

**Chemistry Student Enthusiasm:
Exploring Student and Teaching Staff
Perspectives**



**Zoë Nicolaou
St Anne's College
University of Oxford**

Abstract

The first aim of a general chemistry degree course is to ‘*instil in students an enthusiasm for chemistry*’ (QAA Chemistry Benchmark Statement, 2019), and chemistry enthusiasm is a required student characteristic within the Oxford MChem admissions criteria.

Through qualitative interviews with students and teaching staff, this study explored what student enthusiasm means, why it is important in chemistry education, and how the Oxford MChem course affects student enthusiasm.

Findings suggested the four-phase model interest of development usefully explains definitions of chemistry enthusiasm, how it develops and why it is important in education. Subjective vitality explained how students’ general enthusiasm affected their experience of chemistry enthusiasm, and self-determination theory explained why it developed.

A rich theme across interview responses was workload, or more specifically how workload and chemistry student enthusiasm interacted. Respondents perceived that the Oxford chemistry degree had a distinctively heavy workload; chemistry enthusiasm reduced students’ experience of workload; high workload could make or break student enthusiasm; and excessive workload caused three things: superficial learning, perceived lack of control, and significant enthusiasm loss. This analysis agreed with previous studies which found that interest reduced perceptions of workload, and high workload caused superficial learning and reduced interest.

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Abbreviations

FMID: The Four-Phase Model of Interest Development

HE: Higher Education

ID: Interest Development

QAA: The Quality Assurance Agency for Higher Education

RSC: Royal Society of Chemistry

SDT: Self-Determination Theory

Vitality: Subjective vitality

WDII: Well-Developed Individual Interest

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Chapter 1: Literature Review

1.1 Enthusiasm in HE: Overview

The word ‘enthusiasm’ is commonplace in the language of Higher Education (HE). It describes a characteristic which is assumed to be desirable in students and instructors alike. Institutions frequently express subject enthusiasm as an expectation of prospective students, and policy states it is an attribute that degree courses should foster.

In this chapter I will argue that theories of interest, vitality and self-determination may be combined to model enthusiasm.

1.1.1 HE Policy: a Degree Should Instil Chemistry Enthusiasm

1.1.1.1 QAA Benchmark Statement

The Quality Assurance Agency for Higher Education (QAA) has drawn up subject benchmark statements, written by representatives from UK universities and industry. These outline the characteristics prospective students and employers should expect from a graduate in that subject, and guide course designers to meet these academic standards. According to the QAA (2019), the first aim of a chemistry course is to *‘instil in students an enthusiasm for chemistry, an appreciation of its application in different contexts, and to involve them in an intellectually stimulating and satisfying experience of learning and studying’*,¹ so student enthusiasm is a mark of chemistry degree quality.

1.1.1.2 RSC Accreditation Requirement

Royal Society of Chemistry (RSC) accreditation assures students and employers that a course is of high quality. To meet accreditation requirements, a chemistry degree course must align its aims with the QAA chemistry benchmarks, which includes striving to instil enthusiasm for chemistry in graduates.²

By necessitating that a degree should make enthusiastic chemistry graduates, the RSC and QAA policies imply that enthusiasm is an important outcome of chemistry courses. However, neither body explains why enthusiasm is a priority, or how someone could ascertain if a course satisfactorily instilled enthusiasm.

1.1.2 Admissions and Enthusiasm: Universities Want Enthusiastic Students

It is important for prospective students to demonstrate enthusiasm when they apply to university. The UCAS website suggests that enthusiasm is one of the top student characteristics admissions teams look for when reviewing personal statements, enthusiasm enables success at university, and during interviews universities will be *'be looking for enthusiastic students with lots to offer' during interviews.*³⁻⁵ In the Oxford MChem admissions criteria, enthusiasm and interest are characteristics that tutors look for in prospective students, and a prerequisite for the course (**Table 1.1**).

<i>Academic ability</i> Spirit of enquiry: desire to understand the reasons for observations; enthusiasm and curiosity in science
<i>Interest in Chemistry</i> Including an appreciation of some aspects of it outside the confines of the A level syllabus (or equivalent)
<i>Motivation and perseverance</i> An enthusiasm for chemistry and the motivation to pursue an academically demanding four-year course
<i>Independent working and communication</i>
<i>Educational achievement</i>

Table 1.1: The Oxford MChem Admissions Criteria related to enthusiasm

But why is enthusiasm so important for university admissions? Universities not only want students that are academic, but students that are interested and motivated towards their course. Perhaps these students are more likely to independently engage with the course, enjoy the content, and stick with it if it becomes difficult. Oxford's grouping of enthusiasm under motivation and perseverance implies that enthusiastic students are more likely to persevere and meet the degree's 'academically demanding' requirements: enthusiasm is a

desirable learner characteristic due to its enabling and motivating character. Moreover, enthusiasm may indicate genuine preference or liking of a subject in a way that grades cannot communicate. A paper looking at student enthusiasm in university applications used enthusiasm to mean students' active desire (to attend a specific university), and this was indicated by students ranking it over other institutions.⁶ Here, preference was a proxy for enthusiasm. Chemistry enthusiasm may cause students to prioritise chemistry, *i.e.* devote more time and energy to it, due to intrinsic enjoyment of the content. They may be more likely to persevere and succeed at the course, and less likely to struggle or drop out. This may be particularly pertinent for the '*academically demanding*' Oxford course.

1.1.3 HE and Enthusiasm: The Need for Greater Clarity

Student enthusiasm is seen as both an important prerequisite for and outcome of studying at university. This may be because enthusiastic students are more motivated, hardworking, resilient, and curious, making them more successful students and employees.

The American Psychology Society defines it as '*a feeling of excitement or passion for an activity, cause, or object,*' but enthusiasm is rarely mentioned in psychology literature, poorly defined in educational psychology and understudied across all disciplines.^{7,8} Although the importance of 'enthusiasm' in chemistry education may be intuitively appealing, the term's weak theoretical basis and nebulous definition mean it remains hard to adequately define. To justify its place in chemistry education and make guidance fit for purpose, we should clarify what 'enthusiasm' is. This would make it easier for institutions to observe and measure enthusiasm, and increase their accountability to enthuse chemists.

1.2 Usage of 'Enthusiasm' in Student Contexts: a Murky Construct

'Enthusiasm' is particularly under-researched, poorly defined, and seldom used in the student motivation literature. Many papers fail to mention enthusiasm beyond the abstract

and fail to define the concept. Recent papers tend to use the word either as a synonym or a catch-all for other constructs; to illustrate the term's ambiguity, some papers where the term 'student enthusiasm' was used in their titles are presented below.

1.2.1.1 Enthusiasm as Student Engagement and Interest

Often enthusiasm was used as a synonym for engagement, which itself is a poorly defined construct that can include behavioural (participation, doing the work), affective (interest, value, emotions) and cognitive (motivation, effort) aspects.⁹ A paper titled *Does student enthusiasm equal learning? The mismatch between observed and self-reported student engagement* only mentioned enthusiasm once.¹⁰ Instead, behavioural, affective, and cognitive engagement were measured through student observations and self-reports. 'Enthusiasm' has been used to solely describe behavioural engagement. Students' attention levels were coded as 'enthusiastic' or 'uninterested,' suggesting enthusiasm contrasts with disinterest.¹¹ Another paper summed up interest and engagement as enthusiasm, which was inferred from student reflections, continuous assessment, and results.¹² Other researchers suggested that engagement may be a result of enthusiasm, not synonymous with it.¹³

In multiple papers evaluating student engagement with a learning intervention, enthusiasm was used to mean affective engagement with the learning environment.^{12,13,14} It described their attitude, such as levels of liking or eagerness, towards these interventions. These resulted from students' perceived value of the project, *e.g.* utility or enjoyability.

1.2.1.2 Enthusiasm as Motivation

Student enthusiasm also serves as a vague term to sum up student motivational constructs, sometimes as a precursor to motivation or a result of motivation. A paper exploring engineering student motivation stated '*students who continue to aspire to the creative/high-impact notions of engineering also maintain an enthusiasm,*' implying that enthusiasm is

affected by students' motivation.¹⁵ It is unclear whether researchers also used student enthusiasm to encompass motivation, aspirations and attitudes. In the book *The motivated student: unlocking an enthusiasm for learning*, student enthusiasm has a motivating character, and the few mentions associated it with positive attitudes, displayed energy, excitement, and engagement.¹⁶ Enthusiasm was described as contagious: '*When you teach with energy and enthusiasm, your students will likely take on the same positive attitude.*'

1.2.1.3 Summary

The word 'enthusiasm' is central to the QAA Chemistry Benchmark Statement, but its use in the student literature is broad, describing affective, behavioural, and cognitive student characteristics (*e.g.* engagement, enjoyment, attitude, interest, eagerness, and motivation). Perhaps authors' preference for using it, particularly in titles and abstracts, is because its broad nature means they can sum up many concepts concisely (but at the cost of specificity). Other times it may be used stylistically as a synonym to avoid repetition of other, better-defined concepts. However, the term is vague, so it may be theoretically useful to unpick its connotations. In the recent student literature, two exceptions were found where researchers had attempted to define or rigorously measure enthusiasm in student contexts.

1.2.2 Law Student Enthusiasm as Interest and Vitality

Zimmerman's paper *An Interdisciplinary Framework for Cultivating and Understanding Law Student Enthusiasm* was an exception in the vague usage of student 'enthusiasm'.¹⁷ In it, she explicitly and extensively defined law student enthusiasm as a combination of two psychological constructs – interest and vitality – in the context of law study.^{18,19} Law interest described students' commitment to law study, and law vitality described their feelings of positive energy towards law study. Her definition is derived from general psychological constructs, so it is applicable to student enthusiasm in any discipline – only the contents

which the enthusiasm is directed towards changes. A more detailed review of interest theory and vitality is given in **section 1.3**.

Zimmerman's definition provides an affective account of enthusiasm that focuses on how the student feels about a specific subject. She contrasts this with more generic descriptions of enthusiasm as an outward manifestation of energy or feelings of excitement that are not subject-specific. A limitation of her model is that it is theoretical, so further research would be valuable to test its validity. Nevertheless, she sets out a persuasive account to explain enthusiasm's significance in education.

1.2.3 Peer Enthusiasm

Literature searching uncovered only one instance of rigorous measurement of student enthusiasm.²⁰ Researchers measured individual students' perceptions of their class's overall group behaviour or mood, or **peer enthusiasm**, and how this affected their interest. They found that peer enthusiasm increased students' triggered and maintained situational interest, suggesting that positive classroom energy increased students' value of course content. The peer enthusiasm scale had good internal validity but, due to a lack of literature, it was adapted from a teacher measure. The authors highlighted that further research is needed into the psychometric characteristics of peer enthusiasm. Despite this, the study revealed another important effect of student enthusiasm: if students experiencing enthusiasm display positive energy, other students' sense of this may trigger their interest, helping their learning. If this increases their displayed enthusiasm, this study could explain the observed contagious nature of enthusiasm. Increasing student enthusiasm may set up a positive feedback loop.

1.2.4 Teacher Enthusiasm

In contrast to the dearth of student enthusiasm literature, researchers have investigated enthusiasm more deeply in the context of teacher affect and behaviour. However, there is

no agreed definition of ‘teacher enthusiasm’ and researchers have used many different conceptualisations.²¹ Although caution should be taken when applying theories about teacher’s motivational characteristics to learners,²¹ many of the constructs used in definitions of teacher enthusiasm might usefully be extended to students.

1.2.4.1 Displayed vs Experienced Enthusiasm

‘Teacher enthusiasm’ is divided into two categories:²¹ **Displayed enthusiasm** describes types of behaviour, such as instructional behaviour (dynamic, motivating, or funny teaching style), and nonverbal expressiveness (gesticulation or facial expressions). **Experienced enthusiasm** connotes a mental state, which relates to interest and motivation; this may manifest itself in teacher instruction, causing displayed enthusiasm.^{8,21}

Looking to policy, the QAA benchmark statement says that a degree should ‘*instil in*’ students an enthusiasm for chemistry, which implies that enthusiasm is conceptualised here as an internal, experienced characteristic. In the context of learning, we should focus on making students feel enthusiastic, rather than appear enthusiastic (presumably if they feel more enthusiastic, they will behave more enthusiastically). It is likely that student enthusiasm is also conceptualised as both experienced and displayed, so the distinction is still useful. The research will focus on the experienced definitions, particularly Kunter *et al.*’s affective conceptualisation of teacher enthusiasm.^{8,22}

1.2.4.2 Individual Interest

Kunter *et al.* suggest that experienced enthusiasm is close to the concept of individual interest: a relatively enduring disposition to reengage with contents over time. This was also in the law student definition described earlier.¹⁷ However, they claim enthusiasm is a purely affective disposition, whereas interest has both affective and cognitive components. They also say individual interest is insufficient because discipline interest does not necessarily

make a teacher enthusiastic or good at communicating knowledge to their students. Therefore, they draw a theoretical distinction between topic-related (subject), which was like individual interest and activity-related (teaching) enthusiasm. Their 2011 study confirmed that these two dimensions of enthusiasm are separable.⁸

Implicit in their rationale is an assumption: enthusiasm for teaching cannot be described as interest, because it is characterised by a tendency to reengage with an activity (teaching), not a subject. However, the contents of interest can include activities.²³ Perhaps teaching enthusiasm signifies individual interest specific to the activity of teaching, and a teacher with both subject and teaching individual interest would be particularly enthusiastic. Furthermore, it is unlikely these two interests are completely separable; teaching may be one of the ways teachers engage with their subject interest. It is also likely that teachers manifest their enthusiasm to differing extents, as there are other characteristics such as general expressiveness, or interest in people, that affect how enthusiastic teachers appear.

1.2.4.3 Intrinsic Motivation

Kunter *et al.* suggest that teacher enthusiasm is also like intrinsic motivation – the disposition to pursue a task for the satisfaction inherent in the task rather than an external reward – as both relate to experienced positive affect arising from engagement.²² Intrinsic motivation implies that this experience is the ultimate reason for behaviour, whereas enthusiasm refers to the experience itself. However, teachers are somewhat driven by external motivation (such as salary), so enthusiasm describes the habitual positive emotions associated with reengagement with teaching which may be intrinsically or extrinsically motivated. Kunter *et al.* argue that enthusiasm is not intrinsic motivation because engagement can be externally motivated. This argument seems flawed. Regardless of whether teachers are externally motivated at first, if teaching enthuses them, they will

associate enjoyment with it. This enjoyment causes engagement to become intrinsically motivated, so experienced enthusiasm is intrinsically motivating.

Again, experiencing enthusiasm as positive affect suggests it is similar to interest. Interest is part of intrinsic motivation and positive affect is associated with interest, so it may be that enthusiasm describes positive affect resulting from interest. Enjoyment and interest are reciprocal, and as interest develops, feelings of enjoyment and interest become increasingly correlated.²⁴ Overall, Kunter *et al.* have defined interest narrowly, so it is possible that individual interest could sufficiently explain teacher experienced enthusiasm.

1.3 Defining Enthusiasm: Interest, Vitality and Self-Determination Theory

1.3.1 The Four-Phase Model of Interest Development

Interest is a motivational variable which *'refers to the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, [activities] or ideas over time.'*^{18,23} Interest underpins learning by positively influencing attention, goals, and levels of learning.¹⁸ However, teachers often hold the misconception that students either do or do not have interest, so do not recognise their role in helping students to develop interest. If Oxford tutors hold this misconception, it could be barrier to increasing students' enthusiasm for chemistry, therefore reducing their ability to fulfil the QAA benchmark.

Two primary types of interest have been investigated in education: **situational interest**, (*i.e.* the focussed attention and affective state triggered momentarily by an external stimulus), and **individual interest** (*i.e.* the disposition to reengage with specific contents regularly, voluntarily and independently over time, and with increasing depth of understanding).^{18,23} Situational interest refers to a psychological state, whereas individual interest refers to a trait that emerges from situational interest. Hidi and Renninger propose a four-phase model for the development of interest (FMID)(**Figure 1.1**).¹⁸

Despite individual interest's enduring character, interest is a dynamic concept, and students' academic environment strongly determines whether it will wax or wane.^{18,23} Without support from others, interest development (ID) can become dormant, recede, or disappear entirely, even in well-developed phases. External support should be given to students to trigger their interest, allowing it to be internalised so individual interest can develop.



Triggered situational interest

arises from an external stimulus, such as surprising information, personal relevance, or intensity, and is short-lived.

Maintained situational interest

involves a long or repeated period of sustained attention, usually supported by an external stimulus.

Emerging individual interest

is the start of a tendency to reengage with content over time. Stored value, knowledge and positive affect arise from prior engagement with the content. It is mostly self-generated but there is some external influence.

Well-developed individual interest (WDII)

Is a more enduring form of individual interest characterised by more stored value, knowledge, positive feelings. It is almost entirely self-generated.

Figure 1.1: Hidi & Renninger's Four-Phase Model of Interest Development (FMID)^{18,23}

1.3.2 The Importance of Interest in Education

Both types of interest have been demonstrated to positively influence learning.¹⁸ Situational interest helps students' cognitive performance, inferencing ability, attention, integration of information with prior knowledge, and levels of learning. Individual interest has similar effects: it is correlated with increases in attention, recognition, and recall; persistence and effort; motivation; and learning. Additionally, both forms of interest contribute to positive affect which has been found to enhance cognitive performance.

The importance of individual interest may be greater when courses require students to do more independent learning,²⁵ such as in the Oxford MChem. Students with high individual interest tend to reengage with content out of their own volition and do not need as much

external support. This suggests they would be better independent learners compared to their less interested counterparts, so developing interest in students is educationally useful.

1.3.3 From Enthusiasm to Interest

Although interest and enjoyment are often complementary and reciprocal, they can be triggered separately.²⁴ However, as triggered interest progresses to WDII, feelings of alertness, absorption, and curiosity (associated with interest) combine with feelings of pleasure and satisfaction (associated with enjoyment) into one positive experience.

Many descriptions of student enthusiasm and associated concepts by the educational literature can be explained using interest theory. Interest is highly motivating and causes a tendency to reengage.²³ Motivation and engagement are visible outcomes of students' experienced interest, explaining the terms' conflation with enthusiasm: it is possible that displayed enthusiasm occurs in the absence of experienced enthusiasm (*e.g.* if students are motivated by other things). Increased attention, focus, and effort are also a part of the state of interest, so interest would explain why enthusiastic students are more engaged and they are able to persevere for longer with difficult work. This would explain the attribution of success and hard work to enthusiasm in HE discourses. Enthusiasm's definition as the positive feelings and enjoyment associated with engagement can also be explained by interest theory, as states of interest become increasing linked to the experience of enjoyment as interest develops.²⁴ Furthermore, Kunter *et al.* and Zimmerman both describe interest as overlapping significantly with enthusiasm.^{8,17} As a result of enthusiasm's overlap with this much more extensively-researched concept, it would be valuable to test whether interest can be used to explain staff and students' conceptualisations of enthusiasm.

In students, I propose that conceptualisations of experienced enthusiasm are the same as the construct of interest, and that displayed enthusiasm are types of behaviour and engagement

that can be attributed to student interest, but may not be caused by interest, *e.g.* students may be read as enthusiastic without feeling enthusiastic.

1.3.4 What Causes interest? Looking to Self-Determination Theory

Understanding the conditions needed for continued ID is gap in the current interest research, particularly in educational settings.¹⁸ Some researchers have used self-determination theory (SDT) to explain ID, and interest is a value within the SDT theoretical framework.^{23,26,27}

SDT is a meta-theory that consolidates several theories relating to human motivation.^{28,29} It argues that satisfaction of the three basic psychological needs (**Table 1.2**) is what underlies human motivation and drives psychological growth and development. Satisfaction of all three needs is necessary for psychological health; fulfilment of two is not enough.

Competence
A person's perception of having mastery over activities or the environment. It is related gaining knowledge or skills.
Autonomy
A person's sense of their ability to make independent decisions and behave according to their personal values. It relates to a person's sense of freedom.
Social-relatedness
A person's human desire to feel connected to others, as well as giving and receiving love and care.

Table 1.2: Three Basic Psychological Needs within SDT²⁷

In SDT, fulfilling basic needs is used to explain why people reengage with contents and the conditions necessary for ID. Interest is an outcome of people fulfilling their autonomy, competence, and relatedness needs by engaging with specific contents; this fulfilment is a prerequisite for ID, and if needs are not met then interest cannot develop and may recede.

However, Hidi and Renninger argue that the link between interest and basic needs is more complex;²³ engaging with contents of interest can also increase autonomy and competence, so there is a reciprocal relationship between needs fulfilment and increasing interest. Needs satisfaction can be an outcome of interest as well as a precondition for developing interest.

Despite this, Miesner argues that SDT is a useful framework for explaining the progression of triggered interest to WDII, even if the process is more complicated.²⁷

There is a good theoretical basis to use needs satisfaction as a mechanism to explain the cause of ID, so this thesis will use SDT to explain why students do or do not develop chemistry interest. If ID results in increased feelings of competence and autonomy, this reciprocal relationship may cause a positive feedback loop – this increased satisfaction of needs arising from interest would allow students to re-engage their interest more.

1.3.5 (Subjective) Vitality and Enthusiasm: is Interest the Whole Picture?

Zimmerman argues that enthusiasm contains vitality as well as interest. **Subjective vitality** is a positive sense of aliveness and energy, or the experience of possessing enthusiasm and spirit.¹⁹ It is the self-perceived energy someone has for a task, not their observable behaviour or the energy actually expended. Physical variables (*e.g.* illness or fatigue) and psychological variables (*e.g.* being in love or feeling effective) contribute to vitality.

1.3.5.1 Self-Determination Theory and Vitality

SDT researchers argue that needs satisfaction maintains or enhances subjective vitality, whereas thwarting of needs satisfaction diminishes it.²⁹ For example, individuals who engaged with a task non-autonomously had lower vitality compared to individuals who engaged autonomously.³⁰ If subjective vitality and interest are both outcomes of a person fulfilling their basic needs, it is logical that the two feelings would occur together. Repeated experience of the two affects simultaneously may lead a person to identify them as one feeling, which might be described as enthusiasm. Because ID is always related to specific contents, such as chemistry, this feeling of enthusiasm would also be specific to the same contents.

1.3.5.2 Is Vitality Separable from Interest?

Zimmerman says that vitality intuitively captures enthusiasm's energetic character, but does not capture its specificity to law, hence her inclusion of interest. However, in her definition vitality is also specific to law, and by treating them as separate concepts, her inclusion of interest does not explain why students' vitality is specific. If subject-related vitality is a result of subject-related interest, this would explain its specificity.

Theory supports the link between interest and vitality.^{18,19,23} Interest is described as having a '*highly energising and positive affective character,*' suggesting that vitality arises from interest and is part of its motivating character.¹⁸ Interest is specific, so this vitality is associated with the contents of interest. Furthermore, the experience of interest is associated with feelings of flow, effortlessness, and an increased ability to persevere through frustration. This perceived reduced effort could be described as increased vitality – in both cases, individuals feel as though they possess more energy for the task – so subjective vitality associated with a subject may result from ID.

Overall, I would argue that chemistry vitality and chemistry interest are inseparable. Zimmerman's definition could be reframed to describe enthusiasm as the subjective vitality that *arises from* interest. If this is the case, increased enthusiasm should result from increased interest, so interest research could be used to make more enthusiastic chemists.

However, there may be value in including general subjective vitality in a definition of enthusiasm because general vitality affects how enthusiasm is experienced – it describes students' general enthusiasm. Vitality is also affected by factors unrelated to chemistry study, such as illness. If a student's general vitality is reduced, this will reduce their perception of chemistry-specific vitality. This reduces their experienced enthusiasm, even though their reduction in vitality is not chemistry-specific and their chemistry interest is not

reduced. If vitality motivates students to reengage with their interest, reduced general vitality may reduce their tendency to reengage. This could arrest or slow their ID. General vitality is an outcome of needs satisfaction, so increased vitality may mediate the relationship between needs satisfaction and ID.

It may be that chemistry enthusiasm as a student trait is synonymous with individual interest, but experienced enthusiasm is a combination of positive affect arising from engaging with contents of interest (which may include chemistry-specific subjective vitality) combined with a student's current general subjective vitality levels. If a student has low subjective vitality (*e.g.* for a non-academic reason like illness), they will be unable to experience high enthusiasm.

1.4 Conclusion: Modelling Enthusiasm with Interest, SDT and Vitality

Usage of 'enthusiasm' in student contexts is imprecise and muddled. Grounding the concept in psychological theory is necessary as it enables evidence from research to confirm and protect the intuitive importance of student enthusiasm in education.

The four-phase model of interest development is a first approximation of this thesis's model of student enthusiasm. It explains the student characteristics and behaviours attributed to enthusiasm (*e.g.* motivation, engagement and enjoyment), its content-specificity, and *how* it develops. Needs satisfaction in SDT can then be used to explain *why* enthusiasm develops. The FMID explains the feelings of chemistry-specific vitality associated with chemistry enthusiasm, but the inclusion of general vitality in the model explains why the perception of this specific vitality may be limited by factors unrelated to chemistry study – it describes students' general enthusiasm. Sufficient general vitality may be needed for independent reengagement with content thus necessary for ID.

Chapter 2: Aims and Methodology

2.1 Overall Aims

The research presented in this thesis has two main concerns:

First, it asks whether Hidi and Renninger's FMID theory along with subjective vitality and SDT could usefully explain conceptualisations of enthusiasm.

Second, responding to a central theme in the interviews, the research explores workload – how much work students had to do, the type of work they had to do and the amount of time they had to do it – and how this interacts with students' enthusiasm.

2.1.1 Specific Research Questions:

- 1. Can FMID, subjective vitality and SDT be used to model enthusiasm?*
- 2. How does students' enthusiasm affect their workload?*
- 3. How does students' workload affect their enthusiasm?*

2.2 Qualitative Methodology

This research was situated in a qualitative paradigm to capture richer explanations for the interaction between the MChem and enthusiasm, with the aim of informing development of interventions to improve student enthusiasm.³¹

Qualitative work is under-represented in the affective chemistry education literature.³² Affects like enthusiasm are subjective, changeable and interact with the context in which they are expressed, so researchers have questioned how reliably quantitative methods can measure emotions.³²⁻³⁴ Even if the results are reliable, they rarely give explanations for the correlations they find, which makes it difficult for them to inform learning interventions. Conversely, qualitative methods contextualise experience, allowing themes and explanations to be constructed.³⁵

2.2.1 Why Semi-Structured Interviews?

Interviews are useful for research questions investigating people's experiences, perceptions and understanding, and generate richest data when participants have a personal stake in the topic.³⁵ This research explored perceptions of student enthusiasm on the Oxford MChem, so interviews were an appropriate method. As all participants were invested in this topic, interviews were likely to generate the deep responses needed for good qualitative research.

2.2.2 Interview Design

The interviews followed an established semi-structured interview approach.³¹ The interviewer followed an interview guide. This contained a set of questions which they planned to ask interviewees, as well as anticipated follow-up questions and prompts (see **appendix**). This allowed the interview to explore participants' conceptualisations of enthusiasm, what features of the chemistry degree caused students to gain or lose enthusiasm, and how the degree could be changed to improve student enthusiasm. The guide was not fixed so the interviewer could ask unplanned questions to probe responses; this flexible format should generate richer data and let participants discuss topics that are important to them.

2.2.3 Analysis

Following transcription, the data was analysed using thematic analysis; this was guided by methods outlined by Braun and Clarke.^{31,35,36} NVivo, a qualitative analysis software, aided the analysis. Initially, the researcher familiarised themselves with the transcripts. Then, three of the transcripts were coded using a mixture of inductive and deductive codes, including motivational theories related to enthusiasm, and with the initial research questions in mind. It became apparent that theories of interest matched conceptualisations of enthusiasm well. Following this discovery, deductive coding focussed on interest theory.

Workload was a rich inductive theme crystallising during these initial stages, so the scope was narrowed to focus on workload only. Excerpts that were relevant to workload were collected. Ideas relating to how workload interacted with enthusiasm and general workload were inductively coded. The interest literature and workload literature were then used to deductively code the data. The full transcripts were read through again to check all workload-related excerpts were included. The workload-related excerpts were read through again to check that all relevant codes had been assigned. Codes were refined and regrouped alongside each stage. Themes and subthemes were constructed during coding and writing.

2.2.4 Ethical Considerations

2.2.4.1 Ethical clearance

We received ethical clearance from the Medical Sciences Interdivisional Research Ethics Committee (reference: R79439/RE001) before distributing recruitment emails and posters.

2.2.4.2 Informed Consent

Participants reviewed an information sheet and consent form before volunteering for interview. At the start of interviews, participants gave verbal consent, and the interviewer produced a written record of this. They could withdraw their consent at any point up to a date specified after the interview, which gave them the chance to change their minds.

2.2.4.3 Recruitment

Near the end of Hilary term (after receiving ethical approval (reference: R79439/RE001)), the student and tutor recruitment emails from Dr Michael O'Neill were distributed by Laura Fenwick to the relevant mailing lists. Only first and second year students were emailed. Participants volunteered to be interviewed *via* a form linked to the email or poster (see **appendix**). Students indicated their year of study and whether they had lost or gained chemistry enthusiasm since studying at Oxford. Out of a possible estimated 390 students,³⁷

5 first years, 6 second years and 5 tutors volunteered *via* the form. They were all invited to interview. 5 students were interviewed (see **Table 2.1**) and all 5 tutors were interviewed.

<i>Student pseudonym</i>	A	B	C	D	E
<i>Year of study, enthusiasm change</i>	2, lost	2, gained	2, gained	1, gained	2, lost

Table 2.1: Student interviewee characteristics

2.2.4.4 Interviews

Interviews were conducted online *via* Microsoft Teams call, and audio was recorded using Microsoft Teams and an external dictation device. To minimise the amount of personal data collected, no video recording of participants occurred. Microsoft Teams was used to transcribe the interview. These transcriptions were imperfect, so they required extensive verification. Errors were amended manually before deleting the audio recordings. 7.3 hours of recording were transcribed (approximately 80,000 words).

2.2.5 Reflexivity

Qualitative research is inherently subjective, but subjectivity is not seen as something which can or should be eliminated.³⁵ The participant and interviewer generate data together. If the identity of either person changed, the data and its interpretation would inevitably change. This does not make the results less rigorous – just different. However, it is important that qualitative researchers reflect on their own assumptions during the research process, and how these may affect the production and analysis of data. The aim of this is to resist limiting participants’ responses and conclusions drawn. This reflection process is called ‘reflexivity.’ Part of reflexivity is acknowledging the researcher’s position.

2.2.5.1 Positionality Statement

Zoë Nicolaou is a white woman and home-status, non-first-generation student in her fourth year of the Oxford MChem course. She recently completed Part I of the course, during which she lost chemistry enthusiasm. She recognises that studying the Oxford MChem was

not the only reason for this, especially as her university years were heavily impacted by COVID-19. Her experience has made her interested in how university courses interact with students' enthusiasm and the importance of student affect in high-quality chemistry education. Her research is underpinned by her commitment to improving chemistry students' experience and learning through an evidence-led practice, and she hopes that it can inform course improvements. She believes that increasing chemistry enthusiasm is not only compatible with maintaining a rigorous course but a crucial aspect of degree quality.

2.2.5.2 Implications of Positionality

Zoë's position influenced the data she generated with participants. In the case of students, she was of a similar life stage and degree experience, including the coronavirus pandemic. She could relate to their perspectives in more ways than an outsider, letting students feel comfortable in their information disclosure.³¹ Furthermore, some student perspectives may be systematically inaccessible to certain people, such as academic staff.

Similarly, it is likely that Zoë's position as a student limited her access to tutor perspectives. Tutors and Zoë differed significantly in experience, and the tutors may have seen her as one of their students. Their position of power may have made the interview more unequal.³¹ Furthermore, the tutors may have felt unable to give sensitive information to a student-like researcher due to an interpersonal distance maintained within tutor-student relationships. Tutors also self-censor to protect their position in case they are identified. This may also be the case for student, but the ramifications are likely to be more serious for a tutor's career.

2.2.6 Limitations

2.2.6.1 Remote Interviews

We decided not to offer in-person interviews, despite them being considered the 'gold standard' for research because evidence suggests they generate richer data.³⁸ This was to

speed up the transcription process, reduce the participant cost by removing travel, and make the interview format consistent between participants. Coronavirus risk meant participants may have felt uncomfortable with in-person interviews and there was a higher likelihood of disruptions; as most of the interviews occurred during the Easter vacation, it was likely that many interviewees would not be in Oxford anyway.

2.2.7 Sample Characteristics

2.2.7.1 Size and Data Saturation

This study may be limited by a small sample size; the data generated may lack breadth or saturation,³⁵ making it harder to construct coherent themes across responses. In qualitative methods, ‘data saturation’ refers to a point in a study where interviewing more participants would not add to the analysis and justifies when data collection is stopped.^{35,39} Time constraints on this master’s project meant that there was only time to carry out ten interviews, so further participants could not be interviewed to test if the data was saturated. Lack of generalisability due to the small sample was not a relevant limitation to the findings but will limit the extent they can be rigorously transferred to other contexts;³⁵ Qualitative research seeks to understand people’s unique and complex experiences in depth, rather than flattening many experiences into a monolithic ‘average experience’.

Although other qualitative methods, such as surveys, are more suited to a large sample than interviews, they often generate shallower data. Furthermore, because of the term’s breadth, interviews meant that notions of enthusiasm could be probed in dialogue. In this regard, a ‘one-shot’ survey would have been more limiting: rigid questions prepared in advance would constrain the scope for unexpected or complicated responses.

2.2.7.2 Self-selection bias

Interviewees volunteered, adding a self-selection bias to the data. The prospect of intimate self-disclosure in the interview may have led to a sample of people who were more open, more patient and more interested in student enthusiasm than the general cohort.⁴⁰

2.2.7.3 Year of Study: Exclusion of 3rd and 4th Year Students

This study only investigated experiences of students in their first two years of the course. Third and fourth year students would have valuable perspectives on earlier and later years of the course, but these were not included. This was because they could not give as immediate accounts of their earlier years of study as current first and second years, and their perspectives would be less focussed on the first two years. Experiences are likely to differ more significantly across years, making it harder to find coherent themes between accounts. Investigating third and fourth year experiences would be valuable in future work.

2.2.7.4 Cross-Sectionality and Influence of the Coronavirus Pandemic

The study was cross-sectional, and all the interviews took place in the first three weeks of the Easter vacation. Responses will have been affected the point in the academic year when interviews were conducted. However, a longitudinal study was beyond the scope of this project and would be valuable in future research. Students' university and pre-university experiences will be somewhat defined by the coronavirus pandemic. Changes to course delivery and university life will affect how their chemistry enthusiasm has changed since starting the degree. This may make their responses less transferable for future students. However, the pandemic has altered the pedagogical landscape forever; many course changes persist, for better or for worse. Students' experiences of these novel teaching methods give them a unique perspective.

Chapter 3: How Enthusiasm Affects Perceptions of Workload

3.1 Why workload?

As explained in **section 2.2.3**, workload was a feature of the degree that was found to significantly interact with students' enthusiasm. Due to the ubiquity of this rich theme across responses, it seemed valuable to focus the project on workload and its interplay with enthusiasm. This chapter explores how enthusiasm affects the experience of workload, addressing research question 2: 'How does enthusiasm affect students' experience of workload?' whilst simultaneously validating whether or not interest theory can be used to model enthusiasm (research question 1).

Overall, this chapter shows how enthusiasm makes it easier for students to work. By exploring how participants express this idea, analysis presented develops an account of enthusiasm which centres the concept of well-developed individual interest (WDII).

3.2 Workload: Looking to the Literature

The workload literature often distinguishes between two types of workload: **objective workload** and **perceived workload**.⁴¹ A study found that actual workload only explained 4% of the variance of perceived workload: this indicated that perceived workload is a complex function of a variety variables beyond objective workload.⁴²

3.2.1 Objective workload

Objective workload is the time students actually spend on studying and learning in a given course and includes time they need to complete learning activities (including contact hours), projects, independent study and exams.⁴¹ Measures have been developed, but large variation in students' time required for learning tasks makes it hard to estimate objective workload.

3.2.2 Perceived Workload

Perceived workload is a combination of the demands placed upon the student and the effect that these demands have on the student (*e.g.* triggering frustration and stress).⁴¹ Perceived workload can be categorised into two distinct subtypes: **quantitative** and **qualitative**.

3.2.2.1 Quantitative Perceived Workload

Quantitative perceived workload describes the time or amount of work demanded by the task.⁴¹ This differs from objective workload, as perceptions of available and necessary time for studying may not reflect how much time students actually invest. Quantitative workload can be divided into good workload and bad workload. Good workload is the amount of time students spend on activities seen as useful (*e.g.* a helpful lecture), and bad workload is work time spent on activities seen as not useful (*e.g.* not paying attention in a lecture). The number of learning and assessment tasks also affects perceptions of a workload's manageability.

3.2.2.2 Qualitative Perceived Workload

Qualitative perceived workload refers to affects arising from the workload, including stress, pressure, overburden, and frustration.^{41,42} I suggest that this definition could be expanded to include other negative affects *e.g.* tiredness, pain, anxiety, panic, and overwork.

3.2.3 Interest Reduces Perceptions of Workload

Previous studies have linked interest to lowered perceptions of workload and lack of interest to excessive perceived workload.^{41,43} Because ID can be supported by the environment, these findings support that students' perceived workload could be reduced without reducing their objective workload. However, their research also suggested that there is a limit to the effects of interest: an excessive perceived quantitative workload could overwhelm interest in a subject, so that students experience a negative qualitative workload overall.

3.3 Results and Discussion: Enthusiasm Made it Easier to Work

3.3.1 Context: The Oxford MChem has a Heavy Workload

All participants, apart from Tutor 3, discussed elements of workload as a feature of the degree that affected students' enthusiasm. The degree was characterised as demanding: the contact hours were perceived as high, the content was heavy (high in volume, wide in breadth, and difficult), and the number of tasks and deadlines required a student to develop a wide variety of distinct skills rigorously. Heavy workload was associated with Oxford degrees and chemistry degrees in isolation, and it was suggested that the combination of both resulted in an even higher workload for the Oxford MChem course specifically. Due to the course's reputation, participants said students who apply expect the heavy workload.

'Chemistry has many many more hours than other subjects' – Student E

'You've willingly gone to the university with the highest workload and most contact hours [...] we do a masters worth of content in 3 years, which is a lot' – Student C

'They've chosen hopefully what they realize is a demanding degree. Then they see what it's like, halfway through 1st term of 1st year. They're like, oh, OK, this university level chemistry, this is Oxford Chemistry, and it does shock quite a number of them, in terms of the content and what we're actually studying and expecting of them.' – Tutor 2

'We're expected to spend 40 hours [each week] on the reading and questions [for tutorials]. Being told that number made me think what am I signed up for' – Student B

Despite this reputation, many participants implied that the workload is initially a shock for most students, and some students could never adjust to it.

3.3.2 Quality of Work

Tutors attributed high quality tutorial work to student enthusiasm. Reasons given for this increased effort included an optimistic outlook on their work, increased feelings of autonomy and competence, as well as enjoyment and interest associated with the work.

'Since there's quite a few required lab hours and quite a few contact time hours, you can see enthusiasm by how much effort people put into their work' – Student E

They speculated that when students were enthusiastic, they were more diligent and tended to produce higher quality work. Tutors suggested enthusiastic students were better at coping with the degree's demands because they dedicated more time and effort to their study.

'It might be the enthusiasm means that you do your homework diligently and so the quality of your work output goes up as a function of time, because you're just simply dedicating more hours because you're enthusiastic' – Tutor 1

'Part of [measuring a student's enthusiasm] would be is their output good? [...] Are they answering all the questions you've set to a good standard? You would then infer from that that they were enthusiastic about the topic' – Tutor 2

'Someone could be enthusiastic and shy and so they might not want to contribute in tutorials and it might just be that their work shows a kind of a level of [...] diligence that shows that they're actually enjoying it.' – Tutor 4

Another potential reason why students might produce high quality work is that they find it easy. However, some tutors discussed cases of when students have struggled with their work or got it wrong, but they could still see enthusiasm. This included evidence of engagement, perseverance or taking care with their work.

'If someone writes 2 or 3 pages in answer to each question, that's not necessarily enthusiasm [...] But sometimes you get notes on work from students saying I didn't quite get this or sorry, I struggled with this, but can we talk about it [...]. It suggests that they're engaged rather than just sort of looking at it and giving up.' – Tutor 2

'...it looks like they've taken pride in the work handed in even if it's wrong, rather than something that looks like it's torn out the back of an envelope' – Tutor 4

Enthusiasm is often not directly observable in students, so tutors attributed observables like work quality or evidence of effort to enthusiasm levels, even though other variables like content difficulty or external motivation also affect work quality. However, this attribution suggests an intuitive link between effort and enthusiasm: enthusiastic students work harder.

3.3.3 Enthusiasm Reduced Perceived Effort

Some participants implied that the correlation between enthusiastic students and increased effort occurred because enthusiasm made it easier for students to put in effort. This stemmed

from chemistry interest associated with their enthusiasm. Enthusiasm was motivating; this was important in the context of maintaining motivation in a difficult degree.

'I think that [enthusiasm and grades] do interact because I think that if you're enthusiastic it's much easier to work hard if you are interested in the subject. It's very difficult to stay motivated, so enthusiasm definitely does help.' – Tutor 4

'If you're enthusiastic about something surely it's easier to get started with putting in that effort to pursue whatever you want to pursue. [...] It's been significantly harder for [my less enthusiastic friends] because they've had to work harder at overcoming that [...] procrastinative urge that presents this massive hill that we have to climb up before we get to do our work.' – Student D

Student D implied that increased feelings of effort arising from lower chemistry enthusiasm has a two-fold effect on workload. Not only does work feel more effortful once unenthusiastic students start working, but they are also intrinsically less motivated to work to begin with and so must work harder to resist procrastination and begin working.

3.3.3.1 Perceived Effortlessness in Interest Theory

Participants attributed perceived effortlessness and motivation to enthusiasm, which supported that interest theory could model enthusiasm. The psychological concept of interest is characterised by increased attention, effort, and concentration as well as reduced feelings of effort.²³ Sustained attention increases students' ability to dedicate effective time to study, enabling them to cope better with the time constraints of a high objective workload.³⁷

Furthermore, Student D's comment *'when you're enthusiastic about something [...] I suppose it comes back to that saying 'time flies when you're having fun'* echoed the concept of flow, an aspect of interest.^{23,44} Flow refers to *'the psychological state of engagement during which a person is so focused on an activity that they may lose track of time'*. When students are interested in a subject, they may feel like they spend less time on it, reducing their perceived quantitative workload, while the perceived reduction in effort reduces their

perceived qualitative workload. Here, reduced perceived workload lets students work harder, actually increasing their objective workload.⁴¹ It may reduce students' avoidance of associated tasks, reducing their feelings of time pressure and stress; this reduces qualitative workload. Kyndt *et al.* also found that when students are interested in a subject, they spent more time on it but perceived a lower workload, demonstrating how perceived and objective workload are not always correlated.⁴¹ Students perceived a higher workload in subjects they are not interested in, despite dedicating less time (or effective time) to it.

3.3.4 Enthusiastic Students Enjoyed Chemistry Study

Most participants said that enthusiasm was feeling enjoyment or interest in the subject.

'[Enthusiasm] relates to enjoying the course, feeling pleased that you chose to study that, it's something that you want to be studying. People could think it was a good choice, but not be enthusiastic. It has to go along with it being something you feel positive and enjoy and along with that this is what I want to be doing' – Tutor 4

'I often procrastinate less if I know I'm going to enjoy something' – Student D

Enjoyment was an intrinsic motivation for students and linked to the reduced effort enthusiastic students experienced, partially explaining why enthusiastic students work harder. Some participants said that enthusiasm made study feel less like an obligation.

'If there's lack of enthusiasm, it'll be just seen as work, doing the problems 'cause you have to do the problems, doing the lab 'cause you have to do the lab. For the sake of paying for the degree, you have to show up [... If] you have some positive outlook on that work the enthusiasm [...] makes it less work-like' – Student C

'I think [enthusiasm is] finding studying not a chore' – Student B

Enthusiastic study felt like a choice because students intrinsically wanted to do it. This is in line with research which has shown that interest increases feelings of autonomy.²³

3.3.4.1 Enjoyment in Interest Theory

Although interest and enjoyment can be triggered separately, they are often complementary and reciprocal.²⁴ For ID, students must experience both enjoyment and interest in their learning. *'Interest and enjoyment are a hallmark of capable, confident and enthusiastic learners.'*²⁴ The two affects become increasingly correlated as interest develops into WDII. Participants' association of enthusiasm with enjoyment and interest supported that enthusiasm is closely related to the concept of WDII.

Developing interest will increase students' enjoyment of the workload, which reduces their feelings of negative affect associated with qualitative workload and allows them to feel more autonomous in their studying, also increasing their feelings of vitality. However, part of ID is simultaneously experiencing enjoyment. Students with lower chemistry interest will have lower intrinsic enjoyment of the subject, so they will need more external support to experience enjoyment, allowing them to develop their interest.

3.3.5 Enthusiasm Increased Perseverance

Despite strongly associating reduced effort and enjoyment with enthusiasm, participants believed that enthusiastic students still found the course demanding and did not enjoy all their work. Instead, enthusiasm was seen as an *overall* enjoyment of the course.

'You can be very enthusiastic about chemistry without needing to enjoy all of it, but certainly having lots of areas where you do really enjoy it and that enjoyment outweighs any of the difficulties that they you face. – Student E'

'You could be studying a course that's taught in a very dry and boring way, but still intrinsically enjoy the subject. [...] It's being enthusiastic about [...] the subject area and thinking I really like this, I really want to study this [...] even if you're not enjoying the course at that moment' – Tutor 4

'If you have [...] just a bit of enthusiasm for chemistry and you're going to do a chemistry degree, the workload will easily swamp that, and you'll have a miserable time. But if you've got loads of enthusiasm for chemistry, you [can] push through that and you have a little bit of a fun time with it' – Student D

Enthusiastic students were seen to persist with aspects they did not enjoy, and enjoy aspects they found difficult. For unenthusiastic students, being unable to persevere through the difficult workload was a barrier to overall enjoyment of the course.

'Instead of saying it was terrible, it was difficult and scary they may say, yeah, OK, it was a good experience, it was a challenge that they enjoyed' – Student E

'The benefits to teaching as though people are enthusiastic about chemistry are you can teach with enthusiasm about this subject that you're interested in, and they will hopefully rise to that and see the benefit in rising to the challenge and seeking harder things and grappling with more and more complex materials' – Tutor 1

This reduced the negative affect they experienced when attempting difficult work, reducing their perceived qualitative workload. Enthusiasm also caused students to understand the value of tackling hard problems and enabled them to stretch themselves academically. On the other hand, unenthusiastic students would shy away from areas they saw as difficult.

3.3.5.1 Perseverance in Interest Theory

Being able to persevere through negative affect to meet goals distinguishes WDII from other interest; in all other phases, a person may not cope with the frustration arising from challenge.²³ This suggests enthusiasm is congruent with WDII and reduces qualitative workload. Students who lack WDII may find the degree too challenging. Furthermore, participants often described chemistry enthusiasm as an enduring disposition, rather than an instantaneous state, suggesting it is closer to individual interest than situational interest.

3.3.6 Enthusiasm, Passion and Individual Interest

Participants' association of enjoyment and perseverance with enthusiasm suggested it is congruent to WDII. Appeals to 'passion' during the interviews supported this further.

'It's not completely the same, but also passionate about it. Passionate is maybe even one step higher, but to me still directly related to enthusiasm.' – Tutor 5

'You're just so interested in chemistry and passionate about it.' – Student A

The concepts are not quite synonymous; passion occurs when a WDII becomes integrated with a person's identity, so all passions are WDII, but not all WDII are passions.⁴⁵ Descriptions of passion as or beyond enthusiasm suggested that enthusiasm contains WDII.

3.3.7 Enthusiasm Was a Desire to Go Beyond

Enthusiastic students were characterised by a tendency to engage with chemistry beyond expectations. As well as putting more effort into their set work as described earlier, this also included doing super-curricular activities that related to chemistry, such as wider reading.

'You want to learn more about the subject and do reading and look at research papers because you want to find out about it not in the interest of passing an exam or getting the degree at the end, it's a consequence of enthusiasm as you want to learn for the sake of learning, rather than for a specific output' – Student B

'If you're enthusiastic about something, it implies that you do things about it, that in your spare time you learn about it or you engage with it' – Student C

'[Enthusiasm means] desire to learn more or do more, or study more' – Tutor 3

'You can see enthusiasm by [...] how willing they are to express and talk about their work outside of [their required hours]? [...] are they still reading about chemistry and do they look forward to the next chemistry tutorial or lab?' – Student E

'Many students that are enthusiastic about starting chemistry, understanding more concepts and being able to link the concepts from the fundamental theory [...] in physical chemistry with inorganic chemistry, and ask about the samples, how we measure them in the lab. That's a clear example of an enthusiastic student' – Tutor 5

In this conceptualisation, enthusiasm meant a desire and motivation to learn more; this desire was primarily due to intrinsic factors such as interest, passion, and enjoyment, and not driven by external factors such as academic performance. Enthusiastic students were less concerned about learning within the bounds of the syllabus because they are not learning just for the sake of getting a good degree. This suggests they were more concerned with mastering general chemistry content rather than performing well during exams.

Enthusiastic students were curious. In tutorials, they were attentive, asked deep questions that were beyond the scope of syllabus and willing to answer questions in a tutorial setting.

'I would characterise a student as enthusiastic about a subject if they ask me questions that extended beyond how to solve this particular problem and ask more philosophical questions that address ideas of how you do this experimentally or what does this result mean in the context of an experimental observable' – Tutor 1

'[Enthusiasm] manifests itself through evidence of engagement, so responding to questions, asking questions. Real evidence they're thinking, listening, trying to move to the next part of the problem, thinking beyond the question that's asked.' – Tutor 3

'If it was a tutorial context, it's someone who looks as though they're being attentive, actually listening [...] willing to have a go at answering [questions...] People who are enthusiastic like to talk about their subject, maybe asking questions' – Tutor 2

Asking and answering questions were seen as evidence of the engagement associated with enthusiasm. Enthusiastic students want to ask beyond their set work and make connections to other parts of chemistry. This not only implied that enthusiastic students favoured deeper learning, but that they already had deep enough knowledge to ask profound questions.

3.3.7.1 Interest Theory and the Desire to Go Beyond

Individual interest in a person is characterised by independent reengagement, reflection, answer-seeking, and identification of resources that allow their knowledge to deepen.²³ Enthusiastic students' propensity to ask questions and identify resources, such as research papers, implied they had those tendencies indicative of individual interest.

Part of workload is locating information.⁴¹ If students with individual interest tend to seek resources that help them deepen their knowledge, this may reduce their qualitative workload relative to less interested students. Furthermore, being able to ask questions to a knowledgeable person is thought to reduce objective workload as it is faster than searching through a library or the internet.⁴¹ If interested students ask more questions, particularly in tutorials, this may facilitate a greater reduction of their peers' workload.

Two studies showed that students with developed interest were more focused on content and less burdened by performing well, compared to their less interested peers.^{23,46,47} Despite weaker achievement goals, more-interested students outperformed less-interested students.

Developing interest in students may reduce their qualitative workload by reducing the pressure they feel to achieve through weakened performance goals. Nevertheless, they still achieve more, perhaps due to an increased propensity for deep learning.

3.4 Summary and Conclusion

The data validated the applicability of FMID to enthusiasm. The association of enthusiasm with enjoyment, perseverance, and passion suggested that chemistry enthusiasm is a type of WDII. Furthermore, the data and interest theory suggested that interest helps students manage high objective workload. In line with workload research, interested students perceived lower qualitative workload and tended to work more effectively and for longer.^{41,43} Interest reduced qualitative workload through increased feelings of effortlessness, enjoyment, autonomy and competence; and through reduced negative affect associated with challenge, achievement goals and procrastination. Interested students also coped better with high objective workload by spending more time on their work, favouring deep learning strategies and mastery of skills, and avoiding their work less.

However, the fact that enthusiasm increases students' ability to work hard and reduces their qualitative workload may lead to the counterproductive assumption that qualitative workload can be reduced enough by increasing enthusiasm independent of workload. Enthusiasm, like interest, is not infallible – even WDII is not immune to receding completely – so features of the learning environment (like workload) will affect whether enthusiasm grows or shrinks.²³ Studies have also suggested that even interested students can experience excessive workload.^{41,43} Therefore, it is plausible that changing the nature of workload would increase student enthusiasm, so we should examine how workload affects enthusiasm. **Chapter 4** will explore this relationship.

Chapter 4: How Perceptions of Workload Affect Enthusiasm

Chapter 3 established that well-developed individual interest (WDII) was a useful approximation for enthusiasm and explored how enthusiasm can reduce the perception of workload. **Chapter 4** explores how workload influences enthusiasm.

4.1 Results and Discussion: Workload Can Make or Break Enthusiasm

4.1.1 Excessive Workload Reduced Enthusiasm

Excessive workload could reduce or overwhelm students' enthusiasm.

'Excess pressure and workload rapidly kills enthusiasm' – Tutor 4

Oxford's high objective workload increased students' negative affect associated with their work; this was seen as a significant cause of enthusiasm loss for students.

'You might be incredibly enthusiastic about something, but then when presented with [the] workload it can get a bit much.' – Student D

'We could do a little bit better. I think it's very heavy [...] obviously we are making good chemists, but we can make good chemists without it being that heavy and hard, sometimes students don't need to suffer that much' – Tutor 5

'The workload is massive. Getting used to that affected how much I liked chemistry in the first couple of terms because I thought is it worth how much time I'm having to put in?' – Student B

4.1.1.1 Did Qualitative Workload Reduce Enthusiasm?

Perceived qualitative workload is the negative student affect that results from the demands of study and is determined by the interaction of learner characteristics with the learning environment. **Chapter 3** suggested that interest is a characteristic which reduces perceived workload. Participants described how high qualitative workload reduced enthusiasm.

'Pressure is linked to that feeling that things mightn't go as well as you hope. That things could go wrong is very demoralising and can quench enthusiasm quickly' – Tutor 4

Repeatedly experiencing negative affect is demoralising. This may reduce the students' value for chemistry study, inhibiting their ID. However, it is possible to experience significant qualitative workload and still have chemistry enthusiasm:

'It's hard to disentangle the enthusiasm students feel with the subject from their exhaustion at the end of 2nd term. I [ask my 2nd year students] how are things? And they say just really tired and want to get through [supplementary exams...] That comes across as not being enthusiastic. But when you ask if they enjoyed the supplementary, they say they found it interesting and liked the material they did in the core course too. It's just a bit too much condensed' – Tutor 2

'Sometimes it's too heavy for them, but I don't think it makes them lose enthusiasm. It makes them panic, but it's not the same [...] [When students see exams] they can be like Oh my God, I'm not going to be able to go through it and they don't know how to deal with the situation. That doesn't mean they aren't enthusiastic about it. Because you are feeling panic inside you are not able to enjoy or show your enthusiasm, but you can still panic about things and be enthusiastic. [...panic is] such a strong feeling that it dismisses all the other feelings' – Tutor 5

If experienced enthusiasm is enjoyment arising from triggered interest, qualitative workload may reduce students' experience of associated positive affect, as well as reducing their general vitality, masking their enthusiasm. Negative affect may overwhelm enthusiasm as a student state, but not necessarily as a student trait. However, responses implied that excessive qualitative workload would reduce enthusiasm in the long run. So, high workload can significantly reduce enthusiasm, but it does not always reduce enthusiasm. How can we use theory to better understand the underlying phenomenon?

4.1.1.2 How Does Excessive Qualitative Workload Reduce Enthusiasm?

Chapter 3 concluded that enthusiasm may be congruent with WDII. Enjoyment is a necessary trigger for interest to develop into WDII, and WDII is strongly associated with experiencing enjoyment during reengagement. If high qualitative workload means students cannot enjoy their work, this may stop their ID. If they associate chemistry study with negative feelings overall, they may avoid their work and even reduce their engagement with

all chemistry content, reducing their interest.

4.1.2 Time Pressure Increased Qualitative Workload

A consequence of the heavy workload was that participants felt as though they did not have enough time to do and learn all the work they were being set.

'It's not that I haven't worked hard, there's just physically not enough time' – Student A

'They don't have time to grapple with the material because there's so much' – Tutor 1

Whether or not the quantitative workload was high, the *perception* of a lack of time made participants lose enthusiasm.

'Everyone's a little bit overworked and just keeping their head above water and that is at odds with finding ways to become enthusiastic about academic material' – Tutor 1

'Most of the chemists I know [...] all seem to feel drained. [...] There's not enough time to do anything. [...] because there's such heavy amounts of content. [...] I'll overwork myself during term time but then during the vac I just feel demotivated and I'll just sometimes I ask myself like why am I still doing this degree? Because it's just so painful.' - Student A

Pressure to do lots of hard work in limited time may cause students to feel out of control of their learning, as well as negative affect – the work feels undoable and they worry about falling short of expectations. They may overwork themselves to avoid academic failure, resulting in fatigue and burnout which reduce feelings of enthusiasm. Perceived lack of control over time may make them feel less free, autonomous, and competent, reducing their interest and vitality.

There is evidence that 'having time' is a necessary condition for experiencing a manageable workload, but not a sufficient one: an infinite amount of time does not guarantee learning.^{42,48} In a study of students' perception of workload, 9 out of 20 engineering students indicated that excessive material or contact hours were the main causes of their perceived workload.⁴¹

4.1.2.1 Objective Time is Necessary for Interest and Learning

'Having time to grasp what you're learning can help enthusiasm. That helped me during my A Levels, that I had quite a lot of time to grasp the content and be content with it' – Student A

'You could get more out of [students] in the long run if you gave them that little bit of space. The best things come from when you've internalized the material you're being taught, and [...] you can start seeing the links between things. The most I learn on any day is the 15 minutes cycle to and from work because it's the only time that I have a complete space to think [...] I really benefit from and enjoy it and hope that students also get similar opportunities' – Tutor 1

There is a physical limit to how much can be learned in a given amount of time; even if students did not perceive a lack of time, objective lack of time would still reduce their learning, as well as their interest. For interest to develop, students must connect what they are learning to their internalised knowledge, which requires time and learning.²³ In earlier phases, connections may be outside of the discipline, whereas in later phases these become intra-disciplinary.²³ By thinking about the connections they make, students develop knowledge and identify its value. Again, reflection needs time and external encouragement. Lack of time arising from heavy workload may directly reduce students' interest as they do not have time to make the connections or time to reflect on what they are learning.

'[a reading week would give a] little bit more breathing space and a little bit of time for opportunity for reflection, more than just crushing deadlines.' – Tutor 1

4.1.2.2 Time to Explore? Heavy Workload and Super-Curricular Interest

Something that made enthused students was the freedom to explore chemistry content.

'Going beyond is what drove enthusiasm before university [...] now going beyond might be a bit much because we've got enough beyond going on'. – Student C

'The freedom that they have in [tutorials] to think, and to move beyond the question that might originally be posed most of them, they really love that.' – Tutor 3

Students found that the heavy workload, lack of time, and volume of content to be learned for exams meant that they were unable to engage with super-curricular chemistry contents.

Some participants implied the course fulfilled students' need to go beyond; the depth of explanation was satisfying, and they did not need more time to identify areas of interest due to the breadth of material, unlike at school.

'There is plenty of material in the Oxford course that makes students enthusiastic. They cover almost every area of chemistry in their undergraduate syllabus so there's maximum opportunity for people to find areas to become enthusiastic about.' – Tutor 1

'Finding out the limits of classical mechanics was interesting in terms of a molecular perspective 'cause there are things that happen on the quantum level which can't be explained with classical mechanics. It was interesting to have confirmation of something that once my chemistry teacher told me 'it just does. Don't worry about it'' – Student D

The supplementary subjects in second year were identified as a valuable opportunity for students to choose to go beyond the syllabus. However, tutors identified these as a feature that made the workload excessive for many students, diminishing enthusiasm overall.

'The time that I currently see [excess pressure and workload kill enthusiasm] the course is around the time of the 2nd year supplementary subject exams'. – Tutor 4

'Inherently doing the Quantum supp is going above and beyond a little bit' – Student C

'There's incentives to do [the supplementary subjects] and there's a bit of an arms race to do them. Everyone feels they have to do at least one in 2nd year to not fall behind everyone else.' – Tutor 2

Although they were optional, strong incentives meant that many students did not see supplementary courses as exploratory or a choice. If students are already finding the core workload excessive, they may not have time for exploration through an additional course.

A lack of time for super-curricular study reduced some students' enthusiasm. One participant said there was time for this in vacations, but other participants' responses implied this was not the case: the holidays were already spent catching up on and consolidating the previous term's content.

'You can still be enthusiastic because there are vacation periods where you can do some internships and look at additional bits of chemistry' – Student E

'There's no time in [term to look into what you want to look into from a tutorial]. It's gonna be over the vac, where there's other things that you need to do too' – Student B

4.1.2.3 Students Need Time to Self-Regulate Their Interest

Some students felt that more time would let them self-regulate their chemistry enthusiasm: by identifying content they valued more and connecting it to required content they valued less, students could increase their overall chemistry enthusiasm. The heavy workload made it harder to become curious about chemistry and explore specific areas of chemistry that triggered their personal interest.

'There's so many wider concepts you could look at to broaden your understanding and see the real-world applications. If you're set all this theoretical work, there's no opportunity. I get to the point where I'm going, what's the point of doing this? [...] The workload means that anyone who does the degree will have a very good understanding of chemistry [...] but not necessarily for creating a passion and people who want to stay in it because they found one thing that happens to not be in lectures' – Student B

'[The structure] doesn't lend itself to inquisitive thought [because students feel like] "I [don't] have time to process the things that I do and don't get and how these things relate together because I've got 2 tute sheets due in 4 days' time and I need to get them bloody done.'" – Tutor 2

A study of veterinary students also found that heavy workload meant they did not have the opportunity to focus on their areas of interest.⁴³ Excessive workload reduced their opportunities for self-direction, reducing their interest and motivation, and they appeared to be surviving rather than enjoying the work. Although ID is usually supported externally, students also identify regulatory processes that increase their interest, such as modifying the task or goals, to contribute to their continued engagement – this may involve wider reading to help them identify value in the content.

Opportunities to engage of their own volition may intrinsically increase students' perceived autonomy when engaging with chemistry, increasing their enthusiasm.

'[At school] freedom and encouragement to think for yourself, not regurgitate what someone else has written [...] was rewarding and made me love chemistry' – Student C

When students are motivated autonomously to perform a task and can self-regulate this enhances their vitality compared to controlled activities.³⁰ More time lets students engage with chemistry out of enjoyment, increasing their chemistry interest and reducing their relative external motivation. For ID, student interest should be triggered externally, but if students are encouraged to self-regulate their ID this may also increase their autonomy and vitality.

4.1.3 Gaining Control: How Responses to Workload Affected Enthusiasm

4.1.3.1 Perceived Control Increased Enthusiasm via Qualitative Workload

Being on top of work was important for feeling enthusiastic.

'It's natural to be discouraged if you end up with a massive pile of work or you stay up too late doing it or just busy busy, you're tired after 2 labs, but things are manageable and it's my error lifestyle-wise that would make those annoying.' – Student C

'There are times in 1st year when things come together. Students have got the time management sorted, they've got it all going. Suddenly, they feel 'I can do this' and that gives a real boost and brings back to life any enthusiasm that was deadened.' – Tutor 4

When students felt out of control with their work, they experienced stress and anxiety. Conversely, if students gained control, this increased their enthusiasm. These findings suggest that perceived control mitigates qualitative workload. This may be because gaining control of the workload satisfies students' competence needs as it proves they have mastered chemistry skills. Perhaps losing control reduces their competence and increases feelings of failure; to regain control, they feel obliged to work more, reducing their feelings of autonomy. Falling behind may reduce students' enthusiasm via frustration of their needs.

The Oxford MChem course had a heavy workload, making it hard to gain control. Participants said if students could gain control, this heaviness boosted enthusiasm; perhaps control over a heavier workload increases perceived competence relative to a lighter one. However, some students adopted strategies to gain or maintain control of the workload that

reduced their enthusiasm; for some, the workload was too much for them to ever feel in control. Feeling in control was a necessary condition for enthusiasm, but not a sufficient one.

4.1.3.2 High Workload Increased Superficial Learning

Time pressure forced students to study superficially, particularly when tackling set work. Students could not increase the time they had for each task, but they could reduce the amount of time they spent by doing it less thoroughly. During term time, many students' energy was spent on their deadlines, so internalising the content was a future priority.

'They're very good at solving problems [but not] rationalizing things. They skim on the details of their explanations [...] they don't have time to grapple with the material because there's so much of it. They're cramming it in and cranking through sheets and solving problems, and they'll worry about internalizing it later, [which isn't] a manner conducive to making people enthusiastic.' – Tutor 1

Intuitively, a rigorous degree should help students access **deep learning** (learning with understanding) rather than **surface learning** (temporary learning) (**Table 4.1**). When students perceive they have insufficient time due to a high workload, they feel overloaded. This may cause them to abandon deep learning strategies.^{41,48}

Deep Learners	Surface Learners
Seek to understand the issues and interact critically with the contents of particular teaching materials	Try simply to memorize parts of the content of teaching materials and accept the ideas and information given without question,
Relate ideas to previous knowledge and experience	Concentrate on memorizing facts without distinguishing any underlying principles or patterns
Examine the logic of the arguments and relate the evidence presented to the conclusions	Are influenced by assessment requirements

Table 4.1: a summary of Deep and Surface Learners⁴⁹⁻⁵¹

4.1.3.2.1 Superficial Learning Reduced Enthusiasm

Too much work in limited time forced students to rush their work and adopt superficial learning strategies, which reduced students' enthusiasm.

'Being able to really understand something deeply [enthuses me...] I've been given so much work I'm running out of time. My understanding feels much more superficial. It feels more like skim-reading a text, which doesn't at all deepen my enthusiasm, because I feel like I'm not getting nearly as much out of it as I could' – Student B

'[To make students more enthusiastic we could] get rid of supplementaries in 2nd year. 2nd year's already hard enough and they could at least focus on the 2nd year material, which is interesting and important stuff that needs to be in a good chemistry degree. Some people just have to rush through it.' – Tutor 2

This echoed FMID because gaining knowledge and value is central to ID: superficial learning is dissatisfying. For Student A, the transition to second year was especially damaging. They devised deep learning strategies in first year, but lack of time in second year caused them to abandon these in favour of superficial study.

'[1st year] was more manageable, the content wasn't as heavy, so I had time to grasp the concept while doing the problem sheet, but in 2nd year, I find myself digging through lecture notes for answers rather than understanding the content.[...] When you haven't understood something you learned last week [...] it unmotivates you when it comes to studying [the next topic...] so then all the enthusiasm you had about chemistry and like all the love you had for the subject just disappears because you're just, tired of doing things that you don't get enough time to understand.' - Student A

Superficial learning and loss of interest became a vicious cycle. They could not internalise enough knowledge to begin with, so that when they moved onto a new topic, they had an insufficient basis to make connections with. The frustration that came with not understanding something properly demotivated them when they came to study new topics; perhaps new topics got in the way of learning the previous one properly, or they anticipated they will not be able to learn new topics deeply either. They are 'tired' of learning with insufficient time, hinting that surface learning can reduce student vitality.

Students' tendency to adopt superficial learning strategies may let them remain in control, but at the expense of feeling competent in their study: they were unable to gain understanding and autonomy when driven to learn in a less satisfying way. Perhaps this becomes a rational decision if losing control of the workload would reduce their autonomy

and competence more. Students also found superficial learning unsatisfying; their lack of understanding meant they were unable to experience the positive affect generated by interest. If lack of time prevents students from feeling competent and autonomous in their chemistry study, engaging with chemistry will frustrate their competence and autonomy needs, so they are likely to lose interest and vitality, reducing their motivation.

4.1.3.3 An Aside: Breadth Also Increased Superficial Learning

Students found that it was not necessarily the volume of work that made the heavy workload feel dissatisfying, but also the number of topics or breadth of work.

'We don't learn about a topic long enough. Maybe there's 7 lectures [...] but we always seem to stop short of the bits to be able to do something.' – Student E

'[In labs] you have more time [so] you can improve like lab report to lab report to lab report because the concept of a lab report and analyzing data stays the same throughout whereas with problem sheets there's obviously different concepts every time. [...] you can't really improve on that one topic because the next week, you have something else, so it's like hard to time manage it' – Student A

'Is it actually beneficial? Do we want them to learn 300 compounds by heart for the exam that they will forget forever? It makes sense that instead [...] we teach them 100 with real life applications so that they can learn them forever' – Tutor 5

Breadth increased perceived workload; when topics were less related to each other, it made it harder to make intradisciplinary links and improve understanding over time. This damaged students' competence and the value students placed on the content. In turn, this encouraged superficial learning; with insufficient time for each topic, students perceived insufficient time to learn each topic deeply; some students resorted to memorisation.

4.1.3.3.1 Unclear Expectations and Recall-Based Exams increased Breadth

Part of adjusting to the workload was learning expectations, but students said some aspects of the course expectations were never clear, such as what material was examinable.

'Organic feels like brute force say as much as you possibly can, any type of niche thing, anything. Remember as much as you can [...] Whereas if we had a mark scheme like other places it would help us focus on memorizing key concepts, and learning them, instead of remembering the most obscure things' – Student E

'It can be frustrating when the majority of a course is just content, because then it gets very scary very quickly if the lecturer mentioned like 50 examples and I don't know how many of these are in the course or expected material and do I have to memorize all of these and then it gets very like disheartening, you don't want to bother' – Student C

This vagueness increased students' objective workload significantly as they felt obliged to memorise as much as they could from lectures in case it came up in exams. It also increased their qualitative workload because not knowing what was required reduced their feelings of control. The exams were also seen to favour recall (including unnecessary or niche content), increasing the breadth of memorisation students felt they had to do. The low value students saw in memorisation made them feel less enthusiastic.

'The stress on memorizing is too great and surprising because I looked forward to coming to uni to develop problem-solving skills. But I've pulled that right back and stopped myself trying to figure things out because as soon as I stopped trying to figure things out myself and just started memorizing my grades instantly went up and that really pulled my enthusiasm back [...] if there was more stress on problem-solving I would be developing more skills and even though chemistry has many many more hours than some other subjects, it would be worthwhile because I'd gain so much [...], my enthusiasm for chemistry would skyrocket because it would make every hour that I worked rewarding' – Student E

Student E emphasised that even though their grades had gone up from below 50% to always above 70% (suggesting they had gained control over the workload), this had made them lose enthusiasm because the degree rewarded superficial learning: perceived control is not enough to feel enthusiastic if the work is unsatisfying or lacks value. For some students it seems that a heavy workload does not inherently make them lose enthusiasm, but a heavy workload amplified the reduction in enthusiasm caused by unsatisfying or low value work.

4.1.3.4 Successful Workload Control: Labs, Time and Deep Learning

All students said that the practical course increased their chemistry enthusiasm, despite some participants saying that the lab course was generally unpopular.

'A lot of people don't like labs. I really enjoy labs and controversially I really enjoy doing the lab reports as well' – Student D

'A lot of students don't engage well with the practical course'. – Tutor 3

Labs were seen to increase qualitative workload because their high objective workload contributed to students' objective lack of time. The high number of contact hours were physically tiring and took an unavoidable chunk of time out of students' week, reducing their time for other tasks; lab write-ups also added to their long list of priorities.

'[Students think] all my friends doing English and history have nothing to do and I'm in the lab 2 afternoons a week and doing 20 hours of tutorial works on top' – Tutor 2

'We're expected to do about 40 hours of preparation for each tutorial, which obviously is a lot plus labs plus lectures' – Student B

The MChem workload was seen as uniquely heavy; this was partly due to the relatively high number of required hours, including labs, additional to set work within Oxford's short terms. However, students did not feel time pressure *within* the lab context.

'You have all those [lab] hours to improve on your lab techniques so it's a slower-paced learning. [...] It's easier to grasp a lab technique because you have to keep on doing it over and over again.' – Student A

The high number of lab contact hours increased students' quantitative workload, but did not directly increase their qualitative lab workload because students *felt* that they had sufficient time. Students felt autonomous in their lab work and learning, and the ability to learn deeply meant they felt more competent: the relative narrowness of techniques or concepts meant they perceived greater opportunity to practice and improve. This echoes another study where students said that project-based work required a large time-investment, increasing their perceived quantitative workload, but they perceived the qualitative workload to be low because the environment was motivating - project-based approaches enthused students because their interest was triggered by the link to practice and creating something tangible.⁴¹

'I like how at the beginning and end of each day we almost have a clean slate, where everyone is brought to the same level of again, some faster than others, but no one is left behind. [...] everyone has to gain something in order to leave the lab' – Student E

Although the obligatory lab hours may reduce students' course-level autonomy, because sufficient hours are dedicated each week to the lab, students' perceived autonomy in the lab itself increased; their highly structured pedagogy made it difficult to fall behind.

4.1.3.5 Reduced Work-Life Balance

Some participants expressed a way to cope with the high workload was to spend all your time studying. As a result, many students had a poor work-life balance.

'Sometimes [students] find problems with time managing – so being able to have a life and to dedicate some time to sport, to this and to the other at the same time that having the course because basically the course, it's all of your time' – Tutor 5

'In first year like I had time to kind of look after myself and go out and have fun along the degree. Whereas in in second year you just don't have time to do that'. – Student A

The degree could be manageable, but this came at the expense of having a life; to remain in control, students felt obliged to dedicate as much time and energy to it .

'I'm doing it all the time because I have to [...]. If I had more time, I probably would still spend the same amount of time on it, but it's this 'have to' versus 'want to' mentality It always feels more enjoyable when I'm choosing to do it rather than when I've got this deadline [...] I've got to get it done. [...] I would cut down how much you have to do [...] to promote a better work-life balance, which would increase my enthusiasm for chemistry [and I would] appreciate it more' – Student B

Poor work-life balance reduced autonomy, but this may be a necessary sacrifice to avoid the greater reduction in autonomy caused by falling behind. Even though students were interested in the work (and may have devoted a lot of time to it anyway), because studying felt obligatory, they enjoyed it less. Their autonomy that came from engaging with chemistry was reduced, reducing their chemistry interest. Students also could not spend time on their other interests, which would reduce their perceived autonomy and relatedness.

Perceiving a good work-life balance is negatively correlated with stress, anxiety, and depression.⁵² In students, depression and anxiety are negatively correlated with subjective vitality, so bad work-life balance may reduce enthusiasm via reduced general vitality.^{19,53}

4.1.3.6 Adjusting and Gaining Control Takes Time

First year was a period where workload extraneous to learning and understanding the degree content is significant. After the initial shock of university chemistry, there was a significant time period where students had to adjust before they could control their workload.

'Not everyone is prepared for [the workload]. That can severely impact your experience, because instead of thinking about what you're learning and enjoying [it], you're more worried about what you've got to do and how you've got to learn it' – Student D

'In the first term, students waste time worrying about what is required in tutorial work so they're much less productive. It tends to be the second term when they have lost that extra perfectionist trying to guess exactly what's going to be perfect, and they can be much more productive, that then they get on top of the workload rather than the workload getting on top of them' – Tutor 4

'The workload is massive [...] but you get used to it, work out how it works. And once you've got used to that, you can get back into enjoying what you're doing. [...] You get to know your tutors a bit better so you know you can ask them more like what their expectations are, so you get a little bit less worried about angering them' – Student B

This period included academic adjustment (*e.g.* developing time management and study strategies), expectations adjustment, and social adjustment to tutors and peers. It also included general adjustment (*e.g.* living alone for the first time). This adjustment period increased qualitative workload as students felt a lack of control in their new context.

4.1.3.6.1 You Can Never Adjust to a Too-Heavy Workload

Some participants expressed that it was not possible to ever feel in control of the workload:

'[In a job] after a period of time you get the hang of it, you know what you're supposed to be doing and when. With this degree, it doesn't feel like that like that. I thought my 2nd year would be better than my 1st year since I got a grasp and understood more revision techniques, but because the content got so heavy, so quickly, I didn't get time to adjust' – Student A.

'I'm not sure you can ever completely be used to it, but it's less of a shock' – Student B

The fact that some students were unable adjust to the workload might mean it was objectively excessive, or they were not given enough support to develop workload strategies. Developing successful study strategies is necessary for students' learning as well as feelings of competence and autonomy in relation to workload. If students cannot adjust to the workload due to insufficient time or support, this could thwart their needs satisfaction, and reduce their ability to learn, both of which may stifle interest.

4.1.3.7 The Precarity of Enthusiasm in Heavy Workload

When students adjusted to the heavy workload, this boosted their enthusiasm. The challenge of a heavy workload stretched them academically and their capability grew.

'It's a real balancing act because if you give a higher workload, people realise they can achieve more than they think they can. That can be a very positive thing and can really help their learning. But if it goes too far, it becomes counterproductive because they can't achieve it. And so they continually feel like they're failing and they're behind. Those are the sort of things that can rapidly get rid of enthusiasm' – Tutor 4.

Students may initially perceive that the workload is beyond their competence level and feel a lack of control over it. However, if they gain control of the workload, they surpass the limit of their expected competence, which enables them to feel relatively greater enthusiasm: *'It's like getting thrown into a swimming pool and finding you can swim' – Tutor 4.* However, for some students, the challenge of the heavy workload was too much. If students are unable to overcome their initial perceived incompetence, the heavy workload becomes counterproductive as they experience feelings of failure, lack of control and competence, significantly reducing their enthusiasm and increasing their qualitative workload.

'For other students it's too much. They still go through it. They are happy that they finished, but once they finish, they need a break from chemistry' – Tutor 5

4.1.3.7.1 A Lack of Slack

If students fell behind, it was hard to catch up due to the time pressure of the course.

'If a student had flu and they missed a week they were trying to catch up and they weren't feeling that great, the same set of circumstances that [really boosted the student who] actually managed to do it all [would demotivate the student that had been ill]' – Tutor 4

The margin between a high workload benefitting or damaging student enthusiasm is narrow due to the lack of slack in the course. A student who misses just one week of work will fall behind, even when this is due to factors outside of their control. Student C implied that falling behind was a personal failing, but student A framed the issue structurally:

'It reminded me it's in my own hands to practice and get better. It's not organic chemistry's fault, it was me falling behind a little bit and not respecting the subject enough to put myself in a position where it wouldn't be frustrating' – Student C

'Last term, because tute work and labs and everything was just so intense, I ended up falling behind on lectures, so I had to spend the holiday doing that, so I didn't get time to revise any of the content from last time. Then this next holiday I'll have to go both through this term and last term's content, which is hard. It's not that I haven't worked hard, but there's just physically not enough time' – Student A

Even though Student A feels that they are working hard, it is not enough to feel in control.

Even if students maintain control, there was a sense that they are always one step away from losing control of the workload due to the course's lack of slack.

'Everyone's a little bit overworked and just keeping their head above water. That is at odds with finding ways to become enthusiastic about academic material' – Tutor 1

Falling behind could be described as a catastrophic lack of control over the workload. Insufficient time to complete the next set of work causes students to constantly feel like they are catching up, leading to progressively reduced autonomy and competence. This may lead students to overwork themselves as they feel unable to take a break from study or relax.

4.1.3.8 How Did Difficult Work Affect Enthusiasm?

4.1.3.8.1 Content Difficulty Increased Enthusiasm

The workload was associated with the difficulty of the degree content. For some students, challenge was essential to their enthusiasm as they found hard work satisfying. Students described how lack of challenge made them feel limited and unenthusiastic at school.

‘Sometimes enthusiasm can die when it’s like, well, you just kind of get held up. I’m sure you know, the feeling of like in school [...] the class had a certain pace they were going at, or the curriculum was only so limited.’ – Student C

‘I think that’s happened more at degree level, than it did at A level and GCSE. So that’s why I’d say that my enthusiasm for the subject has significantly increased because we’re getting to the proper nitty gritty basis of stuff now.’ – Student D

The increase in the subject’s rigour and difficulty at degree level was satisfying for these students. The challenge of the workload could motivate students to push themselves:

‘When you’re pushing yourself, for example going to Oxford, you’re doing that because you have some expectation as to what level you want to be working at [...] you’re doing it because you want to do this subject at the highest level you can’ – Student C

‘There are students that like challenges and it’s tough so they’re more driven to go through it. [...] It motivates them to work harder and still get good grades.’ – Tutor 5

So high workload can reinforce enthusiasm. Students may not enjoy the day-to-day study process, but they enjoy the feelings of self-improvement associated with being able to cope and even achieve during a difficult course. Maybe greater challenge means these students can satisfy their competence and autonomy needs, motivating them to seek harder work.

4.1.3.8.2 Impenetrable Work Reduced enthusiasm

In contrast, some tutors described how difficult work could also reduce student enthusiasm.

‘Subject areas that feel impenetrable to them, that they put a lot of work in, but they really can’t get can kill enthusiasm. [...] I would say it is student specific [...] there are some students for which the maths side of the course is very challenging and others for which the curly arrows part of the course is more challenging. [Giving more choice] would give students the opportunity to not have to do a vast amount of something they

find very challenging if that is denting their enthusiasm for the subject’ – Tutor 4

‘Thermo is notation and, mathematically heavy [...] it’s done rigorously and for people that haven’t done physics and thought about maths with these letters it’s intimidating. [...] 1st year maths] disadvantages more students than it benefits. If you come in with a good grounding in math, you probably thrive, but if your maths is slightly ropey, maybe you just got an A at A level [...] you’re really going to struggle’ – Tutor 2

Participants explained that finding certain content hard was a student-specific characteristic, affected by factors like their previous education and what areas of chemistry they were naturally better at. The wide breadth of the course and lack of choice meant that students were likely to study topics that they did not feel competent in or like. This was another reason given for why Oxford Chemistry had a particularly heavy workload.

‘What sets our chemistry degree aside from other chemistry degrees is the lack of choice. Up to finals you have to do physical, inorganic, organic to a very demanding level. You know depth of understanding over a really wide breadth of material. And you can’t drop anything that you don’t like’. – Tutor 2

Participants said that there were external reasons why certain courses were impenetrable.

‘There are parts of the course that I would still find difficult, even with a good lifestyle. For example, perturbation theory and quantum was taught poorly [...] the lectures are given poorly, it’s very opaque and the lecture notes aren’t very good. So there are courses that are more poorly taught than others’ – Student C

‘External factors such as – there’ll be certain styles of lecturing that make [courses] more impenetrable, or the subject area doesn’t have a good accessible textbook where you’re struggling’ – Tutor 4

Poor resources and specific tutors made students find some courses harder or less enjoyable, increasing perceived and objective workload. Converse experiences reduced workload.

‘When a human explains a topic to you it makes a lot more sense than when you read about it, even though they haven’t said anything new.’ – Student C

‘Working together with people [helped me get used to the workload] – it’s sort of you know when you’re scared first years you’re too worried to ask someone else for help, because you don’t want to look stupid.’ – Student B

Having things explained well by a tutor made content easier to understand, and working with other people reduced feelings of workload. Similarly, labs gave an opportunity for

teamwork, as well as help and support from lab staff. Other research found that shared responsibility in group work reduced students' qualitative workload.⁴¹ Asking questions to teaching staff or other students also reduced these students workload as they spent less time searching through the internet or libraries.

4.1.3.8.3 Optimal Challenge in Interest Theory

Challenge triggers interest.²³ If a person is unchallenged, interest will not develop. However, challenge needs to be at the right level, particularly for students who have not yet reached the phase of WDII, as they do not possess the focus and perseverance to overcome negative affect. For their competence needs to be satisfied, a task needs to be optimally challenging so that individuals can test and widen their academic capabilities, increasing their perceived mastery of the task.⁵⁴ This explains why some level of challenge is necessary for ID, but also why ID can stop if a task is too hard.

For some students, the level of challenge at school was too low, frustrating their competence needs. However, for other students, the Oxford MChem was too challenging. The workload may not be aligned with these students' current competence levels, so they perceive the challenge they must overcome to be competent as too great and feel unable to do it. No one implied that the degree was not challenging enough; the workload may be an optimal challenge level for students with higher levels of interest and competence, but it was too much for students with lower levels.

4.2 Summary and Conclusion

Workload can in principle serve to increase or decrease student enthusiasm, but in the context of the Oxford MChem student and tutor participants agreed that the high workload often had negative effects through several distinct mechanisms:

- qualitative workload directly reduced enthusiasm;
- lack of time resulted in reduced ID, superficial learning, reduced ability to adjust, perceived lack of control and increased qualitative workload;
- strategies to regain control of the workload resulted in further superficial learning, reduced work-life balance and overwork;
- breadth also increased superficial learning and memorisation;
- content impenetrability resulted in overchallenge and frustration; and
- unclear expectations increased objective workload and reduced perceived control.

Heavy workload affected unenthusiastic students disproportionately.

The lab course was an example of manageable workload and deep learning. This resulted from sufficient time, opportunities for practice, support from staff and peers, and more digestible content.

Oxford's short-term structure and high expectations meant that more required content was already condensed into a shorter period of time, but the MChem's high number of contact hours and lab requirement meant this condensation was two-fold: Oxford's ethos of academic rigour magnified the disciplinary demands. Students were expected to become all-round chemists, but the heavy workload came at the cost of grasping the breadth and depth of chemistry learning. They had few opportunities to specialise in areas that they liked and drop areas that they did not.

Chapter 5: Overestimating Enthusiasm May Reduce Enthusiasm

Workload can have positive or negative effects on students' enthusiasm, depending on whether it is of optimal challenge and volume. A central question therefore becomes "how should we judge appropriate workload?" In this chapter, I argue that the difference in staff and student perspectives risks a systematic bias towards setting too much work.

This critical argument presents the work from **Chapters 3** and **4** so that it links it to the policy narratives in **Chapter 1**, drawing the themes of this thesis together in a way which aims to provoke constructive discussion.

5.1 An Assumption: Oxford students were Motivated by Enthusiasm

A central question within a policy analysis of the link between workload and enthusiasm is what levels of enthusiasm students actually have. As explained in **Chapter 3**, enthusiasm was linked to strong work ethic; enthusiasm made it easier to work, and interest theory supported this. A potential assumption arising from this relationship is that Oxford Chemistry students' propensity to work hard is *caused by* high chemistry enthusiasm. The responses implied that some participants held this assumption. The degree's competitive admissions, pure chemistry focus, and rigorous reputation, reinforced by a heavy workload, were seen as selection pressures that favoured students with high chemistry enthusiasm.

'You select students here who are [...] intrinsically interested, because you have to work very hard to get here' – Tutor 1

'To commit yourself to 3 or 4 years of pure chemistry is [...] tough if you really don't like it. [...] There's gotta be some enthusiasm about it. It's true to some extent for all degrees. Obviously, chemistry is a particularly tough course, especially at Oxford [...] A lot of students might not appreciate that before going into it' – Student A

Students were seen as enthusiastic about chemistry. There was an assumption that you must be enthusiastic about chemistry study to push yourself to do such a rigorous degree.

'When you signed up for this, you want to be pushed and you want to push yourself and you want to do well and know a lot and learn a lot'. – Student C

'For people that really want to know chemistry it's a brilliant course [...] you come here because you want to learn chemistry and that's what you get' – Tutor 3

5.2 But Enthusiasm was not the Only Motivation

Participants said it was harder for less-enthusiastic students to cope with the workload, particularly if they were motivated by factors such as expectations, success and career goals.

'I'm not sure if most students choose chemistry because they feel passionate. [...] some know that chemistry will be a steppingstone for getting a nice job elsewhere' – Tutor 5

'Lots of my friends [aren't] as enthusiastic as me about chemistry. They wanted to do the degree because it was a good degree in a good place, and they think about the prospects afterwards' – Student D

'They may be [...] good enough to get in, and that's what their school and parents wanted. They wanted Oxbridge applicants' – Tutor 2

'[Some students] very much enjoy the study of chemistry but recognise that the kind of jobs on offer as a chemist wouldn't be appropriate for them [...] there are so many things that you can do after a chemistry degree that aren't chemistry' – Tutor 4

However, some students were externally motivated and enthusiastic simultaneously.

5.3 Excessive Workload was Masked by External Motivation

If students can do the work by drawing on external motivation, *e.g.* expectations or career success, the faculty may not see that workload is misaligned with their enthusiasm levels.

'Everyone wants to do well, you came to Oxford for reason. Because there's so much content, you end up overworking yourself' – Student A

'A lot of their hard work comes from habit and from culture [...] It's obviously conscious effort, but [also] it's just this is what everyone does when they're doing chemistry here. But I don't know if [...] just 'cause you're exhausted by something doesn't mean [...] you're still not enthusiastic about it' – Tutor 2

However, students with low interest that appear to manage the workload will experience a higher perceived workload, enjoy their work less and experience more negative affect than their more interested peers. If low interest is masked by high performance, tutors may not

fully recognise the role they could play in developing students' interest. They may still meet academic expectations due to external motivation, but at the cost of negative affect and overwork, further reducing enthusiasm.

5.4 Overestimating Enthusiasm can cause Excessive Workload

'There is an assumption that people will go above and beyond [...] a reasonable level of effort required, if you assume someone's passionate about something [...] If a student is motivated by other reasons, you [expect] more of them than they can give' – Tutor 1

Overestimating students' enthusiasm levels and failing to acknowledge external motivation may lead to unrealistic expectations and excessive workload. Zimmerman emphasised that students in their first year of university are expected to learn new material, work independently, receive feedback, and persevere through challenge.¹⁷ Students with WDII in their subject are most able to meet these expectations. However, students with lower interest will experience distress and excessive workload if they are expected to work and learn beyond their actual enthusiasm levels, so there may be a disconnect between the way first students are taught and need to be taught.¹⁷ These students may not be able to persevere through the negative affect caused by challenge and may be unresponsive to critical feedback.²³ Lack of enthusiasm itself might be experienced as qualitative workload.

5.5 Conclusion

Students may experience distress if they must dedicate themselves to a demanding course which they have low enthusiasm for. For these students, lack of enthusiasm may not only be symptom of the degree workload, but a significant cause of perceived workload. The observation that students can cope is not necessarily evidence of enthusiasm, and tutors may be systematically overestimating student enthusiasm on the basis of their performance. Educational decisions made on this basis may inadvertently damage student enthusiasm.

Chapter 6: Final Conclusion and Recommendations

6.1 Conclusion

Participants suggested that enthusiastic chemistry students work hard, enjoy their work, persevere and experience lower workload. These characteristics justified the importance of student enthusiasm in chemistry education and validated enthusiasm's similarity to WDII. However, Oxford Chemistry's distinctively heavy workload was a significant contributor to high qualitative workload and low student enthusiasm: students did not always have opportunities to develop interest, learn in deep ways or feel in control. An inflexible and broad syllabus pushed students to master breadth of content with a veneer of depth. This was inherently unsatisfying and reduced students' feelings of competence and autonomy.

By renewing its curriculum, the department could better '*instil in students an enthusiasm for chemistry*' and '*involve them in an intellectually stimulating and satisfying experience of learning and studying,*' fulfilling the QAA's first aim of a chemistry degree.

On the central issue of workload, University policy stipulates that students should not be regularly spending more than 48 hours a week on study (with 40 being the number students can expect).⁵⁵ At least one student indicated that this was a significant underestimate, with their weekly tutorial work alone taking around 40 hours. This suggests that current policy may seriously underestimate chemistry workload.

6.2 Recommendations

6.2.1 Calculate Experienced and Ideal Objective Workload

To increase enthusiasm, workload must be small enough to let students learn deeply. At the same time, the total amount of time students actually dedicate to work is not visible to staff, so they may underestimate how many hours the degree requires; this could cause them to

set excessive workload. *The department should measure – perhaps through an annual student survey – how many hours of work students are actually doing during the terms and vacations.*

Then, after deciding a reasonable total objective workload, *the course should be adjusted in line with University workload policies so that students have sufficient time.* Centring the student workload in this way forces faculty to examine what aspects of the course or learning should be prioritised. This estimate should be generous to allow slower students (e.g. those with learning disabilities) sufficient time, as well as slack to give students time to catch up if they fall behind. In line with University policy, *the chemistry handbook should include explicit and realistic workload expectations, and describe what to do if students are set workloads which exceed the University's expectations.*^{55,56}

6.2.2 Reduce Memorisation in Assessment

Exams that significantly reward knowledge recall (particularly of niche content) favour superficial learning and memorisation and excessively increase workload. By reducing the extent of memorisation necessary for exams, students could focus on understanding the content deeply and practice their problem-solving skills, both which are satisfying and increase student enthusiasm. This could be done by making a greater proportion of marks accessible without factual recall on exam papers, increasing the problem-solving focus of questions, and giving students a formula or data booklet. Some memorisation is necessary, but it is currently not explicit what material should be memorised for exams. This inflates students' workload because they feel obliged to learn as much as they can, 'just in case'. *The department should specify which content must be memorised for exams.* This would reduce over-memorisation and eliminate the time spent working out what should be memorised.

6.2.3 Reduce Core Content and Increase Choice

Increasing choice within the curriculum would allow students to select courses that best develop their enthusiasm, and feel more autonomous and competent. Crucially, increased choice should not increase objective workload, so must happen alongside reduction of core content: *students in future should be able to choose between topics which are currently mandatory*. Reduction of breadth would give students more scope to learn deeply.

Specialising too early may reduce choice later, so there is balance to be struck. While students in second or third year may have a good enough idea of their interests to justify specialisation, first year may remain mostly core content. Giving first year students a small but significant opportunity to study a course of their choice might allow them to explore a topic aligned with their chemistry interest prior to university, helping their adjustment and increasing the likelihood that they can continue chemistry interest development throughout university.

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Appendix

Semi-structured Interview Design

The prepared questions for the semi-structured interviews were based on the initial research questions.

Initial Research Questions:

1. *How do undergraduate students and staff conceptualise enthusiasm?*
2. *What features of the MChem do undergraduate students and staff perceive to cause students to gain and lose enthusiasm?*
3. *How could the MChem be changed to increase undergraduate students' enthusiasm for chemistry?*

Phase I – Students

We followed the same format for all student interviews, regardless of the direction of their enthusiasm change or year of study.

1. What does the term 'enthusiasm' mean to you?
2. What does 'enthusiasm' mean to you in the context of studying chemistry?
3. Can you describe how a feature of the MChem course has made you gain enthusiasm for chemistry?
4. Can you describe how a feature of the MChem course has made you lose enthusiasm for chemistry?
5. If you could change one thing about the MChem course to make you more enthusiastic about chemistry, what would it be and why?
6. Can you identify something that made you gain enthusiasm for chemistry before you came to Oxford?
7. Students were told the following statements and asked where they would place their response to each one on a Likert scale (fig.) which was sent to them over Teams:
'I currently have an enthusiasm for chemistry'
'At school, I had an enthusiasm for chemistry'
'In first year, I had an enthusiasm for chemistry'*

Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
1	2	3	4	5	6	7

*this statement was only asked to second years

1 and **2** address RQ3 (*How do students and staff conceptualise enthusiasm?*). This question was asked first so students considered enthusiasm means before discussing it in the context of the Oxford chemistry course, focus their attention on the concept of enthusiasm for the duration of the interview, and also to enable the researcher to understand what conception the student was discussing in the later questions during the interview (which was important

due to enthusiasms vague and varying definition). It was also intended to establish rapport with participants so that they would give richer explanations for later questions.

3 and **4** were intended to probe RQ1 (*What features of the MChem do students and staff perceive to cause students to gain and lose enthusiasm?*). Both questions were asked of all students based on the assumption that the overall ‘gained’ and ‘lost’ groups have each experienced things which have increased and decreased their enthusiasm. It also ensures that the interview structure does not skew the data collected between the groups. Furthermore, comparison of these two groups means interventions can be developed that maximise all students’ enthusiasm, rather than benefitting one at the cost of the other, helping to answer RQ2 (*How could the MChem be changed to increase students’ enthusiasm for chemistry?*).

5 addresses RQ2. **6** assumes that students experienced chemistry enthusiasm before coming to Oxford, as this is a prerequisite in the admissions criteria. Finding out what enthused students prior to Oxford could help the department find ways to enthuse students at degree level, also addressing RQ2.

7 Students were also asked to rate their enthusiasm for chemistry at different points in their life. This was to understand where they considered their enthusiasm for chemistry to be at the time of the interview and to understand how much their enthusiasm had changed since coming to Oxford. Furthermore, as the admissions criteria suggest that an enthusiasm for chemistry is a prerequisite for studying Oxford at chemistry, we wanted to see if this was an assumption that could be made about the student sample. It would also confirm if there was any correlation between currently-high enthusiasm students and students whose enthusiasm had increased, and *vice versa*. The purpose of these scales was to complement the qualitative interview data. As they are not validated, and the sample size is small, the scales were not intended to provide quantitative conclusions about enthusiasm.

Phase II – Staff

1. From your experience, can you describe a feature of the MChem which make your students gain enthusiasm for chemistry?
2. From your experience, can you describe a feature of the MChem which make your students lose enthusiasm for chemistry?
3. If you could change one thing about the MChem to make students more enthusiastic about chemistry, what would it be and why?
4. What pragmatic barriers are there to this change?
5. What does the term ‘enthusiasm’ mean to you?

For the staff interviews, questions **1**, **2**, and **3** have been adapted from the student interview questions and **5** is the same.

4 was replaced from the student interviews as staff do not have direct experience of what makes students enthusiastic about chemistry at school and their ideas may be obscured by the admissions process where students are expected to persuade staff of their enthusiasm.

This replaced 4 was asked of the staff because the teaching staff have a role in constructing the MChem course and may have encountered barriers to increasing student enthusiasm when trying to change the course design, addressing RQ2 to ensure suggestions for change are realistic and can have maximum impact.

Recruitment Poster

Dr Michael O'Neill
Departmental Lecturer in Inorganic Chemistry
University telephone number: 01865 272 652
University email address: Michael.oneill@chem.ox.ac.uk



Enthusiasm on the Oxford MChem
Ethics Approval Reference: R79439/RE001

VOLUNTEERS NEEDED FOR PART II RESEARCH ON ENTHUSIASM FOR CHEMISTRY

One aim of a rigorous chemistry degree is to 'instil in students an enthusiasm for chemistry' (QAA Benchmark Statement).

How does the MChem influence students' enthusiasm for chemistry?

We are looking for chemistry undergraduate volunteers in years 1–2 who feel that they have either:

- *gained significant enthusiasm for chemistry since starting their degree,*
- or
- *lost significant enthusiasm for chemistry since starting their degree.*

The interview would take 30 minutes and would be audio-recorded. This would take place online (via Microsoft Teams) or in a Chemistry Department room. Your contributions would be anonymised prior to publication.



Scan the QR code to access more information and a sign-up form.

If you would like more information, please email Dr Michael O'Neill at Michael.oneill@chem.ox.ac.uk.

There is no obligation to take part.

<https://oxford.onlinesurveys.ac.uk/enthusiasm-on-the-oxford-mchem-students-copy>