaskLabels [online]. TaskLabels. Available at: <https://www.tasklabels.com/using-the-pomodoro-technique-with-tasklabels/> (Accessed 4.3.19).
- Dzubak, C.M., 2008. Multitasking: The Good, the Bad, and the Unknown. *The Journal of the Association for the Tutoring Profession*, 1, pp. 1–12.
- Edelson, D.C., 2006. Balancing innovation and risk: Assessing design research proposals, In: Van den Akker, J., Gravemeijer, K., McKenney, S., Nieveen, N. (Eds.), *Educational Design Research*. Routledge, London, pp. 100–106.
- Elliott, H., 1997. The Use of Diaries in Sociological Research on Health Experience. *Sociological Research Online*, 2, pp. 38–48. <https://doi.org/10.5153/sro.38>
- Felisoni, D.D., Godoi, A.S., 2018. Cell phone usage and academic performance: An experiment. *Computers & Education*, 117, pp. 175–187. <https://doi.org/10.1016/j.compedu.2017.10.006>
- Feng, C.S., Hu, T.W., Chen, Y.R., Tsai, C.Y., 2019. Research on Improving the User Experience and Usability Evaluation of Tomato Work Method App-Using Forest App. In: *Proceedings of the 2019 7th International Conference on Information Technology: IoT and Smart City*. Presented at ICIT 2019. ACM, New York, NY, pp. 147-151. <https://doi.org/10.1145/3377170.3377172>
- Ferrari, A., 2013. DIGCOMP: a framework for developing and understanding digital competence in Europe. Institute for Prospective Technological Studies, Luxembourg.
- Fielding, G., Smith, N., Tyson, J., Adams, J., Johns, G., Webb, A., Gray, L., Tinson, P., Maclean, F., 2019. UCISA Digital Capabilities 2019 Survey Report. UCISA, Oxford, UK.
- Flanigan, A.E., Kiewra, K.A., 2018. What College Instructors Can Do About Student Cyber-slacking. *Educational Psychology Review*, 30, pp. 585–597. <https://doi.org/10.1007/s10648-017-9418-2>
- Foehr, U., 2006. *Media Multitasking Among American Youth: Prevalence, Predictors and Pairings*. Kaiser Family Foundation, Washington, DC.
- Fraenkel, J.R., Wallen, N.E., 2009. *How to design and evaluate research in education*, 7th ed. McGraw-Hill, New York, NY.
- Fulton, S., Schweitzer, D., Scharff, L., Boleng, J., 2011. Demonstrating the impact of multitasking in the classroom, In: *2011 Frontiers in Education Conference (FIE)*. Presented at the 2011 Frontiers in Education Conference (FIE), IEEE, pp. F2J-1-F2J-6. <https://doi.org/10.1109/FIE.2011.6142991>

- Gobbo, F., Bozzolo, P., Girardi, J., Pepe, M., 2007. Learning Agile Methods in Practice: Advanced Educational Aspects of the Varese XP-UG Experience, In: Concas, G., Damiani, E., Scotto, M., Succi, G. (Eds.), *Agile Processes in Software Engineering and Extreme Programming*. Springer, Berlin, Germany, pp. 173–174. https://doi.org/10.1007/978-3-540-73101-6_30
- Gobbo, F., Vaccari, M., 2008. The Pomodoro Technique for Sustainable Pace in Extreme Programming Teams, In: Abrahamsson, P., Baskerville, R., Conboy, K., Fitzgerald, B., Morgan, L., Wang, X. (Eds.), *Agile Processes in Software Engineering and Extreme Programming*. Springer, Berlin, Germany, pp. 180–184. https://doi.org/10.1007/978-3-540-68255-4_18
- Goldkuhl, G., 2012. Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems*, 21, pp. 135–146. <https://doi.org/10.1057/ejis.2011.54>
- Google, 2019. Digital Wellbeing - Apps on Google Play [online]. Available at: <https://play.google.com/store/apps/details?id=com.google.android.apps.wellbeing&hl=en> (Accessed 8.5.19).
- Google Developers, 2018. Keynote (Google I/O '18) [online]. Available at: <https://www.youtube.com/watch?v=ogfYd705cRs&feature=youtu.be&t=40m25s> (Accessed 8.5.19).
- Greenfield, D., 2011. The Addictive Properties of Internet Usage, In: Young, K., de Abreu, C. (Eds.), *Internet Addiction: A Handbook and Guide to Evaluation and Treatment*. John Wiley & Sons, Hoboken, NJ.
- Griffey, H., 2018. The lost art of concentration: being distracted in a digital world. *The Guardian*.
- Guinness, K.E., Beaulieu, L., MacDonald, J.M., 2018. Effects of technology breaks on media multitasking with college students. *Behavioral Interventions*, 33, pp. 427–439. <https://doi.org/10.1002/bin.1529>
- Hartley, K., Bendixen, L.D., Olafson, L., Gianoutsos, D., Shreve, E., 2020. Development of the smartphone and learning inventory: Measuring self-regulated use. *Education and Information Technologies*, 255, pp. 4381-4395.
- Herrington, J.A., McKenney, S., Reeves, T.C., Oliver, R., 2007. Design-based research and doctoral students: Guidelines for preparing a dissertation proposal, In: Montgomerie, C., Seale, J. (Eds.), *Proceedings of EdMedia 2007*. Presented at the World Conference on Educational Multimedia, Hypermedia & Telecommunications, AACE, Chesapeake, VA.

- Hillstrom, A.P., Chai, Y.-C., 2006. Factors that guide or disrupt attentive visual processing. *Computers in Human Behavior*, 22, pp. 648–656.
<https://doi.org/10.1016/j.chb.2005.12.003>
- Hole, A., 2016. 3 steps to improving your time management with digital tools. Technology Enhanced Learning [online]. Available at:
<http://blogs.sussex.ac.uk/tel/2016/12/06/3-steps-improving-time-management-digital-tools/> (Accessed 18.5.19).
- Hwang, Y., Kim, H., Jeong, S.-H., 2014. Why do media users multitask?: Motives for general, medium-specific, and content-specific types of multitasking. *Computers in Human Behavior*, 36, pp. 542–548.
<https://doi.org/10.1016/j.chb.2014.04.040>
- Jeong, S.H., Fishbein, M., 2007. Predictors of multitasking with media: Media factors and audience factors, *Media Psychology*, 10, pp. 364–384.
- Jisc, 2018. Building digital capability [online]. Available at:
<https://www.jisc.ac.uk/rd/projects/building-digital-capability> (Accessed 13.2.20).
- Jisc, n.d.1. Jisc Learner Profile [online]. Available at:
http://repository.jisc.ac.uk/6619/1/JiscProfile_Learner.pdf (Accessed 15.1.19).
- Jisc, n.d.2. Learning technology mapping [online]. Available at:
http://repository.jisc.ac.uk/6617/1/JiscALT_learningtechnologymap.pdf (Accessed 9.10.19).
- Jones, C., Healing, G., 2010. Net generation students: agency and choice and the new technologies. *Journal of Computer Assisted Learning*, 26, pp. 344–356. <https://doi.org/10.1111/j.1365-2729.2010.00370.x>
- Judd, T., 2015. Task selection, task switching and multitasking during computer-based independent study. *AJET*, 31, pp. 193-207.
<https://doi.org/10.14742/ajet.1992>
- Judd, T., 2013. Making sense of multitasking: Key behaviours. *Computers & Education*, 63, pp. 358–367.
<https://doi.org/10.1016/j.compedu.2012.12.017>
- Judd, T., Kennedy, G., 2011. Measurement and evidence of computer-based task switching and multitasking by ‘Net Generation’ students. *Computers & Education*, 56, pp. 625–631.
<https://doi.org/10.1016/j.compedu.2010.10.004>
- Junco, R., Cotten, S.R., 2012. No A 4 U: The relationship between multitasking and academic performance. *Computers & Education*, 59, pp. 505–514. <https://doi.org/10.1016/j.compedu.2011.12.023>

- Junco, R., Cotten, S.R., 2011. A Decade of Distraction? How Multitasking Affects Student Outcomes, In: SSRN Electronic Journal. Presented at the A Decade in Internet Time Symposium on the Dynamics of the Internet and Society, University of Oxford, Oxford.
<https://doi.org/10.2139/ssrn.1927049>
- Just, M.A., Keller, T.A., Cynkar, J.A., 2008. A decrease in brain activation associated with driving when listening to someone speak. *Brain Research*, 1205, pp. 70–80. doi:10.1016/j.brainres.2007.12.075.
- Kang, M.S., 2011. Simultaneous media consumption behavior of Seoul citizens. *Korean Journal of Journalism and Communication Studies*, 55, pp. 333–355.
- Katz, I., Eilat, K., Nevo, N., 2014. “I’ll do it later”: Type of motivation, self-efficacy and homework procrastination. *Motivation and Emotion*, 38, pp. 111–119. <https://doi.org/10.1007/s11031-013-9366-1>
- Kember, D., Leung, D.Y.P., McNaught, C., 2008. A workshop activity to demonstrate that approaches to learning are influenced by the teaching and learning environment. *Active Learning in Higher Education*, 9, pp. 43–56. <https://doi.org/10.1177/1469787407086745>
- Kemmis, S., McTaggart, R., 1992. *The Action Research Planner*, 3rd ed. Deakin University Press, Geelong, Australia.
- Kennedy, D.M., Fox, B., 2013. ‘Digital natives’: An Asian perspective for using learning technologies. *International Journal of Education and Development using Information and Communication Technology*, 9, pp. 64–79.
- Kennedy, G., Dalgarno, B., Gray, K., Judd, T., Waycott, J., Bennett, S., Maton, K., Krause, K.-L., Bishop, A., Chang, R., Churchward, A., 2007. The net generation are not big users of Web 2.0 technologies: Preliminary findings, In: *Proceedings Ascilite Singapore 2007*. Presented at the ICT: Providing choices for learners and learning, ASCILITE, Singapore, p. 517-525.
- Kim, J., Cho, C., Lee, U., 2017. Technology Supported Behavior Restriction for Mitigating Self-Interruptions in Multi-device Environments. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*. 1, pp. 1–21. <https://doi.org/10.1145/3130932>
- Kim, Y.-H., Jeon, J.H., Choe, E.K., Lee, B., Kim, K., Seo, J., 2016. TimeAware: Leveraging Framing Effects to Enhance Personal Productivity, In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*. Presented at the the 2016 CHI Conference, ACM Press, Santa Clara, CA, pp. 272–283.
<https://doi.org/10.1145/2858036.2858428>

- King, N., Horrocks, C., 2010. *Interviews in Qualitative Research*. Sage, London, England.
- Konig, C.J., Buhner, M., Murling, G., 2005. Working Memory, Fluid Intelligence, and Attention Are Predictors of Multitasking Performance, but Polychronicity and Extraversion Are Not. *Human Performance*, 18, pp. 243–266. https://doi.org/10.1207/s15327043hup1803_3
- Kononova, A., Chiang, Y.-H., 2015. Why do we multitask with media? Predictors of media multitasking among Internet users in the United States and Taiwan. *Computers in Human Behavior*, 50, pp. 31–41. <https://doi.org/10.1016/j.chb.2015.03.052>
- Lancaster University, 2009. Research Ethics and Research Governance at Lancaster: a code of practice [online]. Available at: <https://www.lancaster.ac.uk/media/lancaster-university/content-assets/documents/res/clinical-research--trials-governance/CodeofPractice.pdf> (Accessed 23.3.20).
- Lancaster University, n.d. Learning Skills [online]. Available at: <https://www.lancaster.ac.uk/learning-skills/> (Accessed 5.6.19).
- Lang, A. (2009). The limited capacity model of motivated mediated message processing. In: Nabi, R. L., Oliver, M. B. (Eds.), *The SAGE handbook of media processes and effects*, Sage, Los Angeles, CA, pp. 193-204.
- Lau, W.W.F., 2017. Effects of social media usage and social media multitasking on the academic performance of university students. *Computers in Human Behavior*, 68, pp. 286–291. <https://doi.org/10.1016/j.chb.2016.11.043>
- Lee, H., Han, K., 2014. Multitasking and Performance under Time Pressure, in: Stephanidis, C. (Ed.), *HCI International 2014 - Posters' Extended Abstracts*. HCI 2014., Communications in Computer and Information Science. Springer, Cham, Switzerland. <https://doi.org/10.1007/978-3-319-07857-1>
- Lee, J., Lin, L., Robertson, T., 2012. The impact of media multitasking on learning. *Learning, Media and Technology*, 37, pp. 94–104. <https://doi.org/10.1080/17439884.2010.537664>
- le Roux, D.B., Parry, D.A., 2019. Off-task media use in academic settings: Cycles of self-regulation failure. *Journal of American College Health*, pp.1-8. <https://doi.org/10.1080/07448481.2019.1656636>
- Levin, J.R., O'Donnell, A.M., 1999. What to do about educational research's credibility gaps? *Issues in Education*, 5, pp. 177–229.
- Levy, M., 2016. *Mindful tech: How to bring balance to our digital lives*. Yale University Press, New Haven, CT.

- LightsAndCandy, 2016. Abandoning Pomodoros, Part One: The Pros and Cons of Pomos [online]. Available at: <https://medium.com/@lightsandcandy/abandoning-pomodoros-part-one-the-pros-and-cons-of-pomos-e3f3e9342ac9> (Accessed 4.3.19).
- Lin, L., 2013. Multiple Dimensions of Multitasking Phenomenon. *International Journal of Technology and Human Interaction*, 9, pp. 37–49. <https://doi.org/10.4018/jthi.2013010103>
- Lincoln, Y.S., Guba, E.G., 1985. *Naturalistic Inquiry*. Sage, Newbury Park, CA.
- Lottridge, D., Marschner, E., Wang, E., Romanovsky, M., Nass, C., 2012. Browser Design Impacts Multitasking. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 56, pp. 1957–1961. <https://doi.org/10.1177/1071181312561289>
- Luo, B., 2020. The influence of teaching learning techniques on students' long-term learning behavior. *Computer Assisted Language Learning*, 33, pp. 388-412. <https://doi.org/10.1080/09588221.2019.1567557>
- Margaryan, A., Littlejohn, A., Vojt, G., 2011. Are digital natives a myth or reality? University students' use of digital technologies. *Computers & Education*, 56, pp. 429–440. <https://doi.org/10.1016/j.compedu.2010.09.004>
- Marien, H., Custers, R., Hassin, R.R., Aarts, H., 2012. Unconscious goal activation and the hijacking of the executive function. *Journal of Personality and Social Psychology*, 103, pp. 399–415. <https://doi.org/10.1037/a0028955>
- Martini, A., 2014. Pomodoro Technique® Considered Harmful (don't worry: you are not using it) [online]. Available at: <https://arialdomartini.wordpress.com/2014/05/19/pomodoro-technique-considered-harmful-dont-worry-you-are-not-using-it/> (Accessed 4.3.19).
- Mayer, R.E., 2003. Learning Environments: The Case for Evidence-Based Practice and Issue-Driven Research. *Educational Psychology Review*, 15, pp. 359–366.
- Mayer, R., Moreno, R., 2003. Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, 38(1), pp. 43-52.
- McCrae, R.R., John, O.P., 1992. An introduction to the five factor model and its applications. *Journal of Personality*, 60, pp. 175–215.
- McFarlane, D.C., 2002. Comparison of Four Primary Methods for Coordinating the Interruption of People in Human-Computer Interaction. *Human Computer Interaction*, 17, pp. 63–139. https://doi.org/10.1207/S15327051HCI1701_2

- Mercer, J., 2007. The challenges of insider research in educational institutions: wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education*, 33, pp. 1–17. <https://doi.org/10.1080/03054980601094651>
- Moreno, M.A., Jelenchick, L., Koff, R., Eikoff, J., Diermyer, C., Christakis, D.A., 2012. Internet use and multitasking among older adolescents: An experience sampling approach. *Computers in Human Behavior*, 28, pp. 1097–1102. <https://doi.org/10.1016/j.chb.2012.01.016>
- Murray, L., Giralt, M., Benini, S., 2020. Extending digital literacies: Proposing an agentic literacy to tackle the problems of distractive technologies in language learning. *ReCALL*, 32, pp. 250-271.
- Nash, K., 2014. *Effective Strategies for Multitasking Behaviors*. Brandman University, Irvine, CA.
- NBC News, 2014. The Multitasking Brain: Juggling Devices Linked to Less Gray Matter [online]. NBC News. Available at: <https://www.nbcnews.com/better/wellness/multitasking-brain-juggling-devices-linked-less-gray-matter-n210866> (Accessed 11.3.20).
- Newman, T., Beetham, H., Knight, S., 2018. Digital experience insights survey 2018: findings from students in UK further and higher education. Jisc, Bristol, England.
- Oblinger, D., Oblinger, J.L., 2005. Is It Age or IT: First Steps Toward Understanding the Net Generation, In: Oblinger, D., Oblinger, J.L. (Eds.), *Educating the Net Generation*. Educause, Boulder, CO.
- Ofcom, 2017. Communications Market Report [online]. Ofcom. Available at: <https://www.ofcom.org.uk/research-and-data/multi-sector-research/cmr/cmr-2017> (Accessed 10.4.18)
- Park, S., 2014. Switching between productive multitasking and distraction: A case study of how users adapt to mobile tablet devices. *Digital Culture & Education*, 6, pp. 120–132.
- Patry, D.A., Blanchard, C.M., Mask, L., 2007. Measuring University Students' Regulatory Leisure Coping Styles: Planned Breathers or Avoidance? *Leisure Sciences*, 29, pp. 247–265. <https://doi.org/10.1080/01490400701257963>
- Patton, M.Q., 1990. *Qualitative evaluation and research methods*, 2nd ed. Sage, Thousand Oaks, CA.
- Patterson, R.W., 2018. Can behavioral tools improve online student outcomes? Experimental evidence from a massive open online course. *Journal of Economic Behavior & Organization*, 153, pp. 293–321. <https://doi.org/10.1016/j.jebo.2018.06.017>

- Penuel, W.R., 2014. Emerging Forms of Formative Intervention Research in Education. *Mind, Culture, and Activity*, 21, pp. 97–117. <https://doi.org/10.1080/10749039.2014.884137>
- Pilotta, J.J., Schultz, D.E., Drenik, G., Rist, P., 2004. Simultaneous media usage: A critical consumer orientation to media planning. *Journal of Consumer Behavior*, 3, pp. 285–292. <http://dx.doi.org/10.1002/cb.141>.
- Pintrich, P.R., 2003. A Motivational Science Perspective on the Role of Student Motivation in Learning and Teaching Contexts. *Journal of Educational Psychology*, 95, pp. 667–686. <https://doi.org/10.1037/0022-0663.95.4.667>
- Plomp, T., 2007. Educational Design Research: an Introduction, In: Nieveen, N.M., Plomp, T. (Eds.), *An Introduction to Educational Design Research*. Presented at the An introduction to educational design research, SLO, Shanghai, China.
- Prensky, M., 2011. Digital Natives, Digital Immigrants. *On the Horizon*, 9, pp. 1-6. <https://doi.org/10.1108/10748120110424816>.
- Prensky, M., 2009. H. Sapiens Digital: From Digital Immigrants and Digital Natives to Digital Wisdom [online]. *Innovate: Journal of Online Education*, 5. Available at: <https://nsuworks.nova.edu/innovate/vol5/iss3/1> (Accessed 3.1.19).
- Przybylski, A.K., Murayama, K., DeHaan, C.R., Gladwell, V., 2013. Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior*, 29, pp. 1841–1848. <https://doi.org/10.1016/j.chb.2013.02.014>
- Reeve, J., Jang, H., 2006. What teachers say and do to support students' autonomy during a learning activity. *Journal of Educational Psychology*, 98, pp. 209–218. <https://doi.org/10.1037/0022-0663.98.1.209>
- Reeves, T.C., 2000. Enhancing the Worth of Instructional Technology Research through “Design Experiments” and Other Development Research Strategies. Presented at the International Perspectives on Instructional Technology Research for the 21st Century, American Educational Research Association, New Orleans, LA.
- Rhee, J.W., Kim, E.M., Shim, M.S., 2006. Exploring dispositional media use motives: An extension of the ‘Uses and Gratification’ theory in a multimedia environment. *Korean Journal of Journalism and Communication Studies*, 50, pp. 252–284.
- Richtel, M., 2011. Multitasking Takes Toll on Memory, Study Finds [online]. Available at: <https://bits.blogs.nytimes.com/2011/04/11/multitasking-takes-toll-on-memory-study-finds/> (Accessed 3.6.19).

- Robinson, H.R., 2017. Towards an enhanced understanding of the behavioural phenomenon of multiple media use. *Journal of Marketing Management*, 33, pp. 699–718.
<https://doi.org/10.1080/0267257X.2017.1328457>
- Robinson, V.M., 1998. Methodology and the research-practice gap. *Educational researcher*, 27, pp. 17-26.
- Roche, D., 2018. The Pros & Cons of The Pomodoro Technique | Roche Online Business Services [online]. Available at: <http://www.rocheonlinebusinessservices.com/2018/02/22/pros-cons-pomodoro-technique/> (Accessed 4.3.19).
- Rooksby, J., Asadzadeh, P., Rost, M., Morrison, A., Chalmers, M., 2016. Personal Tracking of Screen Time on Digital Devices, In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16. Presented at the the 2016 CHI Conference, ACM Press, Santa Clara, CA, pp. 284–296.
<https://doi.org/10.1145/2858036.2858055>
- Rosen, L.D., Cheever, N.A., Carrier, L.M., 2012. *iDisorder: Understanding our obsession with technology and overcoming its hold on us*. Palgrave Macmillan, New York, NY.
- Rosen, L.D., Mark Carrier, L., Cheever, N.A., 2013a. Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior*, 29, pp. 948–958.
<https://doi.org/10.1016/j.chb.2012.12.001>
- Rosen, L.D., Whaling, K., Rab, S., Carrier, L.M., Cheever, N.A., 2013b. Is Facebook creating “iDisorders”? The link between clinical symptoms of psychiatric disorders and technology use, attitudes and anxiety. *Computers in Human Behavior*, 29, pp. 1243–1254.
<https://doi.org/10.1016/j.chb.2012.11.012>
- Ryan, R.M., Connell, J.P., 1989. Perceived Locus of Causality and Internalization: Examining Reasons for Acting in Two Domains. *Attitude and Social Cognition*, 57, pp. 749–761.
- Salvucci, D.D., Taatgen, N.A., 2008. Threaded cognition: An integrated theory of concurrent multitasking. *Psychological Review*, 1, pp. 101-130.
- Sanbonmatsu, D.M., Strayer, D.L., Medeiros-Ward, N., Watson, J.M., 2013. Who Multi-Tasks and Why? Multi-Tasking Ability, Perceived Multi-Tasking Ability, Impulsivity, and Sensation Seeking. *PLoS ONE*, 8, pp. 1-8. <https://doi.org/10.1371/journal.pone.0054402>
- Savin-Baden, M., Major, C.H., 2012. *Qualitative research: The essential guide to theory and practice*. Routledge, New York, NY.

- Schultz, D.E., Pilotta, J.J., Drenik, G., Rist, P. 2003. Simultaneous media usage: A critical consumer orientation to media planning. *Journal of Consumer Behaviour: An International Research Review*, 3, pp. 285-292.
- Schunk, D., 1984. Enhancing Self-Efficacy and Achievement through Rewards and Goals: Motivational and Informational Effects. *The Journal of Educational Research*, 78, pp. 29–34.
- Schunk, D.H., 2012. Learning theories: an educational perspective, 6th ed. Pearson, Boston, MA.
- Schunk, D.H., 1985. Participation in Goal Setting: Effects On Self-Efficacy and Skills of Learning-Disabled Children. *The Journal of Special Education*, 19, pp. 307–317. <https://doi.org/10.1177/002246698501900307>
- Select Committee on Digital Skills, 2015. Make or Break - The UK's Digital Future. Authority of the House of Lords, London.
- Senécal, C., Julien, E., Guay, F., 2003. Role conflict and academic procrastination: A self-determination perspective. *European Journal of Social Psychology*, 33, pp. 135–145. <https://doi.org/10.1002/ejsp.144>
- Silverman, D., 1993. Qualitative Data Analysis: Interpreting Talk, Text and Interaction. Sage, London, England
- Solomon, L.J., Rothblum, E.D., 1984. Academic Procrastination: Frequency and Cognitive-Behavioral Correlates. *Journal of Counseling Psychology*, 31, pp. 503–509.
- Song, K., Nam, S., Lim, H., Kim, J., 2013. Analysis of Youngsters' Media Multitasking Behaviors and Effect on Learning. *International Journal of Multimedia and Ubiquitous Engineering*, 8, pp.191-198.
- Staffordshire University, 2018. Library Resources: Digital Wellbeing: Digital Wellbeing apps [online]. Available at: <http://libguides.staffs.ac.uk/digitalwellbeing/usefulapps> (Accessed 5.6.19).
- Steel, P., 2007. The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, 133, pp. 65–94. <https://doi.org/10.1037/0033-2909.133.1.65>
- Steel, P., König, C.J., 2006. Integrating Theories of Motivation. *Academy of Management Review*, 31, pp. 889–913. <https://doi.org/10.5465/amr.2006.22527462>
- The Design-Based Research Collective, 2003. Design-Based Research: An Emerging Paradigm for Educational Inquiry. *Educational Researcher*, 32, pp. 5–8. <https://doi.org/10.3102/0013189X032001005>

- The Open University, n.d. Digital literacy: succeeding in a digital world [online]. OpenLearn. Available at: <https://www.open.edu/openlearn/education-development/digital-literacy-succeeding-digital-world/content-section-overview> (Accessed 5.6.19).
- Thompson, P., 2015. How digital native learners describe themselves. *Education and Information Technologies*, 20, pp. 467–484. <https://doi.org/10.1007/s10639-013-9295-3>
- Trapani, G., 2007. Jerry Seinfeld’s Productivity Secret [online]. Lifehacker. Available at: <https://lifehacker.com/jerry-seinfelds-productivity-secret-281626> (Accessed 22.3.20).
- Trowler, P., 2016. Doctoral Research into Higher Education: Thesis structure, content and completion. Amazon Create Space, Scotts Valley, CA.
- Tseng, V.W.-S., Lee, M.L., Denoue, L., Avrahami, D., 2019. Overcoming distractions during transitions from break to work using a conversational website-blocking system. In: CHI Conference on Human Factors in Computing Systems Proceedings. Presented at the 2019 CHI conference, ACM, New York, NY, pp. 1-13. <https://doi.org/10.1145/3290605.3300697>
- UCISA, 2018. Technology enhanced learning survey [online]. Available at: <https://www.ucisa.ac.uk/en/Resources/2018/Technology-enhanced-learning-survey> (Accessed 13.2.20).
- UCL, 2018. ISD Digital Skills Development Course Catalogue [online]. Available at: <https://www.ucl.ac.uk/isd/sites/isd/files/dsd-course-catalogue-nov18.pdf> (Accessed 13.2.19)
- UK Digital Skills Task Force, 2014. Digital Skills for Tomorrow’s World [online]. UK Digital Skills Task Force. Available at: <http://www.ukdigitalskills.com/wp-content/uploads/2014/07/Binder-9-reduced.pdf> (Accessed 21.5.19)
- University of Brighton, n.d. Student Digital Literacies Framework [online]. Available at: <https://blogs.brighton.ac.uk/askdigitalliteracies/> (Accessed 5.6.19).
- van der Linden, D., Frese, M., Meijman, T. F., 2003. Mental fatigue and the control of cognitive processes: effects on perseveration and planning. *Acta Psychologica*, 113, pp. 45–65.
- Vardy, M., n.d. The Problem with The Pomodoro Technique [online]. Productivityist. Available at: <https://productivityist.com/the-problem-with-the-pomodoro-technique/> (Accessed 3.4.19).
- Veen, W., 2007. Homo Zappiens and the Need for New Education Systems, In: CERI-New Millennium Learners-Meetings and Conferences. Presented at the Italy-OECD seminar on digital natives and education, Florence, Italy.

- Verbrugge, L.M., 1980. Health diaries. *Medical Care*, 18, pp. 73–95.
- Voorveld, H., van der Goot, M., 2013. Age differences in media multitasking: A diary study. *Journal of Broadcasting & Electronic Media*, 57, pp. 392–408. <http://dx.doi.org/10.1080/08838151.2013.816709>.
- Wallis, C., 2010. The impacts of media multitasking on children's learning & development: Report from a research seminar. The Joan Ganz Cooney Center, New York, NY.
- Wang, F., Hannafin, M.J., 2005. Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, 53, pp. 5–23. <https://doi.org/10.1007/BF02504682>
- Wang, X., Gobbo, F., Lane, M., 2010. Turning Time from Enemy into an Ally Using the Pomodoro Technique, In: Šmite, D., Moe, N.B., Ågerfalk, P.J. (Eds.), *Agility Across Time and Space*. Springer, Berlin, Germany, pp. 149–166. https://doi.org/10.1007/978-3-642-12442-6_10
- Wang, Z., Tchernev, J.M., 2012. The “Myth” of Media Multitasking: Reciprocal Dynamics of Media Multitasking, Personal Needs, and Gratifications. *Journal of Communication*, 62, pp. 493–513. <https://doi.org/10.1111/j.1460-2466.2012.01641.x>
- Whittaker, S., Kalnikaite, V., Hollis, V., Guydish, A., 2016. “Don’t Waste My Time”: Use of Time Information Improves Focus, In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*. Presented at the 2016 CHI Conference, ACM Press, Santa Clara, CA, pp. 1729–1738. <https://doi.org/10.1145/2858036.2858193>
- Winn, W., 2003. Research Methods and Types of Evidence for Research in Educational Technology. *Educational Psychology Review*, 15, pp. 367–373.
- Winter, J., Cotton, D., Gavin, J., Yorke, J.D., 2010. Effective e-learning? Multi-tasking, distractions and boundary management by graduate students in an online environment. *ALT-J*, 18, pp. 71–83. <https://doi.org/10.1080/09687761003657598>
- Wiseman, V., Conteh, L., Matovu, F., 2005. Using diaries to collect data in resource-poor settings: questions on design and implementation. *Health Policy and Planning*, 20, pp. 394–404. <https://doi.org/10.1093/heapol/czi042>
- Wu, J.-Y., Xie, C., 2018. Using time pressure and note-taking to prevent digital distraction behavior and enhance online search performance: Perspectives from the load theory of attention and cognitive control. *Computers in Human Behavior*, 88, pp. 244–254. <https://doi.org/10.1016/j.chb.2018.07.008>

- Xie, K., Debacker, T.K., Ferguson, C., 2006. Extending the Traditional Classroom Through Online Discussion: The Role of Student Motivation. *Journal of Educational Computing Research*, 34, pp. 67–89.
<https://doi.org/10.2190/7BAK-EGAH-3MH1-K7C6>
- University of Hertfordshire, 2016. Study-load: Understanding and managing your studies [online]. Available at: <https://catoolkit.herts.ac.uk/toolkit/study-load-understanding-and-managing-your-studies/> (Accessed 2.2.21)
- Yeykelis, L., Cummings, J.J., Reeves, B., 2014. Multitasking on a Single Device: Arousal and the Frequency, Anticipation, and Prediction of Switching Between Media Content on a Computer. *Journal of Communication*, 64, pp. 167–192. <https://doi.org/10.1111/jcom.12070>
- Yılmaz, R., Yurdugül, H., 2018. Cyberloafing in IT classrooms: exploring the role of the psycho-social environment in the classroom, attitude to computers and computing courses, motivation and learning strategies. *Journal of Computing in Higher Education*, 30, pp. 530–552.
<https://doi.org/10.1007/s12528-018-9184-2>
- Yot-Domínguez, C., Marcelo, C., 2017. University students' self-regulated learning using digital technologies. *International Journal of Educational Technology in Higher Education*, 14, pp. 1-18.
<https://doi.org/10.1186/s41239-017-0076-8>
- Young, K.S., 1998. Internet addiction: The emergence of a new clinical disorder. *Cyber Psychology and Behaviour*, 1, pp. 237-244.
- Zamanzadeh, N.N., 2016. The Effects of Mood as a Mediator of Media Multitasking on Cognitive Performance. University of California, Santa Barbara, CA.
- Zhang, W., Zhang, L., 2012. Explicating multitasking with computers: Gratifications and situations. *Computers in Human Behavior*, 28, pp.1883–1891. <https://doi.org/10.1016/j.chb.2012.05.006>
- Zhang, Y., Mao, M., Rau, P.-L.P., Choe, P., Bela, L., Wang, F., 2013. Exploring factors influencing multitasking interaction with multiple smart devices. *Computers in Human Behavior*, 29, pp. 2579–2588.
<https://doi.org/10.1016/j.chb.2013.06.042>
- Zimmerman, B.J., 2002. Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, 41, pp. 64–70.
https://doi.org/10.1207/s15430421tip4102_2
- Zimmerman, J., 2013. 'Multitasking: What a professor knows that students don't'. *Christian Science Monitor*. 14 November. Available at: <https://www.csmonitor.com/The-Culture/Family/Modern-Parenthood/2013/1114/Multitasking-What-a-professor-knows-that-students-don-t> (Accessed 2.2.21)
- Zuckerman, M., 1994. Behavioral expressions and biosocial bases of sensation seeking. Cambridge University Press, Cambridge, England.

Appendix 1 – Participation information sheet and informed consent form

INFORMATION SHEET

Dear Student,

I am pursuing a part-time PhD at Lancaster University, United Kingdom. The title of my PhD thesis is “Convergence of Learning and Leisure Spaces: How can learners effectively manage online learning?”

The aim of the thesis is to identify what strategies, if any, students employ to minimise multitasking between learning and non-learning activities whilst engaged in digital learning as well as what further strategies students can adopt to effectively minimise multitasking.

I will be grateful if you agree to participate in the study. The study will take place between October 2015 and March 2016. To participate in the study you will be invited to do the following:

- 1) Attend an induction session during the week commencing 12th October 2015. The induction session will introduce how to record your multitasking behaviour, a computer activity tracking software ActivTrak (<http://activtrak.com/>), a mobile activity tracking app RescueTime (<https://www.rescuetime.com/>) and the tracking of web browsing using the Google Web and App Activity feature (<http://bit.ly/1Pw691j>). ActiveTrak and RescueTime track time spent on applications and websites and give you reports and data based on your activity. **The use of ActiveTrak,**

RescueTime and Google Web and App Activity is optional and its purpose is to help you recall your multitasking behaviour. If you choose to use ActiveTrak, RescueTime or Google Web and App activity then I will never ask you to provide me access to the activity reports from these tools. You will also have the opportunity to ask questions about the research in the induction session. Please note that ActiveTrak, RescueTime and Google are hosted on servers outside the European Union (EU) and may not comply with EU's data protection legislation. This means that any personal data (i.e. data from which you can be identified) you share with the aforementioned software/apps may not be handled with the same level of protection as required under the EU legislation.

- 2) Keep a daily record of as many instances as possible when you switched between your study and your non-study activities. Subject to your consent, I will be sending you a daily text reminder to keep your diary. The diary will be kept for a week on three different occasions.
- 3) Following each week of diary keeping, you will be invited to attend an interview for approximately an hour. I will be asking you about your diary entries and the reasons you switched between your study and other activities. I will use the information you provide during interview to devise an intervention (strategies or solutions) that could help you reduce multitasking during your study.

- 4) You will be asked to incorporate the intervention in your practice as well as, for a week, keep a daily diary recording your multitasking behaviour. It will be entirely up to you to incorporate the intervention as this will not be compulsory. Each period of intervention will be followed by an hour-long interview. I will use the information provided by you in the interview to assess the effectiveness of the solution proposed. This will be followed by a review and, if you are agreeable, a revision of intervention. Two cycles of revised interventions and review will take place.

The schedule for induction, diary keeping, interviews, interventions and review/revisions is provided in Table 1 below. All periods of research activity and interaction will be at a day and time of your convenience.

12 Oct – 16 Oct 2015	Induction
19 Oct – 23 Oct 2015	Diary keeping 1
26 Oct – 30 Oct 2015	First interview
23 Nov – 27 Nov 2015	Participants introduced to new interventions
30 Nov – 4 Dec 2015	Diary keeping 2
7 Dec – 11 Dec 2015	Second interview
11 Jan – 15 Jan 2016	Participants introduced to revised interventions
18 Jan – 22 Jan 2016	Diary keeping 3
25 Jan – 29 Jan 2016	Third interview
22 Feb – 27 Feb 2016	Participants introduced to revised interventions
29 Feb – 4 Mar 2016	Diary keeping 4
7 Mar – 18 Mar 2016	Fourth and final interview

Table 1

All information gained from you will be maintained in a strictly confidential manner. I will be the only person who will have access to the information. I will be recording the interviews as audio using my personal laptop via the Audacity (<http://audacityteam.org/>) audio recording software. You can request to listen to the audio at the end of the interview and any parts you are unhappy with will be deleted, or disregarded from the data. The audio files will be encrypted using WinZip encryption software. The laptop will be encrypted and both the laptop and the audio files will be secured by a password. A pseudonym will be given to protect your identity and any identifying information about you will be removed from the transcriptions. Following completion of transcriptions and the assignment of pseudonyms all personal data and interview audio will be deleted. Data may be used in the reporting of the research (in the thesis and then potentially in any papers or conference presentations). Please note that if your data is used, it will not identify you in any way or means.

Any software/apps that you are recommended to install in order to track multitasking behaviour or as an intervention to manage multitasking is voluntary. You are expected to use your own discretion and risk when installing these software/apps to your devices and that you are solely responsible for any damage to your devices or loss of data that results from the download/use of these software/apps. You are allowed to install these software only on the devices you own. If you share your devices with others then you will need to inform them about installation of the software and its purpose. I will only ask you to install the free/trial versions of these

software/apps and will never ask you to pay for their full license and/or premium features.

There are no expected disadvantages or risks for you from taking part in this study. Your participation is done purely on a voluntary basis. You are free to withdraw from this study at any point without disadvantage and without having to provide a reason. In addition, you will be given two weeks following each of the four interviews to decide whether you would like to continue with the study. If you decide to withdraw from the study within two weeks of an interview, your data will be destroyed and not used; but after this point the data will remain in the study. If you decide to withdraw from the study at any point, I will be seeking your permission for using any data already collected from you.

If you have any questions or problems, please contact me either via phone (redacted) or via e-mail (redacted).

Yours sincerely

Salman Usman

Contact details:

1. Salman Usman, Academic E-learning Developer. Organisation: redacted. E-mail: redacted. Tel: redacted.
2. Dr Steven Dempster, Thesis Supervisor, Lecturer in Higher Education, Dept. of Educational Research, Lancaster University. Email: redacted. Tel: redacted.

3. Prof. Paul Ashwin, Head of Department of Educational Research, Lancaster University. Email: redacted. Tel: redacted (Contact for concerns about the project, participation or my conduct as a researcher).

Thank you for taking the time to read this information sheet.

WRITTEN CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Statement by participant

- I confirm that I have read and understood the information sheet/letter of invitation for this study. I have been informed of the purpose, risks, and benefits of taking part.

(Title of Study)-----

- I understand what my involvement will entail and any questions have been answered to my satisfaction.
- I understand that my participation is entirely voluntary, and that I can withdraw at any time without prejudice.
- I understand that all information obtained will be confidential.
- I agree that research data gathered for the study may be published provided that I cannot be identified as a subject.
- Contact information has been provided should I (a) wish to seek further information from the investigator at any time for purposes of clarification (b) wish to make a complaint.

Participant's Signature-----

Date -----

Statement by investigator

- I have explained this project and the implications of participation in it to this participant without bias and I believe that the consent is informed and that he/she understands the implications of participation.

Name of investigator -----

Signature of investigator -----

Date -----

Appendix 2 – Interview guide

Questions for the first interview

1. How do you feel about switching to non-study-related activities whilst studying?
2. Why did you decide to participate in this study?
3. Do you use any strategies to avoid distraction when you are performing study-related activities?

Questions for the first, second and third interview

Q4. Take me one by one through each of the slots you devoted for study-related activities during the week for which you have kept the diary. For each of the time slots tell me:

- 4a. What study and non-study-related activities did you intend on performing and/or completing?
- 4b. Where were you situated for the period of this time slot?
- 4c. What devices or technology were you using to perform your study-related activities?
- 4d. What resources and applications did you use to perform your study-related activities?
- 4e. Did you switch to any non-study-related activity?
 - 12e.i If so, how many times did you switch between study and non-study-related activities within the time slot?
 - 12e.ii For each of the switches, how would you classify your non-study-related activity you switched to. Choose one of the following categories:

- A non-study-related activity on the same technology device that you were using
- A non-study-related on a different technology device
- A non-study-related activity not dependent on technology devices
- A non-study-related activity related to your family
- A non-study-related activity related to your work

4e.iii What was the reason for each of the switch and what were you feeling at the time of switch?

4e.iv How much time did you spend on each of the non-study related activities?

4e.v What caused you to switch back to your study-related activity?

Q5. Do you think that switching between your study and non-study-related activity has impacted on your learning? If so how?

Q6. How did you feel about keeping the diary?

Q7. Is there anything else you would like to bring up or ask about before we finish the interview?

Q8. How would you describe your experience of interview?

Questions for the second, third and fourth interview

Q9. Did you implement the intervention that was proposed to you?

Q10. Do you feel the intervention has minimised the switch between study and non-study-related activities? If so, can you please explain how the intervention has helped you in minimising multitasking?

Q11. If the intervention has not helped you, why do you think this is the case?