Cardiff University

BSc Mathematics with Operational Research and Statistics

Year 3 Project

The Effect of Personality Traits on Academic Achievement in Flipped versus Traditional Learning Environments

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Abstract

The purpose of this report is to analyse the effect of personality traits on academic achievement in a flipped versus a traditional learning environment. The study was based on a class of 170 first year students studying the module "Computing for Mathematics" at Cardiff University. This was taught in the style of a flipped classroom. Academic achievement was measured by class test and coursework marks in the Computing module, representing achievement in a flipped learning environment, and the mean mark obtained in all other modules, representing achievement in a traditional learning environment. A 44-item personality questionnaire, created by John, Donahue and Kentle in [61], was distributed amongst the students to understand the personality traits, according to the Big Five Personality Model, present in the class. Conscientiousness was found to be the greatest predictor of high achievement in the traditional learning environment, whereas openness to deep learning was found to be the greatest predictor for success in a flipped learning environment. 3 additional questionnaires and 2 focus groups were conducted at different time points throughout the semester to understand student perceptions towards different aspects of the flipped classroom approach. The results concluded that student perceptions regarding how they believe they learn best do not have a significant effect on achievement in the flipped learning environment: as long as students want to learn, they will succeed. The findings of this study may be useful to an educator believing that students learn best in a socialist or constructivist learning framework.

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Contents

Chapter 1

Introduction

The purpose of this study is to analyse the effect that learning in a flipped environment has on academic achievement, compared to achievement attained in a traditional learning environment. Personality traits will also be taken into consideration in this study to gain an understanding as to whether academic success in a flipped learning environment lends itself more to any particular type of student.

The main findings of this study will give an insight into the types of students who are most likely to succeed in the flipped learning environment. It will therefore also identify the types of students who should be focused upon to ensure that everyone has the opportunity to benefit from this type of learning environment.

In general, this study will highlight that the flipped learning environment fits mostly into socialist and constructivist learning frameworks. This pedagogy is therefore perhaps an appropriate style to be used by an educator who believes that students learn best in either (or both) of these frameworks.

1.1 Literature Review

As stated in [30]: "education is about the development of understanding and the formation of minds and identities". The main ongoing question of interest in educational theory however is how exactly students can be educated, in order to maximise their learning potential and personal development.

There have been many discussions on how one learns and, as a result of this, a range of learning frameworks have been suggested to define different categories explaining how students are believed to learn best. Some theorists [50, 68] believe that learning is about the interplay between new information and existing concepts. Many other educational theorists [50, 57, 74, 112] argue that the majority of learning takes place when the students are actively involved in learning activities, through being able to make their own decisions, conduct their own investigations and come up with their own ideas. Simon (1961-2001) (as cited in [72]) adds to this by stating that "the teacher can advance learning only by influencing what the student does to learn". This role of the educator has also been discussed in a similar way in [65]. Another suggestion given is that learning has more to do with awareness and understanding of the purpose of learning than with the techniques or mechanical learning [50].

Over time, many learning frameworks have been introduced to try and describe what constitutes learning. Some of the earlier ones are described below:

1. **Empiricism**

   The learner in this learning framework is seen to be the passive recipient of experience, with the teacher and the curriculum being responsible for arranging such a learning experience [65]. The only thing required from the learner here is a willingness to learn [65].

2. **Romanticism**

The learner in this learning framework is seen to learn through one's sensory experiences and reflections on these experiences, according to Locke's theory [65, 85]. As described in [65], it is about the emotions and education of the whole person, with the emphasis being on a child-centred compared to a teacher-centred approach.

3. **Behaviourism**

   Learning in this framework is defined in [65] as a relatively permanent change in behaviour (otherwise referred to as conditioning), as the result of experience. This is what lectures in a traditional learning environment generally address: students learn through receiving content knowledge directly from the instructor.

4. **Cognitivism**

   This learning framework is centred around the mental process whereby information is encoded, organised and processed effectively, in order for new material to be transferred to long term memory [65].

5. **Socialism**

   This learning framework believes that socialisation of individuals is essential in maximising learning potential, through being able to maintain and transmit integrative social values [83]. Students do not only learn internally (i.e. defining constructivism: see later on in this section) or by receiving content knowledge directly from the instructor (i.e. defining behaviouralism), but also by constructing the content relative to their social environment.

6. **Constructivism**

   This learning framework focuses on what people do with the information they are provided with, to develop their knowledge [65]. The learner is seen to construct their own understanding of the content through experience and reflection on their experiences [5]. This framework will be discussed in detail later in this section.

More recent research into active styles of learning will be focused on however in this study. The pedagogy in particular that will be concentrated on combines socialist and constructivist theory to create the relatively new flipped learning environment. The latter two frameworks will therefore be discussed in more detail.

The constructivist approach believes that learning happens by actively building knowledge and relating previous experience and knowledge to new information. One argument given by Kamii in [125] is that if children are free to do their own thinking, they invent increasingly efficient procedures. This could be related to the fact that people learn how to speak through trying themselves: everyone naturally uses a constructivist approach. It is stated in [125] that the role of the teacher is to prompt students to reflect on their own thinking rather than correct errors or provide answers. This learning framework is further defined by Duffy and Jonassen in [38] (cited in [123]): "'learning' is not a passive, knowledge-consuming and externally directed process, but an active, constructive and self-directed process in which the learner builds up internal knowledge representations that form a personal representation of his or her learning experiences".

The above discussion leads onto the concept of active learning. Some theorists [46, 97] define active learning as engaging students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. This learning framework encourages group work and higher-order thinking [46] which relates to the idea of collaborative learning, whereby students work together in small groups towards a common goal [97]. This latter comment relates to the learning framework of socialism, defined earlier in this section.

As mentioned previously, the flipped classroom pedagogy lends itself more to the constructivist and socialist learning frameworks. This is because, in this pedagogy, lower-level tasks such as watching instructional videos and reading explanatory course content notes, are completed independently before class, with the focus in class being on group discussions [48, 105, 115, 117, 119]. The purpose of this is to give students increased responsibility, enforcing self-regulated learning, and set students up to be true, lifelong learners [117]. In-class discussions also have the advantage of forcing students to explain,

analyse and defend their answers through becoming aware of different perspectives on ideas, learnt from their peers [25].

Comparing this style to nonflipped classroom models, Jensen, Kummer and Godoy in [59] argues that the main difference between the two is the role of the instructor: in nonflipped classrooms, the instructor's role is to facilitate content attainment, whereas in a flipped classroom, the role is to facilitate concept application. The role of the instructor is nonetheless still existent in this pedagogy however, as emphasised by Talbert in [117]: the students are encouraged however to take a more independent approach to learning, through minimal guidance. The latter idea highlights how the flipped classroom pedagogy fits into the constructivist learning framework.

One point to note about using this pedagogic approach for the first time is that students do not tend to see the benefit straight away [117]: there tends to be some time before students "buy in" to the new approach. This was demonstrated by the study conducted in [15] in that, by the end of the module (which had been taught in the style of a flipped learning environment), 54 out of 97 students stated that they "strongly prefer this approach"; 28/97 students stated that they "slightly prefer this approach" and only 2/97 students stated that they "strongly prefer the traditional approach".

One of the major parts of this study will involve analysing the effect of the flipped classroom on academic achievement attained by first year, university-level students and how this compares to attainment in traditionally taught modules. In this study, modules which are **traditionally taught** are defined as those in which information is relayed to the students from the instructor in lectures, and then students attempt complex problems outside of class.

Taking into consideration previous studies of this kind is therefore useful in forming well-informed predicted outcomes of the study and having an ability to confirm, contradict and/or enhance previous research findings.

Many studies [23, 98] have found that active learning has a positive correlation with improvement on learning gains. The meta-analysis conducted by Norman and Schmidt in [88] (cited in [97]) additionally found that students working in small teams has a positive effect on academic achievement, whereas self-directed learning has a slightly negative effect on academic achievement. This confirms previous research found by Johnson, Johnson and Smith in [64] (cited in [97]) who found that cooperation improved learning outcomes relative to individual work. The study conducted in [25] furthermore supports the conclusions made regarding the advantages of working in groups. In this study, many students commented on the fact that "hearing other explanations from those outside their own group helped them to grasp difficult concepts". Others stated that knowing that other students gave wrong answers to questions "had the effect of increasing their confidence and willingness to participate in peer and class-wide discussions". This whole paragraph therefore creates strong links to the socialist learning framework.

Some very similar studies to the one carried out in this report [12, 46] found that active learning is a more effective means of instruction over a traditional, didactic approach. Hake in [57] in fact found that students taught using active strategies learned twice as much as students taught using a direct instruction approach. The study in this report however takes this further by specifically focusing on the flipped learning environment which incorporates an active approach to learning, by definition.

In terms of comparing the effect of the flipped learning environment against the effect of the traditional learning environment on academic achievement, many researchers [59, 115, 119, 120] have found positive trends in the flipped environment over the traditional environment.

Another focus in the study of this report is the incorporation of personality traits. This study will investigate whether personality has an effect on academic achievement in a flipped learning environment, compared to a traditional learning environment. The reason behind including an analysis of these personality traits as well is due to the sufficient evidence given in previous studies [20, 34, 96, 124] that personality measures explain a moderate percentage of the variance in academic achievement.

There are five main personality traits that are considered in this study, which create the "Big Five Personality Model" [51]: conscientiousness, openness, agreeableness, neuroticism and extraversion. The first main study looking into personality traits was conducted by Germal, Allport and Odbert in [11] (cited by [62]) who identified 18000 terms in the unabridged English dictionary through a seminal lexical

study where they included all terms that could be used to "distinguish the behaviour of one human being from that of another". The history of how these personality traits were adapted and condensed into five main mutually exclusive traits is discussed in [62] whereby theorists, such as [24, 26, 36, 43, 89, 121] conducted many investigations and analyses to find the most relatively strong and recurrent factors. Although there are many other personality models that could have been chosen for this study, such as the Birkman Method [4] and Belbin's team roles [2], the Five Factor Model was chosen due to the fact that the traits involved in the model have been shown by Poropat in [96] "to be reliable statistical predictors of academic performance, and to have meaningful relationships with learning and associated activities".

Many studies (e.g. [28, 95, 96]) have been conducted on the effect of personality traits on academic achievement. For example, Pintrich in [93] (cited by [18]) found that self-regulation potentially mediates the relationship between personal characteristics and academic achievement. In addition, empirical evidence indicates that personality and intelligence are important predictors of academic performance, due to their relation to learning [27, 41, 47].

Taking the context of this report into consideration, the next section will describe the sample used for this study.

1.2 Study Design

The study in this report will be based on a class of 170 first year students studying Mathematics at Cardiff University. One of their modules: Computing for Mathematics (which will from here onwards be referred to as **CfM**) is being taught by Dr Vincent Knight (who will from here onwards be referred to as **VK**) using a flipped learning environment. As part of this pedagogy, students are timetabled with two laboratory sessions towards the start of the week (which consist of up to sixteen students and are taken by second year students who completed the module the previous year) and one class meeting (towards the end of the week). (Note that a **class meeting** here is defined as the gathering of all students in one room to discuss work carried out during the week, specifically focusing on areas which students struggled with. This is led by the instructor, VK.) VK then has "office hours" for students to visit him in his office to ask any queries on the course material, towards the end of the week.

Before the class meetings, on a weekly basis, students are encouraged to watch videos and learn the course content uploaded online to VK's website. Each week they are then given task sheets for them to complete. These task sheets consist of a mixture of tickables and non-tickables. Tickables are defined as questions which must be completed before the students' last lab session each week so that they can be marked by their lab tutor. These tickables are marked by either a 0 or 1. These marks are not given on success rate however, they are given with regards to how hard they have tried to answer the question. The purpose of this is to allow for mistakes to occur (if necessary) so that students can learn from them. The aim of this therefore is to constantly encourage learning to take place, as well as, and arguably most importantly, allow for VK to gain feedback on the areas which should be discussed in more detail in the class meetings.

The next section will discuss the main aims of the study.

1.3 Aims

The main aim of this study (hereon referred to as **Aim 1**) is to analyse the effect of personality traits present in students (using the Big Five Factor Model, as mentioned and discussed in Section 1.1) in the flipped learning environment on academic achievement. This will then consequently be compared to student attainment in traditionally-taught modules.

A secondary aim of this study (hereon referred to as **Aim 2**) is to confirm and/or contradict literature discussed in Sections 1.1 and 2.4.1.

Chapter	**Aim Addressed**	**Content**
Chapter 2	Contributes towards Aim 1	Explanation as to the process involved in the collection of quantitative and qualitative data for this study. This chapter contributes towards Aim 1 since these data collection methods allow for later analysis to be conducted on the effect of personality traits on academic achievement in the flipped versus traditional learning environment.
Chapter 3	Aims 1 and 2	Analysis on the effect of personality traits on academic achievement in the flipped learning environment compared to the traditional learning environment. This chapter also relates the results found to literature discussed in Section 1.1 throughout.
Chapter 4	Aims 1, 2 and 3	Analysis on the effect of personality traits on academic achievement through considering different categories of students. Literature previously discussed in Section 1.1 is also constantly referred back to here.
Chapter 5	Aims 2 and 3	Analyses on discussions made by students taking CfM and student tutors in charge of laboratory sessions in different focus groups conducted. Different categories of students are identified here and results are related to quantitative results found in Chapters 3 and 4, as well as literature previously discussed in this report.
Chapters 6 and 7	Aims 1, 2 and 3	A summary of all results found, concluding overall outcomes of the study and how aims have been met.

Table 1.1: Report structure illustrating where aims will be addressed

The final aim of this study (hereon referred to as **Aim 3**) will be to identify the effect of different categories of students, with regards to their attitudes towards CfM, on academic achievement in the flipped versus the traditional learning environments. The personalities of these categories of students will also be included in the analyses to see if any trait in particular predicts academic achievement in these different learning environments.

Table 1.1 illustrates where each of the aims discussed above will be addressed in the report, as well as briefly describe the contents of the report.

The next chapter will look at what data was collected and how exactly it was collected.

Chapter 2

Data Collection

This chapter focuses on the methods used to collect the data required on which to perform appropriate analyses for this study, satisfying Aim 1 (as detailed in Section 1.3). Both quantitative and qualitative data was collected as part of this process. Quantitative data was collected to gain an understanding as to how many people hold a certain opinion or view, whereas the qualitative data was collected to allow for better exploration as to how the opinions identified through the quantitative data were constructed [67].

A timeline indicating when each data type was collected is shown in Table 2.1. (Note that 'A' denotes quantitative data and 'B' denotes qualitative data.)

2.1 Quantative Data: Design of Attitudes Questionnaire

2.1.1 Introduction: Aims of the Questionnaire

The purpose of using questionnaires to collect data was to aid statistical analysis of students' attitudes towards learning Computing in a flipped learning environment. Three questionnaires were sent out throughout the duration of the first semester of CfM, as outlined in Table 2.1 in the introduction to Section 2.

Apart from slight alterations in the questionnaires with regard to tenses, the questionnaires contained mostly the same questions. (Some questions were also removed or added to different questionnaires depending on the appropriateness of these questions being included. See Section 2.2 for more information on this.) The purpose of this cross-sectional design [90] was to allow for accurate comparisons between the questionnaires [78], in the analysis of student attitudes throughout the semester.

When Data was Collected	**Data Type**
Semester 1, Week 1	Attitudes Questionnaire 1 (A)
Semester 1, Week 4	Focus Group with Students 1 (B)
Semester 1, Week 7	Focus Group with Undergraduate Tutors (B) Attitudes Questionnaire 2 (A)
Semester 1, Week 10	Focus Group with Students 2 (B) Attitudes Questionnaire 3 (A)
Semester 2, Week 2	Personality Questionnaire (A)

Table 2.1: Timeline of data collection

2.1.2 Choosing the Questions

Choosing the questions to be included in the questionnaires was of vital importance to this study. Questions had to be carefully decided upon to ensure validity and reliability of responses, as well as ensure that the correct questions were asked so that the appropriate data was collected, in terms of being able to satisfy the aims of this study (see Section 1.3).

Introducing the Questionnaire

The introduction to the questionnaire was extremely important in terms of encouraging respondents to give up their time to complete the questionnaire accurately. The following questions, suggested in [19], were therefore used as a model to ensure that the correct information was included, as concisely as possible:

- What is the study about?
- Who is conducting it?
- Why is the study important?
- What will be done with the study results?
- Why is the study beneficial to the student?

The main body of the questionnaire was then created using the following pieces of literature:

1. **The MSLQ (Manual for the Use of the Motivated Strategies for Learning Questionnaire) [94]**

   This manual is a "self report instrument designed to assess college students' motivational orientations and their use of different learning strategies for a college course" [94]. It consists of questions which each focus on one (or more) of nine different learning strategy scales and one of six motivational scales. Three of these scales motivated the formation of the questions in this study:

   - task value
   - self-efficacy of learning and performance
   - effort regulation

   The other scales were not included in the questionnaires due to the fact that they focused on how exactly students learn and remember information; this study on the other hand aims to focus on attitudes towards and the effect of academic achievement on the flipped learning environment (see Section 1.1), not how students organise their time and actually absorb the information as such.

   Task value defines the extent to which students believe the task is interesting, important and useful [94]. Some examples of questions included under this category in questionnaires 1 to 3 are:

   Section 2, Question 1: "How interested are you in the following two items: a) Programming, b) Mathematics?"

   Section 2, Question 2: "How useful do you think the content of this course will be for you to learn?"

   These questions aim to solely understand student attitudes towards CfM. This would later allow for analysis to be conducted on how attitudes towards the module have an effect on academic achievement in a flipped learning environment compared to a traditional learning environment.

   Self-efficacy of learning and performance defines self-judgment of one's ability to accomplish a task and the level of self-confidence obtained in students. Some examples of questions included under this category in questionnaires 1 to 3 are:

   Questionnaire 1 only, Section 2, Question 2: "Please predict what mark you think you will get for the class test for this module (out of 100)"

   Questionnaire 1 only, Section 2, Question 4: "Please rank the following in order of how important each is to you: a) I aim to pass the exam, b) I aim to understand the content as thoroughly as

possible, c) I aim to get a good mark in this module, d) I aim to use this module as a starting point so that I can develop my own ideas around the content."

These questions have been included to gain an understanding of the mindset of the students throughout the duration of the module. These will then later be compared to personality traits in the Big Five Factor Model (see Section 1.1) and the effect this has on academic achievement in flipped and traditional learning environments.

Effort regulation defines the "commitment to completing one's study goals, even when there are difficulties or distractions" [94]. The following questions aim to collect information with regards to this scale:

Section 2, Question 3a: "Please predict what mark you think you will get for the class test for this module (out of 100)"

(**Note:** This question was included across all questionnaires, with slight alterations in terms of tense used, as appropriate.)

Comparing the results of this question to actual marks achieved in CfM will later allow for analysis to be performed on the effect of commitment towards one's study goals on academic achievement in the flipped compared to the traditional learning environments. This will also later be extended in terms of considering the main personality traits of the students with high/low commitment and whether this has a resulting effect on achievement with regards to the different learning environments mentioned.

2. **The "Quintamensional Plan of Question Design" [49]**

   This design believes that one can "approach any topic from five different paths" [49, 92]:

   (a) Awareness of the public is first ascertained by a free answer knowledge question

   (b) Uninfluenced attitudes on the subject are next developed in a free-answer question

   (c) Specific attitudes are then elicited through a two-way or a multiple-choice question

   (d) Reasoning behind the attitudes follows in a free-answer reason-why question.

   (e) Intensity of feeling comes last in an intensity question.

   Although all of these five points are deemed not to always be necessary, Gallup believes that "it is always advisable to keep in mind these five elements" [49, 92].

   Three questions which demonstrate the application of this model (in the order in which the questions are given in the questionnaires) are:

   (a) *Section 1, Question 5: "Please rate your level of knowledge in programming"* This is based on the free-answer knowledge question in that this encourage students to start thinking about what they know about programming in general at the start of the questionnaire.

   (b) *Section 2, Question 1a: "How interested are you in programming?"* This question focuses on obtaining uninfluenced attitudes on student opinions towards programming.

   (c) *Section 3, Questions 6a and 6b: "Please rate how important you believe the following are in your learning process: a) self-study time, b) time with instructor"*. This question focuses on specific attitudes towards the learning process.

   The purpose of considering this model when choosing questions to incorporate into the questionnaires was to increase the potential likelihood of students wanting to participate in and complete them. If students are uninterested in the questions, then reliability of the responses they give could be affected. (See Section 2.1.3 for more information on reliability and accuracy when creating questionnaires.)

The next section discusses the importance of wording questions correctly in order to increase reliability and accuracy of responses.

2.1.3 Question Wording: Literature/Theory

Awareness of the importance of question wording is extremely important when creating questionnaires, due to the fact that a leading, biased or ambiguous questionnaire would yield inaccurate and unreliable results. Five different points on this topic will therefore be discussed in this section:

1. **Question Formation**

   Several pieces of literature [90, 92] suggest that questions should be no longer than twenty words long. The main reason for this is so that the questions are concise and easy to read in order to eliminate any chance of confusion over the meaning of the question. As [19] states:

   "We must think through each question from the perspective of the plausible situations to judge whether all or most respondents will be able to answer it in the expected manner."

   By being specific and direct in question formation [92], the ability of the students to answer the questions as intended should be increased. The questionnaires were therefore created with this in mind.

2. **Presuppositions**

   In [78], it is highlighted that questions should not assume anything about the respondent in advance. For example, asking the question "what are your usual hours of work?" presupposes that a respondent works and that the respondents' hours of work are regular. Instead it is necessary to split the question into more than one question, such as: "do you work?" and then "if yes, do you work regular hours?" [78]. By splitting questions up in this way, respondents should not feel obliged to answer a question which is not necessarily true.

   This research was applied specifically to Section 3 of questionnaires 2 and 3:

   "Q3. Please rate the effect that the delivery of this module currently has on your attitude towards Computing." "Q4. If you gave a rating of 2 or above in question 3, please state whether the effect is positive or negative.".

   If question 4 read: "please state whether the effect that the delivery of this module currently has on your attitude towards Computing" on its own, the question would presuppose that there exists an effect of the module delivery on attitudes towards Computing. The incorporation of both questions therefore eliminates potential bias caused by presupposition.

   An alternative form of presupposition is defined by the use of forced choice questions, implying that one of the options given are definitely true [78]. With the exception of questions requiring a numerical answer (see Section 2.2 for more information), a five-point Likert scale has been introduced for the majority of answers (see Section 2.1.5 for more information) in order to cover as many options as possible for respondents to provide accurate responses. This, again, should therefore contribute towards the elimination of potential bias in responses.

3. **Double-Barrelled Questions**

   It is suggested in [19, 90] that double-barrelled questions should be avoided as the respondent may have differing opinions on each part of the question. By breaking the question down into two or more questions, this should increase the questionnaire's ability to collect the true attitudes and views of the respondents, focusing on each topic in question individually.

   One particular question included in the questionnaires which does not incorporate the guidelines given by this research is in Section 3, Question 5:

   "Please rate how useful you think this module AND its delivery will be for your personal development".

   In accordance to the above literature, this question should have been split into two questions: one which focuses on the effect of the module *content* on one's personal development, and one focusing on the effect of the module *delivery* on one's personal development. The purpose of using this double-barrelled question however is to allow for recognition of the effect of the module on

personal development to be made as a whole (known as a summary judgment [19]), regardless of the learning environment specifically.

4. **Eliminating Bias**

   Throughout the process of developing questions, it is suggested in [19] that the question of whether or not bias is being introduced in the data-gathering process should constantly be asked. In order to support this idea, [92] suggests six questions which should be considered when choosing words for the questionnaires:

   (a) Does it mean what we intend?

   (b) Does it have any other meanings?

   (c) If so, does the content make the intended meaning clear?

   (d) Does the word have more than one pronunciation?

   (e) Is there any word of similar pronunciation that it might be confused with?

   (f) Is a simpler word or phrase suggested (either in the dictionary or thesaurus)?

   These were all considered in the creation of the questionnaires for this study.

5. **Other Points Considered**

   In [90], it is suggested that hypothetical questions should be avoided, for example, where respondents have to make predictions about their future. It is believed that this can give poor predictions because respondents may or may not have experienced this before. In questionnaire 1 however, the following question is asked:

   Section 2, Question 3a: "Please predict what mark you think you will get for the class test for this module (out of 100)".

   This question is then asked throughout all three questionnaires, with slight variation as to the tense used where appropriate. Despite the literature above stating otherwise, this question has been included to allow for trends in expectations over the duration of the module to be analysed. Even though the respondents in questionnaire 1 would not have yet taken the class test, and so not know what to expect, initial views of the respondents can be obtained from answering this question, therefore allowing for comparison of their predictions against actual marks obtained to be carried out.

   Several pieces of literature [19, 90] state that it is important to avoid technical terms. The reason behind this is that respondents may not understand what these mean and so respond to the questions inaccurately. Additionally, by using language that respondents are familiar with, respondents should be able to express their views and opinions more accurately, due to greater understanding of the question. The only technical term incorporated in the questionnaires is "flipped classroom", which is used in the introduction. This is supported by its definition however so that respondents are fully-aware of its meaning [92].

   Another technique for ensuring that respondents have understood the questions asked is by asking the same question in different ways and then comparing the responses of both to check for consistencies [90]. An example of this lies in Section 3 of the questionnaires:

   Question 1b: "Please rate your views on the statement: I think I learn best when someone explains something to me"

   and

   Question 6: "Please rate how important you believe the following are in your learning process: a) Self-study time; b) Time with instructor".

   In the data analysis of these questionnaires, responses to these two questions will be compared in order to identify whether the respondents' definition of 'someone' in their response to question 1b refers to the instructor or their peers (i.e. depending on their answer to question 6).

The next section will discuss how the questions should be organised in the questionnaire, to prevent any potential bias.

2.1.4 Question Order: Literature/Theory

It is suggested in [78] that the influence that one question may have on any subsequent ones should be considered. For example, the respondents' answer to one question may have an effect on their thought process for the subsequent question. Careful thought was therefore administered in the creation of the questionnaires in this study, to reduce any potential bias.

One particular set of questions in the questionnaires aimed to use this idea of bias as an advantage, For example, the order of:

Question 3: "Do you have any qualifications in Computing?"

and

Question 5: "Please rate your level of knowledge in Computing"

was chosen with the intention that respondents who had opted "yes" to question 3, would rate their level of knowledge in Computing slightly higher than those who did not have any previous qualifications in Computing. By asking question 3 before question 5, respondents should therefore have been prompted to thoroughly think about what level of knowledge of Computing they have, based on whether or not they have previous qualifications in Computing. This should encourage a more accurate response.

Using this idea additionally, [78] states that it is important to consider the influence of the questionnaire context on initial attitudes and opinions generated by respondents, before even looking at the questions. The introduction was therefore created as impartially as possible through simply giving an explanation of what a flipped classroom is and stating the purpose of the questionnaire in a non-leading way: *"this short questionnaire will help better understand your learning experience in such an environment"*.

According to [19], the first question should be:

- easy to answer
- applicable to and answerable by most respondents
- closed format

Combining the above point with research on the fact that questions should get progressively more difficult throughout the questionnaire, in order to allow the respondents to progress smoothly and quickly through the questionnaire [19], the questionnaires were divided into three sections. Taking this research into consideration, the general structure of the questionnaires is outlined in Figure 2.1.

The next section will discuss the response categories chosen for each of the questions in the questionnaires.

2.1.5 Choosing the Response Categories/Scaling

Choosing the correct type of response categories was essential for ensuring that the correct data was collected, in a valid, unbiased and reliable way.

For the majority of questions, a five-point Likert scale [94] was provided so that respondents could rate their thoughts. Inspiration for this was taken from the MSLQ [94] (see Section 2.1.2 for more information). Unlike the MSLQ however, the questionnaires in this study consisted of only five points, instead of seven. The Research Report Series [78] suggested that the number of response categories on a Likert scale should be between five and nine points. The lower bound of these quantities was chosen so that clear labeling of each point could be given. According to [78], research carried out by Krosnick and colleagues [70] found that the idea of labeling each point on the scale has been found to increase reliability, due to each point meaning (roughly) the same thing for every respondent.

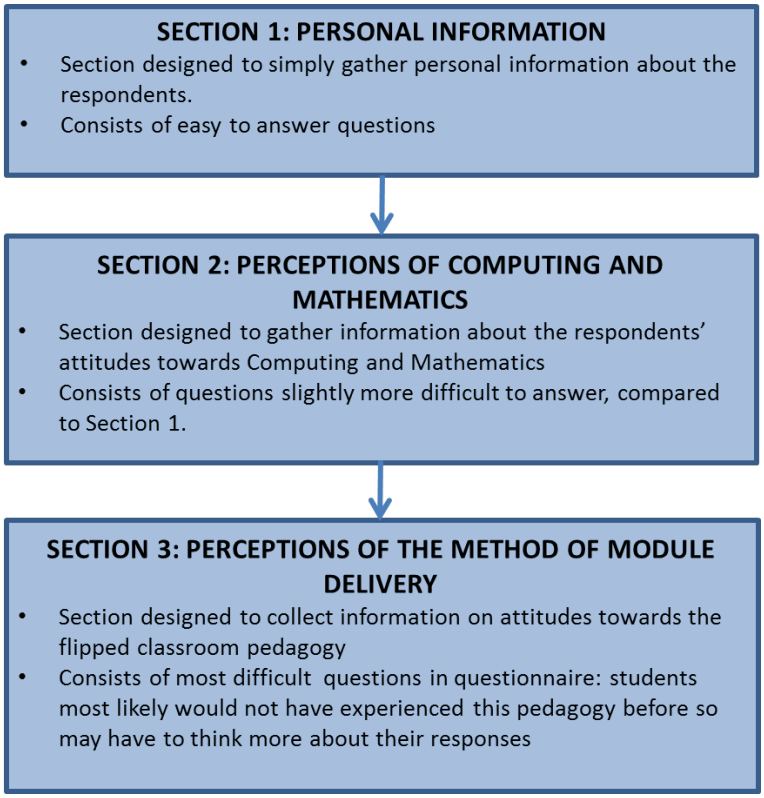

Figure 2.1: General structure of Questionnaires 1 to 3

Apart from the questions which involved giving a numerical response (for example, providing one's student number and the questions involving predicting assessment marks), the rest of the questions had multiple choice options for respondents to give their responses. It was really important when creating these to ensure that all options were covered to increase the accuracy of responses, as discussed in Section 2.1.3. As stated in [78], the following questions were hence considered:

- Are these really the only options?
- Are they too blunt and need to be expanded?

The final type of response category used was simply a blank space for respondents to write in their answer. This type of response was given to questions which asked for numerical responses, such as *"please predict what mark you think you will get in the class test for this module (out of 100)"* (Questionnaire 1, Section 2, Question 3a). The purpose of using this type of response category as opposed to multiple choice questions was to avoid bias in responses. According to [78], if frequencies are given as multiple choice answers, such as 1-2 hours, 3-4 hours, many respondents tend to naturally go for the normative or average (middle) response in the scale. By providing a space therefore for respondents to write their own answer, knowledge of the "ideal answer" should be eliminated.

The next section discusses the procedure of pretesting carried out on the questionnaires.

2.1.6 Pretesting

Having created a draft version of the questionnaire, pretesting [19] was carried out to gain an understanding as to how students of university level interpreted the questions. This process was vital in terms of allowing for further adaptation and improvement to be made on the questionnaires to increase the reliability of the results obtained from them.

For the purpose of confidentiality in this report, the students who gave their views will be referred to as

letters from A to H. The descriptions below address some of the points made in the pretesting and are included in this report for illustrative purposes.

1. **Section A:**

   B: *"In question 1 of section 2: "Please rate your level of knowledge in programming", there would have to be a subtle underlying assumption of what that actually means. In other words, the responses to this could very much vary depending on what students view their level of knowledge to be."*

   It is true that this question can be considered as ambiguous due to the fact that it is difficult to define what exactly expert knowledge is, for example. Although [90, 92] state that ambiguity is something to avoid in questionnaire design, this question has not been altered with the intention that it will grasp a natural overview of how confident the students feel in their knowledge and understanding of programming. Understandably this may be criticised as giving "unreliable" results, however, the two questions preceding this question in the questionnaire ask whether the respondent has any qualifications in Computing and what exactly these are. Where necessary in later analysis, these two questions will therefore be compared to enable conclusions to be made that would eliminate this ambiguity.

2. **Section 2:**

   C: *"In question 3a: "Please predict what mark you think you will get for this module", it may be unclear to the first year students what this mark may be out of."*

   As a result of this point being raised, this question was adapted to include "(out of 100)" at the end of the question through acknowledging the fact that first year students may not yet be aware of the assessment system within the university, especially at the start of the year when the first questionnaire was sent out. The input field for the answer was also adapted to ensure that students could only input integers between 0 and 100. The purpose of this was to ensure valid responses are given.

   D: *"Two of your option choices in question 4: "I aim to pass the exam" and "I aim to get a good mark in this module" seem the same to me. Surely if you want to pass the exam you will have received a good mark? Unless you mean the difference of just passing the exam and then getting a high mark and excelling?"*

   Assessment marks obtained by first year Mathematics students at Cardiff University do not count towards their overall degree mark: they just need to pass. This relationship suggested between the two aims may therefore not be true in this study. Having said this however, the statement "I aim to get a good mark in this module" could be classed as ambiguous. The aim of this question was to obtain general views on whether a student aims highly therefore this question was not altered. When analysing this aim however, the questions regarding the students' predicted class test marks will be used to gain an understanding as to how these students define "good mark" to eliminate ambiguity as much as possible.

3. **Section 3**

   E: *"Question 1a: "Please select the rating below which describes how you think you work best" is very wordy and sounds a bit heavy-weighted. Maybe consider something a bit more concise? You also don't need the "how you think" part as the students are giving their opinions anyway."*

   This point confirms previous research [90, 92] that questions should be concise to eliminate confusion. The wording of this question was therefore changed to "Please select the rating below which describes how you work best."

   G: *"Question 5: "Please rate how successful you think the delivery of this module will be in developing your skills for the future" is a bit confusing. I don't really understand what it is asking."*

   H: *"I don't really know what you are trying to establish from question 5? Should you ask the students how beneficial it would be instead of how successful? I also don't think you need the "in the future" part because developing skills is an ongoing process".*

The uncertainty in meaning of this question was acknowledged through these two points and therefore consequently changed to "please rate how useful you think the module and its delivery will be for your personal development".

2.2 Attitudes over time

Three questionnaires were distributed throughout the first semester of CfM (as illustrated in Table 2.1 in Section 2):

- The first questionnaire was given out in the first week, which was designed to gage initial perceptions of the module and attitudes towards programming.
- The second questionnaire was given out after the students had taken their class test, but before they had received their results. The aim of this targeted time to distribute the second set of questionnaires was to identify the attitude changes in the students having experienced the flipped learning environment for, at this point, seven weeks, as well as receive an indication as to how students felt they performed in the class test.
- The third and final questionnaire in this series was distributed in week ten: the second to last week of the first semester. The purpose of distributing the final questionnaire at this point was to gain an understanding of how students felt at the end of the first half of the module, having experienced a whole semester of learning in a flipped learning environment, as well as after having received some assessment feedback (i.e. from their class test).

The questionnaires were very similar in content: the only changes that were made were the phrasings of some questions, in terms of grammar tenses, and also a question about coursework estimation was included in the final questionnaire. The purpose of this was to provide more opportunities for comparison against different variables in the study.

Copies of each of these three questionnaires can be found in Appendices Section C.

The next section will discuss the assessment measures used to analyse academic achievement of students in flipped and traditional learning environments.

2.3 Assessment

Three types of assessment results were collected in order to compare the results of the questionnaires against: the respondents' class test marks in CfM, the respondents' coursework marks in CfM and the marks each respondent obtained for all other modules.

An average mark was calculated for the total marks attained in CfM by adding together 40% of the class test total received and 30% of the coursework total received. (These were the weightings that were given to these different types of assessment within the module). This new total will be referred to throughout the rest of this report as the **CfM total mark**.

From the data set of marks obtained from all other modules, the mean mark per respondent was found. Short discussions with the lecturers for each of these modules indicated that all of these modules had been taught in a "traditional way" whereby students were taken through the notes in lectures and then they had to work on exercises in their own time outside of lectures. The purpose of having this **mean mark for the other modules** was to allow for comparisons to be made between the achievement of students in a flipped learning environment and achievement in a traditional learning environment, contributing towards satisfying Aims 1 and 3, as described in Section 1.3.

Another indicator which was calculated from these data sets was the relative ratio in achievement between a flipped learning environment and a traditional learning environment, referred to as α. This was simply calculated by dividing the CfM total mark by the mean mark obtained in all other modules. The median of this whole data set (i.e. for all respondents) was then taken to represent α. This gave the overall

value of α to be 1.260. (This value will hereon be referred to as $\alpha_{\mathbf{med}}$.) Any respondent with a ratio greater than α_{med} is therefore believed to achieve higher in a flipped learning environment, whereas any respondent with a ratio less than α_{med} is believed to achieve higher in a traditional learning environment.

The next section will discuss the methodology used to find the main personality traits present within the sample of students used for this study.

2.4 Personality Questionnaire

2.4.1 The Big Five Personality Model

The Big Five Personality model consists of five main categories which define personality, according to [24, 36, 89]. Namely, these categories, which are a replication of the work of Allport and Odberg in [11] (as discussed in Section 1.1), are: openness, conscientiousness, extraversion, agreeableness and neuroticism. These are "conceptualised as stable, individual difference characteristics explaining an individual's disposition to particular patterns of behaviour, cognition and emotions" [58].

The name was chosen by Goldberg in [51], not only to "reflect their intrinsic greatness, but to emphasise that each factor is extremely broad". According to [62], due to the broadness of these personality traits, they may not be entirely useful in predicting specific behaviours of a particular individual. On the other hand, Dilchert, Ones, Van Rooy and Viswesvaran in [32, 37] state that the model is a strongly generalisable framework for describing personality traits.

Despite this argument, Messick in [84] noted that underlying personality traits may be responsible for consistency in information processes, which, in turn, is measurable as a learning characteristic [18]. The study involved in this report therefore aims to support this, through analysing the links between these personality traits and academic achievement.

1. **Openness**

   This personality trait is characterised by originality, curiosity and ingenuity [35, 52, 53, 63]. People high in openness tend to have a willingness to try and learn new things, consider new ideas and have an open mind in general [7]. It can also be interpreted as having an emphasis on intelligence, sophistication and reflection [8]. Norman in [89] initially labeled this category "culture". This links to Porpopat's [96] interpretation of this personality trait in that there are two main facets under this category: "openness to culture", which refers to the broadness or narrowness of one's own cultural interests and "openness to experience", which refers to openness to different values and interest towards people, habits and lifestyles.

   Other researchers named this trait "intelligence" [7], however McCrae and Costa in [81] disagreed with this because they argued that intelligence may be a result of openness. The relationship between openness and intelligence was researched further by Ackerman and Heggestad in [10] who found that openness had the highest correlation with intelligence. Simultaneously however, they also found that openness did not have the highest correlation with academic performance [10].

   Having said this, Richard et al's meta-analysis in [99] found that openness had stronger correlations with academic performance compared to measures of general intelligence. Poropat in [96] further speculated the relationship between openness and academic achievement through stating that the "thinking and curiosity aspect of openness [17] is expressed in a deep approach to learning, in which students follow their extrinsic interests in pursuit of intellectual satisfaction [29] which mediates the correlation between openness and academic achievement [116]".

   Blickle in [20] also found that openness to experience is associated with academic performance. This is perhaps supported by the work of Vermetten et al. in [122], who found that openness is positively correlated with an open approach to learning, and Tempelaar, Gijselaers, Vander Loeff and Nijhuis in [118], who found that there exists a positive correlation between openness and learning motivation.

Taking these points about the relationship between openness and academic achievement into consideration, Orvis et al in [91] stated that through assessing levels of openness amongst students, teachers should provide discovery learning to students high in openness, of whom would therefore benefit most from that approach, but then provide more structured learning to those low in openness, in order to maximise their learning.

2. **Conscientiousness**

   Conscientiousness is defined by orderliness, responsibility, dependability and perseverance [18, 35, 52, 53, 63, 7]. It also includes features such as the ability to plan and organise [18, 7]. Furthermore, conscientiousness is the personality trait which is most linked to motivation and effort expenditure [14, 27].

   Poropat in [96] believes that conscientiousness falls into two main facets: "scrupulousness", which consists of dependability, orderliness and precision, and "perseverance": the measure of which determines the capability of fulfilling one's own tasks and commitments.

   The two attributes within conscientiousness: sustained effort and goal-setting have been found to contribute towards academic success [113], as well as learning-related time management [18]. Following on from this, MacCann in [76] found that conscientious students tend to have increased confidence which should allow them to stay focussed on educational activities, leading to greater learning. This was later confirmed by Saklofske in [104] who also added that this provides significant advantages in stressful situations.

   Of all the Big Five Factors, many studies have found that conscientiousness remains the strongest correlate of academic performance [18, 27, 28, 31, 34, 95, 96].

3. **Extraversion**

   Extraversion is characterised by talkativeness, assertiveness and energy [35, 52, 53, 63]. It can also be defined by how outgoing or sociable a person might be [7].

   Poropat in [96] states that this category can be split into two different facets: "dynamism", which refers to expansiveness and enthusiasm, and "dominance", which refers to assertiveness and confidence.

   Eynseck and Cookson (1969) in [42] found that extraversion was correlated with academic performance, arguing that this was due to extraverted students interacting more with their teachers and so being able to increase their learning and achieving higher academically. De Raad and Schouwenberg in [34] also confirmed a positive correlation between extraversion and academic performance, however believed this was due to higher energy levels and enthusiasm, leading to a desire to learn and understand. Poropat in [95] confirmed this relationship later on, but only for primary school students.

   Bidjerano and Dai in [18] believed that extraversion could support social behaviours, such as help seeking and peer learning. On the other hand however, Eynseck in [40] suggested that extraverted students would be more likely to socialise and participate in other activities, rather then studying, resulting in lower levels of performance. In addition to this, Matthews in [80] found that extraverts tended to be poorer in reflective problem solving due to them reaching cognitive closure prematurely.

4. **Agreeableness**

   This personality trait is characterised by good-naturedness, cooperativeness and trust [35, 52, 53, 63]. It reflects qualities such as social warmth, likeability, nurturance and emotional supportiveness [7], as well as friendliness and trust [8].

   Two main facets which this personality trait categorises into, according to Poropat in [96], are: "cooperativeness/empathy", which refers to consideration of other people's needs, and "politeness", which refers to kindness, civility and trust.

   Bidjerano and Dai in [18] believe that students with high agreeableness have better time management skills and effort regulation. Poropat in [96] then found through further investigation, that

more agreeable students tend to be extrinsically motivated due to a better compliance with educational instruction. This confirmed earlier research that agreeableness was linked to compliance with teacher instructions and staying focused on learning tasks [122].

The positive relationships associated with high agreeableness are believed by Poropat in [96] to help facilitate learning. In relation to the effect of agreeableness on learning, De Raad and Schouwenberg in [34] argued that agreeableness may have some positive effect on academic performance by encouraging team work and discussion within the learning processes. This relationship was later confirmed by Vermetten, Lodewijks and Vermunt in [122], who identified a positive relationship between agreeableness and effort and surface learning.

5. **Neuroticism**

   Neuroticism is defined by upsetability, experiencing high levels of anxiety and emotional instability [35, 52, 53, 63, 7]. In other words, high scores in neuroticism imply emotional instability, whereas low scores in neuroticism imply emotional stability. The two main facets Poropat in [96] categorises neuroticism into are: "emotional control", which is about one's capacity to cope adequately with one's own anxiety and emotionality, and "impulse control", which is defined by one's capability of controlling imitation, discontent and anger.

   Zhao in [126] found that less emotionally-stable students focus on worrying about errors rather than upon the errors themselves, which impedes learning from those errors. Lubbers et al in [75] on the other hand found that students who are more emotionally stable have greater focus and so are able to concentrate more on learning activities.

   In terms of relating emotional stability to academic achievement, Poropat in [95] found that there was a negative correlation between neuroticism and academic performance at primary level, i.e. in other words, students with high emotional stability achieve higher academically. Poropat did not however find any significant correlations at secondary or tertiary levels of education. He suggested that the reason behind this was that if it is only the more capable students who continue to higher academic levels, then they should automatically be able to cope with negative consequences of low emotional stability, resulting in a smaller effect on academic performance.

   Judge and Bono state in [66] that emotional stability is associated with self-efficacy, which was found to be positively correlated with academic performance, according to Robbins et al in [100], indicating therefore that emotional stability should have a similar correlation, thus confirming the points argued by Poropat above.

   Norem and Cantor in [87] gave evidence that neuroticism can help increase motivation and effort expenditure since students, in anticipating failure, then gear up their efforts to pre-empt it. On the other hand however, Poropat in [96] believes that less emotional stable students are renowned for getting distracted or avoiding learning situations.

   The above two points raised could, arguably, support the conclusions made by Entwistle in [39] in that individuals high in neuroticism are likely to have a surface approach to learning instead of achieving deeper, meaningful understanding of the material.

Many studies have also been conducted looking at the relationships between two or more of these personality traits and their consequential effect on academic achievement.

For example, in early studies, conscientiousness and openness were jointly seen to predict school performance, when measured with objective tests in adolescence [60, 101]. At college level however, Noftle and Robins in [86] found that conscientiousness contributes towards higher academic achievement, whereas openness was found by Goldberg, Sweeney, Merenda and Hughes in [55] to predict the total years of education completed by middle adulthood. This relationship was also later confirmed by Poropat in [95] who found that, after conscientiousness, openness has the next strongest positive correlation with academic performance.

In general, Bidjerano and Dai in [18] stated that links of conscientiousness, intellect and agreeableness to components of self-regulated learning currently have more theoretical and empirical justifications than links of extraversion and neuroticism.

Having looked at some of the literature explaining the effect of the big five personality traits on academic achievement, it was then necessary to use this knowledge to create a personality questionnaire, as detailed in the next section.

2.4.2 Creating the Questionnaire

The "Big Five Questionnaire" has been created to measure and understand the main (and underlying) personality traits of the respondents [3], according to the Big Five Personality Model, outlined in Section 2.4.1, which might be responsible for and measurable as a learning characteristic [84].

It is important that the questionnaire contains very basic language and short phrases to try and prevent misinterpretation of the statements. Goldberg and Kilkowski in [54] highlight that the questionnaire should include phrases and/or statements, but not single adjectives as such items tend to be answered less consistently than when they are accompanied by definitions or elaborations. Poropat in [96] elaborates on the usefulness of incorporating short statements in the questionnaire through stating that they can offer an increased precision in the description of the personality.

To ensure that the correct information needed for a rigorous, useful analysis of the data and comparison against academic performance achieved by the students in Computing was collected, the 44 item questionnaire, created by John, Oliver P., Eileen M. Donahue, and Robert L. Kentle in [61], was used. A copy of this questionnaire is shown in Appendices Section D.

The next section will discuss how the questionnaire was analysed, in terms of extracting the big five personality factors.

2.4.3 Analysing the Questionnaire

In total, 87 responses out of a possible 170 responses were received from the 44-variable personality questionnaire. To identify the main factors which most explained the personalities of the respondents, principal components analysis was performed on the data, as suggested by Cattell in [7]. The first main decision was to make an informed choice as to the number of components to retain which would also correspond to the personality traits discussed in Section 2.4.1. The four different methods used below are as described in [9].

Method 1: Analysing the SS Loadings

Principal components analysis was firstly applied to the whole data, with 44 components to match the 44 variables included within the questionnaire (i.e. each variable was its own component). The results were as shown in Appendices Section B.1.

By looking at the SS loadings, the values remained greater than one up until (and including) the 11th component. This therefore implied that 11 components should be retained, since the SS loadings for the 12th component onwards are minimal enough to not include, according to [9].

Method 2: Creating a Screeplot

The second method entailed creating a screeplot which shows the eigenvalues of each factor. The graph always displays a downward curve, as illustrated in the screeplot for the data collected in this study (see Figure 2.2). The point where the slope of the curve levels off, otherwise known as the "elbow", then indicates the number of factors which should be retained [1]. In this case, looking at the "elbow" of the black line, it is clear that six factors explain most of the variability of the data and so six factors should be retained. This is also confirmed by the red line which illustrates the point of intersection between the red line and the green triangles, called the optimal coordinates [6]. Alternatively, a non-graphical solution to the Cattell subjective scree test is proposed by the acceleration factor, according to [6], which indicates where the elbow of the screeplot is. This solution in fact yields the number of factors to be 1. Finally, the parallel analysis, indicated by the green triangles on the screeplot, implies a Monte Carlo simulation which looks for significant factors [71]. These are categorised as significant if the associated eigenvalue is bigger than the

mean of those obtained from the random uncorrelated data. The parallel analysis therefore reveals in this study that six factors should be retained. Taking all of this into consideration, method two hence indicates that 6 factors should be retained, according to [9].

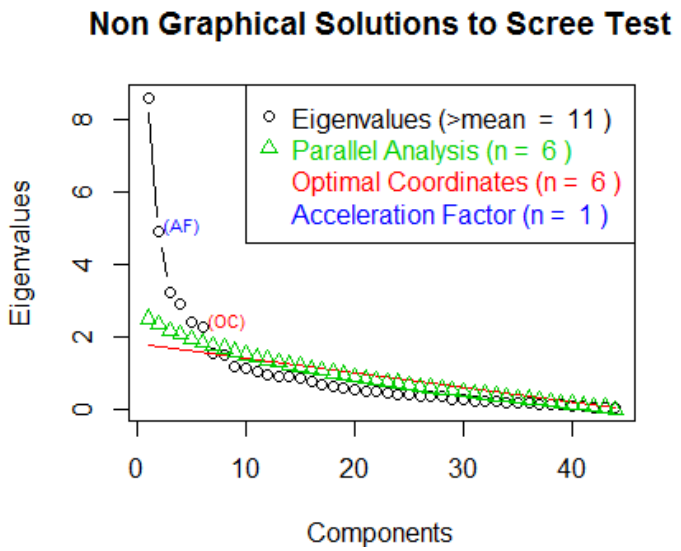

Figure 2.2: Screeplot illustrating the results of the principal components analysis

Method 3: Analysing the Total Variance

Referring back to the principal components analysis on all variables as components from method 1, the total variance can now be considered. According to [9], we can retain components that account for at least x% of the total variance. This is usually 5% or 10%. The first 6 components account for at least 5% of the total variance in this case, therefore it is conclusive from this method that 6 components should therefore be retained.

Method 4: Analysing the Cumulative Variance

Considering the same principal components analysis referred to in methods 1 and 3, [9] states that components to be retained should account for at least 70% (usually) of the cumulative variance. The loadings given in this case show that the first 11 components account for 70% of the total variance. This method hence implies that 11 components should be retained.

Using the conclusions from the four methods above, 6 components were consequently chosen to use in the new principal components analysis on the data. This amount was chosen, as opposed to 11 components, since the aim of this principal components analysis was to identify the main personality traits within the data.

Principal components analysis with 6 components was then carried out on the data (see Appendices Section B.2). As described in [61, 62] and illustrated in Table 2.2, each question asked within the questionnaire referred to one of five specific personality traits: conscientiousness, agreeableness, openness, neuroticism and extraversion. (Note that the question numbers which are followed by (R) indicate that these questions were reversely marked such that a lower score meant a higher indication of the factor being present.)

Using this information, the coefficients for the loadings of each question (identified from the principal components analysis) (see Appendices Section B.2) were then analysed in terms of each of the categories. For example, variable 1 was said to refer to extraversion according to Table 2.2. The highest loading for this variable was in RC2 (i.e. component 2), from (see Appendices Section B.2). This first variable therefore implied that RC2 represented extraversion. This same idea was then carried out with all variables to identify the personality trait which each component corresponded to the most (as detailed

Personality Trait	Corresponding Questions
Extraversion	1, 6(R), 11, 16, 21(R), 26, 31(R), 36
Agreeableness	2(R), 7, 12(R), 17, 22, 27(R), 32, 37(R), 42
Conscientiousness	3, 8(R), 13, 18(R), 23(R), 28, 33, 38, 43(R)
Neuroticism	4, 9(R), 14, 19, 24(R), 29, 34(R), 39
Openness	5, 10, 15, 20, 25, 30, 35(R), 40, 41(R), 44

Table 2.2: Personality traits defining personality questionnaire statements

Principal Component	Personality Trait
RC1	Agreeableness
RC2	Extraversion
RC3	Neuroticism
RC4	Openness1
RC5	Conscientiousness
RC6	Openness2

Table 2.3: Principal component labels

in the Appendices Section B). The final results of this were then as outlined in Table 2.3.

Note: From this analysis, RC4 and RC6 were both found to represent openness. The variables which were categorised under these two factors were then analysed with the intention of trying to identify two different types of openness to uniquely describe these factors.

Statements included within RC4 were:

"*5. I see myself as someone who is able to come up with new, original ideas frequently.*"

"*10. I see myself as someone who is curious about many different things.*"

"*20. I see myself as someone who has an active imagination.*".

RC6 included statements such as:

"*30. I see myself as someone who values artistic, aesthetic experiences.*"

"*35. I see myself as someone who prefers work that is routine.*" (Reversely marked)

"*41. I see myself as someone who has a few artistic interests.*" (Reversely marked)

Having analysed these two categories, the interpretation that will thus be used in this study is that **RC4 describes openness to deep learning** (from now on referred to as openness1) and **RC6 describes openness to creativity, imagination and surface learning** (from now on referred to as openness2).

With this new information, it was then possible to use the scores from the principal components analysis to identify the weightings of each individual personality trait for each respondent of questionnaires 1 to 3. Combining all of this together, a new data set, namely **Factors with Marks**, was created (see Section 2.6 for more information).

The next section will discuss how qualitative data was collected for this study and the purpose of collecting this type of data.

2.5 Qualitative Data: Focus Groups

2.5.1 Introduction

Three focus groups were conducted for this study (recall Table 2.1 from Chapter 2): two with a selection of first year students studying CfM and one with the undergraduate tutors who were leading the lab

Focus Group	Number of Students	Length of Focus Group
Focus Group 1 with the Students	17	Approximately 45 minutes
Focus Group 2 with the Students	7	Approximately 30 minutes
Focus Group with the Undergraduate Tutors	9	Approximately 30 minutes

Table 2.4: Focus group details

sessions. The purpose of running these focus groups was to gain some more in-depth opinions and views regarding what the students and undergraduate tutors thought about the module content and the module delivery, in terms of the flipped learning environment. Different questions were created for each individual focus group as a guide for the main points of discussion. These were carefully chosen with the aim of collecting information from the focus group participants that could be compared to the results received from the quantitative data collected in this study [67].

There was no specific selection method for the student focus groups. The two student focus groups were announced in class meetings and were opened out to any student that wanted to attend and discuss their opinions. It is therefore important to remember in the analysis of these focus groups that there may be an element of bias in the results, due to the fact that the students who took part in the focus group, most likely felt strongly about the module, whether this be positively or negatively.

The focus group for the undergraduate tutors consisted of ten out of eleven of the tutors. These tutors are second year students who took the module in the same flipped environment design last year and are acting as mentors and tutors for the students during this particular year. Again, there exists some element of bias here in that, whilst the supervisor for this project, VK, was not present during this focus group, he is ultimately the supervisor of all the tutors (who are paid for their tutoring time) and so the tutors may have felt obliged to speak positively about their experience.

The next section will discuss how the focus groups were conducted in more detail.

2.5.2 Focus Groups: Methodology

The first of the three focus groups with the students studying CfM was conducted during week 3 of the first semester and the second was conducted during week 10 (as detailed in Table 2.1 in the introduction to Section 2). These particular timings were chosen so that potential changes in attitudes towards the module could be identified through comparisons between initial views and views at the end of the first semester. As also detailed in Table 2.1, the focus group with the undergraduate tutors was conducted in week 7 of the first semester. This specific timing was chosen so that attitudes of the students, from the tutors' point of view, on the module, as well as identify whether class atmosphere had changed over time, since the class test.

Details of the running of these focus groups is illustrated in Table 2.4.

All focus groups were audio recorded, then transcribed verbatim afterwards [16] (see Appendices Sections A.1, A.2 and A.2 for copies of these). (**Note:** Audio transcripts of these focus groups have not been included due to issues with anonymity.) By transcribing the focus groups, it was hoped that a better understanding of the content of the discussion could be obtained [114], in preparation for later analysis.

A set of questions were created as a guide for each focus group to initiate discussion: additional points introduced as a result of these discussions were readily encouraged however so as to learn as much as possible about the attitudes of the students and undergraduate tutors through this data collection method. The questions asked in all three focus groups are illustrated in Table 2.5 and the analysis of these focus groups are discussed in Section 5.

The next section will summarise all of the data collected in this study, taking into consideration everything discussed in this chapter.

Focus Group 1 with Students	**Focus Group 2 with Students**	**Focus Group with Undergraduate Tutors**
1. What do you hope to get out of your lectures in university?	1. Was the class test how you expected? Did you feel like answering the questions in the class test came naturally to you or do you feel like you had to go through all of your notes repeatedly to find the answers?	1. Are you enjoying your roles as undergraduate tutors?
2. What are your opinions between the way this module is delivered compared to other modules?	2. Do you think your results in the class test were affected by how much work you did outside of lectures, in terms of pre-lab material?	2. Do you feel you're well-informed as to what your role actually is? For example, do you feel like you know how much information you're allowed to give the students?
3. What are your views towards attending lectures through this style of module delivery? Do you think that they are necessary?	3. Do you feel like your class test result was affected by your attendance and/or contribution in lectures?	3. How do you feel about your role as a tutor in this style of module delivery as opposed to perhaps other times you have tutored?
4. Do you feel like there is a structure to the module? Do you know where the module is leading?	4. Do you feel like you've had a good amount of support throughout the module to allow you to learn the content to your standards?	4. How does this module delivery style compare to when you did the module?
5. How much time have you roughly spent on the module outside of labs and lectures per week so far? Do you think that this is the corect amount of time to be spent on a module? (Do you think that there is enough time?)	5. Have your attitudes towards Programming changed since the start of this module?	5. What is your relationship with the students like?
6. What do you think of the feedback/assessment part of this module? Do you feel like you know how well you are progressing?	6. What have you learnt about yourself, in terms of how you learn best, through experiencing this style of module delivery?	6. Do you feel like the students can get the most out of the content and university learning experience this way?
7. If you could design the university teaching system, what would be your ideal structure, in order to learn most effectively?	7. What do you think you're going to take away from this module afterwards, if anything? In other words, what do you think you'll remember from this module in the future, if anything?	7. What is the general attitudes of the students like in lab sessions?
8. Do you have anything else you would like to add about this module and/or style of delivery in general?	-	8. Have you seen much change or difference in the attitudes of the students throughout the duration of the module so far? Especially perhaps since the class test?
-	-	9. How do you think VK could have better prepared you for your role?

Table 2.5: Main questions asked in the focus groups

2.6 Data Summary

Due to the range of data collected, a summary of all the data which has been discussed in this chapter has been compiled and illustrated by means of two tables: Table 2.6 summarises the quantitative data collected; Table 2.7 summarises the qualitative data collected.

The next two chapters will discuss the analysis undertaken on the data collected. In particular, the next chapter will look at the scores obtained by the respondents for each of the Big Five personality traits (see Section 2.4.1) and analyse the effect of these on academic achievement in flipped and traditional learning environments.

Data Set	**Contents**	**Number of Respondents**	**Where Used in Report**
Data 1 with factors	Responses from questionnaire 1, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	53	Section 4.5
Data 2 with factors	Responses from questionnaire 2, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	64	Section 4.1.2
Data 3 with factors	Responses from questionnaire 3, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	65	Section 4.1.3
Data 12 with factors	Responses from questionnaires 1 and 2, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	39	Not needed: sufficient information provided in other data sets with larger numbers of respondents
Data 13 with factors	Responses from questionnaires 1 and 3, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	41	Section 4.2
Data 23 with factors	Responses from questionnaires 2 and 3, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	50	Not needed: sufficient information provided in other data sets with larger numbers of respondents
Data 123 with factors	Responses from questionnaires 1 2 and 3, Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	30	Not used since too little data set: any information required to perform analyses in this report was provided through other data sets with larger numbers of respondents
Factors with marks	Scores for each personality trait, Main personality trait, Class test total in Computing, Coursework total in Computing Total marks in Computing, Mean mark in other modules, α	83	Section 3.2.1, Section 3.2.2 and Section 3.2.3

Table 2.6: Summary table of all quantative data collected

Data	**Respondent Type**
Focus Group 1	Students from the Year One Computing Module
Focus Group 2	Students from the Year One Computing Module
Focus Group 3	Student Tutors in Year Two for the Year One Computing Modules

Table 2.7: Summary table of all qualitative data collected

Chapter 3

The Effect of Personality Scores on Academic Achievement in Different Learning Environments

This chapter focuses specifically on the effect of different personality traits (as defined in Section 2.4.3) on academic achievement in a flipped versus traditional learning environment. It aims to understand whether the flipped learning environment incentivises higher academic success for a specific type of student and compares this to the type of student which generally seems to achieve highly in a traditional learning environment (satisfying Aims 1 and 2, as described in Section 1.3). The results are then discussed from a pedagogic point of view, with suggestions as to the effect this pedagogy has on academic success in practice.

3.1 Distribution of Personality Traits

In this section, the scores obtained from the principal components analysis on the personality questionnaire (see Section 2.4.3) for each respondent will be discussed, in terms of the range of personality traits present within the respondents.

Figure 3.1 shows the distribution of personality scores, for each response received from the personality questionnaire (see Section 2.4).

It is clear from Figure 3.1 that there is little variation in the scores for each personality trait. This implies that more accurate results can be obtained from comparing these scores against other factors later on in the study, due to a more equal spread of personality traits.

Having looked at the distribution of scores for the different personality traits, the next section looks at the effect of personality traits on academic achievement, in general.

3.2 Personality Traits which Best Predict Academic Achievement

To determine the traits which best predict academic achievement in CfM (i.e. a flipped learning environment), other modules (i.e. traditional learning environments) and the median ratio between both types of learning environment (i.e. α) (whilst ultimately also confirming some of the literature discussed in Sections 1.1 and 2.4.1), stepwise linear regression was carried out on the personality traits in all three

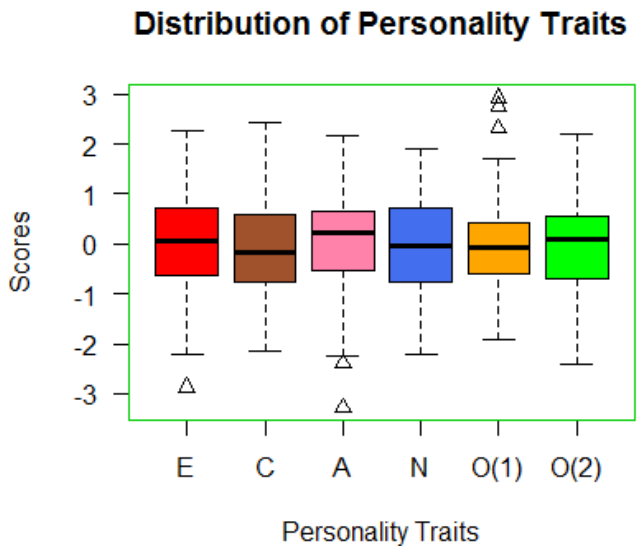

Figure 3.1: Distribution of personality scores: E = Extraversion, C = Conscientiousness, A = Agreeableness, N = Neuroticism, O(1) = Openness1, O(2) = Openness2

Coefficients	**Estimate**	**Standard Error**	**p-value**	**Pr(> |t|)**
Intercept	62.668	1.345	46.600	less than 2e-16
Conscientiousness	3.075	1.366	2.250	0.027

Residual Standard Error	12.25 on 81 degrees of freedom
Multiple R-squared	0.059
Adjusted R-Squared	0.047
F-Statistic	5.064 on 1 and 81 DF
p-value	0.027

Table 3.1: Results of stepwise linear regression on the mean mark in other modules for all data

cases. The largest data set used containing all of this information (and so increasing accuracy of the results) was **Factors with Marks** (see Section 2.6 for more details).

The next section firstly discusses the stepwise linear regression carried out on the personality traits in order to predict the mean mark obtained in other modules.

3.2.1 Stepwise Linear Regression on Mean Mark in Other Modules

The results of the stepwise linear regression on all personality traits against the mean mark obtained in the other modules for the data set **Factors with Marks** is shown in Table 3.1.

The adjusted R-squared value displayed in the results of the final stepwise linear regression results on the mean mark obtained in other modules (see Table 3.1) is extremely low. This implies that only 4.7% of the variance can be accounted for by this regression line. On the other hand however, this model is statistically significant, indicating that the null hypothesis of the conscientiousness coefficient to be equal to 0 is rejected.

The results from this stepwise linear regression therefore conclude that it is sufficient to say conscientiousness is the best predictor of the mean mark achieved in other modules, with the final regression line being:

Coefficients	Estimate	Standard Error	t-value	Pr(> |t|)
Intercept	78.225	1.448	54.025	¡ ¡ 2e-16
Openness1	4.474	1.533	2.918	0.005

Residual Standard Error	13.01 on 79 degrees of freedom
Multiple R-squared	0.097
Adjusted R-Squared	0.086
F-Statistic	8.516 on 1 and 79 DF
p-value	0.005

Table 3.2: Results of stepwise linear regression on the CfM total for all data

Mean mark achieved in other modules = 3.075×Conscientiousness + 62.668.

The coefficient of conscientiousness in the above linear regression model is relatively big, suggesting that students who score highly in conscientiousness achieve highly in a traditional learning environment.

Using the information from this model, a scatterplot illustrating the relationship between scores in conscientiousness and mean marks achieved in other modules was created (shown in Figure 3.2) as a visual representation of the model.

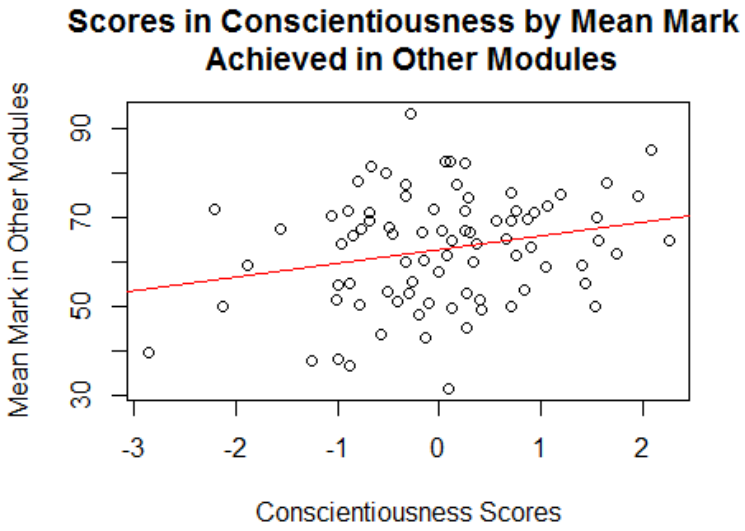

Figure 3.2: Scatterplot illustrating scores in conscientiousness against mean mark achieved in other modules

The positive correlation between conscientiousness and academic achievement achieved in this study confirms conclusions made in previous studies (e.g. [18, 27, 31]), as discussed in Section 2.4.1.

The next section discusses the stepwise linear regression performed on the personality traits by the total marks achieved in CfM.

3.2.2 Stepwise Linear Regression on CfM Total

The results of the stepwise linear regression on all personality traits by the CfM total for the data set **Factors with Marks** is illustrated in Table 3.2.

The adjusted R-squared value is very low in this model, implying that only 8.6% of the variance can be

accounted for by the regression line. Having said this however, the model is very statistically significant indicating that the null hypothesis of the openness1 coefficient to be equal to 0 is rejected.

From this analysis, it is sufficient to say, in conclusion, that openness1 is the best predictor of the CfM total mark, with the final regression line being:

$$\textbf{CfM Total} = \mathbf{4.474}\times\textbf{Openness1} + \mathbf{78.225}.$$

Using the information from this model, a scatterplot illustrating the relationship between scores in openness1 and total marks achieved in CfM was created (shown in Figure 3.3) to provide a visual representation of the model.

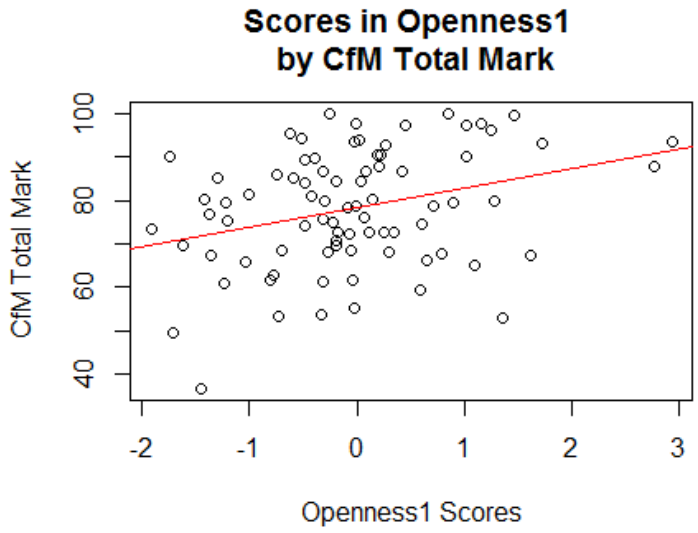

Figure 3.3: Scatterplot illustrating scores in openness1 against CfM Total Mark

It is clear from the model above that openness1 (i.e. openness to deep learning) has quite a substantial effect on achievement in CfM. This implies that students with high scores in openness to deep learning (recalling the interpretation of openness1 described in Section 2.4.3) are likely to achieve highly in a flipped learning environment. This confirms many studies which identify a relationship between openness and academic achievement (e.g. [96, 116, 122]), as detailed further in Section 2.4.1. Other research [91] found that discovery learning approaches [72] enhance learning potential for students who score highly in openness. The results found in Figure 3.3 therefore also confirms this piece of literature.

The next section discusses the stepwise linear regression performed on the personality traits by α_{med}.

3.2.3 Stepwise Linear Regression Model on α

Stepwise linear regression was then finally performed on α. The purpose of this was to find the best indicator, in terms of personality traits, of students who did better in CfM (i.e. a flipped learning environment), compared to their other modules (i.e. a traditional learning environment), confirming conclusions made in sections 3.2.1 and 3.2.2.

The results shown in Table 3.3 indicate a low adjusted R-squared value, implying that only 16% of the variance can be accounted for by the regression line. Despite this result however, the model is very statistically significant, therefore indicating that the null hypothesis of extraversion, conscientiousness and openness1 coefficients being equal to 0 is rejected.

Coefficients	Estimate	Standard Error	t-value	Pr(‖t‖)
Intercept	1.293	0.032	40.551	¡ 2e-16
Extraversion	-0.066	0.0317	-2.090	0.040
Conscientiousness	-0.099	0.032	-3.059	0.003
Openness1	0.077	0.034	2.281	0.025

Residual Standard Error	0.2862 on 77 degrees of freedom
Multiple R-squared	0.192
Adjusted R-Squared	0.160
F-Statistic	6.078 on 3 and 77 DF
p-value	0.001

Table 3.3: Results of stepwise linear regression on α for all data

The above result therefore implies that it is sufficient to say that conscientiousness, extraversion and openness1 are the best predictors of α, with the final regression line being:

$$\alpha = \textbf{-0.066}\times\textbf{Extraversion - 0.099}\times\textbf{Conscientiousness + 0.077}\times\textbf{Openness1 + 1.293.}$$

The linear regression model above shows that openness1 (i.e. openness to deep learning) has a positive effect on α, implying that students who scored highly in openness1 generally achieved higher in CfM compared to their other, more traditionally-taught modules. It could therefore be suggested using this model that openness1 is the greatest predictor of achievement in a flipped learning environment (due to the fact that CfM was taught in this way). This confirms the results found in Section 3.2.2.

Additional information can also be obtained from the linear regression model: extraversion and conscientiousness both have a negative effect on α. The coefficient values indicate that conscientiousness has the largest negative effect on α, however the difference between the coefficents for conscientiousness and extraversion is so small, that it is perhaps more accurate to say that conscientiousness and extraversion combined have the greatest negative effect on α. Theoretically this suggests that students who score highly in conscientiousness and extraversion are more likely to achiever higher in a traditional learning environment (i.e. due to achieving higher in their other modules) compared to the flipped learning environment.

Considering all three of these factors together, with conscientiousness and openness1 having the largest effect on academic achievement (in traditional and flipped learning environments respectively), this confirms earlier studies of similar interest [55, 86, 95] (as discussed in more detail in Section 2.4.1).

The next section interprets all of he results found in this section.

3.2.4 Interpretation of Section 3.2

The conclusions made in the above three sections (Section 3.2.1, Section 3.2.2 and 3.2.3) potentially imply that for one to do well academically in a flipped learning environment, one must want to learn the subject being taught. This interpretation has been created through recalling the definition of openness1 (i.e. an openness to deep learning and curiosity as to what more can be learned about a subject [35, 52, 53, 63]). This highlights a relationship between the flipped pedagogy and the empiricism learning framework whereby students require a willingness to learn (see Section 1.1).

Considering this study in particular, it is important to highlight that many students may not have experienced learning in a flipped environment before. Using this information, another interpretation could therefore be that students need to be open, in terms of having a willingness to try and learn new things [7], by trusting that high marks can still be achieved through this relatively new pedagogy.

From a pedagogic point of view, these results highlight that the category of students who are open to deep learning have an opportunity to do so through this learning environment. In further explanation, whereas

more traditionally taught modules focus on students learning through understanding and memorising material given to them (i.e. through educators in this type of environment believing that the behaviourist learning framework helps students learn best), the flipped pedagogy encourages students to gain the same (or arguably greater) understanding of the material through coming up with their own ideas and learning independently (demonstrating how the flipped pedagogy fits into a constructivist learning framework).

It could be argued in relation to this that the flipped learning environment incentivises deep learning. If this pedagogy favours students who are open to deep learning, then students who are used to academically achieving highly, through perhaps working hard and memorising material (defining conscientiousness), are thus introduced to a style of learning which allows them to access higher-order thinking in a different way, without an increased workload for them.

Having taken all of this into consideration, the next chapter will look at the effect of personality traits on academic achievement, with regards to different targeted categories of students.

Chapter 4

Categories

The next part of the analysis on quantitative data collected (recall Table 2.6 in Section 2.6) involved separating the responses into different categories in relation to the questions asked in questionnaires 1 to 3 (see Section 2.2 for more details on this). The purpose of this was to analyse the effect that different personality traits have on different types of students, with regard to their academic achievement, satisfying Aims 1, 2 and 3 (as detailed in Section 1.3).

Three main categories of students were created altogether:

1. **Category A: Achievement in the Flipped Classroom compared to Achievement in the Traditional Classroom**
    - Students who achieved higher in the flipped classroom versus students who achieved higher in the traditional classroom
2. **Category B: Assessment Prediction and Estimation**
    - Class Test Predictions for CfM
    - Class Test Estimations for CfM
    - Coursework Estimations for CfM
3. **Category C: Attitudes over time**
    - Interest in Programming
    - Usefulness of Content
    - Importance of Contact Time
    - Learning through Explanation
    - Importance of Attending Class Meetings
    - Importance of Non-Contact Time

When analysing each of these different categories, the results from previous studies (discussed in Section 2.4.1) were taken into consideration to allow for comparison, where appropriate.

4.1 Category A: Achievement in the Flipped Classroom Compared to Achievement in the Traditional Classroom

This category aims to analyse the effect of personality traits on students who achieved higher in a flipped learning environment compared to a traditional learning environment. In order to do this, two subcategories of students were created within this category:

Category	Number of students
High Achievers in the Flipped Classroom Learning Environment	42
High Achievers in the Traditional Classroom Learning Environment	42
Total	84

Table 4.1: Number of students in each class test prediction category

- **Relatively high achievers in the flipped classroom learning environment**

  These were the students who achieved a ratio α higher than $\alpha_{\text{med}} = 1.260$. (Recall here that α is the ratio between the CfM total marks obtained and the mean mark obtained in other modules.)

- **Relatively high achievers in the traditional classroom learning environment**

  These were the students who achieved a ratio α lower than $\alpha_{\text{med}} = 1.260$.

The data set used for the analysis on this category was **Factors with Marks** (see Section 2.6). This was because this data set received the most responses out of all data sets containing the required data, therefore increasing the accuracy of results found in this section. The number of students that were distributed into the different categories are shown in Table 4.1.

Under each of these subcategories, the distribution of the personality scores was illustrated as boxplots (see Figures 4.1 and 4.2), with the aim of analysing the effect of personality on academic performance in a flipped versus a traditional learning environment.

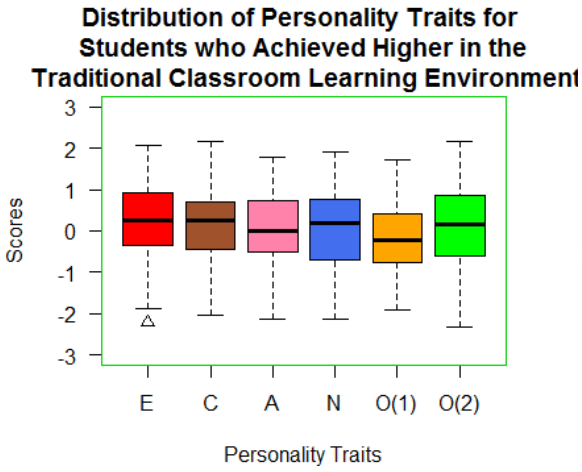

Figure 4.1: Distribution of personality traits for the students who achieved higher in the flipped classroom learning environment

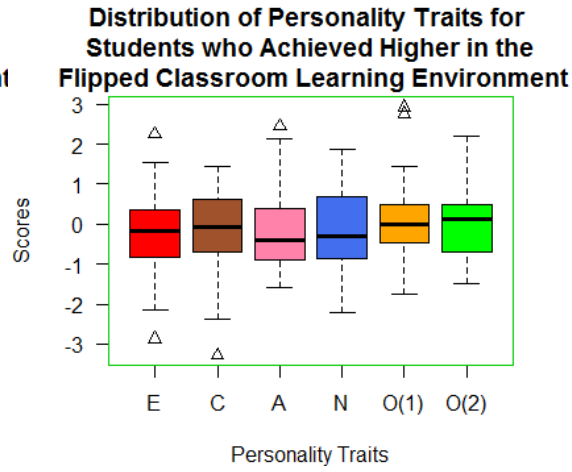

Figure 4.2: Distribution of personality traits for the students who achieved higher in the traditional classroom learning environment

The boxplots illustrate that the median scores across all personality traits are very close to zero. This implies that that there is a roughly even distribution of personality traits across both subcategories, meaning that further analysis on the personality traits within this section will not be biased towards any one type of personality trait for any particular subcategory.

Following on from this, stepwise linear regression was then performed on each subcategory individually to identify the personality traits which best predict the CfM total mark, mean mark in other modules and α. A summary of all stepwise linear regression models created are illustrated in Table 4.2.

An initial noteworthy point about the stepwise linear regression models created is that all of the adjusted R-squared values are very low, meaning that the models are not entirely reliable, due to a very low percentage of the variability of the data being accounted for.

Due to the stepwise linear regression models being very weak, logistic regression was then carried out on the two categories in an attempt to find the main personality trait(s) which best predict the type of

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
High Achievers in the Flipped Learning Environment	CfM Total Mark = 2.687×Openness1 + 82.656	0.032	0.140
High Achievers in the Flipped Learning Environment	Mean Mark in Other Modules = 3.357×Conscientiousness + 55.786	0.068	0.058
High Achievers in the Flipped Learning Environment	α = -0.067×Conscientiousness + 1.521	0.050	0.088
High Achievers in the Traditional Learning Environment	CfM Total Mark = 5.109×Openness1 + 74.150	0.080	0.042
High Achievers in the Traditional Learning Environment	Mean Mark Achieved in Other Modules = 2.960×Openness1 + 71.151	0.058	0.073
High Achievers in the Traditional Learning Environment	α = -0.047×Agreeableness + 0.039×Openness2 + 1.040	0.113	0.041

Table 4.2: Results of stepwise linear regression on all assessment types for all learning achievement categories

Coefficients	**Estimate**	**Std. Error**	**Pr(< |z|)**
Intercept	-0.116	0.233	0.618
Conscientiousness	0.548	0.256	0.032
Agreeableness	0.419	0.262	0.111
Openness1	-0.223	0.251	0.374
Extraversion	0.265	0.241	0.270
Neuroticism	0.091	0.231	0.692
Openness2	0.049	0.246	0.844

Table 4.3: Results of the logistic regression on students who achieve higher in a flipped versus a traditional learning environment by personality traits

students likely to fit into these two subcategories. The results of the logistic regression is illustrated in Table 4.3.

It is clear from Table 4.3 that conscientiousness is the only statistically significant personality trait which best predicts these categories, in this study. The coefficients as they currently stand however are not useful since they are calculated on a log-likelihood scale. The true coefficients are therefore outlined in Table 4.4.

This table indicates therefore that conscientiousness yields a 73% relevant increase in doing better in a traditional learning environment compared to a flipped learning environment (due to the categories being given binary values: 0 for high flipped achievers and 1 for high traditional achievers). Additionally, although not statistically significant, the table indicates that openness1 yields a 20% relevant decrease in achievement in a traditional classroom compared to a flipped classroom. This confirms the conclusions made in Section 3.2.4 in that students who want to learn (i.e. indicated by high scores in openness1) are more likely to achieve higher in a flipped environment.

The next section categorises students based on their assessment predictions and analyses the effect of the students' personality traits within these categories on academic achievement in a flipped and traditional learning environment.

Personality Traits	Coefficients
Intercept	0.894
Conscientiousness	1.730
Agreeableness	1.520
Openness1	0.800
Extraversion	1.304
Neuroticism	1.095
Openness2	1.0497989

Table 4.4: True coefficients of personality traits, derived from the logistic regression

Category	Number of students
Realistic Predictors	8
Under-predictors	33
Over-predictors	12
Total	53

Table 4.5: Number of students in each class test prediction category

4.1.1 Class Test Predictions

The data set used to create this category was **Data1 with Factors** (see Section 2.6 for more details on this) due to the fact that out of all the data sets which included the required information (i.e. the class test predictions and class test total marks), this data set received the most amount of respondents and so would be more likely to give accurate results.

Three main subcategories of students were created within this category:

1. **Realistic Predictors**

   These were the students who predicted their class test mark to be within five marks of the actual mark they received. (Note that five marks indicates half a degree level.)

2. **Under-predictors**

   These were the students who predicted a mark of at least five marks under their true mark attained in the class test.

3. **Over-predictors**

   These were the students who predicted a mark of at least five marks over their true mark attained in the class test.

By calculating the differences between the students' class test predictions and actual class test marks, the subcategories described above were created with the number of students given in summary in Table 4.5. Figure 4.3 also gives a visual representation of the distribution of these results.

Table 4.5 and Figure 4.3 illustrate that almost two thirds of the total respondents in this data set were categorised as under-predictors. Because of the distinct difference in size between this category and the other two subcategories, caution must be taken when making conclusions in this section.

The distribution of the scores obtained for each personality trait were then found under each subcategory. The graphs of these are shown in Figures 4.4, 4.5 and 4.6.

From these graphs some suggestions can be made about the personality traits of different types of students, with regards to levels of self-confidence and self-belief when predicting their class test marks:

1. Firstly, the interquartile ranges for the extraversion trait covers both negative and positive scores within the under-predictors and over-predictors categories. The majority of scores for this trait in the realistic predictors category however were positive. One possible justification of this could be constructed from using the definition of extraverted students in that they are assertive [7]: students

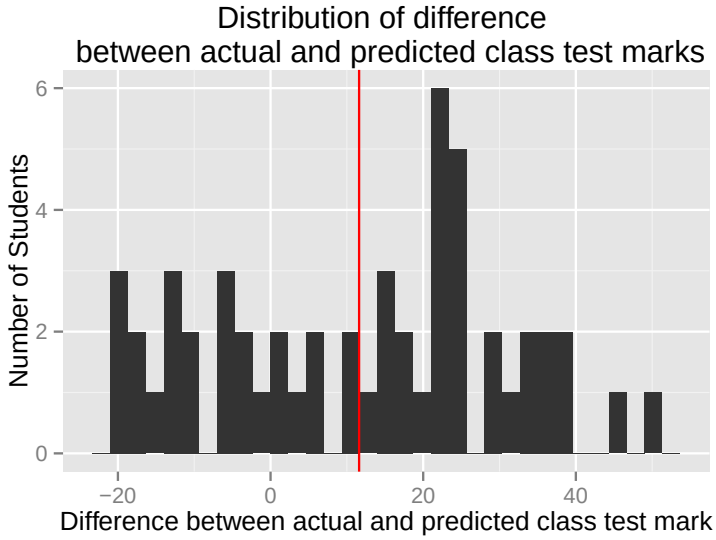

Figure 4.3: Distribution of the differences between actual and predicted class test marks

in the realistic predictors category feel confident in stating and reaching their aims accurately. The fact that this subcategory only contained 8 students however questions the reliability of this interpretation.

2. The interquartile range for neuroticism is noticeably smaller in the over-predictors category compared to the other subcategories, with a negative median. This implies that over half of the students in this subcategory have a low score in neuroticism. This makes sense in that students who have low scores in neuroticism (implying emotional stability [7]) are likely to be more self-confident and so are perhaps more likely to aim higher.

3. The personality trait which varies the most between subcategories is openness1. This personality trait has a relatively small interquartile range centred close to zero in the under-predictors category. This implies that this subcategory of students are not very open to deep learning (recalling the definition of openness1). One interpretation of this could be that students who are less willing to learn new things [7] are perhaps, as a result of this, less likely to aim high in a module involving content they have perhaps not experienced before. Due to the relatively large sample size of students in this category (33) this result could be considered as an accurate representation of under-predictors.

The next part of the analysis in this section involved applying stepwise linear regression to each category to identify which personality trait(s) best predict the CfM total mark, mean mark in other modules and α in each category.

A summary of all stepwise linear regression models in this section are illustrated in Table 4.6.

For the under-predictors category, the model suggests that students with higher scores in openness2 (i.e. an openness to surface learning) are more likely to achieve higher in CfM. The same result was also found in terms of the mean mark achieved in other modules. Despite low adjusted R-squared values for these models questioning the reliability of these models, one interpretation that could be made from this is that, regardless of the students' lack of self-confidence in aiming high, the fact that they scored highly in openness2 (implying openness to creativity and imagination) contributed towards their academic success. The fact that this result was true for both learning environments (flipped and traditional), confirms the general relationship between openness and academic achievement identified in [96].

The results for the over-predictors category suggest that students who scored highly in neuroticism did not achieve as well in CfM. One interpretation of this could therefore be that students who fall into the over-predictors category perhaps have low self-esteem (as suggested by high scores in neuroticism

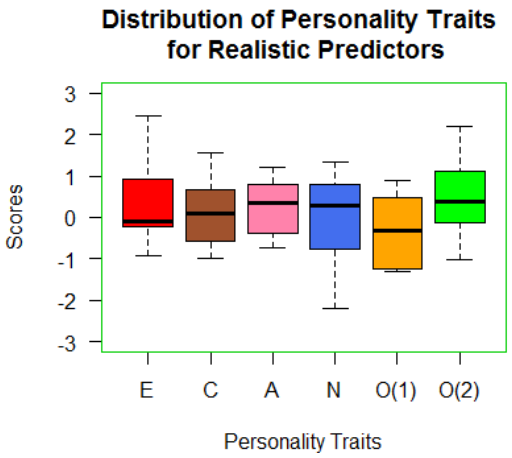

Figure 4.4: Distribution of Personality Traits for the Realistic Predictors

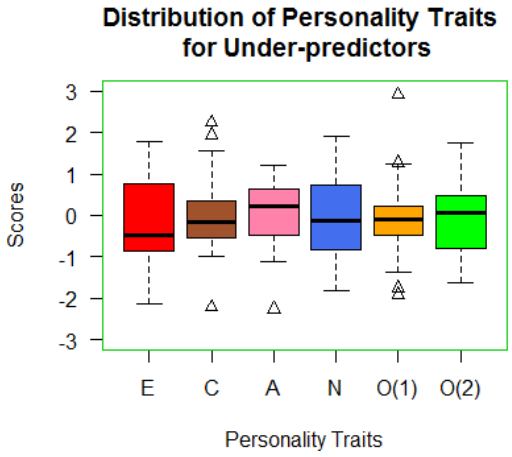

Figure 4.5: Distribution of personality traits for the under-predictors

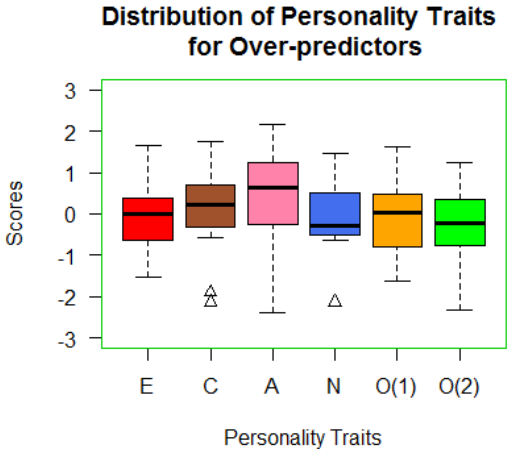

Figure 4.6: Distribution of personality traits for the over-predictors

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Realistic Predictors	CfM Total Mark = -2.974×Neuroticism + 4.609×Openness2 + 73.951	0.010	0.421
Realistic Predictors	Mean Mark in Other Modules = 7.875×Extraversion + 32.242×Conscientiousness + 35.395×Agreeableness + 7.091×Openness1 + 49.530	0.999	4.311e-06
Realistic Predictors	α = -0.149×Extraversion - 0.687×Conscientiousness - 0.743×Agreeableness - 0.121×Neuroticism - 0.253×Openness1 + 0.180×Openness2 + 1.454	0.966	0.131
Under-predictors	CfM Total Mark = 4.422×Openness2 + 84.449	0.126	0.0244
Under-predictors	Mean Mark Achieved in Other Modules = 4.036×Openness2 + 65.847	0.073	0.070
Under-predictors	α = -0.083×Extraversion + 1.311	0.076	0.066
Over-predictors	CfM Total Mark = -6.962×Neuroticism + 62.518	0.219	0.071
Over-predictors	Mean Mark Achieved in Other Modules = 7.219×Openness1 + 60.944	0.372	0.020
Over-predictors	α = -0.112×Conscientiousness - 0.135×Agreeableness - 0.090×Openness1 + 1.135	0.298	0.129

Table 4.6: Results of stepwise linear regression on all assessment types for all class test prediction categories

implying emotional instability) and varying levels of confidence (as demonstrated by the extraversion trait in Figure 4.6). This could perhaps explain irrational behaviour in predicting higher marks than realistically achievable. It could therefore be concluded from this that, to achieve highly in a flipped learning environment, one has to have full intrinsic belief that one is capable of succeeding to be able to reach the higher marks.

In terms of the personality traits which best predicted high achievement in other modules, extraversion, conscientiousness, agreeableness and openness1 all had a positive effect in the realistic predictors category. The adjusted R-squared value for this model was extremely high, implying that 99.97 percent of the variability of the data could be explained by this model. These students are therefore the ones who had:

- a goal and were able to use energy and enthusiasm (extraversion)
- perseverance (conscientiousness)
- openness to deep learning (openness1)
- knowledge that the style of learning will definitely work for them (i.e. since it most likely has done for them in the past) (agreeableness)

The largest predictor of the mean mark obtained in other modules for the over-predictors category is openness1. This perhaps provides a different interpretation of openness to deep learning. In Section 3.2.4 it was found that openness1 is the best predictor of high achievement in the flipped learning environment, whereas in this case, it is seen to be the best predictor of high achievement in a traditional learning environment. One interpretation of this could therefore be that over-predictors are open to deep learning in terms of learning everything they need to know for the exam (hence being able to achieve higher in the traditional learning environment) but not necessarily about the subject as a whole (as would be needed to succeed in a flipped learning environment).

In terms of the effect of the different personality traits on α, Table 4.6 indicates that, in the realistic predictors category, only openness2 has a positive effect on relative achievement in a flipped learning environment, whereas all other personality traits have a greater effect on traditional learning environments. One interpretation of this could be that students who can realistically set goals have the drive and motivation to reach their target(s) in a traditional learning environment. It is the additional personality trait of openness2 however whereby students have creativity, imagination and willingness to try new things [7], that allows them to succeed in the flipped learning environment. This positive correlation between creativity and academic performance confirms the results found in [110]. (It is important to note in this section that the adjusted R-squared value for this model is also very high and so the results given appear to be quite reliable.)

The final analysis carried in for this section involved looking at the assessment marks achieved for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.7) and through boxplots (see Figures 4.7, 4.8 and 4.9). (Note that the horizontal red line shown in Figure 4.9 represents $\alpha_{\text{med}} = 1.260$).

To analyse Table 4.7 properly, it is useful to recall that $\alpha_{\text{med}} = 1.260$. The table indicates that the only subcategory of students which seemed to achieve higher in the flipped learning environment, compared to the traditional learning environment (i.e. identified through having a value of α higher than the α_{med}) was the under-predictors category. This yields a contradiction to results previously discussed in that this subcategory lacks openness1 (as illustrated in Figure 4.5), which we found previously to be a large contributor towards high achievement in CfM (see Section 3.2.3). This variation in results could however be explained by the small sample size defined by this subcategory.

An ANOVA test was also carried out to test the statistical significance of these results. The results of this are shown in Table 4.8 and can be summarised as the variation in marks achieved between different subcategories in this section was statistically significant for marks achieved in CfM and α_{med}.

One possible interpretation of the flipped learning environment is that it gives the impression that there is always more to learn in terms of discovering new ideas through discussion and exploration [25, 64]. One could therefore suggest from these results that, using this definition, students in the under-predictors

Realistic Predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	76.293
Mean mark achieved for mean mark in other modules	62.400
α	1.161
Under-predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	84.371
Mean mark achieved for mean mark in other modules	65.776
α	1.342
Over-predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	63.386
Mean mark achieved for mean mark in other modules	63.289
α	1.002

Table 4.7: Summary measures for academic achievement under each subcategory

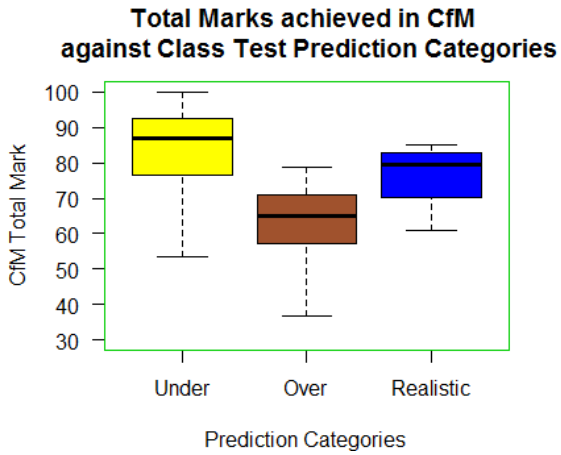

Figure 4.7: Distribution of CfM total marks based on class test prediction categories

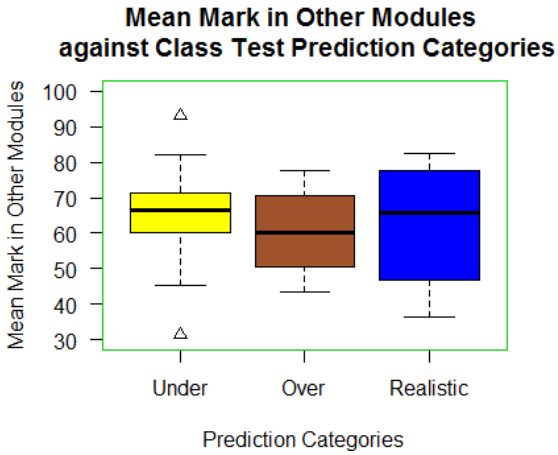

Figure 4.8: Distribution of mean marks obtained in other modules based on class test prediction categories

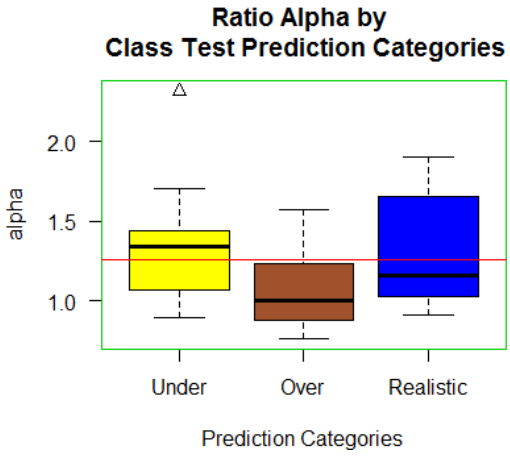

Figure 4.9: Distribution of α based on class test prediction categories

Type of Assessment Measure	Kruskal-Wallis Chi-Squared Statistic	df	p-value
CfM Total Mark	21.250	2	2.43e-05
Mean Mark in Other Modules	1.571	2	0.456
α	6.890	2	0.032

Table 4.8: Statistical significance of mark distributions for the class test prediction categories

Category	Number of students
Realistic Estimators	6
Under-estimators	56
Over-estimators	1
Total	63

Table 4.9: Number of students in each class test prediction category

category perhaps predicted a lower mark because of believing that they will never be capable of accessing the higher marks in CfM, due to there always being more to learn.

Another interpretation of the results can be obtained from analysing the over-predictors category. This category seemed to have a very small value of α, implying that this category of students seemed to do much better in the traditional learning environment. This could be due to the fact that they initially predicted a high mark for the class test due to the fact they had perhaps always previously achieved highly in school (recalling that this information on class test predictions was collected in the students' first couple of weeks of university). By attempting to learn in the same way as before (knowing that this method had previously worked for them) this could explain the reason behind these students achieving higher in a traditional learning environment.

The next section will analyse different categories of students based on the class test mark they estimated they would get, having sat the class test in CfM, and the actual mark they obtained.

4.1.2 Class Test Estimations

The data set **Data 2 with Factors** (see Section 2.6 for more information) was used to create this category of students, due to the fact that it is the largest data set which contains the required information to perform the appropriate analyses on in this section. As before, the purpose of choosing the data set with the largest possible amount of respondents was to increase reliability and accuracy of the results.

As done in the previous section, this category was split into three main subcategories:

1. **Realistic estimators**

   These were the students who estimated their class test mark (after they had sat the class test in CfM) to be within five marks of the actual mark they obtained.

2. **Under-estimators**

   These were the students whose estimated class test marks were at least five marks lower than the actual mark they obtained.

3. **Over-estimators**

   These were the students whose estimated class test marks were at least five marks higher than the actual mark they obtained.

By calculating the differences between the class test estimations and actual class test marks, the subcategories described above were created with the number of students given in summary in Table 4.1.2. Figure 4.10 also gives a visual representation of the distribution of these results.

Table 4.1.2 and Figure 4.10 highlight the very low numbers of students in the realistic estimators and over-estimators categories. Having considered this information, no statistical analyses will be carried out

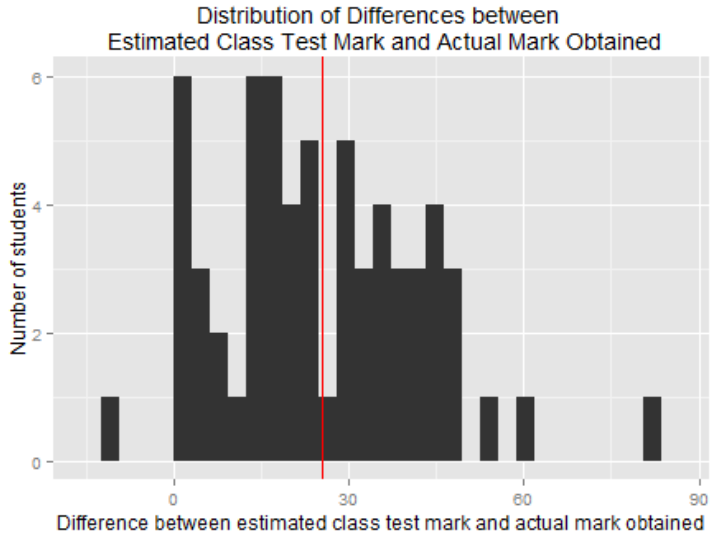

Figure 4.10: Distribution of the differences between actual and estimated class test marks

on these subcategories due to lack of reliability in conclusions to be made.

As in the previous section, the distribution of the scores for each personality trait for the under-predictors category were analysed. The graph illustrating this distributions is shown in Figure 4.11.

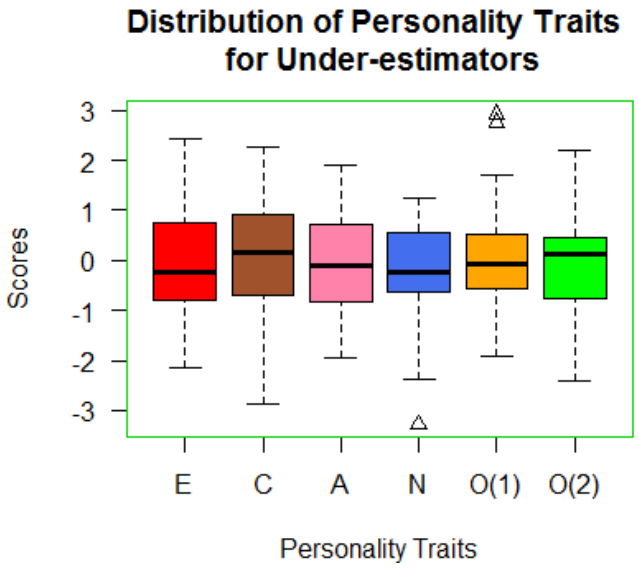

Figure 4.11: Distribution of personality traits for the under-estimators category

It is clear from this graph that there seems to be a fairly even distribution of personality traits in this subcategory. This could be due to the fact that the majority of the class were categorised into this subcategory and so a range of different personality traits are therefore shown as a result of this (as detailed further in Chapter 3).

Combining the ideas of personality traits and academic achievement, three stepwise linear regression models were then created on students in the under-predictors category to identify the personality traits which best predict student achievement in CfM, other modules and α.

Regression Model	**Adjusted R-squared Value**	**p-value**
CfM Total Mark = 3.578×Openness1 + 79.902	0.057	0.043
Mean Mark in Other Modules = 2.980×Conscientiousness + 63.471	0.0631	0.035
α_{med} = -0.109×Conscientiousness + 0.062×Openness1 + 0.068×Openness2 + 1.300	0.300	7.726e-05

Table 4.10: Results of stepwise linear regression on all assessment types for the under-estimators category

Under-estimators Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.804
Mean mark achieved for mean mark in other modules	63.864
α	1.283

Table 4.11: Summary measures for academic achievement under the under-estimators subcategory

A summary of the stepwise linear regression models for this category is given in Table 4.10.

Table 4.10 illustrates that students within the under-estimators category who score highly in openness1 were more likely to achieve highly in CfM. This supports the interpretation made in Section 4.1.1 in that this category of students perhaps lack belief in their ability to do well in this module, due to the fact that there are endless discussion points to learn more about the subject. The fact that these students achieved higher than they expected therefore highlights that students who are interested in deep learning (as defined by the openness1 trait) are more likely to do well in a flipped learning environment (as found also in Section 3.2.4).

The personality trait which best predicts the mean mark in other modules within the under-estimators category, according to the model, is conscientiousness. This makes sense: the students who did not feel they were going to do very well perhaps felt they did not work as hard. Those who did however persevere and take responsibility for their own learning (in other words, the conscientious students [18, 35, 52, 53, 63, 7]) then managed to achieve highly in other modules, as a result of this.

It is important to note with the comments made above however that the two models forming predictions regarding achievement in CfM and other modules have very low adjusted R-squared values, implying that a very small amount of the variability of the data is explained by these models. Despite the statistical significance of these two models, the results may not therefore be as conclusive as intended.

The stepwise linear regression models based on predicting α confirms the above results: conscientiousness is seen to have a negative effect on α (implying that students who score highly in conscientiousness seem to do better in a traditional learning environment) and openness1 and openness2 have a positive effect on α (i.e. students with high openness1 (deep learning) and/or openness2 (surface learning) scores are likely to do better in a flipped learning environment). Due to the fact that the majority of students were categorised as under-estimators here, this supports the conclusion made in Section 3.2 that, to do well in a flipped learning environment, students do not have to necessarily be able to work hard: one just has to be open to the idea of deep learning and actually want to learn.

The final part of the analysis involved considering the academic achievement of the under-estimators category in terms of CfM, the mean mark obtained in other modules and α. As done for the previous section, the mean mark for each of these assessment categories were then calculated. The results of these are shown in Table 4.11.

To analyse this table properly, it is useful to recall that $\alpha_{\text{med}} = 1.260$. The table therefore implies that, since the value of α for the under-estimators category is higher than α_{med}, this category of students seemed to achieve higher in a flipped learning environment, compared to a traditional learning

Category	Number of students
Realistic Coursework Predictors	9
Under-coursework-predictors	49
Over-coursework-predictors	7
Total	65

Table 4.12: Number of students in each class test prediction category

environment.

One interpretation of this result could be that the students were perhaps unaware of how much they were actually learning, due to the fact that they were absorbing the information in a different way. As a result of this, they therefore perhaps estimated that they would achieve a lower class test mark than they were actually capable of achieving. This demonstrates the reverse effect of the fact that high expectations are usually shown to be positively correlated with high achievement [65]. In this case, low expectations have arguably motivated students to exceed their expectations [87]. This result was also true in the previous section for the under-predictors subcategory (see Table 4.7), therefore the above interpretation could be classed as global for all students who underestimate what they can really achieve.

The next section will analyse different categories of students based on their predicted coursework marks, having been set the coursework, and the actual marks they obtained.

4.1.3 Coursework Predictions

The data set used to create this category was **Data3 with Factors**, since this was the largest data set containing the relevant information. The same reason for choosing this data set as given in the previous sections is true here: to increase accuracy and reliability of results.

The purpose of including a coursework section as well as a class test section is to see if there is any difference in achievement between learning in a flipped compared to a traditional environment, with regards to the type of assessment used.

Like in the previous two subsections, this category was split into three subcategories:

1. **Realistic Coursework Predictors**

   These were the students who predicted their coursework mark to be within five marks of the actual mark they received.

2. **Under-coursework-predictors**

   These were the students who predicted a mark of at least five marks under their true mark attained in the coursework.

3. **Over-coursework-predictors**

   These were the students who predicted a mark of at least five marks over their true mark attained in the coursework.

By calculating the differences between the actual coursework marks obtained and the students predicted coursework marks, the subcategories described above were created with the number of students given in summary in Table 4.12. Figure 4.12 also gives a visual representation of the distribution of these results.

Like in the previous two subsections, Table 4.12 and Figure 4.12 illustrate that the under-coursework-predictors category contains the most amount of students. The same reasons given in Section 4.1.2 for this potentially apply here. The large number of students in this category, in comparison to the number of students in the other two subcategories, will therefore be taken into consideration when analysing the subcategories further.

As done in the previous two subsections, the distribution of scores for each personality trait was then illustrated in the form of boxplots. The graphs of these are shown in Figures 4.13, 4.14 and 4.15.

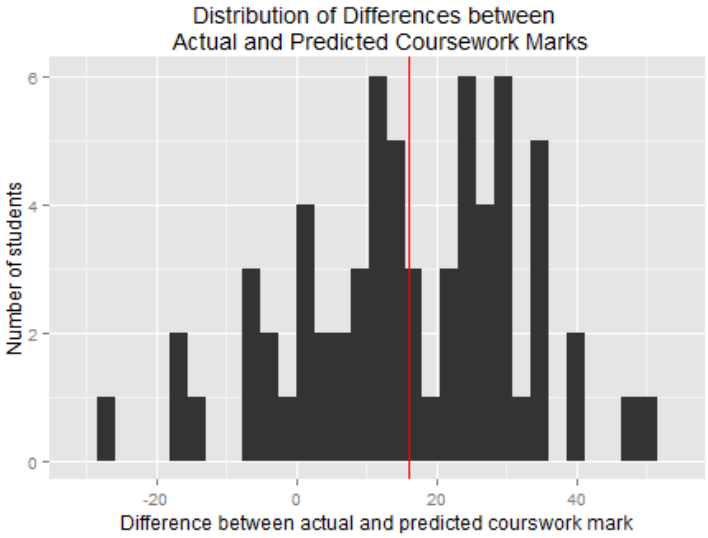

Figure 4.12: Distribution of the differences between actual and predicted coursework marks

The boxplots illustrate wide variation between the personality traits in each subcategory for this section. The personality traits demonstrating the most variation between categories will therefore be discussed in more detail below:

1. In general, the median scores for extraversion appear to be negative across all subcategories, with the realistic coursework predictors category containing the most negative extraversion score of all subcategories. One interpretation of this could be that students who were realistic in predicting their mark did not aim to exceed their expectations and so had a potential lack of energy and enthusiasm towards achieving as highly as possible.
2. The median conscientiousness score is very close to zero for the realistic and under-coursework-predictors categories however it is extremely relatively high in the over-coursework-predictors category. One possible justification for this is that students in the over-coursework-predictors category perhaps predicted a high mark because of feeling confident in their ability to work hard and persevere until they achieved their desired mark [104]. The reliability of this interpretation is questionable however, due to the small number of students in this subcategory.

As in the previous two subsections, stepwise linear regression was then performed on the distribution of personality scores under each category in terms of marks achieved in CfM, other modules and α.

A summary of all stepwise linear regression models in this section are illustrated in Table 4.6.

Table 4.13 immediately highlights that conscientiousness has a very strong negative effect on the CfM total mark obtained for the realistic coursework predictors category. This is supported by conscientiousness also having a negative effect on α. One interpretation of this could be constructed through using the fact that students with high expectations are more likely to commit themselves to achieving desired results [65]. In this sense, the students who intend to work hard and persevere towards reaching their intended goals are perhaps more likely to achieve higher in the traditional learning environment (confirming conclusions made in Section 3.2.4).

The results given in the model predicting α for the realistic coursework predictors and under-coursework-predictors categories support previous interpretations in the fact that openness1 contributes towards high achievement in the flipped learning environment (i.e. one must want to learn).

It is noteworthy that the adjusted R-squared values for all models in the realistic coursework predictors category were extremely high, implying that these models are seen to be quite reliable. The small number of students in this category (9) should also be recalled when considering this category however.

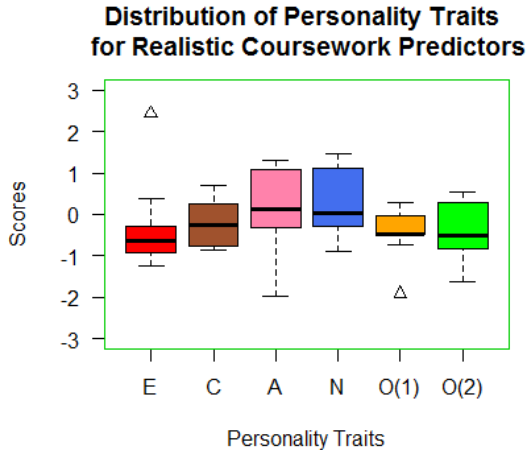

Figure 4.13: Distribution of personality traits for the realistic coursework predictors subcategory

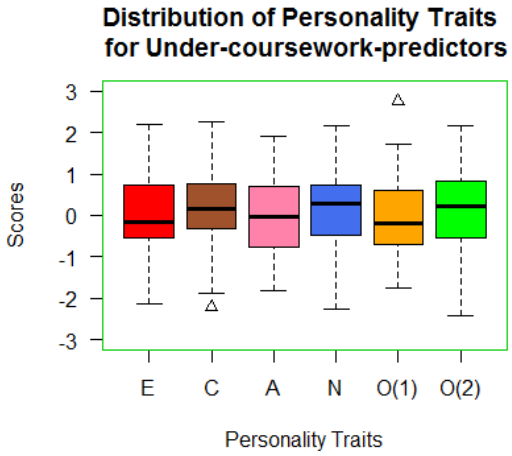

Figure 4.14: Distribution of personality traits for the under-coursework-predictors

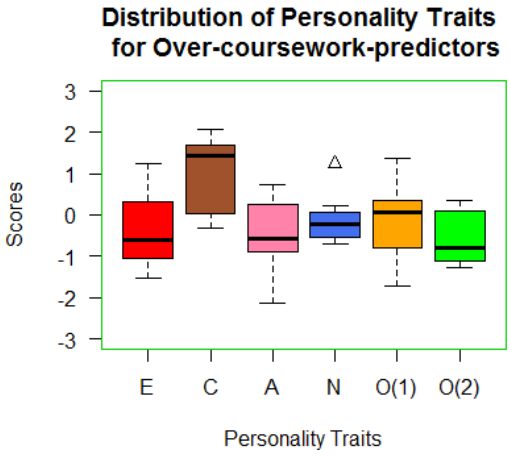

Figure 4.15: Distribution of personality traits for the over-coursework-predictors

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Realistic Coursework Predictors	CfM Total Mark = -12.568×Conscientiousness + 78.327	0.782	0.001
Realistic Coursework Predictors	Mean Mark in Other Modules = -7.542×Extraversion + 19.976×Conscientiousness - 6.264×Openness1 + 19.008×Openness2 + 69.488	0.962	0.001
Realistic Coursework Predictors	α = 0.104×Extraversion - 0.601×Conscientiousness - 0.081×Agreeableness + 0.025×Neuroticism + 0.046×Openness1 - 0.277×Openness2 + 1.162	0.999	0.0002
Under-coursework-predictors	CfM Total Mark = 5.978×Openness1 + 80.113	0.161	0.002
Under-coursework-predictors	1	-	-
Under-coursework-predictors	α = -0.099×Extraversion + 0.109×Openness1 + 1.274	0.196	0.003
Over-coursework-predictors	CfM Total Mark = -4.050×Extraversion - 2.749×Openness1 + 64.126	-0.292	0.742
Over-coursework-predictors	Mean Mark Achieved in Other Modules = 5.748×Extraversion + 1.076×Openness1 + 67.414	-0.354	0.815
Over-coursework-predictors	α = -0.254×Extraversion - 0.044×Openness1 + 1.023	-0.185	0.624

Table 4.13: Results of stepwise linear regression on all assessment types for all coursework prediction categories

Realistic Coursework Predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	80.340
Mean mark achieved for mean mark in other modules	62.467
α	1.320
Under-coursework-predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.990
Mean mark achieved for mean mark in other modules	64.743
α	1.262
Over-coursework-predictors Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	65.9449
Mean mark achieved for mean mark in other modules	65.31429
α	1.115477

Table 4.14: Summary measures for academic achievement under each coursework prediction subcategory

Type of Assessment Measure	**Kruskal-Wallis Chi-Squared Statistic**	**df**	**p-value**
CfM Total Mark	5.753	2	0.056
Mean Mark in Other Modules	0.789	2	0.674
α	5.428	2	0.066

Table 4.15: Statistical significance of mark distributions for the coursework prediction categories

A result contradicting previous interpretations was highlighted in the over-coursework-predictors category: openness1 is seen to have a negative effect on CfM. This suggests that students who are confident and have high expectations tend to do less well if they are open to deep learning. Attention should be drawn to the fact that the adjusted R-squared values for all parts of the over-coursework-predictors category are negative, suggesting that the personality traits do not help to predict the different types of assessment measures very well at all. The reason behind this could be due to the low number of students within this category.

The final part of the analysis for this section, as done in previous subsections, involves looking at the distribution of marks for each subcategory with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.7) and through boxplots (see Figures 4.16, 4.17 and 4.18). (Note that the horizontal red line shown in Figure 4.18 represents α_{med}).

To analyse Table 4.14 properly, it is useful to recall that $\alpha_{\text{med}} = 1.260$. This table implies that:

- Realistic coursework predictors seem to do better in a flipped learning environment
- Under-coursework-predictors seem to do about the same in both types of learning environment
- Over-coursework-predictors seem to do better in a traditional learning environment

These results on their own could therefore suggest that, to do well in a flipped learning environment, one has to be able to set realistic goals, implying that one is in control of one's learning environment.

The results of the ANOVA test to test the statistical significance of the results are shown in Table 4.15 and are summarised by stating that none of the graphs represent results which are statistically significant.

The box plots given in Figures 4.16, 4.17 and 4.18 illustrate the results given in Table 4.14 in a more visual way.

The fact that the realistic coursework predictors category appears to achieve higher in a flipped learning environment compared to a traditional learning environment is perhaps justified by the purpose of coursework naturally encouraging students to address the cognitive, motivational and social perspectives

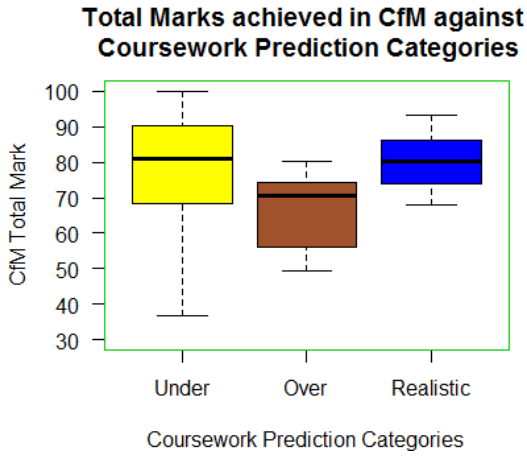

Figure 4.16: Distribution of CfM total marks based on coursework prediction categories

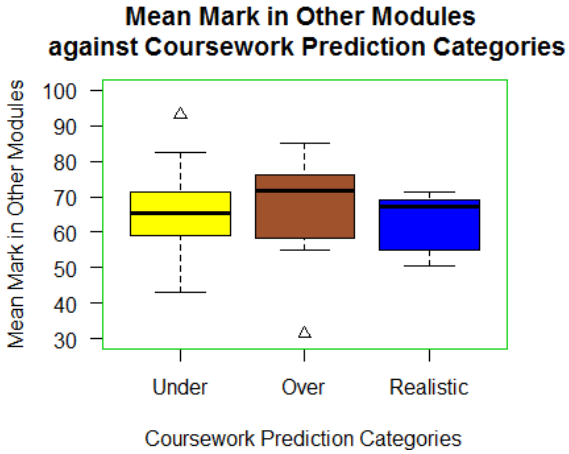

Figure 4.17: Distribution of mean marks Obtained in other modules based on coursework prediction categories

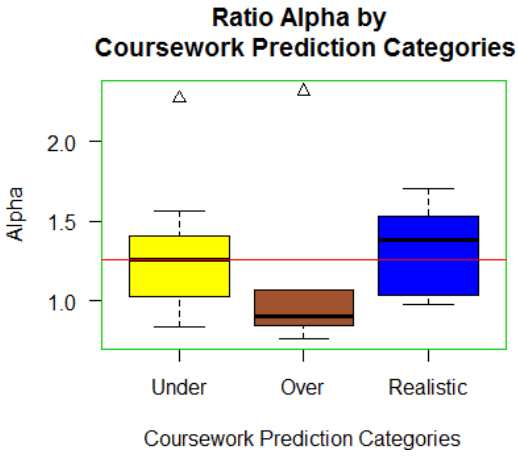

Figure 4.18: Distribution of α based on coursework prediction categories

of learning [82]. Through channeling their drive to reach specific targets and goals appropriately, students should therefore be able to achieve higher in a flipped learning environment, through being responsible for one's own learning.

The results found for the over-coursework-predictors category in that they seem to do much better in the traditional learning environment compared to the flipped learning environment is the same result as found in Section 4.5. This implies that the interpretation regarding the fact that students who over-predict their marks probably do so because they naturally believe they will achieve highly through learning in the same way as they had done pre-university level (knowing that this had worked before for them) is perhaps quite an accurate interpretation.

From a pedagogic point of view, the latter interpretation confirms previous conclusions made: to do well in a flipped learning environment, students need to fully want to learn so that high marks are achieved as a result of intrinsic motivation. In other words, aiming high and believing that hard work on its own will allow one to reach these high aims is not the key to success in a flipped learning environment.

An alternative interpretation of the above could be that a flipped learning environment incentivises deep learning. In further explanation, the flipped learning environment supports and encourages students with high aims to channel this drive into gaining a deeper understanding of the subject, as suggested also in Section 3.2.4.

The next section will look at analysing different categories of students based on their potential change (if such a change exists) in attitudes towards different factors throughout the duration of the module.

4.2 Category C

Each of the subcategories outlined for Category C in the introduction to Chapter 4 will now be considered in more detail. To create each of these subcategories, the data set **Data13 with factors** will be used since this is the largest data set which contains all of the necessary information required to be analysed. The purpose of choosing a data set with this criteria was to increase accuracy of the results found.

4.2.1 Interest in Programming

The purpose of creating this categorisation is to try and identify how this style of learning affects students' attitudes towards programming and whether this, as a result, has an effect on academic performance.

To start analysing this category in more detail, the differences between the scores given by respondents for the question *"How interested are you in programming?"* in questionnaire 3 and questionnaire 1 were initially calculated (see Section 2.1.5 and 2.2 for more information about these questionnaires and the response scales/categories used.) The following four subcategories were then created from these initial calculations:

1. **Increased interest in programming**

   These were the students who gave a higher score in terms of interest in programming in questionnaire 3 compared to questionnaire 1.

2. **Decreased interest in programming**

   These were the students who gave a lower score in terms of interest in programming questionnaire 3 compared to questionnaire 1.

3. **Consistently high interest in programming**

   These were the students who gave scores of 4 or 5 with regards to interest in programming in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently low interest in programming**

Category	Number of students
Increased interest in programming	10
Decreased interest in programming	8
Consistently high interest in programming	17
Consistently low interest in programming	6
Total	41

Table 4.16: Number of students in each subcategory with regards to interest in programming

These were the students who gave scores of 1, 2 of 3 with regards to interest in programming in questionnaire 1 and then gave the same score in questionnaire 3.

The number of students in each category are summarised in Table 4.16. This table shows only a small amount of variation between the number of students in each category, therefore implying that, despite the sample size of this data set being quite low in general, the results found in this section are likely to not be biased towards any particular subcategory of students.

The first part of the analysis in this section involved looking at the personality traits of each of the students in each subcategory. The purpose of this was to identify if interest levels in programming could be predicted by one's personality type. Depending on the results of the analysis, the results could then be used by future educators to adapt their teaching style to encourage perhaps the personality types which automatically lend themselves to low interest levels.

Boxplots were thus created showing the distribution of the scores given for each personality trait under each subcategory. The graphs of these are shown in Figures 4.19, 4.20, 4.21 and 4.22.

Due to a quite obvious variation between personality traits in the boxplots for each subcategory, the traits yielding the most variation will therefore be discussed in more detail as follows:

1. The median conscientiousness score across the different categories was very close to zero. In the category of students whose interest in programming increased however, there exists a relatively large range of positive scores in conscientiousness (shown by the relatively large upper quartile in Figure 4.19). Despite the small number of students that fit into this upper quartile (approximately 5 students), this result confirms findings in several other studies [106, 107] in that there is a positive correlation between working hard and interest in the subject.

2. The median neuroticism score for the category of students whose interest in programming remained consistently low was the most negative compared to all other categories, with a score close to -1. Students who have low scores in neuroticism (and so are more emotionally stable) therefore seem to have lower interest in programming, in this study. This could arguably be due to the fact they have enough control over their emotions to be certain as to whether they like or dislike a subject and so choose not to alter their opinion on this. It is noteworthy to remember in these results that only 6 students were included in this category however and so this interpretation is perhaps quite unreliable.

3. The median score for openness1 was the highest in the category of students whose interest in programming remained consistently low throughout the duration of the module. Despite there only being 6 students in this category, this could perhaps relate to the comment made above in that these students have been open to learning about the subject, however they still do not like programming. This just sums up the fact that not every student likes every topic they have to learn.

4. The distribution of openness2 for students whose attitudes remained the same throughout was fairly equal in terms of positive and negative scores. The boxplot of the category of students whose interest in programming increased shows a purely positive range of scores for openness2 (see Figure 4.19). This implies that having an open mind and a creative imagination contributes towards increased interest in programming. The negative scores of openness2 illustrated in Figure 4.20 therefore support the interpretation just made.

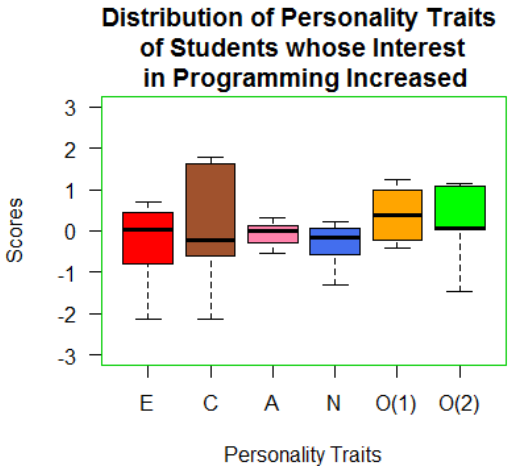

Figure 4.19: Distribution of personality traits students whose interest in programming increased

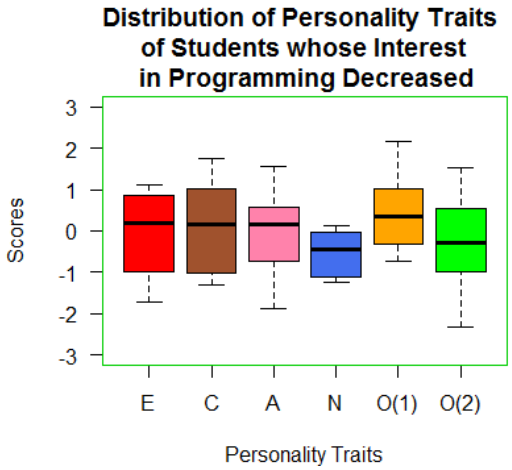

Figure 4.20: Distribution of personality traits of students whose interest in programming decreased

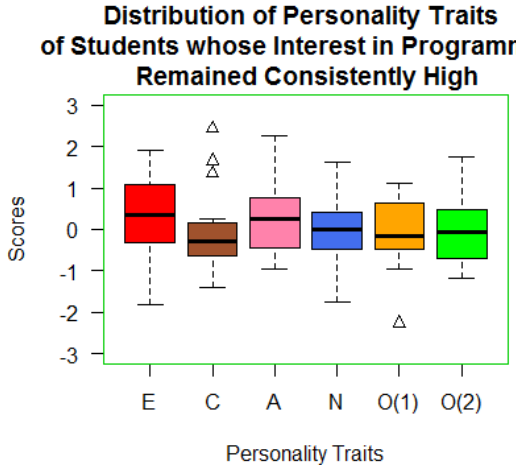

Figure 4.21: Distribution of personality traits of students whose interest in programming remained consistently high

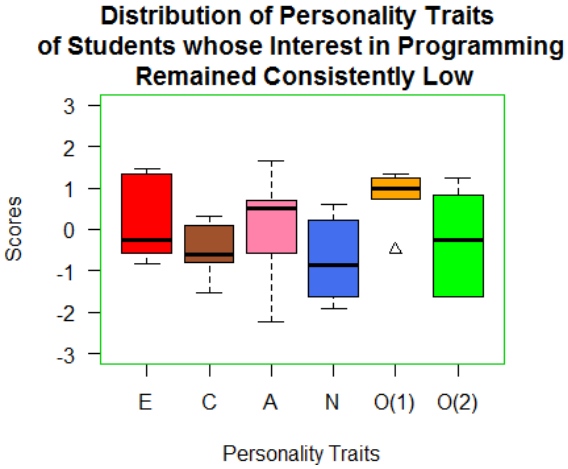

Figure 4.22: Distribution of personality traits of students whose interest in programming remained consistently low

Using all of the assessment data collected (see Section 2.6), stepwise linear regression was then performed on the distribution of personality scores under each subcategory to predict these different assessment marks, as done in the previous sections. A summary of all stepwise linear regression models created are illustrated in Table 4.17.

In order to analyse this table, each assessment type will be looked at individually across all categories.

1. **Personality traits predicting total mark in CfM**

   In terms of the category of students whose interest in programming remained high throughout its duration, the stepwise linear regression models suggest that students who score highly in openness2 are more likely to do better in CfM. This implies that students who are open to surface learning (i.e. openness2) are more likely to have an increased interest in the subject and so achieve higher in CfM. This interpretation could be taken further by suggesting that through this attitude towards CfM, students may be able to access the higher-order thinking required to do well in a flipped learning environment [117].

   All other modules predicting CfM have a negative or non-existent adjusted R-squared value, implying that only invalid conclusions can be made from these models.

2. **Personality traits predicting mean mark in other modules**

   The personality trait which made a largest contribution to this mark for the category of students whose interest in programming increased is openness2. This model (which has a fairly large adjusted R-squared value, implying that the model predicts the variability of the data well) suggests that to do well in more traditionally taught modules, and enjoy a subject, one needs to be open to new ideas and not just go along with the norm.

   Considering only the models predicting the mean mark in other modules which have an adjusted R-squared value above 0.500 (i.e. the more reliable models), it is clear that agreeableness seems to have the greatest effect on marks with regards to student interest levels. Since this personality trait has a negative effect on marks for students whose interest has increased over time and a positive effect on those who interest has decreased over time, the results suggest that students who are interested in a subject who have low scores in agreeableness are more likely to achieve higher in other modules. One interpretation of this could be that agreeableness prevents one from being interested in a subject, due to the fact that these students follow the guidelines set by the instructor [96, 122] and work towards what is expected of them: in this sense, they are unable to explore their own personal thoughts and ideas related to the subject. The fact that agreeableness then has a positive effect on the mean mark in other modules for students whose interest has decreased, perhaps furthers this interpretation in concluding that levels of agreeableness have a mediating effect on interest levels.

   The effect of agreeableness on academic achievement found in this study therefore perhaps enhances the study results found in [102] whereby agreeableness was found to have a negative effect on academic performance. In other words, either the results of this previous study are correct, but they are dependent on interest levels, or the sample size used in this current study (recall that there are 10 students in this subcategory) is not large enough to create reliable conclusions on the data.

3. **Personality traits predicting α**

   The above points made are confirmed by the models created with respect to α: agreeableness contributes towards higher academic success in traditionally-taught classrooms, dependent on interest levels.

   For the category of students whose interest in programming has increased openness1 (openness to deep learning) has a positive effect on α whereas openness2 (openness to surface learning) has a negative effect on α. This confirms the study in [39] which found that interest facilitates deep level learning but not surface level learning. Taking this further, it is perhaps conclusive here that interest therefore has a positive effect on high achievement in a flipped learning environment due to this pedagogy encouraging students to access the higher-order levels of thinking [117].

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Students whose Interest in Programming Increased	CfM Total Mark = 1	-	-
Students whose Interest in Programming Increased	Mean Mark in Other Modules = -11.835×Agreeableness + 14.511×Openness2 + 73.847	0.592	0.018
Students whose Interest in Programming Increased	α = 0.286×Agreeableness + 0.277×Openness1 - 0.167×Openness2 + 1.150	0.837	0.003
Students whose Interest in Programming Decreased	CfM Total Mark = -3.516×Neuroticism + 71.863	-0.015	0.380
Students whose Interest in Programming Decreased	Mean Mark in Other Modules = -9.824×Conscientiousness + 8.023×Agreeableness + 8.281×Neuroticism - 26.058×Openness1 + 9.439×Openness2	0.693	0.203
Students whose Interest in Programming Decreased	α = -0.257×Agreeableness + 1.463	0.146	0.189
Students whose Interest in Programming Remained Consistently High	CfM Total Mark = 7.759×Openness2 + 83.397	0.259	0.021
Students whose Interest in Programming Remained Consistently High	Mean Mark Achieved in Other Modules = 4.267×Agreeableness + 67.288	0.220	0.033
Students whose Interest in Programming Remained Consistently High	α = -0.136×Openness1 + 1.269	0.163	0.061
Students whose Interest in Programming Remained Consistently Low	CfM Total Mark = -12.400×Agreeableness + 75.650	0.050	0.324
Students whose Interest in Programming Remained Consistently Low	Mean Mark Achieved in Other Modules = -7.734×Agreeableness + 70.501	-0.0778	0.468
Students whose Interest in Programming Remained Consistently Low	α = -0.057×Agreeableness + 1.077	-0.216	0.756

Table 4.17: Results of stepwise linear regression on all assessment types for all categories concerning interest levels in programming over time

Students whose Interest in Programming Increased Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	82.131
Mean mark achieved for mean mark in other modules	73.720
α	1.131
Students whose Interest in Programming Decreased Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	72.070
Mean mark achieved for mean mark in other modules	57.300
α	1.350
Students whose Interest in Programming Remained Consistently High Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	83.829
Mean mark achieved for mean mark in other modules	67.094
α	1.264
Students whose Interest in Programming Remained Consistently Low Category	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	65.812
Mean mark achieved for mean mark in other modules	64.367
α	1.032

Table 4.18: Summary measures for academic achievement under each programming interest subcategory

The final part of the analysis for this section involves looking at the distribution of marks for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.18) and through boxplots (see Figures 4.23, 4.24, 4.25. (Note that the horizontal red line shown in Figure 4.25 represents α_{med} and in all of these Figures just mentioned, Incr. = Increased belief in programming interest, Decr. = Decreased belief in programming interest, Low = Consistently low belief in programming interest, and High = Consistently high belief in programming interest.)

To analyse this table properly, it is useful to recall that $\alpha_{\text{med}} = 1.260$. From Table 4.18, it is clear that there is a large variation in results with regards to the subcategories of students who achieved higher in a flipped learning environment compared to a traditional learning environment. As a result of this, one could argue perhaps that interest in a subject does not have an effect on achievement, regardless of the learning environment. This is arguably supported by general prior research that has been carried out in this area (e.g. [69, 108, 107]) where it has been found that there exists relatively strong relationships between interest and achievement in mathematics, regardless of the learning style.

The above point slightly contradicts the research found by Köller, Baumert and Schnabel in [69] who found that the relationship between interest and academic achievement is moderated by changes in the instructional setting in that interest has a greater contribution towards academic achievement when learning is not as highly teacher-centred and learning activities are not primarily driven by extrinsic values. Due to how the category of students whose interest in programming decreased was created however, it could be that the majority of these students still had high levels of interest in programming, therefore actually confirming the above research. Table 4.19 has therefore been created to show the final ratings given for interest in programming for the subcategories of students whose interest in programming changed.

The results of the Table 4.19 indicate that, out of the students whose interest in programming increased, 70% of these students now have a "high" rating of interest in programming (where "high" is as defined previously). Out of the category of students whose interest in programming decreased, 87.5% of these students now have a "low" rating of interest in programming (where "low" is as defined previously). It is therefore conclusive from this study (assuming that reliable conclusions can be made despite the small sample sizes used in this study) that interest does not have an effect on academic achievement with regards to the learning environment, contradicting the study in [69].

Students whose Interest in Programming Increased Category	
Rating	**Frequency**
3	3
4	4
5	3
Students whose Interest in Programming Decreased Category	
Rating	**Frequency**
1	1
2	3
3	3
4	1

Table 4.19: Ratings given by the attitude changers with regards to interest in programming

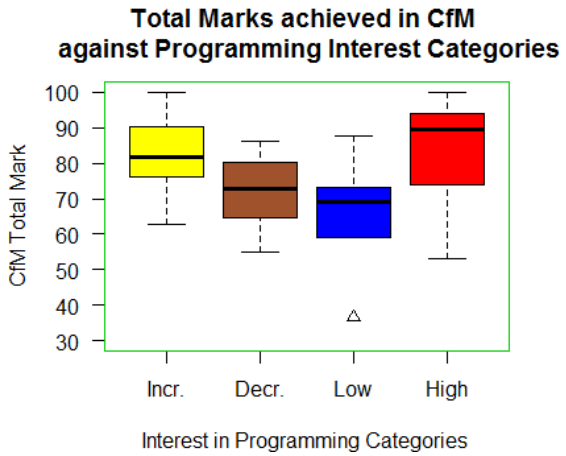

Figure 4.23: Distribution of CfM total marks based on interest in programming categories

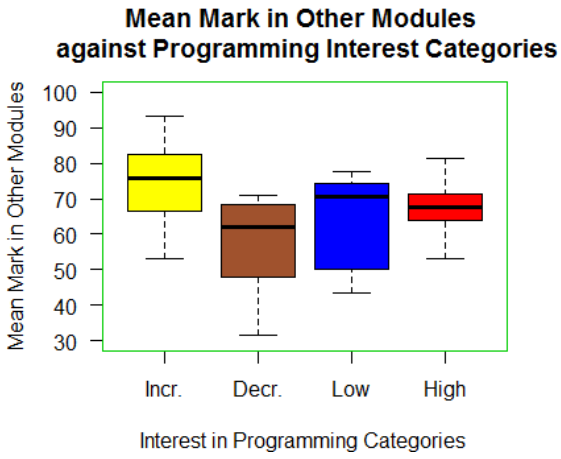

Figure 4.24: Distribution of mean marks obtained in other modules based on interest in programming categories

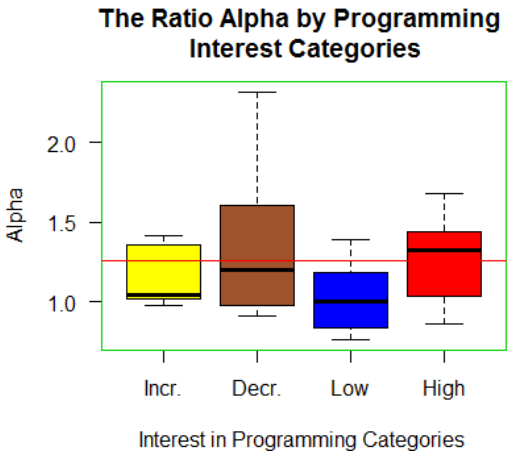

Figure 4.25: Distribution of α based on interest in programming categories

Type of Assessment Measure	Kruskal-Wallis Chi-Squared Statistic	df	p-value
CfM Total Mark	9.663	3	0.022
Mean Mark in Other Modules	6.809	3	0.078
α	4.342	3	0.227

Table 4.20: Statistical significance of mark distributions for the interest in programming subcategories

The results of the ANOVA test to test the statistical significance of the results are shown in Table 4.20 and are summarised in that the only set of results that are statistically significant is the variation between the set of categories against their total marks obtained in CfM (see Figure 4.23).

The boxplots given in Figures 4.23, 4.24 and 4.25 indicate that only the students who consistently had a high interest in programming throughout the duration of the module achieved better in a flipped learning environment compared to a traditional learning environment. Conversely, the students who had a consistently low interest in programming throughout the duration of the module achieved higher in the traditionally taught modules.

One interpretation of this could be that students who are very interested in a subject are more likely to flourish in a flipped learning environment, as this style allows students to fully explore the subject they are interested in, through lots of discussion and constant encouragement to come up with new ideas [25]. This supports work by Schiefele and Csikszentmihalyi, cited in [106], which found that topic interest is significantly correlated with involvement, enjoyment, concentration and activation. This could explain why this group of students in particular seem to excel in the flipped learning environment: they are able to adapt to the style of learning quickly through wanting to participate in learning activities, as required for this style of learning, allowing them to achieve the highest marks.

One limitation that could be argued from this research is that it is difficult to differentiate between the effect of interest in the flipped versus the traditional learning environments due to the fact no evidence is given with regards to whether the students were interested in the other modules specifically. The focus in this study however is on relative academic success, therefore research into more detail about interest in different subjects is something for future study.

The results of this study therefore give two sides to the argument regarding whether interest has an effect on achievement in a flipped learning environment compared to a traditional learning environment. These contradicting results can perhaps be explained by the small sample size used. One important part of this section that has been highlighted however is that there is a broad range of literature which suggests that there is a positive correlation between interest and academic achievement. Using that interest does have an effect on achieving highly in a flipped learning environment (although perhaps not a unique effect on this pedagogy in particular), from a pedagogic point of view, this study therefore suggests that for students to do well in a flipped learning environment, students need to be interested in the subject. This relates to previous conclusions made regarding the fact that students need to want to learn: if students are interested in a subject, they are more likely to want to gain a deeper understanding of it [39].

The next section will analyse the students' views on the usefulness of the programming content over the duration of the module.

4.2.2 Usefulness of Content

This category was created with the intention of gaining an understanding as to the effect of content usefulness (according to the views of the students) on academic achievement across the flipped and traditional learning environments.

Initial analysis involved finding the differences between the scores given by the respondents for the question *"how useful do you think the content of this course will be for you to learn?"* in questionnaire 1 (distributed in week 1 of lectures, as detailed in Chapter 2) and *"from what you have studied so far, how useful have you found the content of this course for you to learn?"* in questionnaire 3 (distributed in week 10 of lectures, as detailed in Chapter 2). The four subcategories created were as follows:

Category	Number of students
Increased belief of content usefulness	5
Decreased belief of content usefulness	17
Consistently high belief of content usefulness	14
Consistently low belief of content usefulness	5
Total	41

Table 4.21: Number of students in each category with regards to interest in programming

1. **Increased belief of content usefulness**

   These were the students who gave a higher score in terms of how useful they believed the course content was for them to learn in questionnaire 3 compared to questionnaire 1.

2. **Decreased belief of content usefulness**

   These were the students who gave a lower score in terms of how useful they believed the course content was for them to learn in questionnaire 3 compared to questionnaire 1.

3. **Consistently high belief of content usefulness**

   These were the students who gave scores of 4 or 5 with regards to how useful they believed the course content was for them to learn in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently not high belief of content usefulness**

   These were the students who gave scores of 1, 2 of 3 with regards to how useful they believed the course content was for them to learn in questionnaire 1 and then gave the same score in questionnaire 3.

The number of students in each subcategory is summarised in Table 4.21. The table shows that there was approximately a 50:50 split between the number of students who found that the content was less useful to learn over time, and those who found that the content was always useful to learn. The fact that there exists similar proportions of students for these two subcategories in particular, allows for useful analysis to be undertaken, due to the fact that the results will not be biased towards one particular subcategory.

The analysis for this section was as for the rest of the subsections within Section 4.

The distribution of the scores given for each personality trait under subcategories "decreased belief of content usefulness" and "consistently high belief in content usefulness" are illustrated as boxplots (see Figures 4.26 and 4.27). (The other two subcategories were not considered here since there were not enough students in these categories to perform accurate statistical analyses on.)

There are two main conclusions that can be made from Figures 4.26 and 4.27:

1. It is firstly noticeable that the scores for agreeableness in the category of students who now believe that the content is not very useful tends to be quite positive, whereas the median score for agreeableness in the category of students who have always believed that the content is useful is negative. Since there is roughly a 50:50 split in the amount of students in these two subcategories, this result could simply be due to differing opinions about the subject: one group of students may find the subject useful and so all of that group are likely to agree with each other, and then a similar idea for the opposing view.

2. The other personality trait which seemed to yield a more obvious difference in scores between the groups is openness1. The median score for openness1 in the subcategory of students who no longer believe the content is useful is slightly higher than in the subcategory of students who have always found the content useful. Related to the first point made above, this could indicate that the students who initially found the content useful were open to the idea of learning a potentially new aspect of mathematics to broaden their understanding of all branches of the subject, however, after time, believed that the content was not useful for them. The median score for openness1 is in fact extremely close to zero in the category of students who have always found the content useful.

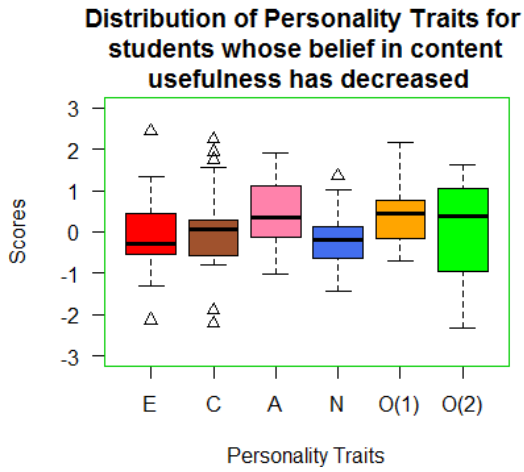

Figure 4.26: Distribution of personality traits of students who believe that contact time is now less important

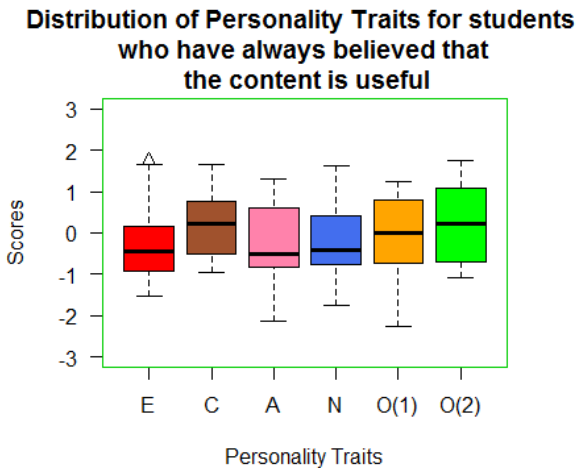

Figure 4.27: Distribution of personality traits of students who have always believed that the course content is useful

This could simply be justified by the fact that this category of students are not open because they have always found the module useful for them and so there has been no need for them to be open.

Using all of the assessment data collected (see Section 2.6), stepwise linear regression was then performed on the distribution of personality scores under each subcategory to predict these different assessment marks. A summary of all stepwise linear regression models carried out is illustrated in Table 4.22.

One very important result to identify from this table is that, considering the subcategory of students who have always found that the course content is useful to learn, openness1 and openness2 (along with conscientiousness) have a negative effect on α, implying that students in this category who scored highly in these two personality traits achieved higher in the traditional learning environment compared to the flipped learning environment. This yields an opposing argument to previous conclusions made throughout this report regarding the need for openness to succeed in the flipped learning environment. Two possible interpretations can be made from this:

1. If students find the content useful, they are perhaps more likely to naturally create purposeful work goals which will automatically increase their motivation to learn [33] and so ultimately achieve higher marks (see Section 4.2.1). It is therefore perhaps having an openness to other modules (i.e. topic areas) which would direct them away from programming and, as a result, contribute to higher academic success in other modules.

2. The results are inaccurate due to a small sample size of students used to create the stepwise linear regression models. This interpretation could also be supported by the fact that, for this specific model, only 28.83% of the variability of the data is explained by this model.

The final part of the analysis for this section involves looking at the distribution of marks for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.23) and through boxplots (see Figures 4.28, 4.29, 4.30). (Note that the horizontal red line shown in Figure 4.30 represents α_{med} and, in Figures 4.28, 4.29, 4.30, Incr. = Increased importance of content usefulness, Decr. = Decreased importance of content usefulness, Low = Consistently low belief in the importance of content usefulness, and High = Consistently high belief in the importance of content usefulness.)

Recalling that $\alpha_{\text{med}} = 1.260$, Table 4.23 indicates that the subcategory of students who now believe that the content is less useful achieved higher in the flipped learning environment compared to the traditional learning environment. These results contradict studies found by previous researchers (e.g. [13, 45]) in that "work believed to be more relevant to one's personal identity could be more academically motivating and meaningful, potentially leading to increased educational engagement". Taking these studies into

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Students who now believe that the content is useful	*Too little data to be useful*		
Students who now believe that the content is less useful	CfM Total Mark = 7.229×Openness2 + 77.436	0.163	0.061
Students who now believe that the content is less useful	Mean Mark in Other Modules = 6.503×Conscientiousness + 11.706×Agreeableness - 7.527×Neuroticism + 4.907×Openness2 + 63.846	0.118	0.254
Students who now believe that the content is less useful	α = -0.298×Agreeableness + 1.351	0.315	0.011
Students who have always believed that the content is useful	CfM Total Mark = -6.801×Conscientiousness + 82.109	0.132	0.1101
Students who have always believed that the content is useful	Mean Mark Achieved in Other Modules = 5.640×Openness1 + 4.153×Openness2 + 67.952	0.391	0.026
Students who have always believed that the content is useful	α = -0.143×Conscientiousness - 0.125×Openness1 - 0.110×Openness2 + 1.243	0.288	0.098
Students who have always believed that the content is not useful	*Too little data to be useful*		

Table 4.22: Results of stepwise linear regression on all assessment types for all subcategories concerning the usefulness of course content over time

Students who now believe that the content is useful	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*
Students who now believe that the content is less useful	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	77.686
Mean mark achieved for mean mark in other modules	65.835
α	1.224
Students who have always believed that the content is useful	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	80.383
Mean mark achieved for mean mark in other modules	67.900
α	1.203
Students who have always believed that the content is not useful	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*

Table 4.23: Summary measures for academic achievement under each subcategory involving usefulness of the course content

Type of Assessment Measure	**Kruskal-Wallis Chi-Squared Statistic**	**df**	**p-value**
CfM Total Mark	2.817	3	0.421
Mean Mark in Other Modules	0.745	3	0.863
α	0.269	3	0.966

Table 4.24: Statistical significance of mark distributions for the usefulness of content subcategories

consideration, there are two main interpretations that could be made from the study carried out in this report:

1. To succeed in a flipped learning environment, one does not have to find the content useful necessarily: there are other factors which contribute to one's success. One example of this additional factor could be openness1 which is present amongst this subcategory of students, as illustrated in Figure 4.26. This also confirms results found in Section 3.2.4 where openness1 was found to be the largest predictor of high achievement in the flipped learning environment.
2. The results collected are inaccurate due to the statistical analysis being applied to only a small sample size of students.

Interpretation 1 above could also be applied to the subcategory of students who always believed that the content was useful. This category of students were found to lack openness 1 in Figure 4.27 and so this could explain why, regardless of whether they found the content useful to learn, they achieved higher in the traditional learning environment compared to the flipped learning environment.

The results of the ANOVA test to test the statistical significance of these results are shown in Table 4.24 and are summarised by concluding that no set of results with regards to the categories by assessment mark type are statistically significant.

The boxplots given in Figures 4.28, 4.29 and 4.30 (note that the horizontal red line shown in Figure 4.30 represents $\alpha_{\text{med}} = 1.260$) confirm the conclusions made earlier in this section: content usefulness does not have an effect on how highly one achieves in the flipped learning environment. The only subcategory which appeared to achieve higher in the flipped learning environment, as opposed to the traditional learning environment, was the category of students who now believe the content is more useful. Since

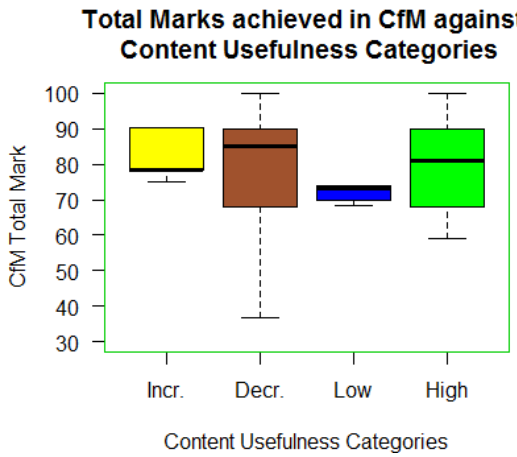

Figure 4.28: Distribution of CfM total marks based on the usefulness of content subcategories

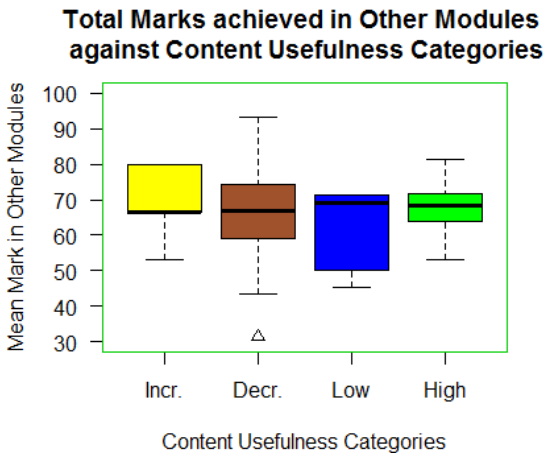

Figure 4.29: Distribution of mean marks obtained in other modules based on the content usefulness subcategories

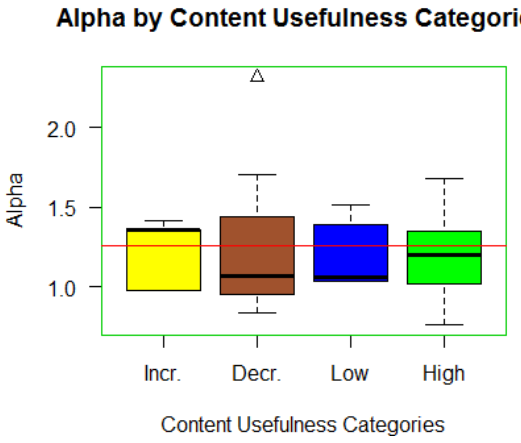

Figure 4.30: Distribution of α based on the content usefulness subategories

there were only five students in this subcategory however, no accurate conclusion can be made based on this result.

These findings are as predicted due to the fact that a flipped learning environment aims for students to gain a deeper understanding of the module's content [46] (i.e. as opposed to establishing a surface approach) and so the actual content material is arguably not as important.

Another point to raise about this category is that many lecturers do not actually want students to remember the actual content of the module: they want students instead to remember the techniques used so that these can be applied in the future. The questions asked in the questionnaires which define this category could therefore be ambiguous in the sense that the content could be interpreted as:

1. the actual material (such as how to do "for" loops in Python)
2. the techniques used (i.e. how to program)

This category has been interpreted through defining content as the actual material included in the module. With this point in mind, the results found are even more understandable through the fact that content material is essentially worthless nowadays as one can simply research queries using the internet or books. Hence this could additionally justify why content does not have an effect on achievement in the flipped learning environment: this pedagogy involves focusing on the techniques used and becoming lifelong learners [117].

The next section will analyse the importance of contact time in the learning process on academic achievement in the traditional and flipped learning environments.

4.2.3 Importance of Contact Time

The reasoning behind creating this categorisation is to gain an understanding as to whether the importance of time with the instructor has an effect on academic achievement, in the flipped learning environment.

This category was created through initially finding the differences between the scores given by the respondents for the question *"6) Please rate how important you believe the following are in your learning process: b) Time with instructor (lectures etc)"* in questionnaires 1 and 3. (See Sections 2.1.5 and 2.2 for more information about these questionnaires and scoring used.)

It is noteworthy here that the students were asked to give their rating based on the learning process as a whole, not just in terms of any particular learning environment. This design therefore means that more useful and reliable comparisons between subcategories in this section and academic achievement between the traditional and flipped learning environments can be made. The following four subcategories were then created from these initial calculations:

1. **Increased contact time importance**

   These were the students who gave a higher score in terms of the importance of contact time with the instructor in questionnaire 3 compared to questionnaire 1.

2. **Decreased contact time importance**

   These were the students who gave a lower score in terms of the importance of contact time with the instructor questionnaire 3 compared to questionnaire 1.

3. **Consistently high belief in the importance of contact time**

   These were the students who gave scores of 4 or 5 with regards to the importance of contact time with the instructor in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently low belief in the importance of contact time**

   These were the students who gave scores of 1, 2 of 3 with regards to the importance of contact time with the instructor in questionnaire 1 and then gave the same score in questionnaire 3.

Category	Number of students
Increased contact time importance	3
Decreased contact time importance	21
Consistently high belief in the importance of contact time	16
Consistently low belief in the importance of contact time	1
Total	41

Table 4.25: Number of students in each subcategory with regards to importance of contact time

The number of students in each subcategory is summarised in Table 4.25. The table shows that there is a roughly 50:50 split in terms of the amount of students who have always believed or now believe that contact time is important, and the number of students whose belief that the importance of instructor contact time has decreased. This arguably sums up the different views that one could have on the importance of the existence of an instructor through this type of learning. On one hand, students may feel that time with the instructor is less useful now, due to the fact that they now have the skills to work independently and have faith that this learning style works for them. On the other hand, students may have grasped and understood the need to work independently but appreciate the existence of the instructor to further their learning and ask more questions. An obvious alternative interpretation could also be that some students simply struggle to work independently and that the flipped learning environment has made them aware of how much they appreciate support and guidance from the instructor: they may perhaps still feel dependent on the instructor helping them learn.

The analysis for this section was then carried out in the same way as shown in Section 4.16.

Boxplots were firstly created showing the distribution of the scores given for each personality trait under each subcategory. The graphs of these are shown in Figures 4.31 and 4.32.

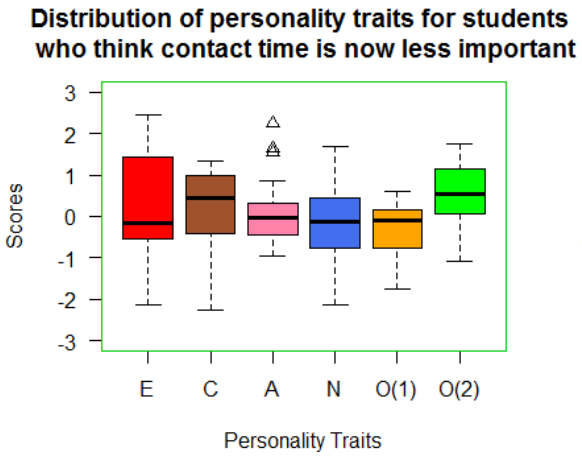

Figure 4.31: Distribution of personality traits of students who believe that contact time is now less important

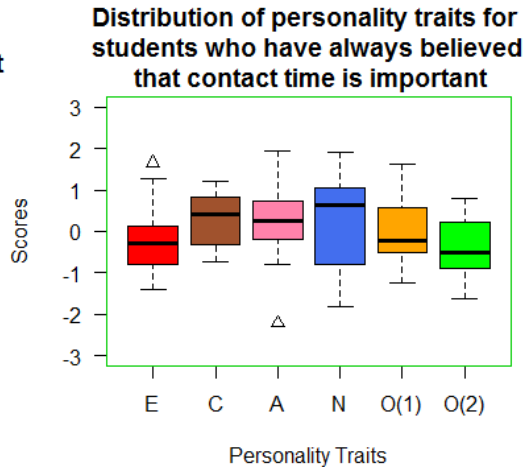

Figure 4.32: Distribution of personality traits of students who have always believed that contact time is important

The only two personality traits that clearly differ between the two subcategories shown is neuroticism and openness2.

The category of students who have always believed that contact time is important have a very high median score in neuroticism. It is useful to recall here that students who score highly in neuroticism tend to be emotionally unstable. This supports one of the interpretations mentioned at the start of this section in that students who fall into this subcategory perhaps do not have enough confidence and self-belief to be able to work independently. As a result of this, students are perhaps unable to achieve highly in this learning environment because they feel they need the instructor there to give them full guidance and support throughout. One possible explanation for this is that some students may not yet

feel comfortable in adapting to this learning environment. Due to the fact that this study was based on first year students, they may still believe that the traditional learning environment is more favourable for them due to the security of this style having worked for them previously.

The second and final personality trait whose median score across both subcategories clearly changed is openness2. The subcategory of students who believe that contact time is now less important illustrate high scores in openness2 (i.e. an openness to creativity, imagination and new ideas). On the other hand, the students who have always believed that contact time is important have a negative openness2 score. This makes sense in that students who are more open to new ideas and experiences, such as the flipped learning environment, are more likely to adapt well to the new style, in terms of becoming more independent.

Another point to make here is that, despite the encouragement of working independently in the flipped learning environment [117], the role of the educator should still be seen as important and useful to enhance one's learning opportunities. One could therefore interpret the fact that students who have always believed that contact time is important are not open to working fully independently because they still hold this view. Combining the analysis of the neuroticism personality trait to this discussion on openness2 however, it is clear that the interpretation just given is perhaps not true: this subcategory of students are not open because they are emotionally unstable and genuinely feel they need the instructor to fully support them throughout the learning process. This highlights the importance of scaffolding (i.e. maintaining high levels of support from the instructor) in an active learning environment [59], as detailed in Section 1.1.

Using all of the assessment data collected (see Section 2.6), stepwise linear regression was then performed on the distribution of personality scores under each subcategory to predict these different assessment marks, as done in previous subsections within this chapter. A summary of all stepwise linear regression models created is illustrated in Table 4.26.

The table indicates that for the subcategory of students who believe that contact time is now less important, those who scored highly in agreeableness seemed to do better in the traditional learning environment, compared to the flipped learning environment. One interpretation of this result is that the students who fell into this subcategory because of giving a response they felt obliged to give (i.e. they prefer working independently in this learning environment because this is what they have been told they should feel by the instructor) have achieved higher in the traditional learning environment, as a result of this.

In terms of the subcategory of students who have always believed contact time is important, high scores in extraversion are seen to contribute towards achieving higher in a traditional learning environment compared to a flipped learning environment. This implies that students who have lots of energy and enthusiasm, and believe that contact time is important, are more likely to excel in traditional learning environments. This relates to an interpretation made earlier in this section and one of the discussions given in Section 4.16. Achieving highly in a flipped classroom is not about high levels of interest towards the subject or having guidance and support from others (such as the instructor): it is about being intrinsically motivated and having the drive to want to learn more about the subject, regardless of other factors. (It is noteworthy that this creates a further link to Section 3.2.4 which highlights that openness1, i.e. openness to deep learning, is a large contributor towards achieving highly in a flipped learning environment.)

The final part of the analysis for this section involves looking at the distribution of marks for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.27) and through boxplots (see Figures 4.33, 4.34, 4.35. (Note that the horizontal red line shown on Figure 4.35 represents α_{med} and, in the Figures just mentioned, Incr. = Increased importance of contact time, Decr. = Decreased importance of contact time, Low = Consistently low belief in the importance of contact time, and High = Consistently high belief in the importance of contact time.)

Recalling that $\alpha_{\text{med}} = 1.260$, it is clear from Table 4.27 that none of the subcategories of students appear to have achieved higher in the flipped learning environment compared to the traditional learning environment. One possible conclusion that could be made from this is that the perception of the relationship

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Students who believe that contact time is now more important	*Too little data to be useful*		
Students who believe that contact time is now less important	CfM Total Mark = -6.438×Agreeableness + 82.859	0.111	0.077
Students who believe that contact time is now less important	Mean Mark in Other Modules = 6.914×Openness1 + 72.223	0.118	0.071
Students who believe that contact time is now less important	α = -0.109×Agreeableness + 1.209	0.160	0.041
Students who have always believed that contact time is important	CfM Total Mark = -6.876×Extraversion + 9.143×Openness2 + 78.196	0.278	0.047
Students who have always believed that contact time is important	Mean Mark Achieved in Other Modules = 6.408×Extraversion + 65.721	0.163	0.068
Students who have always believed that contact time is important	α = -0.265×Extraversion + 1.180	0.317	0.014
Students who have always believed that contact time is not important	*Too little data to be useful*		

Table 4.26: Results of stepwise linear regression on all assessment types for all subcategories concerning the importance of contact time over time

Students who now believe that contact time is more important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*
Students who now believe that contact time is less important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	81.250
Mean mark achieved for mean mark in other modules	69.552
α	1.182
Students who have always believed that contact time is very important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	76.171
Mean mark achieved for mean mark in other modules	64.200
α	1.243
Students who have always believed that contact time is not very important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*

Table 4.27: Summary measures for academic achievement under each subcategory involving importance of contact time

Type of Assessment Measure	**Kruskal-Wallis Chi-Squared Statistic**	**df**	**p-value**
CfM Total Mark	5.2804	3	0.1524
Mean Mark in Other Modules	3.988	3	0.263
α	2.425	3	0.489

Table 4.28: Statistical significance of mark distributions for the importance of contact time subcategories

between the student and the instructor is not perhaps a contributing factor towards achievement in a flipped learning environment. This arguably relates to research found by Sheffield in [111], who identified that the lecturer is important in conveying principles rather than details, and Bliss and Ogborn in [21], who believe that lecturers are most effective when they are able to generate interest. As long as the students believe these outcomes are achieved, regardless of whether they have come from contact time with the lecturer or independent learning, there will hence be an increase in academic achievement regardless.

The results of the ANOVA test to test the statistical significance of these results are shown in Table 4.28 and are summarised by concluding that no set of results with regards to the categories by assessment mark type are statistically significant.

The boxplots given in Figures 4.33, 4.34 and 4.35 (the horizontal red line shown in Figure 4.35 represents α_{med}, confirm earlier discussions that all subcategories (apart from the students who always believed that contact time is not very important, which contains a negligible amount of students anyway) seem to have achieved higher in the traditional learning environment compared to the flipped learning environment. This therefore implies that the perception of importance of contact time in the learning process has a minor effect on academic achievement.

From a pedagogic point of view, students should therefore be made aware at the start of a module being taught in this way that regardless of how important they believe contact time is, less contact time in the form of class meetings defining the flipped learning environment, for example, does not have a negative effect on academic success.

The next section will analyse the importance of learning through being explained to on academic achievement in the traditional and flipped learning environments.

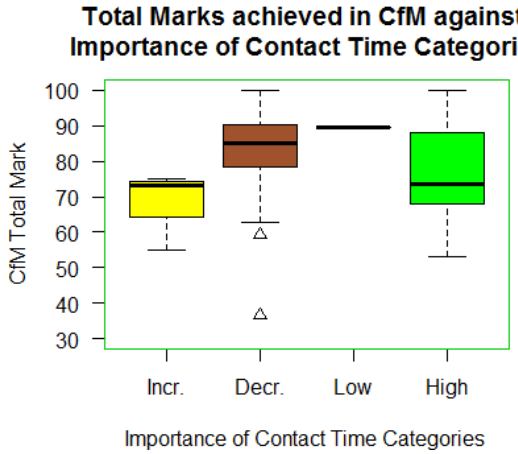

Figure 4.33: Distribution of CfM total marks based on the importance of contact time subcategories

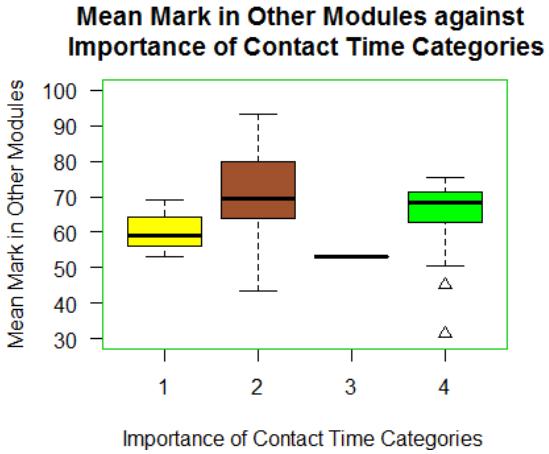

Figure 4.34: Distribution of mean marks obtained in other modules based on the importance of contact time subcategories

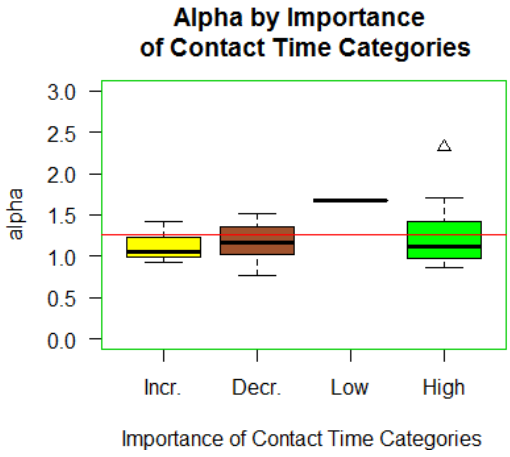

Figure 4.35: Distribution of α based on the importance of contact time subcategories

Category	Number of students
Increased importance of being explained to	8
Decreased importance of being explained to	15
Consistently high belief in the importance of being explained to	15
Consistently low belief in the importance of being explained to	3
Total	41

Table 4.29: Number of students in each category with regards to the importance of being explained to

4.2.4 Learning through Explanation

The purpose of creating this categorisation is to identify the effect of learning through someone explaining the content to the student, on academic achievement in flipped versus traditional learning environments.

Initial calculations involved finding the differences between the question *"please rate your views on this statement: I think I learn best when someone explains something to me."* in questionnaires 1 and 3. (See Sections 2.1.5 and 2.2 for more information about these questionnaires and scoring used.) The following four subcategories were then created from manipulation of these differences:

1. **Increased importance of being explained to**

   These were the students who gave a higher score in terms of the importance of being explained to in questionnaire 3 compared to questionnaire 1.

2. **Decreased importance of being explained to**

   These were the students who gave a lower score in terms of the importance of being explained to questionnaire 3 compared to questionnaire 1.

3. **Consistently high belief in the importance of being explained to**

   These were the students who gave scores of 4 or 5 with regards to the the importance of being explained to in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently low belief in the importance of being explained to**

   These were the students who gave scores of 1, 2 of 3 with regards to the importance of being explained to in questionnaire 1 and then gave the same score in questionnaire 3.

The number of students in each category are summarised in Table 4.29. The table illustrates equal amounts of students who either now believe that being explained to is less important in the learning process and those who have always believed that being explained to is important in the learning process. In total, almost two-thirds of the amount of students (23) in this study now believe that being explained to is important in the learning process (whether this is a change in attitude or not) compared to only a third of students who no longer believe that being explained to is important (11). The variation between the categories will therefore be considered throughout this section when making interpretations on results.

The analysis for this section was then carried out in the same way as shown in previous subsections within Section 4.

The distribution of the scores given for each personality trait under each subcategory were firstly illustrated as boxplots. The graphs of these are shown in Figures 4.36, 4.37 and 4.38.

The graphs highlight three personality traits in particular which appear to clearly differ between the three subcategories. This leads to three main points which can be made about the results:

1. The category of students who have always found that being explained to is important have a more positive distribution of scores in extraversion compared to the other subcategories. One interpretation of this could be that extraverted students perhaps require more attention in the learning process. By being explained to, the needs of extraverted students are thus satisfied, resulting in their increased motivation to achieve highly in the subject. The lack of extraversion

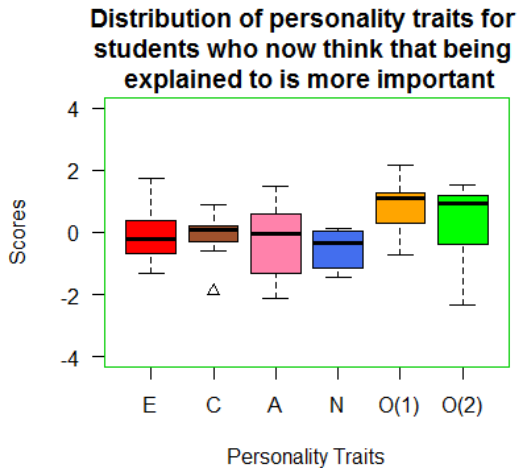

Figure 4.36: Distribution of personality traits of students who believe that being explained to is now more important

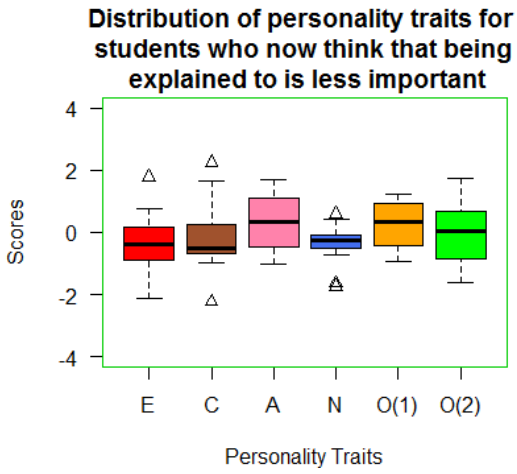

Figure 4.37: Distribution of personality traits of students who believe that being explained to is now less important

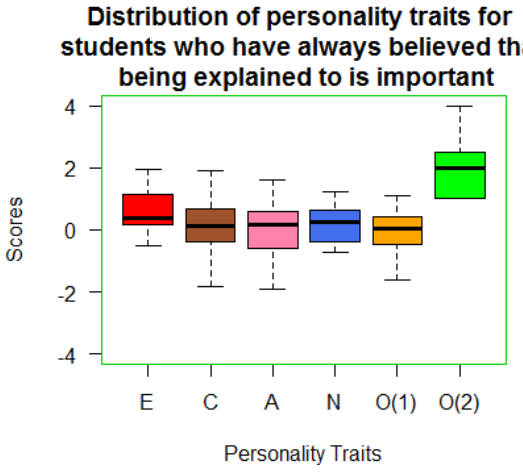

Figure 4.38: Distribution of personality traits of students who have always believed that being explained to is important

illustrated in the other two subcategories implies that the attitudes of these students towards the importance of being explained to have changed for reasons other than the need for attention.

2. Another personality trait which clearly differs between subcategories is openness1. Students who now think that being explained to is important in the learning process have a generally high positive score in openness1. One interpretation of this is that, due to their openness to deep learning, this subcategory of students now believe that being explained to is more important in the learning process due to their increased opportunity of having access to gaining a deeper understanding of the topic, through open discussion. With regards to the students who have always felt that being explained to is important, the fact that their openness1 score is very close to zero, implies perhaps that this subcategory of students have this belief due to the fact that they know that this method of learning has always worked for them in the past: they therefore have perhaps a sense of security in learning the necessary material to the correct standard through being explained to.

3. The final personality trait of interest in this analysis is openness2 (i.e. an openness to creativity and new ideas). The median score for openness2 for the subcategory of students who have always believed that being explained to is important is extremely high, compared to scores given for all other personality traits across all categories in this section. This perhaps implies that students in this subcategory find being explained to important as it allows them to gain a broader understanding of the topic through generating their own opinions about and interpretations of the subject's content (i.e. an opportunity to satisfy the openness2 segment of their personality). In addition, for those who prefer being explained to in situations where opportunities for discussion are increased, this idea is supported by the fact that students in this subcategory have high scores in extraversion. High energy and enthusiasm may therefore enhance the ability of these students to excel academically through these discussion opportunities, due to high participation rates (as perhaps implied in [42]).

   The above point on the effect of openness2 is supported by the results given in Figure 4.36 where the median score for openness2 is approximately 1. In this case, students perhaps now think that being explained to is more important due to the realisation that discussing ideas (arguably provided through being explained to in small groups) creates increased learning opportunities, as suggested by the socialism learning framework (see Section 1.1).

Using all of the assessment data collected (see Section 2.6), stepwise linear regression was then performed on the distribution of personality scores under each subcategory to predict these different assessment marks. A summary of all stepwise linear regression models carried out is illustrated in Table 4.30.

From the table of stepwise linear regression models, it is clear that the subcategory of students who believe that being explained to is now less important, confirms the results found in Section 4.2.3 for the subcategory of students who now think that the importance of contact time is less important. This implies that this subcategory of students are referring to the instructor when they are considering their perceptions of the importance of who they are being explained to by.

One noteworthy model to highlight is the stepwise linear regression model for α for the category of students who believe that being explained to is now important. This model has an adjusted R-squared value of 0.8512 implying that 85.12% of the model is explained by the variability of the data. Despite the small number of students within this category (8), this model is therefore suggested to be quite accurate. In this model, students who score highly in conscientiousness seemed to achieve higher in a flipped learning environment compared to a traditional learning environment. This contradicts results found previously in that conscientiousness was found to be a better predictor of high achievement in a traditional learning environment (see Section 3.2.4). One interpretation of this model could be that, to achieve highly in a flipped learning environment, being explained to contributes well to academic success when accompanied by hard work, focus and perseverance in one's study. This highlights the need for students to be responsible for their own learning in the flipped learning environment [117]. By being explained to, students may receive the potentially false impression that they understand the content, referred to as "an illusion of explanatory depth" [103]. It is only when they are able to apply the content themselves through practice, discussion or explaining the content to someone else that they are able to actually demonstrate that they have at least some understanding of the material [77].

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Students who believe that being explained to is now more important	CfM Total Mark = 12.909×Conscientiousness + 71.808	0.289	0.098
Students who believe that being explained to is now more important	Mean Mark in Other Modules = -8.252×Neuroticism - 15.024×Openness1 + 50.465	0.087	0.343
Students who believe that being explained to is now more important	α = 0.956×Conscientiousness + 0.224×Neuroticism - 0.527×Openness2 + 1.610	0.851	0.013
Students who believe that being explained to is now less important	CfM Total Mark = -10.109×Agreeableness + 82.552	0.400	0.007
Students who believe that being explained to is now less important	Mean Mark in Other Modules = 11.277×Openness1 + 73.073	0.250	0.033
Students who believe that being explained to is now less important	α = -0.194×Agreeableness + 1.252	0.194	0.057
Students who have always believed that being explained to is important	CfM Total Mark = 9.119×Openness2 + 79.822	0.188	0.060
Students who have always believed that being explained to is important	Mean Mark Achieved in Other Modules = 3.594×Conscientiousness + 3.833×Agreeableness + 64.202	0.089	0.227
Students who have always believed that being explained to is important	α = 0.155×Openness2 + 1.194	0.241	0.036
Students who have always believed that being explained to is not important	*Too little data to be useful*		

Table 4.30: Results of stepwise linear regression on all assessment types for all categories concerning the importance of contact time over time

Students who now believe that being explained to is more important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	70.034
Mean mark achieved for mean mark in other modules	60.725
α	1.236
Students who now believe that being explained to is less important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.972
Mean mark achieved for mean mark in other modules	68.800
α	1.203
Students who have always believed that being explained to is important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.168
Mean mark achieved for mean mark in other modules	67.147
α	1.183
Students who have always believed that being explained to is not important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*

Table 4.31: Summary measures for academic achievement under each subcategory involving the importance of being explained to

Type of Assessment Measure	**Kruskal-Wallis Chi-Squared Statistic**	**df**	**p-value**
CfM Total Mark	4.895	3	0.180
Mean Mark in Other Modules	1.117	3	0.773
α	1.654	3	0.647

Table 4.32: Statistical significance of mark distributions for the importance of learning through explanation subcategories

This model also suggests that neuroticism contributes towards higher achievement in the flipped learning environment compared to a traditional learning environment. An interpretation of this could be that students who are emotionally unstable are capable of doing well in a flipped learning environment, as long as the content is explained to them, i.e. support and guidance is perhaps required to build their self-confidence and keep them focused on task (as defined by neuroticism implying dependency [22]).

The final part of the analysis for this section involves looking at the distribution of marks for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.31) and through boxplots (see Figures 4.39, 4.40, 4.41. (Note that the horizontal red line shown on Figure 4.41 represents iα_{med} and, In the Figures just mentioned, Incr. = Increased importance of being explained to, Decr. = Decreased importance of being explained to, Low = Consistently low belief in the importance of being explained to, and High = Consistently high belief in the importance of being explained to.)

Recalling that $\alpha_{\text{med}} = 1.260$, Table 4.31 indicates that no category of students in particular seems to achieve higher in a flipped learning environment compared to a traditional learning environment. This relates to the conclusions made in Section 4.2.3, in that the perception of importance of being explained to appears to be unimportant with regards to academic achievement in a flipped learning environment versus a traditional learning environment.

The results of the ANOVA test to test the statistical significance of these results are shown in Table 4.32 and is summarised through stating that no variations in subcategories for each of the different assessment types were statistically significant.

Figure 4.41 highlights that the subcategory of students who always thought that being explained to was

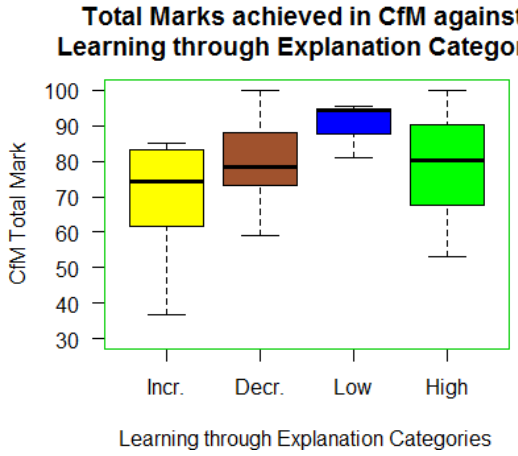

Figure 4.39: Distribution of CfM total marks based on the importance of learning through explanation subcategories

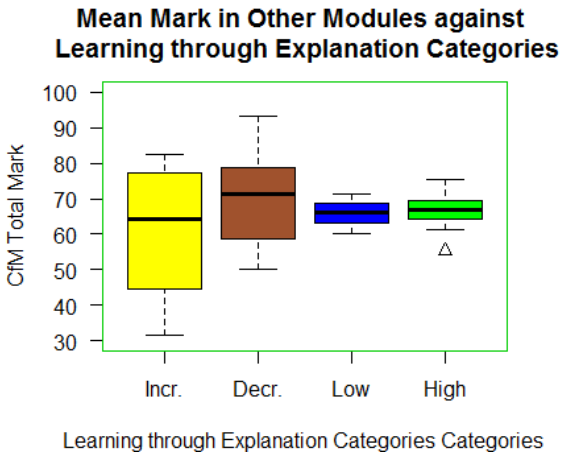

Figure 4.40: Distribution of mean marks Ootained in other modules based on the importance of learning through explanation subcategories

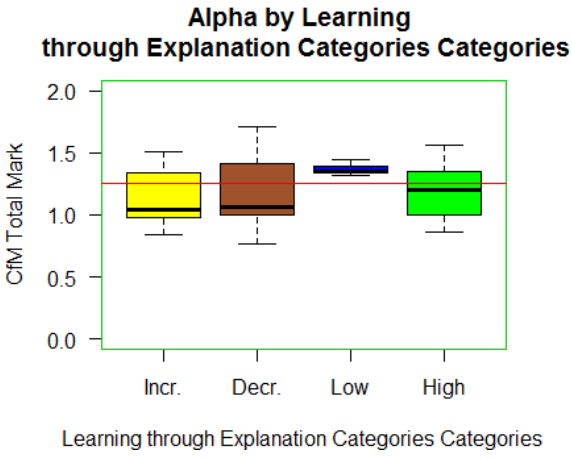

Figure 4.41: Distribution of α based on the importance of learning through explanation subategories

unimportant in the learning process was the only category who achieved higher in a flipped learning environment as opposed to a traditional learning environment. This leads on to making the conclusion that to succeed in a flipped learning environment, the perception of the importance of learning through explanation (whether from the instructor or from peers) does not have a large effect on final academic outcomes. This relates to the conclusions made in Section 4.2.3 in that contact time does not have an effect on academic success in the flipped learning environment, supporting the belief that students were thinking about being explained to by the instructor when answering this question.

The latter point raised regarding the fact that student perceptions on learning through someone explaining the material to them supports a point made in [44]:

"student perceptions about what will enhance their chances of success or diminish their chances of failure at university are likely to have a strong influence on the behaviour of students regardless of the actual influence of those factors".

This research highlights the fact that student perceptions towards different aspects of learning may affect the way they behave, but in reality, it is suggested that these perceptions are not explanatory of the actual effect of these factors. In other words, students may not be aware of the actual effect this learning pedagogy has on their learning process. This was demonstrated through the fact that the students' perceptions on learning through being explained to were shown to not have an effect on how well they achieved in the flipped learning environment. This idea further supports conclusions made within previous sections of this chapter.

From a pedagogic point of view, these results imply that students who prefer to learn through someone explaining the material to them will not necessarily achieve higher in a flipped learning environment. How students choose to absorb and learn the information is therefore completely up to the students, encouraging independent learning [117] and supporting the results of the study conducted in [109] that "students need to acquire those skills ... that will allow them to succeed" since the responsibility for success rests entirely with the students.

The next section will analyse the importance of attending class meetings, on academic performance in the traditional and flipped learning environments.

4.2.5 Importance of Attending Class Meetings

This categorisation was created with the aim of identifying whether the effect of the perception of attending class meetings is important with regards to achievement in the flipped learning environment compared to the traditional learning environment.

As in the previous sections, initial calculations involved finding the differences between the question *"please rate how important you think attending lectures will be for this module"* in questionnaire 1 and *"please rate how important you believe attending lectures have been for this module"* in questionnaires 3. (See Sections 2.1.5 and 2.2 for more information about these questionnaires and scoring used.) (Note here that the questions asked included the term "lectures" instead of "class meetings". This was because students are perhaps more familiar with the term lectures, due to them having lectures for other modules, and so by using this term, confusion should have been prevented when answering this question.) The following four subcategories were then created using these differences:

1. **Increased importance of attending class meetings**

   These were the students who gave a higher score in terms of the importance of attending lectures in questionnaire 3 compared to questionnaire 1.

2. **Decreased importance of attending class meetings**

   These were the students who gave a lower score in terms of the importance of attending class meetings in questionnaire 3 compared to questionnaire 1.

3. **Consistently high belief in the importance of attending class meetings**

Category	Number of students
Increased importance of attending class meetings	2
Decreased importance of attending class meetings	24
Consistently high belief in the importance of attending class meetings	11
Consistently low belief in the importance of attending class meetings	4
Total	41

Table 4.33: Number of students in each category with regards to the importance of attending class meetings

These were the students who gave scores of 4 or 5 with regards to the importance of attending class meetings in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently low belief in the importance of attending class meetings**

   These were the students who gave scores of 1, 2 of 3 with regards to the importance of attending class meetings in questionnaire 1 and then gave the same score in questionnaire 3.

The number of students in each subcategory is summarised in Table 4.33. The majority of students now believe that class meetings are less important to attend (whether this is a change in attitude or they have always felt this way). Just over a quarter of students believe that attending class meetings is now important (whether this is a change in attitude or they have always felt this way). The varying amounts of students in each subcategory shown will therefore be taken into consideration when making interpretations of results later on in this section.

The analysis for this section was then carried out in the same way as shown in previous subsections within Chapter 4.

The boxplots illustrating the distribution of the scores given for each personality trait under each subcategory are shown in Figures 4.42 and 4.43.

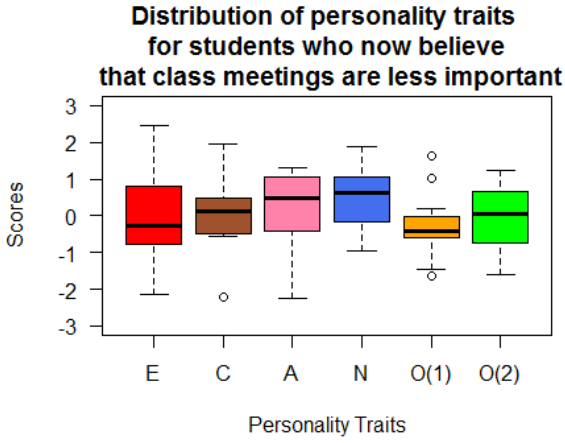

Figure 4.42: Distribution of personality traits of students who believe that attending class meetings is now less important

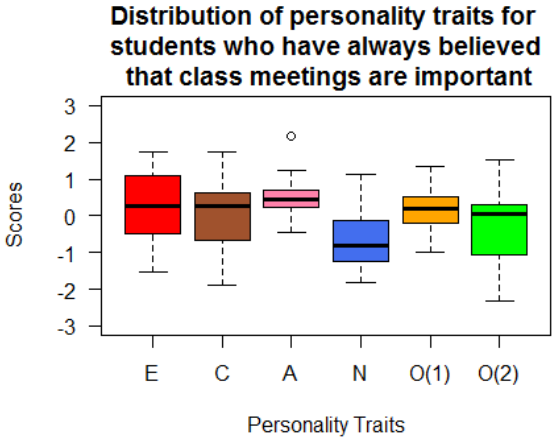

Figure 4.43: Distribution of personality traits of students who believe that attending class meetings has always been important

The graphs illustrate some quite clear differences amongst the different personality traits between each subcategory. Three main points can therefore be made from these Figures:

1. The first personality trait that varies quite obviously between both subcategories illustrated is agreeableness. The median score for agreeableness in the subcategory of students who now believe that attending class meetings is less important is very positive (i.e. close to 1), whereas the median agreeableness score for students who have always believed attending class meetings is important

is close to -1. One explanation of this could be described simply by general differences in opinion. One group of students may feel like class meetings are unimportant and so the agreeable students believe the same regardless; the students then who have always believed that class meetings are unimportant have low scores in agreeableness because they have chosen to disagree with students who fall into the group just mentioned.

2. The second personality trait which appears to differ quite substantially between groups is neuroticism. The median score for this personality trait in the subcategory of students who now feel that attending class meetings is less important is negative, whereas this median score is positive for students who have always believed that attending class meetings is important. This could suggest that students who are emotionally stable feel comfortable in being able to learn the content on their own, without the need for class meetings, whereas students who are less emotionally stable may believe that they still need some guidance and support to help them learn. This supports the interpretation made regarding students who score highly in neuroticism in Section 4.2.4. An alternative interpretation however is that neuroticism simply is not a large predictor of students perceptions of the importance of attending class meetings, due to the fact that the median neuroticism scores are fairly close to zero across both categoried.

3. The final personality trait to mention is openness1. The interquartile range for this personality trait in the category of students who believe that attending class meetings is now less important is very large, mainly in the positive half of the graph, whereas the category of students who have always believed that attending class meetings is important have a very small range of scores between approximately 0 and 0.75. One possible interpretation of these results could be that students who have always believed that attending class meetings is important believe they can access a deeper level of understanding this way. The other category perhaps think that attending class meetings is not important because they believe they can access deeper levels of understanding of the subject in their own time. In other words, student perceptions with regards to importance of attending class meetings is a result of whether or not students see value in the idea of attending class meetings [79].

Using all of the assessment data collected (see Section 2.6), stepwise linear regression was then performed on the distribution of personality scores under each subcategory to predict these different assessment types. A summary of all stepwise linear regression models carried out is illustrated in Table 4.34.

This table mainly confirms results found previously for similar categories (e.g. Sections 4.29 and 4.2.3) regarding the fact that student perceptions on the importance of attending class meetings does not have an effect on achieving higher in the flipped learning environment compared to the traditional learning environment.

One more point to add to this comes from looking at the model based on α for the category of students who believe that attending class meetings is now less important. High scores in agreeableness for this model are shown to have a negative effect on α, meaning that the students who are more likely to follow the lead of other students are likely to achieve higher in a traditional learning environment. This arguably highlights the main definition of the flipped learning environment: one needs to understand that one needs to work independently and be responsible for one's own learning to be able to succeed in this learning environment [117].

The final part of the analysis for this section involves looking at the distribution of marks for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.31) and through boxplots (see Figures 4.44, 4.45, and 4.46). (Note that the horizontal red line shown in Figure 4.46 represents α_{med} and, in these Figures, Incr. = Increased importance of attending class meetings, Decr. = Decreased importance of attending class meetings, Low = Consistently low belief in the importance of attending class meetings, and High = Consistently high belief in the importance of attending class meetings.)

Recalling that $\alpha_{\text{med}} = 1.260$, the results clearly show that no category of students in particular seems to achieve higher in a flipped learning environment compared to a traditional learning environment. Because of these results, the same conclusion can be made as in other sections within this chapter (e.g. Sections 4.2.4 and 4.2.3): attending class meetings perhaps is not a large contributing factor towards

Category	**Regression Model**	**Adjusted R-squared Value**	**p-value**
Students who believe that attending class meetings is now more important	*Too little data to be useful*		
Students who believe that attending class meetings is now less important	CfM Total Mark = -4.376×Extraversion -5.505×Agreeableness + 4.908×Openness1 + 5.407×Openness2 + 82.303	0.170	0.111
Students who believe that attending class meetings is now less important	Mean Mark in Other Modules = 1	-	-
Students who believe that attending class meetings is now less important	α = -0.138×Agreeableness + 1.267	0.120	0.063
Students who have always believed that attending class meetings is important	CfM Total Mark = -11.580×Neuroticism + 69.929	0.372	0.027
Students who have always believed that attending class meetings is important	Mean Mark Achieved in Other Modules = 5.759×Agreeableness + 3.537×Neuroticism + 5.429×Openness1 + 8.197×Openness2 + 65.418	0.879	0.001
Students who have always believed that attending class meetings is important	α = -0.158×Agreeableness - 0.182×Neuroticism + 1.176	0.236	0.140
Students who have always believed that attending class meetings is not important	*Too little data to be useful*		

Table 4.34: Results of stepwise linear regression on all assessment types for all subcategories concerning the importance of attending class meetings over time

Students who now believe that attending class meetings is more important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*
Students who now believe that attending class meetings is less important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.163
Mean mark achieved for mean mark in other modules	66.733
α	1.230
Students who have always believed that attending class meetings is important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	77.280
Mean mark achieved for mean mark in other modules	65.527
α	1.202
Students who have always believed that attending class meetings is not important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*

Table 4.35: Summary measures for academic achievement under each subcategory involving the importance of attending class meetings

Type of Assessment Measure	**Kruskal-Wallis Chi-Squared Statistic**	**df**	**p-value**
CfM Total Mark	1.362	3	0.715
Mean Mark in Other Modules	0.964	3	0.810
α	0.841	3	0.840

Table 4.36: Statistical significance of mark distributions for the importance of class meeting attendance subcategories

one's success in a flipped learning environment. From a pedagogic view, this makes sense: learning has nothing to do with attendance in class since students should be able to learn just as well in class as they do outside of class (i.e. supporting the idea of students being responsible for their own learning [117]).

The results of the ANOVA test to test the statistical significance of these results are shown in Table 4.36 and are summarised through stating that no categories yielded statistically significant variation as to the marks achieved in each different learning environment.

Figures 4.44, 4.45 and 4.46 support previous discussions through observing that no category has a median value of α above the red line, indicating that no category in particular appears to achieve higher in a flipped learning environment compared to a traditional learning environment. Having said this however, the category of students who have always felt that attending lectures is unimportant has a value of α just under $\alpha_{\text{med}} = 1.260$, with the majority of the upper quartile lying above the red line. It could therefore be interpreted that students who do not believe that lectures are important to attend are likely to be more academically successful in a flipped learning environment. Since there were only four students in this category however, this conclusion is very unreliable. It is therefore perhaps more reliable to conclude that, as discussed previously, the ability to succeed in a flipped learning environment is not affected by student perceptions on the importance of attending class meetings.

From a pedagogic point of view, the results for this section suggest that students should not feel disorientated by the lack of class meetings in the flipped learning environment compared to the traditional learning environment because the results highlight that this does not have an effect on their overall academic achievement.

The next section will analyse the importance of non-contact time on academic performance in the tra-

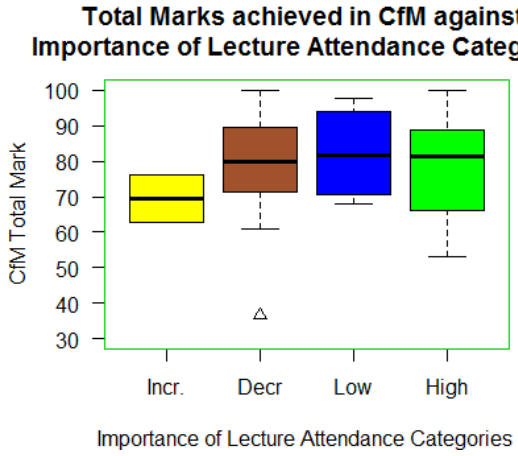

Figure 4.44: Distribution of CfM total marks based on the importance of class meeting attendance subcategories

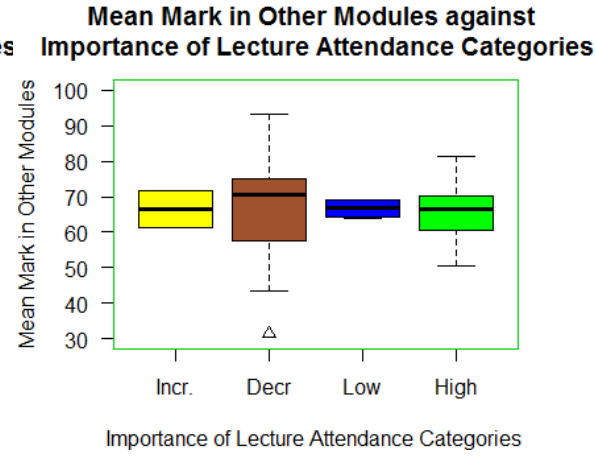

Figure 4.45: Distribution of mean marks Obtained in other modules based on the importance of class meeting attendance subcategories

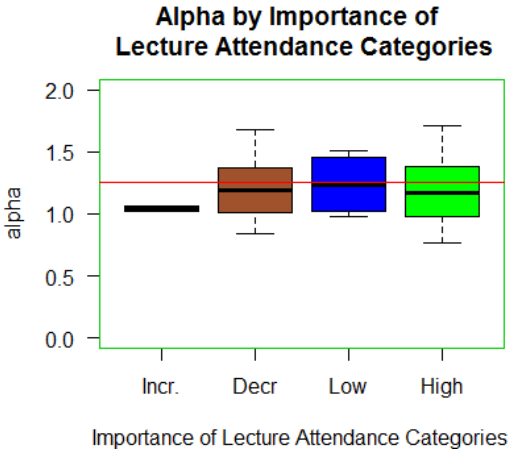

Figure 4.46: Distribution of α based on the importance of class meeting attendance subcategories

Category	Number of students
Increased importance of self-study time	1
Decreased importance of self-study time	15
Consistently high belief in the importance of self-study time	25
Consistently low belief in the importance of self-study time	0
Total	41

Table 4.37: Number of students in each category with regards to the importance of self-study time

ditional and flipped learning environments.

4.2.6 Importance of Non-Contact Time

The purpose of analysing this category is to compare it to attitudes towards the importance of contact time over time (as discussed in Section 4.2.3) and the effect this has on achievement in flipped and traditional learning environments.

As in the previous sections in this category, initial calculations involved finding the differences between the question *"please rate how important you believe the following are in your learning process: self-study time (Alone, in study groups etc...)"* in questionnaires 1 and 3. (See Sections 2.1.5 and 2.2 for more information about these questionnaires and scoring used.) The following four categories were then created using these calculations:

1. **Increased importance of self-study time**

   These were the students who gave a higher score in terms of the importance of self-study time in questionnaire 3 compared to questionnaire 1.

2. **Decreased importance of self-study time**

   These were the students who gave a lower score in terms of the importance of self-study time in questionnaire 3 compared to questionnaire 1.

3. **Consistently high belief in the importance of self-study time**

   These were the students who gave scores of 4 or 5 with regards to the importance of self-study time in questionnaire 1 and then gave the same score in questionnaire 3.

4. **Consistently low belief in the importance of self-study time**

   These were the students who gave scores of 1, 2 of 3 with regards to the importance of self-study time in questionnaire 1 and then gave the same score in questionnaire 3.

The number of students in each subcategory is summarised in Table 4.37. The table illustrates that just over a third of students think that self-study time is now less important and just under two-third of students have always believed that self-study time is important. The differing amount of students in each subcategory will therefore be taken into consideration when interpretations are made on results later on in this section.

The analysis for this section was then carried out in the same way as shown in previous subsections within Chapter 4.

The boxplots illustrating the distribution of the scores given for each personality trait under each subcategory are shown in Figures 4.47 and 4.48.

The only personality trait which appears to differ quite obviously between each subcategory is conscientiousness. For the subcategory of students who have always believed that non-contact time is important, the median score for conscientiousness is positive, whereas the median score for conscientiousness for the subcategory of students who believe that non-contact time is now less important is negative. This supports the definition of this personality trait in that students who have a motivation to work hard and

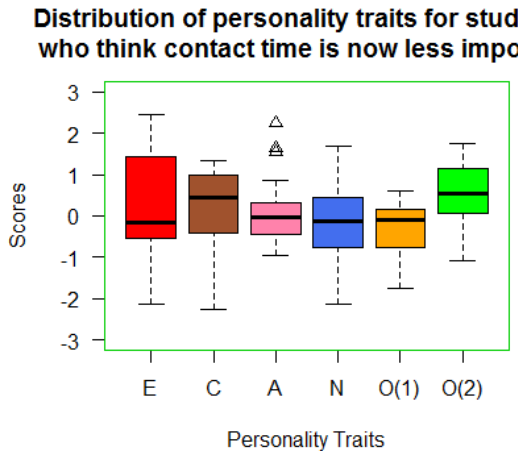

Figure 4.47: Distribution of personality traits of students who believe that self-study time is now less important

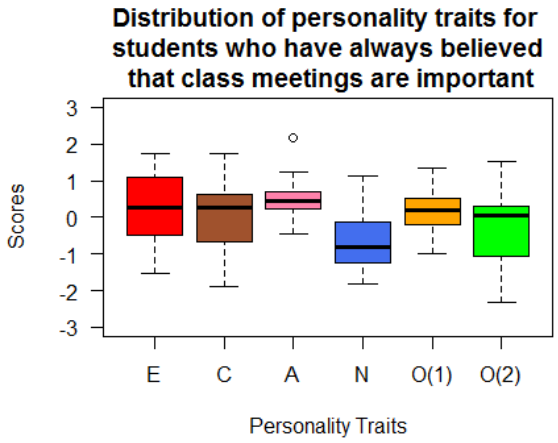

Figure 4.48: Distribution of personality traits of students who believe that self-study time has always been important

persevere [14, 27] prefer to work on their own as they perhaps feel this is the best way they can learn efficiently.

Having looked at the distribution of personality traits in general, stepwise linear regression was then performed on all personality traits against different assessment measures (see Section 2.3 for more information). The models found as a result of these are shown in Table 4.38.

The majority of models created in this subsection appear to be unreliable due to the low adjusted R-squared values given for each model. The main point to make however from this table is that high scores in agreeableness seem to contribute towards higher success in a traditional learning environment compared to a flipped learning environment, regardless of the students' beliefs in the importance of non-contact time. This supports previous discussions within this whole section in that students who are able to create their own opinions and take control of their own learning, regardless of other students' motivations, are more likely to achieve higher in a flipped learning environment.

The final analysis carried out for this section involves looking at the assessment measures for each subcategory, with regards to marks obtained in CfM, the mean marks obtained in other modules and α. This is given in two different forms: by use of a Table (see Table 4.39) and through boxplots (see Figures 4.49, 4.50 and 4.51). (Note that the horizontal red line shown in Figure 4.51 represents $\alpha_{\text{med}} = 1.260$)) and, in these Figures, Incr. = Increased importance of non-contact time, Decr. = Decreased importance of non-contact time, Low = Consistently low belief in the importance of non-contact time, High = Consistently high belief in the importance of non-contact time.)

Recalling that $\alpha_{\text{med}} = 1.260$, Table 4.39 illustrates that students who now think that self-study time is less important achieved higher in the flipped learning environment compared to the traditional learning environment, whereas the students who have always believed that self-study time is important achieved higher in the traditional learning environment. This result is unexpected due to the fact that one definition of the flipped learning environment is that it encourages independence [117] which one would expect to be enhanced through self-study. Three possible justifications can be constructed to explain this:

1. The sample size is too small to make any accurate conclusions
2. The importance of self-study time is deceiving in the flipped learning environment: students perhaps are not aware of the contribution self-study time has had on their results
3. Guided discussion (i.e. in the form of lectures within the flipped learning environment) has facilitated students to think independently and access higher-order levels of thinking required by the flipped learning environment. [117]

Category	Regression Model	Adjusted R-squared Value	p-value
Students who believe that self-study is now more important	*Too little data to be useful*		
Students who believe that self-study is now less important	CfM Total Mark = -6.688×Agreeableness + 77.349	0.134	0.098
Students who believe that self-study is now less important	Mean Mark in Other Modules = 5.168×Openness1 + 64.039	0.131	0.101
Students who believe that self-study is now less important	α = -0.105×Agreeableness + 1.262	0.063	0.186
Students who have always believed that self-study is important	CfM Total Mark = 8.329×Openness2 + 79.459	0.320	0.002
Students who have always believed that self-study is important	Mean Mark Achieved in Other Modules = 5.970×Openness2 + 69.341	0.208	0.012
Students who have always believed that self-study is important	α = -0.140×Agreeableness + 1.239	0.079	0.094
Students who have always believed that self-study is not important	*Too little data to be useful*		

Table 4.38: Results of stepwise linear regression on all assessment types for all subcategories concerning the importance of non-contact time over time

Students who now believe that self-study time is more important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*
Students who now believe that self-study time is less important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	76.939
Mean mark achieved for mean mark in other modules	62.280
α	1.256
Students who have always believed that self-study time is important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	79.551
Mean mark achieved for mean mark in other modules	69.408
α	1.181
Students who have always believed that self-study time is not important	
Summary Measure	**Mark or Ratio Achieved**
Mean mark achieved for CfM total marks	*Too little data to be useful*
Mean mark achieved for mean mark in other modules	*Too little data to be useful*
α	*Too little data to be useful*

Table 4.39: Summary measures for academic achievement under each subcategory involving the importance of self-study time

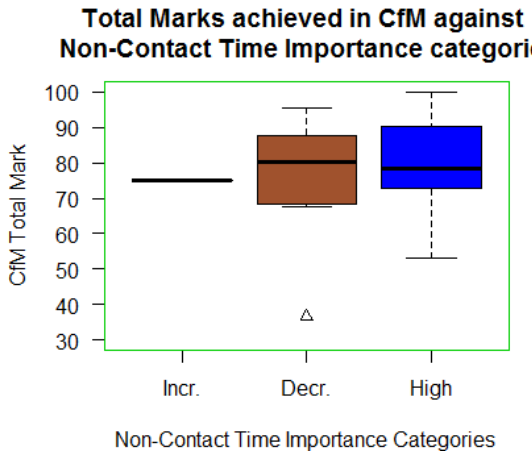

Figure 4.49: Distribution of CfM total marks based on the importance of non-contact time subategories

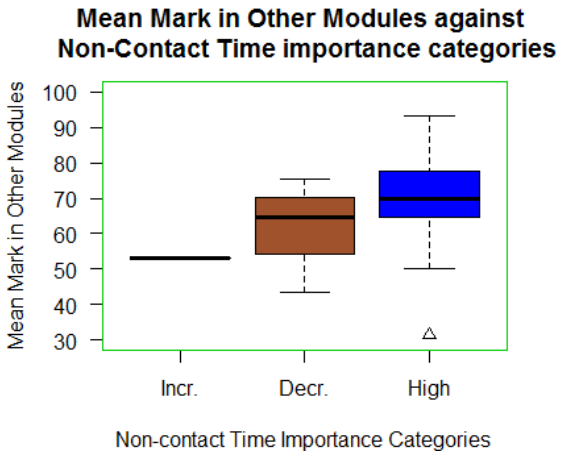

Figure 4.50: Distribution of mean marks obtained in other modules based on the importance of non-contact time subcategories

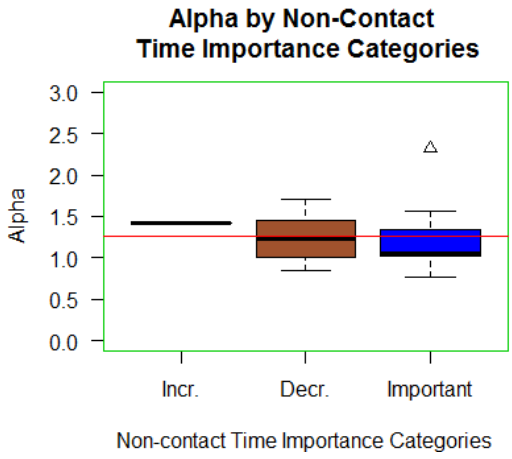

Figure 4.51: Distribution of α based on the importance of non-contact time subcategories

The results of the ANOVA test to test the statistical significance of the results are shown in Table 4.40 and are summarised by stating that no set of categories yield any statistically significant variation in the marks obtained in each learning environment.

It is clear from Figure 4.51 that the only subcategory of students who appear to achiever higher in a flipped learning environment compared to a traditional learning environment is the subcategory of students whose belief in the importance of self-study time has decreased over time. This result is as found in and discussed for Table 4.39.

One further interpretation that can be made from the above result uses the fact that the students who do not realise the extent to which self-study time perhaps has on academic achievement in the flipped learning environment have high scores in openness1 (as illustrated in Figure 4.47). The success of this subcategory could therefore be caused by their interest in deep learning (as suggested in Section 3.2.4 as a requirement for success in the flipped learning environment), guiding these students towards investing more time in learning about subject material outside the scope of the course.

It is important to highlight here however that these results do not necessarily imply that self-study *isn't* important in the learning process: the results of this study highlight instead students' perceptions towards self-study.

Type of Assessment Measure	textbfKruskal-Wallis Chi-Squared Statistic	**df**	**p-value**
CfM Total Mark	0.397	3	0.820
Mean Mark in Other Modules	5.163	3	0.076
α	2.020	3	0.364

Table 4.40: Statistical significance of mark distributions for the importance of non-contact iime subcategories

From a pedagogic point of view, the main conclusion that can therefore be made from this category is that student perceptions on the importance of self-study time is irrelevant with regards to success in the flipped learning environment. This hence sums up previous findings in Chapter 4 that students are encouraged to be responsible for their own learning in the flipped learning environment [117]: all other factors discussed do not have a direct contributing effect towards academic success in this learning environment.

The next chapter will analyse the discussions carried out in the focus groups conducted (i.e. the qualitative data).

Chapter 5

Focus Group Discussion

Once all the focus groups had been transcribed (as detailed in Section 2.5.2), the transcripts were analysed to identify primary themes that were discussed [73]. This chapter therefore contains the analyses of these focus groups.

One important point to make in the analyses given of these focus groups is that there potentially exists some bias through the incorporation of opinion in selecting these themes and interpreting the results [56]. However nonetheless, the analysis aims to give a balanced representation of the views [73]. Through considering all different kinds of viewpoints on the flipped learning environment, this chapter aims to therefore satisfy Aims 2 and 3 (as detailed in Section 1.3).

5.1 Focus Groups with the Students

This section will analyse both focus groups with the students together, to allow for comparisons to be made between the two in order to allow for identification of any changes in attitudes.

Altogether, there were three main themes that were revealed through the analysis:

1. Attitudes towards the importance of attending class meetings
2. Amount of independence required and support available
3. General attitudes towards the flipped classroom approach for Computing

Each of these will be discussed in more detail in this section and related to results found from the analysis of the quantitative data collected (see Chapters 3 and 4) and various pieces of literature discussed.

1. **Attitudes towards the importance of attending class meetings**

   At the start of the first focus group, one student, when asked *"what do you actually want to get out of lectures?"*, replied:

   "to learn something, isn't it?.

   (**Note:** This question uses the term "lectures" as this term is most likely to be more familiar to the students than "class meetings".)

   This was accompanied by group laughter. This reaction arguably implied that students felt this was an obvious response: it is natural to think that every student attends class meetings and goes to university to learn something. Through further discussion however, this assumption was found not to actually be the only reason. The other reasons that were identified and discussed were as follows:

   - To be able to learn Maths in order to use it in a future job

- To pass the exam
- To learn how to be a Mathematician and take it further
- To get a good degree
- To get some transferable skills
- To help you to decide what kind of area you want to go into

In order to satisfy the motivations of every student, a "perfect" class meeting would therefore have to satisfy all of the reasons stated above.

Focusing on whether students believe that class meetings are worthwhile attending within the flipped pedagogy, one student stated:

"I think it depends on whether you've had issues with the module or not. Sometimes he [VK] goes through things that people have found hard and I've found easy and so sometimes it's a waste of time because you're just going over stuff that you've already understood."

When then asked about whether this same student would turn up to a class meeting if they fully understood the module, the student stated *"probably not"*.

On the other hand, another student in the first focus group disagreed slightly with the previous viewpoint by stating:

"When you go to lectures, you just go through issues you've had which I find quite helpful because it helps me to understand."

This perception was also held by two students (at least) in the second focus group:

"I think they're just good because we do so much of it at home and get so much of it at home so it's just like he [VK] gives you that extra little bit to fill in the gaps".

These quotes highlight the fact that class meetings in a flipped learning environment have the main purpose of consolidating concepts learnt and encourage higher-level thinking [117]; they are not about conveying all of the information required to be learnt in a module. Viewpoints given in the second focus group further support this:

"lectures are about 10% helpful compared to actually doing it on your own"

This viewpoint therefore additionally supports the conclusions made in Section 4.2.5 in that class meetings do not necessarily add anything extra as such to the learning process. It is important to remember however when discussing class attendance in this report that the conclusions made are based on perceptions only, not necessarily fact.

Another point introduced was by one student who believed that attending class meetings is important:

"In a big group, we have more questions than we realise so it makes the other people think: "oh ok, this is something I could do" or "what if this happens" etc".

This supports the study conducted in [25] (as detailed in Section 1.1), that understanding that students are not alone in the learning process helps contribute towards increased motivation and learning potential. It is also noteworthy to recall here that this highlights the advantages of the socialism learning framework (see Section 1.1).

2. **Amount of independence required and support available**

When asked *"what do you think about the way this module is taught compared to the way your other modules are taught?"* in the first focus group, three students specifically mentioned that this module is a lot more independent. Some points raised on this idea included:

"I think you're forced to do more stuff by yourself rather than be allowed to be spoon-fed information."

"If I don't have someone helping me, I might struggle because it is very independent and it's very new to a lot of people".

"We are basically very much thrown in the deep end ... this is quite an extreme of independent working".

The students then led the discussion on towards the fact that some of them did not know what to do if they were unsure as to the solution of a problem. In response to this, another student stated:

"You can literally ask the questions online".

The two sides of this argument highlight the differing levels of independence held by the students at the start of the module.

In the second focus group however, all students seemed to prefer the independent approach offered by the flipped learning environment:

"I've realised that I'm able to learn without having to ask the lecturer or even other people because I know I am now able to just piece things together".

(**Note:** It is important to recall however that there were only 7 students in this focus group and so there exists a high level of bias, as discussed in Section 2.5.1.)

Another student spoke about the positive effect of independent learning on their understanding of programming:

"You do probably learn a lot better because you really understand why something happened."

This highlights one of the aims of the flipped pedagogy being achieved in that this student has been able to access and practice higher-order thinking [46].

Through another student having increased his/her confidence in working independently, he/she now feels that they have a *"better understanding"* of how they can best solve problems. This therefore emphasises the effect the flipped pedagogy has on encouraging students to identify which learning approach(es) work best for them.

The conversations in both focus groups were then guided towards discussing the support that was available to them.

In the first focus group, the students felt that the undergraduate tutors were not helpful, since *"they just say "google it"*. Contradicting attitudes were expressed in the second focus group however (although it is important to recall here the potential bias present in this focus group of only 7 students, as detailed in Section 2.5.1): *"there's a lot of access to help, if you want help".*

Another point that was raised in the second focus group was that:

"Even though it [CfM] is not lecture-based or anything, I just know there's always a lot of help for it".

This highlights the fact that students believe support is always readily available, despite the focus on independent learning in the flipped learning environment, as emphasised by Professor Robert Talbert in [117] (see Section 1.1 for more information).

3. **General attitudes towards the flipped classroom approach for Computing**

Many students in the first focus group did not seem to fully grasp the concept of the flipped pedagogy through suggesting that:

"It would be better if we had two lectures, and one of them is about last week's tickables and one of them is about next week's stuff because I think I learn more from him going through things than I do from him just sitting there in tutorials checking through the tickables",

therefore implying that they still felt they could learn best from the instructor's guidance.

Another student suggested, with regards to the structure of the module that:

"Rather than just wasting time, you could do something where people could just submit their tickables online and they if you get the output required, then that's good enough, and then if they don't, they come to labs, and then the labs can be used for other things mostly, but then also if people need help and then you could make a lot more use of it, because a lot of people just sit in the labs and do the tickables which is a lot of silent time wasted for a lab."

Three other students agreed with this opinion in that the lab sessions are very quiet and that everyone is just doing their own thing. This could be justified by the fact that the students at this stage (i.e. at the start of the first semester of their first year at university) probably did not know each other and so were a bit more apprehensive about talking to others.

Towards the end of the first focus group, students were asked to vote on whether they prefer the flipped learning environment to a traditional learning environment (i.e. how their other modules are taught). In response to this, eleven raised their hands in favour, three were not in favour and the remaining three students were unsure. It was clear here therefore that the majority of students in this focus group seemed to prefer the flipped learning environment, at this early stage in the module. This supports research carried out in [14] whereby the majority of students at the end of the module (carried out using the flipped classroom approach) "strongly preferred this approach".

The journey taken by the students who were perhaps unsure about the flipped learning environment to start with was summarised by one of the students in the second focus group:

"Now I've come to the end of it, at first I was kind of very disarrayed about it but now I'm actually quite happy about how it's all gone, and there's very little things I would have probably changed, if any at all."

This summary relates to the idea of "student buy-in" described by Professor Robert Talbert in [117] in that not every student believes that they can learn to the best of their abilities in this learning environment at the start.

A final point that was raised by a student in the second focus group was that:

"You understand straight away whether you understand something, because someone will come up to you and say "oh how do you do that" and you either go "oh you do it like this, this and this" or you go "um, I don't really know" so you can work back through it together".

The latter point therefore (again) supports the socialism learning framework which the flipped classroom approach pedagogy fits into, as detailed in Section 1.1.

5.2 Focus Group with the Undergraduate Tutors

In the analysis of this focus group, three main themes were raised and discussed:

1. Slightly differing perceptions on the role of an undergraduate tutor
2. Relationship between the undergraduate tutors and the students
3. Attitudes towards assessment

This section aims to therefore discuss these in more detail, whilst also relating these viewpoints to quantitative results found in Chapters 3 and 4 and furthermore confirm and/or contradict literary pieces related to these results.

1. **Slightly differing perceptions on the role of an undergraduate tutor**

   All undergraduate tutors who attended the focus groups agreed that they generally enjoyed being an undergraduate tutor. Many points were given as to their reasons behind it, highlighting the intrinsic and extrinsic motivations of the tutors:

   - "You get paid"
   - It reinforces previous knowledge of the subject

- It enhances skills and provides good experience which contributes well towards CV building
- It allows practice in terms of communicating Mathematics to non-technical audience members

The positiveness shown in these reasons towards the role of an undergraduate tutor further highlights the benefits that are brought to these students in enhancing their learning opportunities.

The discussion then moved on to their actual roles and how each tutor thought they should lead lab sessions.

The general description given of their role is that they:

"Check all of the [students'] tickable questions and give advice or guidance, not exactly the right answers, but a nudge in the right direction if they're struggling".

One method identified for tackling the issue of students struggling with certain questions was to *"encourage them [students] to discuss the answers with each other"*. This highlights the incorporation of socialism in the flipped learning environment to enhance learning opportunities, which has been shown in previous studies to improve learning outcomes [25, 64, 97]. The tutors then added to this by stating that if there was a general consensus of students not understanding something, this would then be passed onto VK to discuss in class meetings. This emphasises the focus on higher-level thinking and tackling the more difficult problems in lectures, as defined by the flipped pedagogy (see Section 1.1 for more information).

The tutors were then asked if students were *ever* given the answer in lab sessions, after the students had been seen attempting and struggling on a question for a long time. One tutor responded to this by stating that:

"If you can see they're trying on it for the whole hour and they can't get anywhere but they've tried, then give them a tick and then that's what you tell Vince: that's the thing they're struggling most with".

This implies that students may sometimes need high levels of perseverance to be able to answer questions in CfM. Perseverance is a descriptor of conscientiousness: one of the main personality traits defined in the Big Five Factor Model (see Section 2.4.1). In general, the results from the quantitative data found that conscientiousness was the greatest predictor of achieving highly in a traditional learning environment, not a flipped learning environment (see Section 3.2.4). The only subcategory of students in the quantitative results that yielded conscientiousness to be a positive predictor of achieving highly in a flipped learning environment however was the students who now believe that being explained to is more important. The results from this focus group could therefore suggest that the reasons behind these students believing that being explained to is more important is because they are perhaps the students who had to persevere for a long time at tickables and so were perhaps unable to obtain the correct answers straight away. It is noteworthy to recall with this interpretation however that there were only 8 students in this subcategory and so either the results could be seen as unreliable or this could highlight that this theory only affected a small number of students.

Different tutors appeared to have their own thoughts on when they should give students more information about the solution however (e.g. after discussion with others, "when they are 99 % of the way there", after a "whole hour") and so, in future, the tutors suggested that tutors should be given a role play type activity at the start of the year, where VK could demonstrate to them exactly how much help they should give and when.

An additional question that was asked with regards to this theme centred around any previous experience of tutoring the tutors' had and whether this had an effect on their current role.

Many tutors mentioned that tutoring in the flipped environment was very different to any previous tutoring experience they had. For example, one tutor stated that:

"I think it's a different approach. I think it's good for us as tutors because it is solely us teaching them. Before, it was totally different because you're kind of conveying information by yourself".

This highlights the difference between flipped and traditional learning environments: in the flipped environment, learning is more student-centred, whereas in a traditional environment, learning is more teacher-centred (see Section 1.1). This idea is further enhanced through the fact that students *"learn their own way of doing things"* in the flipped environment, as opposed to following a set method of doing something given by the instuctor, as is done in a traditional learning environment.

Another point raised by one of the tutors was that:

"Because all of the students here are only asking you questions about stuff that they don't understand, it's good for us because it helps us to develop communication skills and we need to take complex ideas and break them down, whereas before in tutoring, they may ask questions about things they are unsure on and then one answer just cleared that up. So it's a lot harder to answer questions in this environment than it was when I've tutored before."

This point suggests another potential advantage of the flipped learning environment over the traditional learning environment: the tutors (and potentially instructor also) benefit in the learning process, as well as the students.

In a traditional learning environment, for example, the students learn through content being given to them by the instructor and them asking questions where necessary, about the content. In this learning environment, the only learning opportunity provided to the instructor arguably here, is in the creation of the material for the class.

In a flipped learning environment however, the instructor, student tutors and students are all fully taking part in the learning process. The students are learning through having to understand the material themselves and asking questions which allow them to access higher-order levels of thinking. Student tutors learn within this flipped environment through needing to revise material to be able to answer questions asked by students. In addition, the student tutors may be asked questions which they are unsure of the answer to, especially if content has changed slightly since they took the module, and so they will be able to learn new things here to do with the module content. Finally, the instructor is able to learn more through this environment by conversing with students and student tutors alike. For example, instructors may have to answer questions on the topic they had not considered before (due to students perhaps coming up with ideas which consider a broader perspective on the content, as a result of them learning with minimal guidance).

With the above discussion in mind, two diagrams illustrating this idea have been created and are shown in Figure 5.1 (for a traditional environment) and Figure 5.2 (for a flipped environment).

2. **Relationship between the undergraduate tutors and the students**

   The general consensus amongst the tutors with regards to this theme is that, due to the fact that they are not technically staff at the university, it is easier for the tutors to develop a rapport with the students. For example, one tutor stated that *"because we're not staff, it is easier to be friendly with them [the students]"*. Another tutor added to this by stating that *"we have something to relate with them"*.

   One perhaps disadvantage of the tutors being students is that they find it more difficult to *"assert authority"*. This point was not an issue for them though as they stated that *"there is no real pressure on us to do that"*.

   Discussions on this theme therefore imply that student tutors are important and useful in terms of establishing good relationships with the students, arguably allowing for students to feel more comfortable in discussing any arising problems in the module.

3. **Attitudes towards assessment**

   One of the main points that was made about the class test is that students *"needed more time"* to complete it. One student in particular argued that *"there is a limit to how quickly you can solve questions"*.

   A positive aspect of the class test however was stated by one tutor in that *"it was an open book test, so you do spend a lot of time going through stuff and looking up bits of code, which I think is great*

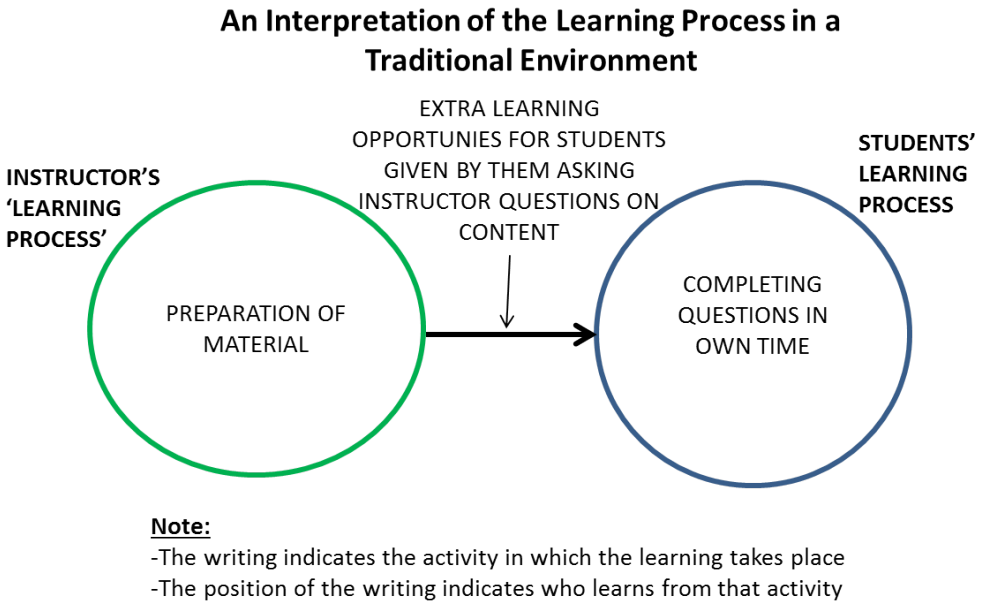

Figure 5.1: An interpretation of the learning process in a traditional environment

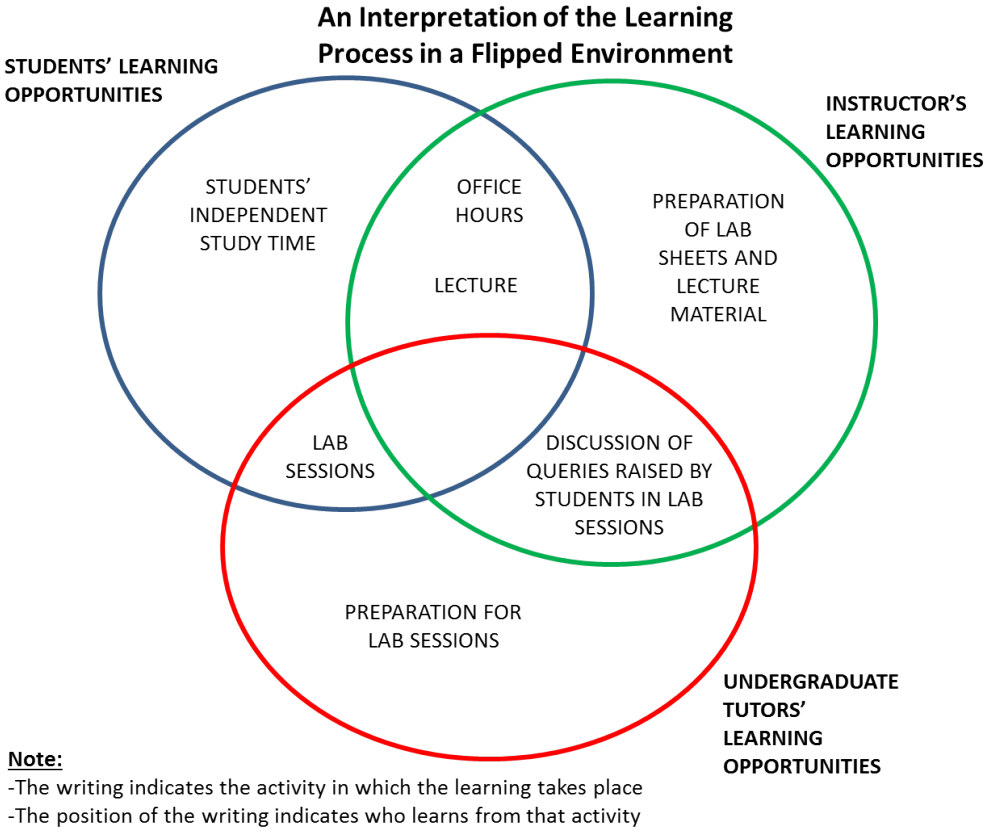

Figure 5.2: An interpretation of the learning process in a flipped environment

because that's exactly how you would write up code normally". This supports the interpretation given in Section 4.2.2 in that memorising content is not important in this module: it is instead about learning the techniques needed to be able to code well in the future.

One argument that could be made about the timing issue of the class test is that students are perhaps not used to being able to research concepts quickly and so this is a skill to be learned in the future. Another (perhaps more obvious) argument is that timings suggested for the class test in future should be more realistically decided upon.

In terms of the attitudes of students in lab sessions after the class test, the tutors stated that the students who felt they did badly now *"seem to be coming to the tutorials with more questions than they did before the test"*. This highlights the positive effect of high scores in neuroticism towards motivation, as discussed in Section 2.4.1: students who are emotionally unstable in anticipating failure, gear up their efforts to pre-empt it [87].

Another tutor however argued *"I'm not really sure if the class test really did much to kind of change people's attitudes towards their work"*. This therefore perhaps implies that the latter point about the effect of students with high scores in neuroticism may only apply to a certain subset of students. This idea is demonstrated by the results of the quantitative data in Section 4.1.3. Students in the realistic coursework predictors category, for example, who had high scores in neuroticism seemed to achieve higher in CfM, therefore highlighting this positive effect of emotional instability.

The final point to be raised regarding this theme is summed up by one of the tutors:

"I think it's just a module that you get out of it what you put in".

Another tutor supports this viewpoint by stating:

"If someone isn't really interested in coding, and doesn't really want to be, there isn't really much you can do to help them".

These viewpoints therefore confirm ongoing discussions within each section of Chapter 4: students who *want* to learn will achieve highly in the flipped learning environment. In a sense this links to the fact that students need to be open to learning (which defines openness1) to be able to succeed in a flipped learning environment, as also suggested in Chapter 3.

Chapter 6

Discussion

Discussions have been carried out within each section of this report, however the main points will be summarised here. Additionally, previous studies that have been undertaken similar to this research will be referenced here so that this study can be compared appropriately to prior findings. As a result of this discussion, it will therefore be clear how Aims 1, 2 and 3 (see Section 1.3 for more information) have been met throughout this report.

The results of this study suggest that openness has the greatest influence on high academic achievement in the flipped learning environment (see Sections 3.2.2, 3.2.3, 4.1, 4.1.1, 4.1.2 and 4.2.1). This confirms the results found in [20, 119, 123] which states that openness to experience is associated with academic performance, but highlights an alteration that can perhaps be made to the result found in [10] that openness does not have the highest influence on academic achievement overall. In further explanation, although openness overall may have been found not to have a large influence on academic achievement, this pedagogic approach favours students who score highly in openness to deep learning the most, therefore emphasising the generality of the study results just mentioned.

Results from this study confirm that conscientiousness has the greatest influence on academic achievement in the traditional learning environment (see Sections 3.2.1, 3.2.3, 4.1, 4.1.2 and 4.1.3), confirming the results found in many previous studies [18, 27, 28, 31, 34, 95, 96].

The study in [76] found that conscientious students tend to have increased confidence which supports their ability to stay focused on activities leading to greater learning. The results of the study carried out in this report both confirm and contradict these results. For example, on one hand, the over-coursework-predictors category in Section 4.1.3 had extremely high scores in conscientiousness, yet had very low scores in extraversion, which is the personality trait defining energy, enthusiasm and confidence (as discussed in Section 2.4.1). This result however is perhaps not entirely reliable due to there only being 7 out of 65 students in this subcategory. On the other hand, the subcategory of students who have always believed that being explained to is important in Section 4.2.4 have high scores in conscientiousness and also achieve higher in CfM. This supports the previous study mentioned above: students who are able to focus more on activities through believing that being explained to is important in the learning process were able to reach higher marks.

The latter result referenced in this report contradicts earlier findings in that conscientiousness was found to have a greater influence on achievement in the traditional learning environment, not the flipped learning environment (see Chapter 3). From a pedagogic view this therefore perhaps suggests that conscientious students can still achieve highly in a flipped learning environment, but they need to believe (and know) that there is enough support and guidance available to them so that they feel comfortable in reaching the higher marks. (In other words conscientious students perhaps lack some confidence in being able to achieve highly working independently, therefore they need this encouragement to support them.)

The point just raised leads onto a discussion about the role of the instructor in the flipped learning environment. The study in [59] found that students believed that time with the instructor in a nonflipped

environment was as influential as time with the instructor in a flipped learning environment. The results in this study overall confirm this previous research through the fact that the importance of contact time (see Section 4.2.3), the importance of being explained to (see Section 4.2.4) and the importance of attending class meetings (see Section 4.2.5) were all found to have no influence on academic achievement in the flipped learning environment.

Previous studies [34, 42] found that extraversion was correlated with academic performance due to extraverted students interacting more with teachers and so increasing their learning potential. A similar result was found in [18] that extraversion supports peer learning and social behaviours. This result was also confirmed in the study contained in this report through the fact that the category of students who always believed that being explained to is important (see Section 4.2.4) have high scores in extraversion implying that they perhaps hold this belief due to the increased likelihood of them creating a strong relationship with their instructor and peers. This result is further enhanced through the fact that students who have always believed that contact time is important (see Section 4.2.3) and have high scores in extraversion achieve highly in the traditional learning environment. The positive correlation between extraversion and academic achievement is therefore highlighted here, furthering the results found by Poropat in [95] who only confirmed the existence of this relationship for primary school students.

Students who scored highly in neuroticism and also believed that being explained to is important (see Section 4.2.4 for more information) achieved higher in CfM compared to other modules. This implies that students who are emotionally unstable (i.e. defined by high scores in neuroticism) are capable of succeeding in the flipped learning environment, as long as they believe that the required amount of help and support is available to them. This highlights how students with high scores in neuroticism (who have previously been found to have lower ability in terms of focusing on learning activities [66, 100]) can access academic success through this pedagogy.

Overall, the main groups of students who appeared to achieve higher in the flipped learning environment compared to the traditional learning environment were:

- Under-predictors and under-estimators
- Realistic and under-coursework-predictors
- Students with high scores in openness1 (i.e. an openness to deep learning)

From a pedagogic view, it is clear therefore from the discussions in this chapter and in other chapters throughout this report that students who do not perhaps believe in themselves to achieve highly but are open to deep learning are more likely to succeed in a flipped learning environment.

Attention should be given however to students who are perhaps over-confident and are very energetic (i.e. extraverted) in ensuring that their energy is channeled correctly towards peer discussion. Further attention should also be given to students who score highly in neuroticism to ensure that they know that the required support is available to them if they so need it.

Having carried out these discussions, there are however some limitations to this study. Firstly, despite attempts to collect views and opinions from all students in CfM, the data sets used were very small, therefore affecting accuracy and reliability of the results.

The second limitation is that this study is based very much on perceptions towards different aspects of CfM and the flipped pedagogy. There is no concrete evidence as such therefore that these attitudes support global opinions on the flipped learning environment.

The final limitation is that this study was conducted on first year students who most likely would not have experience learning independently. This could explain the time period between students starting the module and them actually believing in the fact that their learning potential is not hindered through the flipped pedagogy.

Further research could therefore involve conducting studies on students experiencing the flipped classroom for the first time in different year groups at university level and analysing the effect on academic achievement in this case. Due to the fact that this study centred very much on perceptions of students towards the flipped learning environment, further research which considers more statistically reliable and accurate data could also be conducted.

Chapter 7

Conclusion

The main aim of this study was to identify whether personality traits had an effect on academic achievement in the flipped versus the traditional learning environments in a first year Computing module at Cardiff University. The main findings was that conscientiousness is the largest predictor of academic achievement in a traditional learning environment and that openness to deep learning is the largest predictor of academic achievement in a flipped environment. This led on to concluding that, to do well in a flipped classroom, one must want to learn and access deeper levels of thinking in the topics being studied.

This research does not however conclude that a flipped learning environment facilitates higher academic achievement than a traditional learning environment (as demonstrated through the fact that the subset of students who scored highly in conscientiousness seemed to achieve higher in a traditional learning environment, for example). This study does however suggest that the flipped learning environment offers greater learning opportunities for students who perhaps find it more difficult to concentrate for long periods of time, by encouraging peer and instructor-student discussion so that students can come up with their own ideas and so consequently access higher-order levels of thinking This henceforth highlights how the flipped pedagogy fits into the socialism and constructivism learning frameworks. As a result of this, conclusions made in this study may therefore be useful to an educator believing that students learn best in either or both of these frameworks.

The "perfect" pedagogy is difficult to create due to the fact that it would have to accommodate students of all ages, backgrounds, cultures and personalities: the discussions provided in this study therefore indicate that the flipped learning environment is not by any means the "perfect" pedagogy. The results of this study do however highlight the students who need to be targeted in particular, in terms of personalities traits, for this pedagogy to facilitate high academic success in practice.

Appendices

Appendix A

Focus Groups

A.1 Focus Group 1 with the Students

17 students attended.

16/10/2015

Me: So if I run through the questions and then please all take part as much as possible I'd like to hear from everyone as much as possible. If you disagree with someone, then have a debate as it then shows all of the different views that you have on the module. So the first question is: "What do you actually want to get out of lectures? What do you think is the point of lectures?"

A: To learn something, isn't it?

(Everyone laughs)

B: Content really because people come to uni to learn Maths to then do something with Maths, not to just learn it for fun. I can't speak for everyone but...

C: Rather than learning something, don't you just want to know how to pass the exam?

B: Given that the lecturers write all of the exams, all content is exam testable so anything they say could be tested upon.

C: I'm not saying they don't teach us the stuff, I'm just saying I'm there to pass the exam.

D: I think as well, just learning how to be a Mathematician in terms of like not just how to pass the exams but how to take it on further like in all the notation, in learning the correct way and concise way to write things and stuff

Me: Ok, so everyone's agreed that you kind of want to learn the content? So when you go into your lectures and come out of university, you want to be experts in Maths and remember everything that goes on in lectures?

E: That's not what he said...

Me: Ok so your concensus is...?

D: Getting through uni

B: I want to have a good degree and maybe get some transferrable skills but I don't necessarily care about learning about sequences. I don't think that will help me in life.

D: Are you applying to be a mathematician? Do something Mathsy even?

B: I dunno, it depends if it pays well.

D: I've heard the university lecturer pays very well.

B: Well, yeah ..

F: I think basically it's to become more employable.

B: Yeah

Me: Ok, how about you guys at the back?

G: Well, I'm not certain but I assume that at some point in the course over the three years, you have to start kind of specialising or moving towards a certain area so I guess part of the lectures would be helping you to decide which kind of area you want to go into.

Me: Ok, brilliant. So has anyone else got anything to add to that question? Ok, so moving onto the next question. So this module is taught quite differently to perhaps the other modules you're taking. So how does this module compare to your others? What do you think of the way this module is taught compared to the way your other modules are taught?

D: In a way it's more independent. I think you're forced to do more stuff by yourself rather than be allowed to be spoonfed information, but there is also an error in that because if he doesn't give you all the means to be able to go away and do it independently then you're stuck, like sometimes he doesn't give you all the terminology and what-not. So if you don't know what that is, you won't know what to look up and then you get very lost.

H: I'll be honest, when I was in the first week, there was something saying "open up this new window" somehow and I was searching through this thing trying to find a new window because nothing said the same thing as what he had put on the sheet. I couldn't open the thing to even start the work!

D: Yeah I was like that, I downloaded Python, and then I kept opening like the wrong thing, and just couldn't do any of the stuff for ages until the day before the labs when someone was like "oh now you just do this!", and I was like "oh right!" so sometimes it's quite like, if I don't have someone helping me, I might struggle because it is very independent and it's very new to a lot of people.

A: Considering that we've just come from A-Level as well where you're basically just fed everything and then we write everything up afterwards... we basically are thrown very much in the deep end. I mean, we all suspected that we'd have to do more independent work at university, but this is quite an extreme of independent working, where you literally have to do everything outside of lessons and apart from the lessons he goes over last week's work to try and help you understand but otherwise yeah you're right, its basically just very, very independent working compared to everything else.

I: I think we might benefit from more of a tutorial lab thing like if that was scheduled in for the next year's students or whatever and have more like, not one-to-one but few-to-few interaction with teachers.

J: Yeah so instead of labs like just doing your own thing, they could actually go through the tickables in labs, so the first half in the first lab session and the second half or so, and if people well.. that's a good opportunity, you've only got about 30 people or less than that, so that's a good opportunity to really go through it in detail and have a really interactive lesson I guess.

I: You could like, put in maybe students from the last year or whoever mentors or phd students or whoever, to kind of help out there so that they get training, and we get more help.

Me: Ok, so leading on from that, how about the videos? Do you not find the videos do that?

K: The videos are helpful but I find that myself, I just copy what Vince does on the videos without really understanding it.

E: Yeah, you don't have the option to ask him.

L: Sometimes the videos, like if there's three parts to the question, sometimes the video might only cover the first part.

E: Yeah, and then you're stuck thinking well I know how to do that bit so now where do I go from here?

L: Yeah exactly

E: And you don't know how to follow on

M: And sometimes some of the questions for example are a bit abstract and so maybe he should use a separate example with different numbers and then you're not sure if yours has actually worked and if it doesn't work, it will come back with an error and you don't know why.

G: I think part of the reason why he is doing different examples, or perhaps why he is not doing it in its fullest is so that you can't just sort of copy it off the internet every time.

M: Oh, by all means, but then we can't find something or we can't do something, so he says "have you checked the video links?" and its where the video links just can't help us so by all means it stops us from copying everything down, but then when there's no alternative, trying to search up online everything he says, it can be really hard to find what you're looking for.

I: You can literally ask the questions online. I've seen stuff from our course where people have the questions online and the answers are just on there. So that is also a thing you can do. Also the python.docs is also a good resource for this.

N: I actually prefer the way this module is taught because you get four times the normal amount of tutorials, and he doesn't really lecture the same way as the other modules because I do find sometimes I struggle with the way they lecture because I don't understand much but then there's normally one tutorial a fortnight so you're not actually getting that much help outside of lectures, whereas with this, we get two a week and so it is much more consistent.

Me: Ok, so what would you need then in addition to what you've got, so like you said you've got the videos but they don't perhaps cover everything, what would you need, if we were to give you something extra?

I: Like they said, if you get an error and you don't know what it is, you could like maybe write in perhaps what the other likely mistakes that people might make are and what it means so like not fill in the blanks, but say that "If you get this" it could be "check this" or that kind of more of a structure so if you get lost, they have somewhere to go back to.

Me: So how about the tutors then when you go to the tutorials, do they help you? Can they give you that help that's needed?

H: Not really, every time I ask for help they just say "google it" and I go "well, that's great, but actually like give me some push, rather than google it and come back in 5 minutes" as that's like well why I'm there in the tutorials, to ask the tutors questions and then they're just like "no, look it up on the internet" and so they're not very helpful.

Me: Ok, so in terms of independence, overall kind of views, do you like the amount of independence you have in this module?

M: I think there's nothing wrong with the level of independence, I just feel like there should be someone there to be able to help us, like so we can be as independent as we are, but there should be somebody there to help us in case we are stuck.

J: That kinds of defeats the object of independence though surely?

M: No, like..

F: Someone to fall back on type thing

E: Yeah.

Me: Ok so the next question, through this style of module delivery, do you think the lectures are worthwhile attending? Do you think they're necessary?

A: Is this just for Computing or..?

Me: Yes, just for Computing.

L: Yes, sometimes. I think it depends on whether you've had issues with the material or not. Sometimes he goes through things that people have found hard and I've found easy and so sometimes it's a waste of time because you're just going over stuff that you've already understood.

Me: So if you feel like you've understood everything for the module, would you turn up to the lecture?

L: Probably not.

N: Lectures are quite problem-based compared to the other lectures, they're not very theory-based as we have to learn that ourselves, but then when you go to the lectures you just go through issues you've had which I find quite helpful because it helps me to understand.

E: Yeah I do as well. [find it useful]

Me: Ok, so perhaps if you didn't have as much independence and you did have a bit more in the videos, do you think that would make it even less worth attending lectures

J: Sometimes in the lectures, he says things that are sort of related to questions we've done but aren't things we would specifically do, so it sort of helps to give us more ideas of things around it, like today we were saying things like "can you subtract lists and things" and I wouldn't have thought about that but now after I'm like "oh I'll go into that a bit more and research around that", so it sort of gives you an idea of what you can go further to do and maybe that will help later on when you're doing more difficult things later on.

G: In a big group, we have more questions than we realise so it makes the other people think "oh ok, this is something I could do" or "what if this happens" or "what if I can or can't do that".

Me: So do you find that the lectures are useful then, in general?

(Everyone kinds of murmurs: kind of yes, kind of no)

I: Maybe if he did like half of what he's been doing in the whole lectures and then goes into detail about what we're going to be doing in this week's tickables, so perhaps going into more hints.

J: Yeah, he doesn't go into next week's does he?

I: Yeah, never.

E: He said he would do stuff and then kind of link into the stuff we've done already but he should do that for the things we're going to be doing as well so that we can get an idea of it and so when we see the question we can make a connection to it and go "oh wait, I remember doing something about that" so we can think back to what was covered in that sense. I think that's a way better way of doing it.

G: I think part of the problem is that he doesn't know what we're going to struggle with in the next week's tickables because we haven't actually tried to submit them yet and it might just be that.

I: Yeah but he has like last year's lot..

J: And also as a teacher, he should be able to tell what is more complex and what's harder

M: Maybe he should go over the things that aren't the tickables so that that can help build on ...

I: Yeah, that's so true. Maybe they could just go through the things that aren't the tickables and then the answers will really help us out.

Me: Ok, let me ask you something a second and let's all go round, so how many of the questions do you complete on the exercise sheet?

I: All questions

J: Tickables, sometimes more questions

B: All the questions

C: All the questions

D: All the questions

E: All the questions

M: Most of the questions

F: Most of the questions

G: Most of the questions

H: All of the questions if I can do them

K: Most of them

L: I try to all of them but if the last one isn't a tickable then I don't always do it

N: I do all of them until I've finished the tickables and then stop

A: some of the questions

O: All of them if I can manage it

P: Pretty much the tickables

Q: All of them

R: All of them until I have finished the tickables

Me: One more thing about the lectures, you have one lecture and week and two tutorials a week, is that enough?

I: The tutorials are just for tickables so really you don't really do anything but get those done.

A: Technically you could just do all tickables the night before and then for there for five minutes and then leave.

J: I literally did that. I've only been to one lab, and that was last Wednesday and I did it the night before but I did have help the previous day, and then I just went in for 10 minutes and then left. Just because no one is really speaking, everyone is just doing their own thing.

L: Yeah and you don't learn anything if you don't go out to look at anything. And you do that at home anyway so it is effectively what you would do at home, just in school with other people who you don't necessarily have to be there for.

M: I think that it's the right amount because I do all of the tickables at home and then go the first session, and then any problems I then have I can try and fix during the rest of that session and then I have another tutorial just in case I can't get it all done in the time and I use the lectures then for feedback.

O: I think it would be better if we had like two lectures, and one of them was about last week's tickables and one of them was about next week's stuff because I think I learn more from him going through things than I do from him just sitting there in tutorials checking through the tickables.

I: Rather than just wasting time, you could do something where people could just submit their tickables online and then if they get the output required then that's good enough and then if they don't, they come to the labs, and then the labs can be used for other things mostly, but then also if people need help and then you could make a lot more use of it, because a lot of people just sit in the labs and do the tickables which is a lot of silent time wasted for a lab.

L: I think it would be useful having like one of the tutorials and then a lecture so that while we're going through them, we can have feedback on what people are struggling with but then we have another tutorial to still get the tickables.

P: If they were more spaced out it might be better because I have one on a Monday and then on a Tuesday so if I have really messed something up on the Monday, I don't have a lot of time to fix it if I have a tutorial on the Tuesday.

A: Also, Vince's office hours are on a Thursday which is when I have Probability and then a tutorial so I can't physically fit in any time to go and physically see him.

J: Yeah he told me to go and see him between 1 and 3 today but I was like "oh, I'm busy from 1 to 3"

A: If you email him, he does rearrange it but again, the tutorials are so close together, you have barely any time to do anything.

L: I find I do most of the work on a Tuesday morning just before the last lab session.

Me: What to try and get everything done on time?

L: Yeah, just too try and rush through it all. But then it's taking up a lot more time than all of my other modules.

(About half of the group agreed to this)

Me: Ah, that leads onto my next question. So how much time do you think you roughly spend outside of the module per week? If we go round quickly.

I: Couple of hours

J: Yeah a couple of hours

B: Maybe 2-3 hours

C: Yeah, maybe 2-3 hours

D: Same, 2-3 hours

E: Same

M: 6

F: Yeah about 2-3 hours

G: Same again

H: Yeah quite a few, probably about 3-4

K: Probably 3 or 4

L: 2-3 hours

N: About 3 or 4

A: Yeah about 2 to 3

O: Same

P: Between 1 and 2 hours

Q: 2-3 hours

R: About 5 to 6, yeah.

Me: How does this compare to the work you do outside of your other modules?

M: I do spend longer on computing but it feels more worthwhile because with the other modules I don't feel like I'm getting as much done because I have to spend a lot of time thinking and looking stuff up but in Computing it feels a lot more satisfying.

A: With that, with Computing, the tickables are effectively compulsory and we haven't had many other compulsory things. I do remember Vince saying to someone though that the tickables are meant to be done at home, you don't necessarily go the lab sessions just to do tickables and things, you are just meant to go there to show everything you've done and correct anything if you need to, so if you go by that theory, then everything we're mean to be doing at home, is more or less the Computing, apart from a couple of a few bits from other modules.

Me: So does anyone feel like there is too much to do outside of lectures or does everyone feel like it's about right?

J: Well I think there's too much.

F: I think it's not that bad because it's only a couple of labs and you're meant to be doing that anyway. It's kind of nice that it's structured. For me personally I like knowing what I have to do whereas I don't like going back and thinking "well, what should I have to do?"

H: That's a good point, at least when you're given it you know exactly what you're doing, whereas in other subjects you don't really know where you stand.

M: It's because it's so much more independent for the Computing that you have to spend more time looking at, well to get started each week it's like a new topic for Computing so it takes you a while to get into it and because he doesn't go over it in the lectures, you have to watch the videos to start with and read it all through, whereas for the other lectures they kind of go through all of the examples, and everything and then they get you to work through questions once you know the syllabus and how you do it whereas in Computing you kind of have to figure it all out yourself.

E: I would say that I did to Further Maths at A-Level and I'm often wondering if I would have to spend more time on the other modules if I hadn't have done Further Maths but whether I would be spending 2 or 3 hours outside of lectures on the other modules, but Computing is sort of brand new to me. So I'm wondering if how much of that is why I am spending so much more time on Computing is because I'm just not used to it yet.

(3 people agreed with this)

Me: Has anyone done Computing before in here?

(4 students raise their hands)

Me: So out of those who have done Computing before, do you find that this module is repeating stuff or do you find its all new?

I: It's repeating stuff completely because I did Python in Computer Science in Cardiff so I have all the same content, but I did more content so he doesn't even cover everything.

Me: So do you find that you're bored through these lectures or..?

I: I don't actually have to do it, I'm just doing it for fun.

Me: Ok, how about your guys? (Directing it to the other 3 students who raised their hands)

P: For me, it's repeating ideas, but I used Visual Basic before which was a different programming language so the actual learning Python is new to me.

R: I used Visual Basic as well so it's a different language so you still have to learn the rules, even though you know what it's doing.

Me: Ok, so do you feel like you're still stretched even though you may have done something before?

M: Yeah I still find it interesting, and like I said I still spend a fair bit of time on it.

I: It's a nice refresher.

Me: Ok, let's move on. The module in itself, do you feel like there's a structure to the module, do you know where it's heading?

A: I think more so than anything else, because you know what you are learning and it's all online in front of you. You know what your potentially going to have to use and it's not a bit like "ooh, if you go on a divergent here" which some of the other lecturers might do for another subject.

L: It's definitely more structured I think because with the tickables, you know what it is each week what you've got to do and how it's going to be useful, whereas with the other modules you kind of have to do your own revision at home because you're not set any compulsory things, you've just got to kind of work it out yourself.

I: I wanna say you know exactly where it is going, but you don't feel lost because even if he goes off on a tangent and stuff, everything that you learn, everything is necessary and you know that all the codey parts are what you have to know and the other stuff is what you don't need to know.

O: I think it's because it is like a language, it's like Spanish or French so you know that once your learn something, you know what it means so that when you're asked to do it again, you can use what you've learnt.

I: And you know you need everything, like everything you've learnt in Spanish, you need to remember, like everything you learn in Python, you need to remember.

Me: Ok, so leading on from that idea, do you feel like you know what will be in your class test coming up? Do you know how to prepare for it?

(All said no)

A: But to some extent, I think that's going to be the same with all of them because they can write anything that we've been taught, they could essentially just skip something out this week and include something from next week, but it's just like with A-Level, not everything was going to come up so same here, we won't really know what's going to come up.

C: If you do all of the tickables and the rest of the questions, they are only going to test you on that kind of thing so as it's open book, I would have said I am just going to make sure I'm familiar with all of the tickables I've done each week and I'll be fine.

Me: If you took the class test now, based on everything you've learnt during the last couple of weeks, do you feel like you'd be prepared for it?

(All said no)

Me: How would you prepare for it?

I: I think maybe people could be set more exercises to do to be able to test their own knowledge, like "make a function that does this" and then use all of the little bits that they need, you know, they don't necessarily have to study each thing individually, but they can just bring everything altogether.

A: That's true, because we are only tested on one thing per thing, so it is important that we just understand each section, but then there are loads of examples so it's important that we know these so we can apply these to other question if we're asked to do something else. Our minds might not think "oh let's just do what we did here" because that was such a specific example, and we might not make the click that they're two similar examples because they're worded slightly differently.

J: I think that it would be helpful if there were exercises where they could combine different things that they've learnt and also something to actually help their algorithm writing because even if they learn the syntax of Python, how everything works, they still have to know how to write an algorithm, and we haven't really had that kind of practice.

A: I think that's coming up in like week 4 or week 5.

Me: So in terms of feedback/assessment type thing, the ideas of the tickables and the feedback your receive from this, do you find that useful? Thinking as well about your other modules perhaps and what you get from them?

E: I think it's better than the other lectures.

J: Yeah.

P: I think I actually prefer having the structure and knowing what we're doing and just being able to get on with it whereas the other lectures feel a lot more vague about what exactly we need to be doing.

(General agreement)

R: The other modules haven't given any homework or taken any work in at the moment so we haven't actually received any feedback from the other modules yet.

Me: Ok, so maybe think about this module in particular, do you feel like you're getting a good amount of feedback or any..?

Q: I think we're getting it a lot better.

B: I just go there to get all of my tickables ticked and then I'm just sat there doing nothing. We don't get any feedback, they're just like "yep that's good".

Me: So when you get your tickables, do they literally just look and tick it or do they give feedback on what you've done?

C: They ask you a question on the topic so like when we did the dictionary one, they said "well what actually is a dictionary" and then they go yeah that's fine, carry on. And if you don't know they say "ooh ok, make sure you look into that". But as long as your code is there, sometimes they don't even ask you to run your code to make sure it works properly, they just say "oh yeah it's there".

H: I've got Jason for mine and he's quite good at asking you questions to make sure you understand it so I find that really helpful.

G: I think as well if you didn't get a tickable, you get more feedback, so if you get the tickable, that's fine, but otherwise you might get more feedback if you didn't understand it.

M: I think one of the problems is that you don't know how much time each tickable should take because the up and coming class test is fifty minutes and I don't know whether I'm going to be able to sort of do all of the tickables fast enough for the class test questions quick enough to be able to get it all done within the fifty minutes.

F: With the tickables, I found the feedback quite good if you've got the initiative to say "why does this happen", "why is it like this", "why is it wrong if I put this in"...

L: I feel that if I said that I would get told "ok you don't understand that, you're not getting your tick"

F: That's why you ask, because you want to understand it.

L: But then you don't get the tick.

A: But then you don't actually have to get the question correct to get the tickable, as long as you've shown you've put effort in, even if you've done it 100 times, and each time you got it wrong, you will still get the tickable and if your tutor doesn't give you the tickable, you say "Vince says, as long as you put the effort in, you get the tick" so even if you get it wrong 100 times, you get the tickable.

M: That's the advantage of the two tutorials, if you go at the start of the first one and they don't give you a tick, you then go and have to improve it and then get it sorted out.

Me: So are the solutions online for the tickables?

(Most respond simultaneously: Only the week after)

K: You have to do them first and then get them ticked off, before you see the solutions.

J: I think the teachers here just assume that every student is going to cheat and not bother, but we're all here to learn really so they don't trust us and its like they think we're just going to copy and paste them but most of us actually want to do it ourselves, and use trial and error to try and find a solution.

D: I dunno I still want to get it right but I'm still not really interested in knowing everything that's in the course in detail.

P: I think there is a temptation with Computing in general that if the solutions are given before, you could just put the code in and not want to understand what it means because the code will still work, but you wouldn't necessarily understand it.

A: I think tickable 9 this week was really useful in going through and annotating what you've done. I'm just saying that was very useful for me, because I didn't realise really what I was doing until I'd done tickable 9 this week.

Me: So the solutions that are put online, are they useful? Do you tend to use them?

R: I haven't looked at them yet.

(Most agree and say no)

M: I don't tend to look at them because in the lecture, he goes over problems and solves them anyway so when I've gone to the lecture, I then feel happy, but if I had to do a problem that hadn't been covered in the lecture, I would then have to look at the solutions.

A: It's a nice thing to have, even though most of us may not have looked at them, it's still nice to have them.

Me: Ok, just a couple more questions, if you could design the university's teaching system completely, what would be your ideal structure?

A: For Computing only or for all modules?

Me: For all modules.

I: I think there should be normal lectures like we do in most modules where the lecturer talks in front of everyone and then the labs would be rather than just doing questions and then that be it, have a more classroom environment in the tutorials if you were being taught more directly and stuff.

J: Yeah I agree because I feel like tutorials are such a great time to get a whole class together but I don't think they're being used as well as they could be used.

B: Yeah I think the same, so having a lecture and then having a classroom type environment in the tutorials.

C: Yeah, I think the same, because I think in tutorials if you want help, you'll be sat there for ages waiting because they'll only be one person going around helping everyone individually whereas if they sort of like spaced everyone out into the classes, they would get a lot of people helped at once rather than waiting to be seen and just end up sat there because you can't hear what the tutor is saying to someone else with the same problem across the room. In the lectures, it would be nice to have a heads up about the next week and maybe go through the tickables on the board or something, like actually going through things, rather than if you're stuck, then going through things. Because I like to solidify things: sometimes, if I know it, I like to go through something anyway to make sure I 100 percent know it.

D: Yeah, I definitely prefer I sort of classroom style environment, so like someone stood at the front and going through everything.

E: Yeah the same, and having two lectures a week, one going over last week and one going over next week as a kind of preliminary thing.

M: I would rather that they actually go through the questions, rather than just you've done them, just to confirm that you are doing it right.

F: Yeah I think there should be more of a sort of step-by-step going through the questions working out what you need to do, and what you've done wrong and what you can go and improve on for the next time.

G: Yeah and in tutorials they sometimes say like "right this group do this question" and "this group do this question" but then you miss out on sort of hearing the solution to the other questions so it's like "I can do this one" so I have no idea what to do for the rest of it, so it doesn't help as much so if you had a whole class say doing all of the questions together it would mean that we would just get everything done and so we could say "yeah I understand all of it, not just this one specific part of the questions". For Computing, I think the tutorials are quite good at the moment, I just think you don't feel like, because there's one person going around and everyone's sitting in silence, you just kind of thin "oh I'd better keep to myself and I'll just watch the videos, and try to figure it out myself" and not try and ask other people for help because it's just sort of everyone else sitting in silence typing and I don't feel like I can talk to anyone about it.

H: I'm not sure how clear it is really what tutorials are actually for because on the one hand we're being told just turn up and get your ticks, that's what they're for and you work outside, but then

today, it was quite clear that we have to go and we weren't supposed to miss our classes so we weren't really sure what we're meant to do in those things so a bit of clarity there would be useful.

K: I think it's more important that they put more emphasis on the lab sessions because that's when you get your one-on-one time if you need help or if your tickables aren't done or if you ask for help so I think it's better that the lab sessions are more organised and then better.

L: I think that perhaps at the start of the tutorials the tutors should perhaps find out if there's a question that's causing a lot of people to have problems, and then perhaps do that question on the board, rather than trying to go through all the tickables.

N: I think I'm mostly happy with Computing at least, but I think the other modules need more tutorials, I think one a fortnight is not enough.

A: I think having a good balance of time on being told how to do things, having time to do them and then having someone give you feedback whilst you're trying them and then having time to look back on problems that everyone found difficult so you can kind of learn from the mistakes that you made. O: I find it depends a lot on the tutor and the person in the lab session because like I said, Jason is really helpful, he's not just "I'll give you a tick", he's also checking you understand it and if you don't understand it, you can then ask him. And another tutorial guy was really good, he was basically repeating what was said in the lecture, but it was just like, hearing it twice, hearing it from another person's point of view, juts solidified it in my memory.

P: I like the lab sessions where it's a bit more one-on-one but if you could talk as well rather than classrooms, because in the classrooms it feels like you get asked questions and then one or two people answer all of the questions, and I don't know whether other people understand it because I've had one classroom session where I just didn't get it and everyone else was talking so you don't get the chance to learn.

Q: Yeah I just want more tutorials for like other modules, not Computing, I'm happy with Computing, just more for the other ones.

R: Yeah I agree, I just think there's just not enough of the other tutorials that once a fortnight just isn't frequent enough and we are only focussing on one question and another group are focussing on another question and then we don't sometimes hear all the solutions. I think the tutorials also need to be sort of more lessons and the lessons should sort of be a heads up of what we are actually going to be doing. It is good to know the content so we have a heads up of what we could actually be asked in the test/exam.

Me: In general, could you now put your hand up if you prefer this flipped classroom style approach to the way your other modules are taught.

11 in favour; 3 not in favour; the rest unsure.

Me: Ok, finally does anyone else have anything to add?

P: I like the way you do the flipped classroom style for Computing but I don't think it would work as well for the others. Because Computing is very hands on you need to write the code yourself, whereas with other subjects, I need the content explained so that I can then experiment with it with trial and error.

O: I think Computing is just completely new to a lot of us and so more one-on-one time in Computing is really useful because a lot of us just don't know or understand it, whereas the other things we might be able to just work it out.

Me: So maybe only for this module then, you prefer this style of learning but not for the other ones?

(All = yes)

Me: So the other ones kind of stick to how they are?

L: Yes but I wish they were a bit more structured because I think what I like about Computing is that it is structured and you kind of know what you're doing and the others are kind of like quite vague, we

don't really know what we're doing. There are also a lot resources for Computing that are really helpful but not as much for everything else.

J: Yeah, for others there aren't many online resources, so if you miss a lecture, you have to find people to give you the lecture notes.

Me: So the fact that you don't get lecture notes in this module, how do you find that?

C: It doesn't matter as much because there are tonnes of stuff online and he goes over all of the stuff we have already done so if you are going to write any notes, it's only a few side notes so there would be no point.

Me: So lecture notes aren't necessary for computing then?

(All = no)

Me: Has anyone else got anything else to add?

J: I think he should put more hints in the worksheets that he gives us, maybe just a hints section.

M: Yes, something like for all of the tickables.

I: Yeah, just so you can get a small hint of where to look, not exactly what it is, but some sort of direction to go in.

A.2 Focus Group 2 with the Students

04/12/2014

7 students attended.

Me: Hello everyone, thank you for coming along. So, I'm going to just go through the questions and I'd like you all to answer as much as possible. If you don't disagree with someone then, please, voice your opinion because it shows all of the different views we have on the module. No names will be referred to when I write up this focus group so please feel free to say what you like, it will not be referred back to you.

So, first of all, was the class test how you expected it to be?

A: Yes.

B: Pretty much, yes.

(A couple of other people agreed although they did not seem absolutely convinced.)

C: He did tell us over and over again the structure, so we knew what..

B: We knew question three was going to be really hard.

D: And you knew that question one was going to be copy and paste. He couldn't stress that enough. Every lecture he was like "it's a copy and paste question!". So yeah, you knew what to expect.

Me: Ok, so was it easier or harder than you expected?

A: I think easier than what I was expecting.

D: Yeah, so much easier, especially compared to last year.

E: Yeah question two was really easy, it went a lot smoother than I thought it would, I really didn't expect that.

C: Yeah, question two was easier than question one.

S: Yeah, I completed messed up question one but then question two I was like "ah, ok".

A: But yeah, basically a lot of people said it was a lot easier than last year, and the results clearly show it was a lot easier than last year.

Me: Did you think you'd done as well as you did?

B: I thought I did worse actually. A: Yeah I thought I did worse.

Me: So even though you thought it was easy, you thought you did worse?

A: Ah no, I didn't think it was easy. I just thought it was easier than I was expecting. It wasn't easy.

C: We thought it was going to be impossible, but it turned out to be just really hard.

(Everyone laughs.)

Me: Ok, so did you feel like when you were answering the questions in the class test that the answers came naturally to you or did you have to look up in your notes to try and find the answers type thing?

A: Yeah I had to look up..

D: Question two I think I had to look up.

E: Yeah, but bearing in mind question three I had to look up question three and I still didn't get it.

F: Yeah question three was actually online. I just googled how to do the perfect number and just copied and pasted.

C: It was totally allowed, it wasn't cheating, don't worry!

B: That was the point. You used the internet because it was provided for you.

Me: Did you just copy and paste it though?

F: I slightly changed mine to return false or true so then I did that, but the next part of the question was to create a list and I completely forgot to do that, so I only got 10 out of 30.

E: I just copied and pasted the code and then just changed a couple of things to match what the question was asking.

Me: Ok, so do you think the results in the class test were affected by how much work you did outside of lectures, like, in terms of pre-lab material?

A: Yes.

B: Well, I basically did no work and got 88 so..

D: Did you have any prior coding knowledge at all?

B: No.

E: But you did all your tickables.

B: Mostly.

D: Yeah but that's what she meant. If you did basically none of your tickables..

C: I you didn't do all your tickables you're going to do generally bad anyway.

F: Yeah I did all my tickables and have redone them all recently as well.

Me: So did you find having done the tickables would have helped you do well in the class test?

(Everyone shouts yes.)

F: Yeah you know where all the questions are.

C: Yeah, same nature. You know where to look specifically to find... so basically if you had a question in the class test, you know exactly where to find it in the notes as well. So yeah, I think it was fine.

Me: Ok, so did anyone just do the tickables?

(A couple of people said yes.)

Me: **Did you find you were ok in the class test just from doing the tickables?**

D: Yes.

Me: Ok, how about those who did more than just the tickables?

E: I think it helped more because one of the questions was just like one of the non-tickables.

C: Yeah, that was the hardest non-tickable as well so I'm glad it was just copy and paste.

D: Yeah I hadn't actually looked at the question we had to do the first time but I knew where to look during the test because it had the same sort of structure.

Me: Ok. Do you feel like your class test result was affected by your attendance and/or your contribution in lectures?

F: No.

(A couple of other people said no.)

Me: In what way?

E: It kind of depended more on labs.

A: I never went to the labs so..

G: It's just the fact he went over a lot of the things that people did wrong, so that was helpful but ..

C: Yeah he can be helpful..

G: But not as much as the labs.

B: Solutions are online anyway so I genuinely think I could have done exactly the same in the class test without having gone to a single lecture.

A: I don't know, sometimes he does go through a specific thing which is good to see on the board.

D: I think it's about 10% helpful compared to actually doing it on your own.

B: It's basically like, if you had the issue and he went over that issue in the lecture, then that probably helped you a lot.

C: But if you'd figured it out beforehand on the internet, then that lecture wouldn't have been helpful. Also, in terms of contribution, no one really contributed.

Me: Ok, so do you still go to lectures then?

A: Yes

(A few other people agreed.)

G: Yes, I still go to lectures. It's right after another one so I might as well!

Me: So, how can lectures be improved then?

C: I dunno..

G: I think they're just good because we do so much of it at home and get so much of it at home so it's just like he gives you that extra little bit to fill in the gaps.

A: I think it's the fact that working alone is so good. It's not the fact that the lectures aren't good, is just the fact that the tickables are really good.

D: Yeah, the content of the course is all very personalised. You can't really do that in a lecture. I think the reason that I ... it's not that the lectures are bad, it's just that there are so many online resources that the online resources outweigh the level of the lectures.

E: It's kind of like you don't need lectures unless you're struggling, in which he helps you on that.

D: Yes, that's what I'm trying to say.

F: I would find lectures more useful if... because sometimes I go to the first lab and I'll struggle with something and not get it finished and then I'll deal with it in the second lab and the time in between is when I really want to care and learn things, because by the time of the second lab, I've figured it out in the second lab by the help of the tutors as well, if that makes sense, and so by the time I get to the lecture, all the things I've struggled with, I now understand, so it's not so useful to me then. Unless I actually haven't done the tick, which hasn't happened yet, then it's not useful to me, because he's going over things that I've now come to grips with, so it's teaching me something I already know.

B: To be honest, I've been in lectures where I haven't done the tickables, and the lectures aren't helpful at all. When I've done and tried a tickable, then those lectures are so helpful actually, but when you haven't, they're just really not.

A: So he should definitely keep the lecture after the... um...

D: It's a lot of extra information as well actually, because he may go over a different or better way of doing something. "Look at this, look at that, this is going to help you..."

E: When he shows you a certain way of how to do something, it's quite interesting to see you can do it a different way and you're still right.

D: Exactly. Every now and then he'll show a new piece of code, so he'll show a new function or something and then he'll say "go and check this out because this could help you in the future". So it's actually quite a bit of extra useful information he'll give you, after he's given you the help. So even if you don't need the help, sometimes there's things that make it worth going and sometimes... you know, one person didn't do the class test because he didn't know it was on because he didn't attend lectures. So, information does get distributed through lectures that everyone needs to know.

B: You'd think he would have overheard it!

A: Yeah, didn't they say in the tutorials as well?

C: Yeah, and it's on the website.

D: So yeah, I don't know how that happened!

Me: Ok, let's carry on. Do you think you've had enough support throughout the module to allow you to learn the content to your standards?

G: I think it's just the fact that you have been told to figure it out yourself because there's the online worksheets and stuff but you've got the labs and stuff as well to ask questions.

A: There's a lot of access to help.

C: Yeah I think if you want help...

D: Yeah, every Monday I see him and at first, when I was really struggling with code, it helped significantly, and now we're just doing the coursework and everything like that, it's just helping with codes and everything significant like that as it shows me just better ways of doing things. So there is always, even just for ways to improve your code, not necessarily asking something I don't understand, there's always help for everything you need from sorting out a code, and making it better, to actually trying to understand something. So, even though it's not lecture-based or anything, I just know there's always a lot of help for it .

Me: So right at the start, to those of you who came to the first focus group, you said that you wanted more support, you didn't like the fact it's so independent. Have your views changed on that?

G: Once you've learnt how to figure something out, then there's less of need to someone like help you out.

F: Now we know kind of like the basics of writing code, we are more like, ooh I could try this, whereas when we first started, we were like "I have no idea what we're doing" but now I just know how to do it suddenly.

Me: So do you feel like the more you've done this module, you feel better with the whole independence type thing.

A: It's getting harder as it goes, but then you know more stuff, so it kind of counterbalances that. You know, you just kind of carry on going through.

Me: Ok. Do you tend to ask for help much, or do you tend to work out a lot of things on your own?

C: I think, last resort I ask for help. I won't even ask the tutors unless I'm like half way through the second lab and I have a lot to do.

A: It's quite rewarding though if you do keep going and trying or something and then you do eventually get sorted. It's quite nice to think like "I've sorted that out myself". I haven't had to ask for help with it. So you do try quite hard to fix it yourself.

E: Yeah, and you do probably learn a lot better because you really understand why something happened.

B: The only time I've had to ask Sir is when I had like 10000 iterations and I wanted to optimise it and I couldn't really give google my code and ask google how to optimise it and so that's when I asked for help.

D: I've got a question to ask as well. Did you guys feel you were asking Sir more questions before the class test or the same afterwards, because I think I asked a lot more to the tutorial people before the class test because knowing there was a class test coming up, I wanted to know if I was correct or not, and now after it, there's no more test and now we're all just doing coursework, so I feel asking questions is a bit better. I kind of feel a bit more relaxed asking questions because now I know it's not about whether I'll pass or fail or not because it's just coursework.

C: I understand what you're saying, but I'm not feeling that personally. Like, it's completely sensible what you're saying. I think it's just my personal learning style to be honest.

Me: Ok, have your attitudes towards programming changed since the start of this module?

D: Yes.

E: Yes, definitely.

Me: In what way?

A: More positive.

B: At the beginning, he said that every mathematician should program because everything in Maths is program-based and I think everyone gets that now, especially as we're all now naturally thinking about our projects as programmers.

Me: Ok, how about everyone else?

E: I think, before I started this course, I felt that Programming was just this strange thing, that I would never try and I thought that it's for really, really incredibly, super geniuses and they're all like amazing, and I'm never going to do that, but now like I've done this course, I feel like I can go on and do more with it, and I feel like I could learn different coding because it's just all logical and it's not as impossible as it once seemed.

Me: Ok, great. What have your learnt about yourself in terms of how you learn best through experiencing this style of module delivery?

G: I think I've learnt that I learn best through bashing out the problem, the leaving it, then asking other people, then bashing it out again, and then asking things. So I've learnt like, my method of solving problems, which is quite useful in Maths.

Me: So has that changed to how you solved problems before?

G: I don't think it's changed, I just think I have a better understanding of it than before, because I've never had to do such independent work before.

Me: Ok, let's go round the group and see what everyone thinks.

A: Well, it's been a good way of teaching coding I think, it wouldn't have worked so well with other topics I don't think, but yeah, it's a good way of learning Computing I think. Umm, yeah I think I responded well to this method.

Me: So like, in terms of how you learn best, do you feel like you've learnt more through this style and you'd like to use this style again?

A: I'd be open to using a similar style of learning again, yeah, if it came up. I think it would depend on the topic though, for me, because I think this worked quite well for Computing, but I think for analysis or something it wouldn't work quite as well.

Me: Ok, how about you (directed at person B), how about how you learn best?

B: I think I learn quite well from just being given stuff and then asking how it works. Like, sometimes when people are lecturing you, you kind of daydream and drift off a bit, but when I get given questions, I think "right, I need to work out how to do this" and so as long as I've got people to ask, I'm fine and so I think that's why I like computing, because I can just ask people.

C: Umm, yeah about the same. If I've got people I can ask, then I'm fine.

D: I've realised that I'm able to learn without having to ask a lecturer or even other people because I know I am now able to just piece things together, I don't need someone to give me a strict script on exactly what we're learning and how we're learning it and yeah.

E: I've learnt that it does sometimes take a while to get an answer, and for Computing it's quite fun to do that, because it's trial and error and so you know when you're wrong and you know when you're right, so I don't think you could do it for other modules really, because you won't always know if you get the right answer or not, because for other modules you don't get solutions, so you've just kind of got to hope for the best.

F: I don't think it would work with many other subjects but it's also good like if you figure something out and you've got your code working and then someone says "ooh how did you do that?" and then you have to explain how you did it to them whereas with something else, they'd just ask the lecturer or something, whereas in this module, you can say "well I did it like this, so this is how I did it" and so that helps to sort of increase your understanding because you have to explain it to someone else, whereas if you just did it, you might not register how you're doing it, so you have to explain it to someone else and that kind of helps them learn, and you at the same time. So, yeah, I think it works well.

G: Yeah, similar to that, you understand straight away whether you understand something, because someone will come up to you and say "oh how do you do that" and you even go "oh you do it like this, this and this" or you go "um, I don't really know" so you can work back through it together. But yeah, it's quite easy to copy and paste and change little bits and then you get a different error message and so you know which bit you then have to change, so it's quite a nice way to learn as you progress through it slowly, and eventually you get more and more right until you get the correct answer and then feel pretty good.

A: Oh, I also like the pressure of it. Because in other modules, they may give you exercises to do, but most of the time you won't do it, because for instance, in calculus, for every single lecture, he will give you some questions at the end for you to go home and do, but they're not assessed so if I'm bored, I'll have a look at them, but most of the other times I've got something else to do, so I won't bother with them, so I don't look at them, whereas with this, if you don't do the tickables, you're going to lose 15%, and if you don't do them you're not going to be able to do the exam or coursework, so it's the pressure of you being regularly assessed, and so it's almost like, for calculus we're being assessed on every single question we're being given, whereas for this, because you had to look at everything, you don't really have an option not to, then you're going to have to learn, and I quite like that because that's forcing me to do it, and therefore I'm more or less forcing myself to learn it, so yeah.

Me: Ok, great, so what do you think you're going to take away from this module afterwards? Do you think you'll remember this module in a couple of years time, and if you do, what do you think you'll remember from it?

D: I think because I write my coursework on Word, I'm really excited to now write my coursework on LaTeX so I think that will be really useful to take away with me, knowing how to use that.

C: I think just remembering what you can do with programming, and knowing what you're capable of doing with it.

B: And I think like if you're ever writing a formal report like, in year three and they ask you to do a presentation and all that, LaTeX is quite a good way to write it all for me, so it's another way of doing things.

G: I think it's also a little bit of fun in some sense, because that's what's coding is mostly for, it's about thinking about how you can do this in real life, and especially with doing our projects next term, it's about using coding in a fun way. So it seems like it could be good fun in the future as well as being used for work.

A: I've used it to help me win a few games on Steam. So that's quite fun because I've been able to modify a few games.

Me: Ok, so now you've almost got to the end of this first semester, looking back on what you've done throughout this first term, would you change anything, if you got given the chance to do it all again?

B: I think I'd start the tickables earlier on in the week. That would be something I'd do more often, because it's quite stressful if you get to something like Monday night and realise it's a hard week and you kind of think "great" (sarcastically).

D: I know that when the tutorials are is just a timetabling issue, but having a lab session at the beginning, and one at the end with the lecture in the middle somewhere, but I know it's very much a timing issue, what Vince got given is literally what he had to stick with. If he could somehow book in advance though, I don't know how you do that, but one at the beginning, one at the end, without them both being a day after each other would be better.

C: Those rooms are always free.

D: By all means, but having the lecture half way through where he could go over things the people are really struggling with.

C: I get that but I don't know why you can't book a computer room because every time I go past those rooms, no one is in there.

A: Yes, but it may not be the tutors are free.

C: Ah yeah, true.

G: I think the issue is, like I know some of us have labs Monday, Tuesday and, as I was saying earlier, if I have an issue Monday, I have to finish it by Tuesday, and then I've already solved it by the lecture on Thursday, so..

D: So it would actually give the lecture more purpose to some extent, having it in the middle of the two lab sessions.

C: But we know that's not quite plausible, it's not the easiest thing.

Me: Ok, anything else to add on that one? (Silence.) Ok, one last question, for those who are doing the same module next year, in the same way, if you can give some advice to them, what would you say?

D: Don't be scared. I was terrified starting it, absolutely terrified. I regret kind of not starting off enthusiastic about it, because I started off very pessimistic about it so I'd just say enjoy it, because it's actually really good, and a lot easier than you'd think.

C: I'd recommend that if they find a function online or whatever and they use it for one thing, don't be shy to check it out and see what else is on that webpage in case they find something else that might be useful and they can use that later on. Also, be curious about it, so if they're not sure whether a function would work for 0 or 1 for example, they should just try it out and figure stuff out.

Me: Is there anything Vince can kind of say at the beginning, or any information that you could have been given at the beginning to try and help you through it kind of thing?

E: Try and do the tickables that aren't actually tickables. You only have a certain few out of the massive list, so try and do the unassessed ones as well, because most of the time they show you things that may be useful later on, or it will just give you extra knowledge that you can use later on, whereas if you just do the bare minimum, you'll probably miss something that will make it easier.

C: He could draw like a list of functions on the board that they may find useful which may kind of interest people who do Maths so kind of finding out whether a number is prime or finding factors or factorials or anything, just so like we see a real life application straight away that we may need to do know in the future, to give us a bit of encouragement to show it's worthwhile.

A: You know: "this is fun, you can do this!"

E: Maybe also reassure people that you don't actually need a computing knowledge background to start because I think hearing like "I'll never be able to do any of that", it will just reassure them that they don't need any programming knowledge to do well.

G: Yeah, maybe try and like say that some of the second years have said they found it difficult to start with but then they found it a lot better. From a lot of people I've spoken to, they struggled at the start too. If he says something like that, it may help them because from their perspective at the start, it's probably going to be quite scary.

D: It would be good if you actually got a second year like that to say it in person, that would have made me so happy.

A: I think maybe he should encourage people to do the project Euler that we did in Coding club because I think that would really grab people's interests.

D: Yeah, there's some really fun projects to do on their as well. A: And it's all Python.

Me: So, anymore to add about the module as a whole or the delivery?

D: Now I've come to the end of it, at first I was kind of very disarrayed about it but now I'm actually quite happy about how it's all gone, and there's very little things I would have probably changed, if any at all.

Me: If you got chance to take another Programming module in the future, would you do it?

(Everyone either said yes or definitely yes.)

Me: Ok thank you all for coming, I really appreciate your feedback.

Focus Group 1 with the undergraduate tutors

13/11/2014

9 tutors attended.

Me: Thank you for attending this focus group. I am just going to ask you a few questions about the Computing module as it stands and try to get some of your opinions on how you think the module is going. Please speak as much as possible, and if you don't agree with anyone, have a debate because that will be really interesting to hear.

So my first question is just a general one so are you guys enjoying your roles as undergrad tutors?

(8 people said yes)

E: Generally, yes.

Me: Generally? What's good about it, what's bad about it?

E: You get paid

(Everyone laughs)

G: I think it builds on obviously what we did last year and it helps us to go over what we did last year and it reinforces what we already know.

H: Yeah it encourages us to refresh it really.

(Several yes's around the room)

I: Some of us who are hoping to do placement years are looking at writing up CVs at the moment and saying that the University hires you/ putting a professional company on your CV looks really good.

(A few yes's around the room)

I: So I guess it helps us to develop decent skills as well.

Me: Ok, cool. So your roles: do you feel you're well informed as to what your role actually is?

C: Yeah.

Me: So can you describe to me what your role is?

C: It would be just to go over/well, they do everything before the sessions and they just bring it to the sessions and we go over what they've done. They give us marking sheets as well and we just go over and check that theirs is the same as that.

I: So probably our role would be to go over and check all of the tickable questions and to give advice or guidance, not exactly the answers, but a nudge in the right direction if they're struggling on any of the tickables or other other questions.

Me: Ok, so a student will come to you in your tutorials, if they didn't understand something, what would you say?

G: We could encourage them to discuss the answers with each other, so if somebody else has the answer, like or knows how to do it, or is going in the right direction, we kind of encourage discussion between each other in the groups because our kind of flipped classroom thing of everyone kind of going about it and if there's a general consensus of not many people understanding one area, that's when we can then say to Vince "ah well not many people understand this area" and he can then go over that in the lecture, and it works well that way. You know, having the opportunity to all discuss it together as a group, which is of course difficult at the beginning when they do not all know each other, but now it's much easier.

H: Another thing we tend to do is point them towards the week's sheet and make sure they've read everything thoroughly and make sure they go through all of the video hints and everything.

D: Some people just try and do the tickable questions because that's the least amount they have to do, and if they can't understand one of the tickable questions, what I'd usually say is "have you considered this" or "have you looked at this question" where this question's tickable may give them a bit more of a guidance towards how to get the tickable question they are asking about.

Me: Ok, so if they don't get something and you turn them away and say work a bit harder, if they still don't understand it, do you ever give the answer?

D: Vince said that if you can see they're trying on it for the whole hour and they can't get anywhere but they've tried and stuff, then given them a tick and stuff and then that's when you tell Vince that's the thing they're struggling with the most.

H: I find that what I'd do is tell them what they need to google. If I know like how the code needs to be written and they just haven't used the right function or whatever, I just say "go and look into this and then see if you can get that working". Often they like go and look at docs, like python documentation, and they don't understand what it's saying but you can talk them through that and then they can write it themselves.

I: The only time that I would give an answer to them and say that "this is the correct answer" is when they are 99% of the way there, it's just a comma that's in the wrong place or the wrong type of bracket they've used or something.

E: I think something that I sometimes do, and this might not be what you're supposed to do but if they really have no clue but you think one small kind of thing might help them sort of get on the right tracks, then I might write on the board, like the very beginning of it, give them a clue and say "well, why don't you think about this?", and you'll just write something on the board and say, kind of, "try something along those lines".

Me: Ok, how about you guys? (Directing the question at the two participants who had not yet spoken)

B: Roughly the same.

A: Yeah

Me: So, in terms of your roles as tutors, everyone gives slightly more information than others, some people give the answers straight away perhaps, some people make them try other things for a bit longer, what do you think Vince and Jason could do a bit differently next time to help you prepare for your roles?

(Long pause whilst they're all thinking)

I: Possibly to, if before we'd started tutoring, if he had given us a basic Python question that we may or may not have known, something that we would have struggled on and put us in the students' position, and said here's a question that I'd like you to answer, try, and let's say you're struggling here and he would like, I dunno, demo to us the way in which we should react to us asking him a question. So maybe if he did a little, like a role play of a student and a tutor and then went through exactly how he would like us to answer, and how much he would like us to give away or key words he would like us to use, like have you considered this, or try looking at this. So if he actually showed us "this is how we would like you to respond to a student query", beforehand, that may have given us a little more to work on when we actually came to doing that, but because he didn't , we've all kind of developed our own teaching styles, like you mentioned.

Me: How much do you prepare before you have your tutorials? Do you find like you just turn up, or do you look over the lab sheets and stuff beforehand?

(General murmur of yes's)

G: Usually, because my tutorial in the week isn't the first one, there is usually someone before me, I ask the tutor before me, you know, what the students struggled with and what particular thing that group didn't really understand, so I could be like "ah ok, I can focus on that for my tutorial" and make sure I have that in my head to kind of target the next group I'm dealing with, because it's kind of nice to know, where the areas are that people are struggling with. Obviously, we did it last year and are kind of going through going "ah that's that, OK I remember that" and then when you know that this is what people are going to be asking you about, that's quite good.

Me: Just a side note, if you had observations by Vince or Jason say to make sure you're sort of doing what you're meant to be doing type thing in your roles, how Vince kind of imagined the role to be like, would that put you off?

G: Personally, no.

I: I wouldn't even notice.

H: They did it to start with and they just kind of floated around and came in but you don't really.

I: Yeah, he did that to me once, and at the end of the tutorial he said "it was very quiet in here, I want more noise, so next time try encouraging students to talk to each other" and so he sort of observed what I was doing and gave me some feedback then to improve on, but no, I didn't mind that at all.

F: I don't think you'd notice anyway.

E: Yeah he tends to float around anyway. Him and Jason are just kind of there, all the time.

G: The really tough questions, like one week there were questions four and seven which they said the students didn't understand in the tutorials before and so had a float around so that they could kind of help when you hit a brick wall as well, so that's fine.

Me: Has anyone tutored before?

(Some murmurs)

G: I've tutored Maths before.

Me: How does tutoring in this way, like this style, compare to when you've tutored before?

G: I think it's a different approach and I think it's good for us as tutors because it is solely us teaching them, it is the flipped classroom in that we're working with them during the week and then they go to the lecture so Vince can sum up what they've done and then that works really well for us and them. When I was doing Maths before it's totally different because you're kind of conveying information by yourself and there's no sort of/ it's a more sort of personal thing, but the way we do it here works really well I think for us and for them.

Me: OK, anyone else have anything else to add?

F: With this, they can learn their own ways of doing things, whereas when you're tutoring, you end up giving your way of doing something which can be different to the teacher's or someone else's. So this is a lot better because they can learn it themselves.

I: I mean, anyone could check ticks, you know, compare their answers to the model answer, if they've got the right answer they can put tick in the box, but the only time it really tests us as tutors is when the students come to us and say "I'm struggling with this" so if you compare a student here, in this example, who the only questions they are going to be asking about are about the things they are struggling on and the things they have tried to think about before, whereas before when I have tutored, it has not been like that, you've had to teach them things they may understand instantly or they may not have that problem, and so because all of the students here are only asking you questions about stuff that they don't understand, it's good for us because it helps us to develop communication skills and we need to take complex ideas and we need to break them down and deliver them to that student in a way that they can understand, so, it's kind of difficult to understand, but all of the queries we get here are the things they don't get, whereas before in tutoring, they may ask questions about things they just are unsure on and then one answer just cleared all that up. So it's a lot harder to answer questions in this environment than it was when I've tutored before.

F: On the contrary, I would say that a lot of the difficulty in a way is taken out because Vince has spent a lot of time trying to write the lab sheets, so a lot of the information which we would otherwise have to do is contained within those lab sheets which we have.

Me: Ok, so do you feel like you're gaining anything as tutors?

C: Experience.

H: Yeah, it is good experience, and going back to the placements, one of the things we were talking about was maybe communicating Maths with non-technical audience members, and I think this is quite good for that because they're not, sort of, as into it as you, so it is explaining it to people in ways that people understand.

E: A lot of the stuff I've had to explain, has been not because they don't understand the code side of it, but it's because they don't understand the Maths side of it. So if they're asked to code an iterative and recursive method for giving a certain sequence say, they'd struggle because the students wouldn't know what these would mean. So I'd then have to explain this to them and then the coding would be a whole lot simpler. So yeah I agree with you on that one, it's good for explaining Maths ideas for people who don't understand it.

Me: Do you think it's been useful the fact that you did the module last year?

G: Yeah.

I: Certainly.

D: Yeah, definitely.

(A few other yes's)

H: Yeah I feel like it was kind of a useful thing to have because we've gone through it and have had that experience of doing exactly what the students needed to do and knowing exactly what we wanted from the tutors last year. It means that it's a nice environment to work in. They know you've done it too which is quite nice.

F: Even if it's just a psychological thing, you know that you've conquered this before, so you know, you have the confidence to be able to throw yourself into it.

Me: OK, so you had the flipped classroom approach last year, yeah? Is it different to when you did it last year or is it ..?

(A few yes's murmured)

G: Yeah I think it's the same.

B: Yeah, we are just able to look at both sides of the coin now essentially. From having done it last year and now you're essentially teaching it.

Me: Did you find this style useful?

B: In this way, for Computing, because the only way you can learn Programming is to essentially do it.

G: We've had a lecturer try to do it for a different module, which didn't work nearly as well, because it was, in principle, they said "look at the notes before the lecture", come to the lecture, and then ask me questions, which was difficult to do because you weren't ever/ well for the Computing module you have actual slots where you were timetabled to go into rooms with a specific amount of people and weren't nervous about asking questions because, you know you can just bounce questions off of each other, and you can speak to the tutors through those smaller sessions, and then in the lectures you can go over the things lots of people don't understand, whereas in this other particular module we were doing, it wasn't going to plan because you didn't have that pre-lecture meet-up of small groups that was timetabled, so no-one was kind of doing the pre-requisite bit, whereas because you've got the timetabled bits, it works really well for the lectures [in Computing].

Me: What's your relationship with the students like?

(General murmurs of "pretty good")

A: I think, because we're not staff, it is easier to be friendly with them, whereas if we were staff, there would be more of a kind of teacher-student atmosphere, but being second years, we can be more friendly with them.

G: Mind you, last year, when we had tutorials and had actual, like, tutors and lecturers and people like that, it was still relaxed. I think it's probably more relaxed with us but ..

F: Maybe it's just Vince then because I certainly wasn't relaxed with him..

(Group laughs)

H: I think being the same age helps, like there's plenty of them in there that have done a gap year or something and they're older than me, so there's not really much difference.

G: The fact that they don't know what we've done and they don't know what Vince and Jason have done either helps as well type thing as well, and we have something to relate with them.

Me: Do you think it's better then the fact that you're near enough the same age, or do you think it would be better if the tutors were a bit older, for example?

I: I think, for this part of it, the lab sessions are better that we are the same age, and then when they go to the lecture with their questions and problems, it's better that there is an actual member of staff so there is a kind of distance there type thing.

E: It would be harder for me, for example, to say to a student "you are not doing enough work, compared to what you should be doing", you know, if Vince said something like that, there would be no problem but I would not feel as comfortable saying something like that in my position, because we're so close age-wise and course-wise as well.

Me: OK, so is it harder kind of to assert authority?

E: In a way, but there are no real problems, and there is no pressure on us to do that either.

G: Yeah, if people don't turn up, we're not made to say anything.

E: Yeah, it's not part of what we're supposed to do. If we do have problems, we go and speak to Vince or Jason and let them deal with it and we get on with the people who want to be helped.

Me: You said that Vince and Jason float in and out. Does the atmosphere of the room change when they come in?

(They all say no)

I: It usually gets a bit louder.

(Everyone laughs)

H: Yeah I think it's because Vince comes in and says "what are you doing? Have you done this? Go and try this. Speak to this person". So yeah, it usually gets a bit noisier, which is good obviously, but no, it's not awkward or weird or anything.

Me: The atmosphere in the room: is it dead silent or do people normally chat?

E: Now it's good, but at the beginning it was a real struggle because no-one really spoke to each other but then no-one knew each other. But now, it's every week it's "well, you know what I'm going to say, go and speak to her" and so what I found is that, certainly for our group, when we turn up, there's often a few of them already sat together and getting on with it. Whereas before, they were sat apart and we would have to tell them to sit together, but now they're just sitting down and working together as soon as they arrive.

(A couple of yes's around the room)

F: I think it helps in general, with just the whole university thing, it's part of that whole tutoring session, of all the tutorial sessions you have, the Computing are the ones where I felt like I really got to know people more because it's a lot more chatty based.

C: I would disagree with you on that, I would say, for me, because the tutorial sessions were just coming in, getting the ticks, and the leaving again, there was less of an environment to kind of be developing your skills.

F: I think I enjoyed chatting to people because I liked getting the ticks, but then chatting to people about what I'd done and the way they'd done it and how that worked, but that was just me being me.

Me: If people came straight to your labs and said "look I've done it" and you've given them all of the ticks, what would you say? Would you let them go straight away or. . . ?

I: I find they stay actually.

H: Yeah, stay and get on with the next worksheet.

(A few other yes's around the room)

Me: Is that the same for everyone?

(A few yes's around the room)

F: They used to just get the ticks and go but now they've realised. . .

I: I think some of them don't realise that they can leave.

(Everyone laughs, some agree)

I: I think some of them do just sit there and look over next week's lab sheet because they don't realise they are allowed to go, but I wouldn't tell them they can leave, because I think it's good that they stay around and try for the full hour.

G: If you said to them they could go, they would probably just go.

E: I usually say you can go if you want.

Me: So do yours tend to go when you say that then? (Directed at person E)

E: Well, some of them stay, some of them go.

B: I think it just depends student by student really.

C: Those who get them done in the first tutorial most often never turn up to the second tutorial of the week. But they won't leave at the one they're in.

Me: So has it changed then? Did you feel like at the start, a lot of people got the ticks done and then left but then now people stay, or has it kind of been the same?

(A few people say "the same")

Me: So they've just had their class tests, and you've had one week of tutorials during the class test, has anything changed?

H: They seemed to be quite negative about the class test, those I asked about. I asked them how it went and a lot of them weren't overly happy about how it went and how they'd done. I don't know if it was the same for everyone else...

E: There seemed to be a massive split. About half of them said "yeah it went really well" and the others said "no it went terribly". No one sort of said it was ok.

I: There was a lot of them who said they didn't like it. But a lot of that was to do with timing actually. I don't know about anyone else.

G: Yeah.

F: They just didn't have enough time to be able to attempt the three questions.

I: Yeah, well I felt like that to be honest when I took the test last year.

G: Yeah I found exactly the same last year as well.

Me: Ok, so when you lot did the test last year, you felt the same?

(Everyone said yes)

F: I did the first two questions well, but I just didn't have chance to look at the last one.

Me: Was that because you spent too long on the other questions or was that because they were just hard or..?

F: I just think there just wasn't enough time.

H: Yeah I think there's just a limit to how quickly you can solve the questions.

E: Especially as well, it was an open book test, so you do spend a lot of time going through stuff and looking up bits of code, which I think is great because that's exactly how you would write up code normally.

I: I think if there was a way to just give them extra time, I think just like an extra 15 minutes, so that they can have a proper attempt at the last question.

F: Certainly I don't know where you'd find that in everyday life, where you would be given a certain amount of time to write a piece of code, like in an hour or something especially.

Me: Ok, so do you feel like, since the class test, people have kind of become less motivated to want to do the rest, or?

G: I think the change is kind of the opposite, with some of them. Because they're like, well, quite a few of the ones I've seen, if they've done badly they have been like "well, why did I do so badly" and they're a bit confused because they are getting the ticks and so they are not going over the work more, and seem to be coming to the tutorials with more questions, than they did before the test.

D: I think the change is as well, when you first come into the module, you're not really keen on it because you feel it is all a bit abstract, but then when you change to sage and you're doing more mathematical things, it's all a little bit more mathsy, and quite a few people tend to understand it a bit more because they understand the Maths more, so I'd say the change into sage, changes some people's attitudes towards it, but yeah I'm not really sure if the class test really did much to kind of change people's attitudes towards their work.

I: Not really, no. I think it was just seen as an average test. They did it, they didn't really like it and they carried on.

Me: From when you guys did the class test, did you find it useful?

(A short pause)

G: Umm, I don't think I found it useful.

F: No.

H: I don't think I learned anything from it.

C: I found it useful in the sense that, to revise for it, I just went over the first five lab sheets, so it got me to relook at it and so remind me of what I'd forgot, but other than that, not really.

D: Depending on the result you got, you kind of looked over what you did, which is a bonus to anyone teaching anything.

G: I think, even though I wasn't a fan at the time, I think having it earlier is a good thing as well, because it takes the pressure of that away from Christmas and Summer exams.

H: Yeah, It's definitely the right time, just to refresh everything, and bring it all together, before we start the sage stuff.

I: It is brand new stuff for most people as most people haven't really coded before. So it's good to have that kind of early refresher, as you're learning brand new stuff.

Me: Ok, so if you could change the assessment for this module, how would you change it?

C: More time in the exam.

Me: So you would still have a test?

A: It's good because it'll let you know where you are in getting on with everything but you just need more time to be able to look over the questions, and do them and look up information on them and stuff like that.

B: Yeah, mainly change slightly what's on the test, so instead of like "write these three questions from scratch" you have one function that's given to you that's really broken, and so you have to go through and look at it, and make sure you understand what's going on so that then you can fix the bits that aren't working, because an awful lot of code is actually fixing stuff that doesn't work, rather than coming up with something new.

E: One of the things I was thinking about was, with the 12 week project, although it's a really nice idea and you do really nice things, I think it's quite easy to fall into the trap of that its really unstructured. So you can procrastinate for 11 weeks and kind of just pull everything together in the last week and really if there are kind of more checkpoints along the way to make sure that you're at least making some progress, I think that would be better for me at least.

H: I know a lot of students also don't like the fact that ticks are affectedly a certain case of if you do them, you don't lose marks. A lot of students, well all students do not like that aspect.

G: I think that's because, at first, you always used to get marks for ticks, and then you get told that you don't, so I feel like they think that they don't actually gain anything from doing the ticks, except it is that they have to do them, to stop themselves from losing marks. If there was a way to just say, ah well, actually you are gaining something from this, other than...

D: Yeah, even if it was just 5 percent of the module or something.

B: Yeah, or 5 percent of the class test or something.

C: Because 40 percent for the class test is quite a lot.

D: Yeah, it's almost like a logical thing.

I: I was just about to say, for all of the other modules that I took first year, they were all 85 percent exam, 15% coursework, and so the first coursework we handed it was worth 5%, which is barely anything of the module, especially if it was only a 10 credit module, and so if students did poorly on the first coursework, that might kind of set them straight, and given them a little nudge to tell them that they need to pick up their game and study better for the next one. But because the first coursework, first thing, counts towards the module, this massive 40% of the double module class test means that if students don't do well on that, they don't really have much chance with the rest of their coursework, to pick up their grade. So I think 40% is.. I think the class test is good and it's given at the right time, but maybe shouldn't be worth as much. Maybe, if it was split into two class tests, maybe one just on python and one just on sage, with 20% each, that would give students, well, I mean, that would mean that if students do poorly on the first one, they would have time to put more work in, to pick up the marks in the next one.

Me: So, you do something over Christmas as well don't you..?

H: Yeah, you do kind of a two-page project.

I: Yeah you do that before Christmas though, you don't really do anything over Christmas.

G: Well, you just kind of start thinking about ideas for the second semester.

Me: Do you think maybe it would be useful to have that two-page project before the test, and kind of swap them round?

(Everyone says no)

B: No, you wouldn't know enough by then.

Me: Do the students contact you much outside of labs?

(Everyone says no)

Me: Not at all?

G: Well, apart from a nod in the corridor.

D: I've been in the library a few times and sometimes a student's come up to me a few times and asked me something, but yeah.

Me: Did you all give them your emails?

(Everyone said no)

F: We were advised against it basically because otherwise we'd be bombarded.

I: At no point did I ever say don't contact me, but ..

G: Yeah, Vince said if anyone ever tries to contact you outside of tutorials, divert them to his office: they should know his available hours, so yeah, he told us not to do anything like that.

Me: Ok, so one more question, do you feel like the students are getting the most out of Computing, as like, the module content through this style of module delivery?

B: I think, the module as a whole, it can go one of two ways, because I think that it is quite an independent module in terms of like the individual projects you're given, in that you find your own Maths topic, and you write your own stuff on it, and you delve into it. You're doing it by yourself, and then when you get

into the group project, I found last year, that a lot of the other groups would have a coder, and then the other three people couldn't. So you would have one coder, and then the other three people who would have forgotten everything they learnt in first semester.

D: Just out of interest, who was a coder in here? (Directing it out to all undergrad tutors in the room)

(Everyone puts their hand up and laughs)

I: I think it's just a module that you get out of it what you put in, so all of us round this table, clearly put plenty in. Everyone sat here got a lot out of the module and put plenty in, and it's a skill that we'll probably all keep doing in our own time, and certainly if we go on industrial placements, or into real work, there's half of the year which probably won't do much coding again, until they're forced to in a job, at which point, they'll sit back and think "I wish I listened".

F: I think it's very dependent, on the student because I think a lot of them have come straight from sixth form, where the majority of learning was done inside the classroom and there was more of a focus on the teacher to teach them things, as opposed to them learning stuff themselves. So, because they've come straight from sixth form into university and they're immediately required to do their own studying, some of them may not have the relevant self-study skills in order to make the most out of the flipped classroom and those people are going to be the ones that struggle. On average, well, I don't know if it's the same with you guys, but there are a couple of people who have taken a gap year who are in my tutorial, and they seem to be getting on a lot better with the whole self-study/flipped classroom approach because they've had some time between sixth form and uni. They're a bit more mature and a little bit better at taking learning into their own hands, compared to those who have come straight from sixth form who don't really have those self-study skills, and so the whole flipped classroom approach for them, isn't working as well. So, there isn't really much you can do about that, because it is dependent on the student, and their skills and their attitude towards the module. Obviously if someone isn't really interested in coding, and doesn't really want to be, there isn't really much you can do to help them anyway, but possibly if maybe one of two lectures in the induction week were focused more on self-study skills and .. I think they did have that this year actually, I think they had a couple of lectures on self-study and how to kind of organise your time effectively, so I think stuff like that is good, but it is still very much dependent on the student and their skills set, and their experience and their maturity.
E: I think a lot of them don't see the point either, for the first five weeks. So the first five weeks are kind of just like bits that aren't really put together. They just don't really see the point of what they're doing until, well, the sixth week when you actually start to do some real stuff.

Me: Is that just because they're in first year do you think?

E: No, I think it's just because they don't really know what's involved, so I think when they first start, if there was just something to show like, "by the end of the year, this is the kind of stuff that you can be producing and this is how it is going to be useful to you in your degree and for work", just like drawing graphs for your calculus and stuff, or going into industry and using it. I think that would be really good for them as well. If they can see where they're going with it, because I think just doing list indices and messing around with strings, they're only sort of going "why am I doing this", and saying "why am I doing programming, I chose to do a Maths degree".

G: I think that that's one reason why it's good us being tutors and having been through the module, because when they say "ah this is useless, we're never going to use this", we can tell them how far we've come and tell them what we can do now.

B: We do have something like that in the second semester, where people come in and tell us where coding is useful, but maybe if you could do like just a couple of those in the first semester maybe.

I: Yeah, because I thought some of those were really interesting and it was good to see different uses.

Me: So like, in context almost?

I: Yeah, so maybe just a couple of those to kind of like just motivate them and show them what they're actually working towards.

F: I think to really emphasis the point of coding is that it is vital in knowing because that is kind of the direction that Maths is going in and so you really need to know it. I think that's the point that really

needs to be emphasised more because in your Maths A-Level, you don't ever/ it's never really talked about that much, but then when you go to university, you realise that Maths is not only about doing calculations, and you're not going to be doing just that in a job.

Me: Ok, I just want to go round, this is the final thing, so using the fact that you all did the module last year, what did you gain from doing the module, in terms of what you remember when you look back at it, and what perhaps you've learnt from it?

I: It would probably be a mix of developing self-study skills and also developing teamworking skills because, just like in my tutorial, at the start I didn't know anyone else, and then as the weeks went on, I met more people in my tutorials, most of the time we were working in the tutorials on the tickable questions, and we were also meeting up outside of labs to go over that, so I developed skills as well, working in a group towards the solution to a problem, so teamworking.

H: I'd say it's more that, I've sort of learnt how to program in a way. Not necessarily individual bits of Python syntax or whatever, not something specific, but now if I wanted to go away and learn myself how to learn a new language, or if I'd completely forgotten myself how to do Python and I would need to relearn it, it would be very easy and quick to do that, because I have a very base understanding that I didn't have before. I think that was the most useful thing from me. I can now teach myself all sorts of stuff.

G: I think the kind of way a computer thinks and the way a computer is sort of programmed. It is that kind of general knowledge of looking and realising that when you tell a computer to do something, it will do that something, and a simple thing you would normally do in your head, you can put into code to do on the computer, and also a think that would be difficult to do in your head, you could also write in code and do on the computer, and so knowing how to do that is really useful. Also, of course the kind of self-study, independence and the way of having to go over things yourself was really built on last year.

F: Yeah I think the module is a really good basis for Computing and then into second semester with the project and beyond that, you can either never look at it again and forget it all, or look into it further and do stuff of your own. So yeah, I just think it's a really good introduction.

E: I thought it was just good that I could just learn a new skill [Programming]. I mean, I wasn't expecting to come to university and learn any sort of new skill, and it's nice to sort of have this other discipline within your first year. You know, I don't just do Maths, I do a few other things around Maths that are a bit more diverse which is nice.

D: For me, it was learning how to self-study, because for me, I did A-Level Computing and so I knew how it worked and so kind of had knowledge in this area, but learning by myself is something that I didn't do most often, and so I learnt that.

C: I was probably one of the students who just came and felt like the first lecture of Computing and having to do the module was pointless, but then being able to learn the language and using other languages was quite useful. It was a lot better than it was when I started.

Me: When did the change happen?

C: When I went into second semester and we all started to do then group work.

B: It's the self-study and the fact that I can learn something new with the programming.

A: Probably just the team work in the second semester and being able to get to know everyone's personality traits and how to try and keep everyone happy and to learn how to work well together.

Me: Do you think you'll remember this module?

(About two-thirds of the room said yes)

Me: Ok. Does anyone else have anything else to add?

(Some shake their head, silence.)

Me: Ok, great. Thanks ever so much for taking part, I really appreciate you coming along today and giving your time up for this.

Appendix B

PCA Loadings Analysis

B.1 PCA with 44 components:

https://www.dropbox.com/s/oyr6js161sya97w/PCA44.txt?dl=0

B.2 PCA with 6 components:

https://www.dropbox.com/s/76thzsckz5sgzag/PCA6.txt?dl=0

Appendix C

Attitude Questionnaires

C.1 Questionnaire 1: Attitudes towards the Contents and Delivery of the Computing for Mathematics Module

In MA1003 you will be taught how to code for Mathematics. The course will be delivered using a flipped classroom approach, which is when the transfer of content happens outside of contact time. The thinking for this is that time with the lecturer (in the classroom) is then spent addressing particular difficulties and establishing a deeper level of understanding.

This short questionnaire will help better understand your learning experience in such an environment. We expect that it will take you less than 5 minutes to answer.

Your student number will be used to enter a prize draw for a £15 amazon voucher and will not be used outside of the scope of this research project.

Thank you very much for taking the time to answer this questionnaire.

Section 1: Personal Information

1. Please enter your student number.
   (a) (Blank space for students to input their answer)
2. Please select the option below most appropriate to you.
   (a) Male
   (b) Female
   (c) Other
3. Do you have any qualifications in computing?
   (a) Yes
   (b) No
4. If you answered "Yes" to question 2, please select what qualification(s) you have from the list below.
   (a) Bachelor's Degree/Level 4 Vocational Qualification
   (b) A-Level(s)/ Level 2 and/or 3 Vocational Qualification
   (c) GCSE(s)/ Level 1 Vocational Qualification
5. Please rate your level of knowledge in programming.

(a) 1 - No previous knowledge

(b) 2

(c) 3

(d) 4

(e) 5 - Expert knowledge

Section 2: Perceptions of Computing and Mathematics

1. How interested are you in the following two items:
   (a) Programming
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested
      iv. 4 - Quite interested
      v. 5 - Very interested
   (b) Mathematics
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested
      iv. 4 - Quite interested
      v. 5 - Very interested
2. How useful do you think the content of this course will be for you to learn?
   (a) 1 - Not useful at all
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Very useful
3. (a) Please predict what mark you think you will get for the class test for this module (out of 100).
      i. (Blank space for students to input their answer)
   (b) Please predict what degree class you will achieve at the end of your degree.
      i. 1st (above 70%)
      ii. 2:1 (between 60% and 70%
      iii. 2:2 (between 50%and 60%)
      iv. 3 (between 40% and 50%)
      v. Fail (below 40%)
4. Please rank the following in order of how important each is to you. (Please order the below aims 1 to 4, where 1 labels the most important aim and 4 labels the least important aim.)
   (a) I aim to pass the exam.
      i. 1

ii. 2

iii. 3

iv. 4

(b) I aim to understand the content as thoroughly as possible.

i. 1

ii. 2

iii. 3

iv. 4

(c) I aim to get a good mark in this module.

i. 1

ii. 2

iii. 3

iv. 4

(d) I aim to use this module as a starting point so that I can develop my own ideas around the content.

i. 1

ii. 2

iii. 3

iv. 4

Section 3: Perceptions of the Method of Module Delivery

1. (a) Please select the rating below which describes how you work best.

i. 1 - On my own

ii. 2 - Mostly on my own, but sometimes with other people

iii. 3 - Half on my own, half with other people

iv. 4 - Mostly with other people, but sometimes on my own

v. 5 - With other people

(b) Please rate your views on this statement: I think I learn best when someone explains something to me.

i. 1 - Not at all true of me

ii. 2

iii. 3

iv. 4

v. 5 - Very true of me

2. How many hours a week do you intend to spend on pre-lab material?

(a) (Blank space for students to input their answer)

3. Please rate the effect that the delivery of this module will have on your attitude towards Computing.

(a) 1 - No effect

(b) 2

(c) 3

(d) 4

(e) 5 - Large effect

4. Please rate how important you think attending lectures will be for this module. Think about the way this module will be delivered in particular.

   (a) 1 - Not important at all

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Very important

5. Please rate how useful you think this module and its delivery will be for your personal development.

   (a) 1 - Not useful at all

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Very useful

6. Please rate how important you believe the following are in your learning process:

   (a) Self study time (Alone, in study groups etc...)

      i. 1 - Not at all important

      ii. 2 - A little important

      iii. 3 - Neither important nor unimportant

      iv. 4 - Quite important

      v. 5 - Very important

   (b) Time with instructor (Lectures etc...)

      i. 1 - Not at all important

      ii. 2 - A little important

      iii. 3 - Neither important nor unimportant

      iv. 4 - Quite important

      v. 5 - Very important

C.2 Questionnaire 2: Attitudes towards the Contents and Delivery of the Computing for Mathematics Module

This questionnaire is the second questionnaire aiming to investigate your learning experience in the flipped classroom used for MA1003. Recall that this is when the transfer of content happens outside of contact time. The thinking for this is that time with the lecturer (in the classroom) is then spent addressing particular difficulties and establishing a deeper level of understanding.

This short questionnaire will help better understand your learning experience in such an environment. We expect that it will take you less than 5 minutes to answer.

Your student number will be used to enter a prize draw for a £15 amazon voucher and will not be used outside of the scope of this research project.

Thank you very much for taking the time to answer this questionnaire.

Section 1: Personal Information

1. Please enter your student number.
   (a) (Blank space for students to input their answer)
2. Please select the option below most appropriate to you.
   (a) Male
   (b) Female
   (c) Other
3. Prior to University did you have any qualifications in computing?
   (a) Yes
   (b) No
4. If you answered "Yes" to question 2, please select what qualification(s) you have from the list below.
   (a) Bachelor's Degree/Level 4 Vocational Qualification
   (b) A-Level(s)/ Level 2 and/or 3 Vocational Qualification
   (c) GCSE(s)/ Level 1 Vocational Qualification
5. Please rate your level of knowledge in programming.
   (a) 1 - No previous knowledge
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Expert knowledge

Section 2: Perceptions of Computing and Mathematics

1. How interested are you in the following two items:
   (a) Programming
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested
      iv. 4 - Quite interested
      v. 5 - Very interested
   (b) Mathematics
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested

iv. 4 - Quite interested

v. 5 - Very interested

2. From what you have studied so far, how useful have you found the content of this course for you to learn?

   (a) 1 - Not useful at all

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Very useful

3. (a) Please predict what mark you think you got for the class test for this module (out of 100).

      i. (Blank space for students to input their answer)

   (b) Please predict what degree class you will achieve at the end of your degree.

      i. 1st (above 70%)

      ii. 2:1 (between 60% and 70%

      iii. 2:2 (between 50%and 60%)

      iv. 3 (between 40% and 50%)

      v. Fail (below 40%)

4. Please rank the following in order of how important each is to you. (Please order the below aims 1 to 4, where 1 labels the most important aim and 4 labels the least important aim.)

   (a) I aim to understand the content as thoroughly as possible.

      i. 1

      ii. 2

      iii. 3

      iv. 4

   (b) I aim to get a good mark in this module.

      i. 1

      ii. 2

      iii. 3

      iv. 4

   (c) I aim to use this module as a starting point so that I can develop my own ideas around the content.

      i. 1

      ii. 2

      iii. 3

      iv. 4

Section 3: Perceptions of the Method of Module Delivery

1. (a) Please select the rating below which describes how you work best.

      i. 1 - On my own

ii. 2 - Mostly on my own, but sometimes with other people

iii. 3 - Half on my own, half with other people

iv. 4 - Mostly with other people, but sometimes on my own

v. 5 - With other people

(b) Please rate your views on this statement: I think I learn best when someone explains something to me.

i. 1 - Not at all true of me

ii. 2

iii. 3

iv. 4

v. 5 - Very true of me

2. How many hours a week are you currently spending on pre-lab material?

   (a) (Blank space for students to input their answer)

3. Please rate the effect that the delivery of this module currently has on your attitude towards Computing.

   (a) 1 - No effect

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Large effect

4. If you gave a rating of 2 or above in question 3, please state whether the effect is positive or negative.

   (a) Positive

   (b) Negative

5. Please rate how important you believe attending lectures are for this module. Think about the way this module will be delivered in particular.

   (a) 1 - Not important at all

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Very important

6. Please rate how useful you think this module and its delivery is for your personal development.

   (a) 1 - Not useful at all

   (b) 2

   (c) 3

   (d) 4

   (e) 5 - Very useful

7. Please rate how important you believe the following are in your learning process:

   (a) Self study time (Alone, in study groups etc...)

i. 1 - Not at all important

ii. 2 - A little important

iii. 3 - Neither important nor unimportant

iv. 4 - Quite important

v. 5 - Very important

(b) Time with instructor (Lectures etc...)

i. 1 - Not at all important

ii. 2 - A little important

iii. 3 - Neither important nor unimportant

iv. 4 - Quite important

v. 5 - Very important

C.3 Questionnaire 3:

This questionnaire is the third questionnaire aiming to investigate your learning experience in the flipped classroom used for MA1003. Recall that this is when the transfer of content prior to contact time. The reasoning behind this is that time with the lecturer (in the classroom) is then spent addressing particular difficulties and establishing a deeper level of understanding.

This short questionnaire will help better understand your learning experience in such an environment. We expect that it will take you less than 5 minutes to answer.

Your student number will be used to enter a prize draw for a £15 amazon voucher and will not be used outside of the scope of this research project.

Thank you very much for taking the time to answer this questionnaire.

Section 1: Personal Information

1. Please enter your student number.
   (a) (Blank space for students to input their answer)
2. Please select the option below most appropriate to you.
   (a) Male
   (b) Female
   (c) Other
3. Prior to University did you have any qualifications in computing?
   (a) Yes
   (b) No
4. If you answered "Yes" to question 2, please select what qualification(s) you have from the list below.
   (a) Bachelor's Degree/Level 4 Vocational Qualification
   (b) A-Level(s)/ Level 2 and/or 3 Vocational Qualification
   (c) GCSE(s)/ Level 1 Vocational Qualification
5. Please rate your level of knowledge in programming.

(a) 1 - No previous knowledge

(b) 2

(c) 3

(d) 4

(e) 5 - Expert knowledge

Section 2: Perceptions of Computing and Mathematics

1. How interested are you in the following two items:
   (a) Programming
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested
      iv. 4 - Quite interested
      v. 5 - Very interested
   (b) Mathematics
      i. 1 - Not interested at all
      ii. 2 - A bit interested
      iii. 3 - Neither interested nor uninterested
      iv. 4 - Quite interested
      v. 5 - Very interested
2. From what you have studied so far, how useful have you found the content of this course for you to learn?
   (a) 1 - Not useful at all
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Very useful
3. (a) To what extent were you satisfied with your class test result?
      i. 1 - Not satisfied at all
      ii. 2
      iii. 3
      iv. 4
      v. 5 - Extremely satisfied
   (b) Please predict what degree class you will achieve at the end of your degree.
      i. 1st (above 70%)
      ii. 2:1 (between 60% and 70%
      iii. 2:2 (between 50%and 60%)
      iv. 3 (between 40% and 50%)

v. Fail (below 40%)

4. Please predict what mark you will get on the individual coursework (out of 100).
   (a) (Blank students for students to input their answer)

Section 3: Perceptions of the Method of Module Delivery

1. (a) Please select the rating below which describes how you work best.
      i. 1 - On my own
      ii. 2 - Mostly on my own, but sometimes with other people
      iii. 3 - Half on my own, half with other people
      iv. 4 - Mostly with other people, but sometimes on my own
      v. 5 - With other people
   (b) Please rate your views on this statement: I think I learn best when someone explains something to me.
      i. 1 - Not at all true of me
      ii. 2
      iii. 3
      iv. 4
      v. 5 - Very true of me
2. How many hours a week, on average, have you been spending on pre-lab material?
   (a) (Blank space for students to input their answer)
3. Please rate the effect that the delivery of this module currently has on your attitude towards Computing.
   (a) 1 - No effect
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Large effect
4. If you gave a rating of 2 or above in question 3, please state whether the effect is positive or negative.
   (a) Positive
   (b) Negative
5. Please rate how important you believe attending lectures have been for this module. Think about the way this module will be delivered in particular.
   (a) 1 - Not important at all
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Very important

6. Please rate how useful you think this module and its delivery have been for your personal development.
   (a) 1 - Not useful at all
   (b) 2
   (c) 3
   (d) 4
   (e) 5 - Very useful
7. Please rate how important you believe the following are in your learning process:
   (a) Self study time (Alone, in study groups etc...)
      i. 1 - Not at all important
      ii. 2 - A little important
      iii. 3 - Neither important nor unimportant
      iv. 4 - Quite important
      v. 5 - Very important
   (b) Time with instructor (Lectures etc...)
      i. 1 - Not at all important
      ii. 2 - A little important
      iii. 3 - Neither important nor unimportant
      iv. 4 - Quite important
      v. 5 - Very important

Appendix D

Personality Questionnaire

As part of my year 3 project, based on analysing the attitudes of students towards Computing through the new method of learning (i.e. through the flipped classroom approach), I would like to gain an understanding as to the range of personalities of students in this class. I would therefore be very grateful if you could complete this short questionnaire for me please.

It should take no longer than 5 minutes and all results will be used solely for research purposes.

All participants will be entered into a prize draw to win a £20 Amazon voucher. Thank you.

Please enter your student number.

(Blank space for students to input their student number)

1. I see myself as someone who is talkative.
   (a) 1. Disagree strongly
   (b) 2. Disagree a little
   (c) 3. Neither agree nor disagree
   (d) 4. Agree a little
   (e) 5. Agree strongly
2. I see myself as someone who tends to find fault with others.
   (a) 1. Disagree strongly
   (b) 2. Disagree a little
   (c) 3. Neither agree nor disagree
   (d) 4. Agree a little
   (e) 5. Agree strongly
3. I see myself as someone who does a thorough job.
   (a) 1. Disagree strongly
   (b) 2. Disagree a little
   (c) 3. Neither agree nor disagree
   (d) 4. Agree a little
   (e) 5. Agree strongly
4. I see myself as someone who is reserved.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

5. I see myself as someone who is helpful and unselfish with others.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

6. I see myself as someone who can be somewhat careless.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

7. I see myself as someone who handles stress well.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

8. I see myself as someone who is curious about many different things.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

9. I see myself as someone who is full of energy.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

10. I see myself as someone who starts quarrels with others.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

11. I see myself as someone who is a reliable worker.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

12. I see myself as someone who can be tense.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

13. I see myself as someone who is a deep thinker.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

14. I see myself as someone who generates a lot of enthusiasm.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

15. I see myself as someone who has a forgiving nature.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

16. I see myself as someone who tends to be disorganised.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

17. I see myself as someone who worried a lot.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

18. I see myself as someone who has an active imagination.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

19. I see myself as someone who tends to be quiet.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

20. I see myself as someone who is generally trusting.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

21. I see myself as someone who tends to be lazy.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

22. I see myself as someone who is emotionally stable.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

23. I see myself as someone who is inventive.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

24. I see myself as someone who has an assertive personality.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

25. I see myself as someone who can be distant.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

26. I see myself as someone who perseveres until the task is finished.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

27. I see myself as someone who can be moody.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

28. I see myself as someone who values artistic, aesthetic experiences.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

29. I see myself as someone who is sometimes shy and inhibited.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
30. I see myself as someone who is considerate and kind to almost everyone.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
31. I see myself as someone who does things efficiently.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
32. I see myself as someone who remains calm in tense situations.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
33. I see myself as someone who prefers work that is routine.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
34. I see myself as someone who is outgoing.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly

35. I see myself as someone who is sometimes rude to others.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
36. I see myself as someone who makes plans and follows through with them.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
37. I see myself as someone who gets nervous easily.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
38. I see myself as someone who likes to reflect on experiences.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
39. I see myself as someone who has a few artistic interests.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
40. I see myself as someone who likes to cooperate with others.
    (a) 1. Disagree strongly
    (b) 2. Disagree a little
    (c) 3. Neither agree nor disagree
    (d) 4. Agree a little
    (e) 5. Agree strongly
41. I see myself as someone who is easily distracted.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

42. I see myself as someone who is sophisticated in art, music or literature.

(a) 1. Disagree strongly

(b) 2. Disagree a little

(c) 3. Neither agree nor disagree

(d) 4. Agree a little

(e) 5. Agree strongly

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