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Reflective development in
the Computing curriculum

Myriam Mallet

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Dedication

To Mathys and Floriane.

You are teaching me so much.

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ABSTRACT

This research project was initiated by the realisation that although the development of Computing learners' reflective skills is essential, reflection is a vague and a poorly defined concept. The dearth of literature with regards to supporting and defining reflection in the Computing discipline creates facilitation and assessment issues.

This study starts with an investigation on the topic of reflection from disciplines who have a more mature practice of using reflection with their learners. The lessons teased out demonstrate the strong links between reflection and learning but also its key dimensions and complexity.

The thesis progresses with the establishment of Computing teachers' views and perceptions of using reflection as a learners' evaluation tool. This investigation enabled the distillation of explicit variables (themes) considered key for the support and development of reflective skills in Computing. This work led to the introduction of the new concept of *reflective development* which entails one's own transformation and growth through a profound and inner meaningful change. Additionally, the thesis supplements existing literature on reflection by proposing a new reflective development framework to support teachers through the nurturing of their learners' reflective skills.

Finally, the thesis explores how reflective development can be defined in Computing by analysing sets of learners' reflections and identifying development patterns and concepts which constitute reflective processes. This part of the study enabled the formulation of the reflective development model and attributes of good reflections in Computing.

Action research was used throughout the study as a practice-based, problem-solving methodology as the research focuses on the enhancement of teachers and learners' practice but also contributes to educational theories. Four action research cycles were required to formulate the main contribution to knowledge of the thesis i.e. the reflective development concept including its framework and model.

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CHAPTER 1.   INTRODUCTION

There is an agreement amongst academics that reflection facilitates learning (Ixer, 1999; Moon, 2006) and '*critical reflection continues to gain momentum as a powerful way of adding depth and breadth to learning*' (Jacoby, 2011, online).

The literature on reflection illustrates the evolution of the academic discourse with regards to the place that reflection holds in the learning process from being one stage of the learning process (Lewin, 1951; Kolb, 1984) to being assimilated to deep learning making the relation between learning and reflection explicit (Moon, 1999; Mann *et al.*, 2009). Indeed, these authors argue that a deep approach to learning can *only* occur when the learner engages in reflection, moreover Mann *et al* identify reflection and learning as being mutually enhancing and integral to each other. If indeed reflection leads to learning this makes it an essential tool for any higher education (HE) and lifelong learner.

The proliferation of literature referring to reflection and its models in both HE and professional practice evidences the interest that the concept has raised in the academic community. This applies in particular to the Social Sciences due to the inherited 'reflective practitioner' strand (Schön, 1983).

While the discourse demonstrates a certain maturity with regards to the views, usage and facilitation of reflection, it also highlights its complexity and the lack of common definition of what reflection actually is and what it entails. This leads to the important question of its facilitation and assessment. How is it possible to support and assess something which is not clearly defined?

This research project is set in the Computing discipline and Moon (2006) explains that indeed there are relatively few publications in the literature with regards to the use of reflective assignments in the sciences in general but they evidence that the usage of reflection is beneficial. In Computing there is evidence of how reflection is used in different areas such as the development of problem-solving and analytical skills for instance Hazzan and Tomayko (2005), metacognition skills development for learning to code in Fekete *et al.* (2000) as well as project management (Babb *et al.*, 2014). Still the literature

referring to the usage of reflection in Computing has not achieved the same interest and exposure as in other disciplines and is therefore somewhat lacking. However, learners in Computing must demonstrate reflective skills (QAA Computing benchmark statement, 2007, 2016) and will be either explicitly or implicitly assessed on them.

This thesis examines how reflection could be defined and supported in Computing, in particular in the School of Computing of Teesside University, and explores the possibility of creating both a framework and a model with the aim to support learners in the development of reflective skills and help teachers in the facilitation of these skills. It was anticipated that the outcomes of the research would benefit learners in Computing as it is recognised that learners in the sciences in general often struggle with reflective writing (Chalk and Hardbattle, 2007) and their reflections are often criticised for being too descriptive and not in-depth enough.

The next section explains the different aspects that triggered and motivated this research project.

1.1. THESIS INITIAL MOTIVATION

I had been teaching in the School of Computing at the University of Teesside and completed my PGCE in higher education when embarking on this research project. Based on my personal experience as a Computing student and later teacher in this same discipline, I always favoured constructionist teaching approaches, where learners actively construct their knowledge. Constructionism, a slight alteration of constructivism, was proposed by Papert (1991). It has a lot in common with the constructivism principle but adds the idea that happens '*in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe*.' (p1)

Typical constructionist methods of teaching are problem-based learning and enquiry-based learning where the development of an enquiry or finding a solution to a given problem shapes the learning.

From the start, I developed my practice using an enquiry-based learning approach. The *enquiries* provided to the learners were complex, being real problems provided by clients requiring digital media solutions for their organisations. The learners were expected to think outside the box and for themselves. This was a requirement to provide innovative, but appropriate solutions to their clients; they had to evaluate aspects of the project as well as defend and justify their practice; in a word they had to be reflective.

At that point, I started to realise the benefits but also emerging issues attached to reflection and its assessment. Nevertheless, reflection was still considered an appropriate evaluation methodology to assess the modules' learning outcomes. Indeed, the method was student-focused, meaning-based, process-oriented, and required a lot of interaction with third parties for its in-depth formulation; all aspects being key to a typical constructionist environment (Goodman, 1998; Honebein, 1996).

I was teaching several modules whose assessment strategies were a mix of reflective work written by the learners and the production of an artefact, outcome of an enquiry. The reflection was a key part of the overall assessment to emphasise its importance over the production of the artefact. This was discussed in a published paper before the start of this research project (Bel and Mallet, 2006 a) where it was noted that such an approach was beneficial because the learners meaningfully engaged in the task, they were motivated and as a consequence attendance was not an issue. Moreover, the learners felt a great sense of ownership of the whole process; however, several issues were also recognised.

The first one was related to the learners' difficulties in writing in-depth reflections which really teased out and developed their learning, moreover, they required much support from me to achieve a good standard in this element of the assessment. From a teacher's point of view, the facilitation was not only time-consuming but it also triggered the additional worry that the reflections produced might not be a true representation of the learners' own thinking especially with regards to the discernment of a project's most important aspects upon which to reflect.

The second issue related to the fact that I felt I did not have access to an adequate model to support the development of my learners' reflective skills. Although I was familiar with well-known reflective models such as Gibbs's 'reflective cycle' (1988) or Kolb's 'Experiential Learning Model' (1984), it was felt that these were somehow constraining in their structure or not fully relevant to my learners. For instance, one stage of Gibbs's model encourages the learner to talk about his/her feelings about the subject matter. This stage is not always relevant in the Computing discipline, albeit useful at times, as decision making in this discipline tends to be based more on logic, pragmatism and development of computational thinking rather than feelings and emotions which are not central to the process.

These particular issues triggered the research project as they felt vital to the improvement of my practice and, therefore, success of my learners.

1.2. THE RESEARCH SETTING

Teesside University is situated in the North East of England and counted just under 18,554 students for the academic year 2016/2017 and around 718 academic staff out of 2,396 (University of Teesside, no date).

The University comprises several schools and this research project was situated in the School of Computing*, which offers just under thirty undergraduate and eleven postgraduate programmes as well as two Foundation degrees and one PhD route. There are approximately eighty academics employed to deliver these courses and approximately 1,700 students enrolled in on-campus courses in the school (Teesside Registry Department, Jan 2016). Just under 85% of the school's learners population on campus is male, and 8% of the total number of learners are international (Teesside Registry Department, Jan 2016).

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* Throughout this thesis there are references to the School of Computing which is the original name but since July 2017 a new name is used i.e. School of Computing, Media and the Arts.

According to Oates (2005), within higher education, computing is an academic discipline generally described as including the following fields, Computer Science, Software Engineering, Information Technology, Web Development, Computer Games, Computer Animation and Multimedia. The QAA (2016) also adds Information Systems, Computer networking and some more focused degrees such as Digital forensics. The discipline continues to expand rapidly, and it evolves at a huge rate (ACM and IEEE; 2013). With the fantastic growth of computing power and with businesses now using digital technology extensively, a huge demand has developed for motivated, adaptable graduates, who can engage in life-long learning and necessary up-skilling. Such a rapid pace of change has had a tremendous impact on Computing education, especially in terms of maintaining up-to-date curriculum and degree programmes. Learners are expected not only to have developed strong technical or specialist skills but also, to use theories in context, to demonstrate problem solving skills, have worked in groups and be able to reflect and approach professional situations with critical minds (QAA Computing benchmark statement, 2016; ACM and IEEE, 2014).

However, skills such as critical thinking and critical reflection are somewhat elusive (Stassen *et al.*, 2011; Roger, 2002) and might also be seen as overlapping or feeding into each other (Jones, 2013; Meyers, 1986 in Moon 2008). This uncertainty has led to the issue of their facilitation when they are, in fact, not properly defined. Several higher education teachers explain that they struggle to support their learners in the development of their reflective skills (Fielden, 2005; Bold and Chambers, 2009; Thorpe, 2000; Ryan, 2010) furthermore, Meyer and Land (2005, p375) report that in scientific disciplines such as Engineering some academics '*initially find the now well-established discourse of professional reflection both alien, inaccessible and unnecessary*'. Similar views were also anecdotally noticed from some teachers in Computing. It could be posited that this is a consequence of a misunderstanding of what reflection really is and the lack of support to understand the concept.

Some modules in the School include the assessment of learners' written reflections. It was anecdotally noted that Computing learners found reflective writing difficult especially when they have to demonstrate depth of reflection.

This issue is not unique to this school as other authors in scientific disciplines (King, 2002; Chalk and Hardbattle, 2007) reported that learners also greatly struggle with their reflective writing and tend to produce very factual and descriptive work. Their main difficulty was weighing up arguments and exploring a topic in-depth reflectively.

This thesis argues that there are several gaps in knowledge on the subject of *reflection* when applied to the Computing discipline.

Firstly, the term '*reflection*' itself is very confusing (Moon, 1999) and often used loosely or traded with other descriptions in the academic dialogue. Secondly, there is a gap in the Computing literature with regards to its definition. Indeed, the concept of reflection in Computing is still vague even though the amount of inter-discipline academic discourse on the subject, especially in the social and health sciences, is colossal. Reflection still lacks a consensus regarding its forms and shapes.

When both learning and evaluation heavily rely on reflection, it is important to define it. Thus, drawn from the work of Dewey (1910) and later Ixer (1999) as well as Moon (1999), and focused on the requirements from the QAA Computing benchmark statement (2016), the thesis adopts the following customised definition of what reflection entails:

> *Reflection is a meta-cognitive activity that takes place when the learner is confronted with complex and perplexing materials or experiences which require scrutiny from different perspectives and at different times with the aim to learn and enhance one's self, one's practice or one's community. Reflections are sourced from one's previous knowledge and past experiences, and any assumptions must be systematically critically examined to avoid irrational beliefs and decisions making for instance in problem-solving and planning which are key aspects of the Computing discipline.*

So far, the chapter provides an understanding of my initial motivations to undertake the project as well as the project's setting. The following key points were teased out:

- reflection and critical thinking are key skills that computing graduates should demonstrate as there is a strong link between reflection and learning,
- reflection is a fairly vague concept especially in Computing where the literature is lacking,
- Computing learners find it difficult to write in-depth reflections,
- teachers struggle to support their learners in the development of reflective skills,
- the assessment of reflection is problematic due to the elusiveness of the term,
- existing models of reflection might be inadequate in Computing.

The next section lists the research aims drawn from these points.

1.3. RESEARCH QUESTION, AIMS AND CONTRIBUTION TO KNOWLEDGE

Based on the findings from the two sections above, four different aims were identified for this research project. They explored the following question:

How can reflection be defined and supported in Computing?

The four aims were formulated as follows:

1. Investigate existing definitions and practices with regards to the use of reflection in higher education in general;
2. Establish views and perceptions of Computing teachers with regards to using reflection with their learners;
3. Construct a framework of reflection that demonstrates all key variables encompassed in the development of reflective skills', and
4. Design and evaluate a novel model of reflection targeted to aid inexperienced computing learners to formulate written reflections.

The exploration of these aims enabled the creation of the major contribution to knowledge of this research project which is the novel concept of *reflective*

development including its issues and benefits framework and its model described as follows:

1. A reflective development framework (see Table 5.1) which **identifies the key variables of reflection in Computing**.

    This contribution to knowledge is grounded in primary data (teachers' interviews) analysed in Chapter 4. The interviews analysis helped tease out the main themes, considered essential aspects to take into consideration for the development of reflective skills. They are synthesised and presented in the reflective development framework in Chapter 5.

2. A reflective development model (see Figure 1.2) which **defines reflection in Computing**.

    This contribution to knowledge is grounded in primary data (learners' written reflection) and it illustrates development patterns and high-level concepts used in written reflection in Computing. The model has evolved through three different iterations including systematic evaluations; it is presented in Chapter 6.
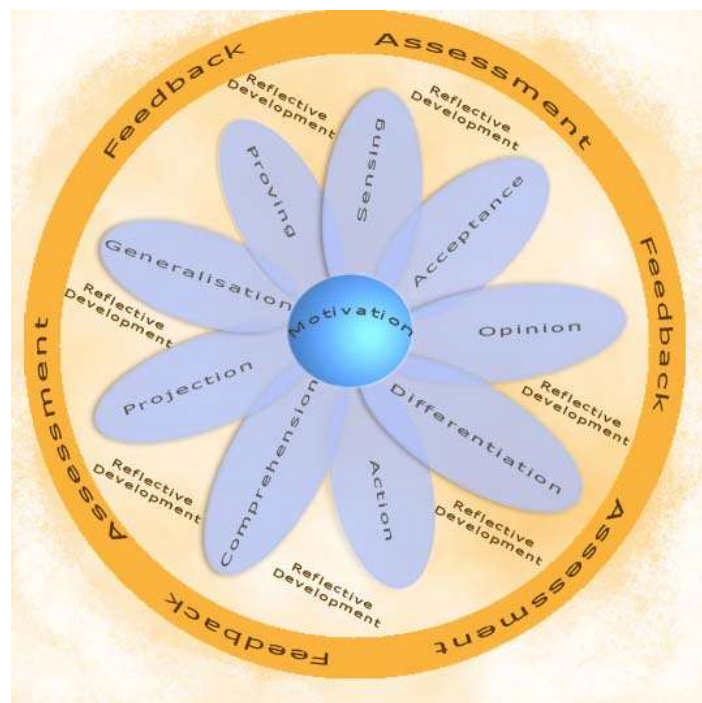
Figure 1.1 - Reflective Development model.

1.4. THESIS STRUCTURE

The following section provides an overview of the thesis:

Chapter 2 explores the literature on reflection in relation to its facilitation, assessment and definition in HE and the Computing discipline.

Chapter 3 discusses relevant research approaches chosen for this research project. Furthermore, it introduces the data collection process, sampling justifications and ethical considerations.

Chapter 4 investigates the views and perceptions of HE teachers in Computing with regards to the usage of reflection in their modules. This qualitative analysis teases out key themes which informs the reflective development framework presented in Chapter 5.

Chapter 5 synthesises the themes collected in Chapter 4 and proposes a new reflective development framework for the development of reflective skills.

Chapter 6 defines reflection in Computing by analysing how learners express their written reflections. It proposes a new reflective development model.

Finally, **Chapter 7** draws conclusions on the research project. It offers a summary of the research project, discusses its contribution to knowledge and highlights research limitations and possible future work. It also includes the researcher's personal reflections on the project.

References and appendices are also included to support or evidence the research.

CHAPTER 2.   LITERATURE REVIEW ON REFLECTION

The information and experiences discussed in Chapter 1 supports the argument that although the development of reflective skills in the Computing discipline is essential, reflection is a vague and poorly defined concept. Learners in Computing struggle to produce in-depth reflections and teachers find it difficult to support the development of reflective skills which leads to assessment issues. Although, the literature relating to the use of reflection in the Computing discipline is less abundant than in other disciplines, the combination of existing Computing-based case studies and lessons distilled from disciplines that are more mature with regards to the use of reflection with learners, might help to draw a clearer picture of the different key facets of reflection when used in higher education.

Chapter 2 concentrates on the first aim of the research 'Investigate existing definitions and practices with regards to the use of reflection in higher education in general' and has three main foci.

The first focus refers to **reflection complexity** (section 2.1). This section explores the literature to identify the main dimensions which make reflection a complex concept. Indeed, the investigation discusses the place of *evidence and emotions* in the reflective cycle as well as the *multi-purposes* of reflection. Moreover, *terms related to reflection* are studied to evaluate their positioning in the reflection domain. Then, *process models* of reflection are evaluated and compared to a possible different way to define reflection based on the identification of cognitive processes.

The second focus elaborates on the **facilitation of reflection** (section 2.2), in particular *facilitation issues* due to reflection complexities enumerated above. This section identifies from the literature what aspects are key to the facilitation of reflection as follows: the appropriateness of the *learning environment*, the *timing of reflection* in the learning process, the *use of reflective models* and their relevance to support learners, the place of *reflection to problem-solve* (important to Computing) and finally the importance of *questioning*, a fundamental aspect of the reflective process.

Finally, the third focus point of the literature review is on the **assessment of reflection** (section 2.3) where an investigation of practices and issues is carried out. The problems with the *grading* of reflective assessments are examined as well as the *pros and cons of assessing* reflective work. The investigation puts forward the value of *written reflection* but also highlights the confusion with *reflective assessment names*.

Evidence & Emotions

There has been an enormous amount of educational literature on reflection in the past (Dewey, 1910; Schön, 1983; Vygotsky, 1986; Ixer, 1999), which relates to the nature of reflection, a thinking process used in context to form some outcome. According to Dewey (1910), recognised as a main contributor on the topic, reflection is a deliberate cognitive process made up of a succession of logical ideas, carefully ordered and each linked to its predecessor. The reflective process aims at beliefs grounded in pondered evidence. Reflection is an operation which always includes the two essential ingredients of *uncertainty* and *inquiry*. The reflective process is continually paused by the surveying of additional facts and by getting a reliable view of the situation. It is also essential to recognise that with reflective thinking comes the possibility of making mistakes, or the possibility of failure thus reflective thinking is not the panacea to rightful belief, it is a troublesome mental process which extracts someone from a blind acceptance of belief. It is interesting to compare Vygotsky's (1986) views of reflection to Dewey's. Indeed, while Dewey emphasises the importance of an evidence-based reflection, Vygotsky (1986) has always been a staunch supporter of the important place of emotions to trigger the thought process and even if Vygotsky's sequential reflective model is reasonable, his explanations with regards to the place that emotions play in triggering reflection are not fully convincing. Why couldn't reflection happen without having to identify feelings first? Emotions might not have to hold a central place in the reflective process, but rather could be considered when required. Although, Vygotsky's view of the reflective process offers a slightly different perspective to Dewey's, it also highlights its complexity and therefore 'is not something that can be neatly packaged as a set of techniques…' (Dewey, 1933, p9). The place of emotion and evidence in the Computing reflective process is discussed in the new reflective model proposed in this thesis (see Chapter 6).

Multiple reflection purposes

The literature demonstrates that there are many purposes to reflection (Cowan, 2014; Moon, 1999; Van Manen, 1991) and Moon's (2006) interesting contribution, based on a thorough literature review, proposes an extensive list

of purposes and outcomes of reflection noted by authors across disciplines. These range from encouraging a deep-approach to learning, developing critical thinking and enhancing problem solving skills to more trivial ones like recording experience, which might not systematically demonstrate reflective thoughts.

A case study on using reflection for a slightly different purpose, namely reflection for peer-assessment can be found in Clark (2005) who argues that reflection was integrated successfully as part of the peer-assessment process in the Computing discipline. Indeed, learners were asked to develop a *reflective contribution report* to justify their peers' assessment. The learners found this way of both assessing their peers and being assessed fair.

The range of purposes demonstrates the extent to which reflection can differ. Indeed, its type and shape depend on its fulfilling purpose(s) but also on who initiates it e.g. the writer or the teacher and if it is assessed. Indeed, in this case specific learning outcomes and format will be expected e.g. weekly diary entries across three years of study, a video, ideas and notes jotted on a notepad to plan a project. Some of those factors can be discipline-based. Moon (2006) argues that the purpose of the journal must be considered, as it lays the ground for its introduction to the learners. It is also important to consider how the journal will be integrated into the module, but also its management with regards to the time required by the teacher for the provision of feedback.

A consequence of the diversity of reflection's purpose is that the word *reflection* is now too vague due to its confusing meaning (Smith, 2011). It has become an ambiguous term as teachers' understanding of it varies based on its purpose. Often, such words as 'reviewing', 'problem solving', 'inquiry', 'reflective thinking', 'critical reflection', which are or 'critical thinking' are listed as synonyms of 'reflection'. One notable issue is the usage of the terms 'Reflection' and 'Critical reflection' often ill-defined and therefore used loosely (Hatton and Smith, 1995; Moon, 1999; Williams *et al.*, 2012). So, what are the differences between commonly used terms such as critical reflection and critical thinking which are often interchanged to the word reflection?

Terms related to reflection

First, consider the term 'critical reflection'. This concept, clearly positioned in the territory of professional practice and mainly sourced from the field of teachers' education, is advocated in numerous fields for professional development and practice (Smith, 2011). The definition of this term varies slightly in the literature but there is an agreement amongst academics that critical reflection is the ultimate, and certainly, the most challenging level of the reflective process whether it is on a three points reflective process (Hatton and Smith, 1995; Jay and Johnson, 2002) or four points (Larivee, 2008; Smith, 2011). It is, therefore, part of one's reflective journey, maybe the most abstract stage, as according to Valli (1990) (cited in Jay and Johnson, 2002) this dimension can relate to the broader historical, socio-political and moral context, certainly useful in the Education section. Critical reflection is clearly positioned under the umbrella of the term reflection although it adopts a particular and specific form i.e. It engages the learners in discovering and questioning their beliefs, action and behaviours in the wider context of society.

Although, Biggs (2003), supports the view that critical reflection is an outcome of learning, this could be questioned. Critical reflection skills ought to be taught and developed early on in HE to support and forge a long-lasting metacognitive habit that would drive the learning process i.e. critical reflection drives learning instead of it being an outcome of learning.

Next, the term 'critical thinking' is considered in relation to reflection. This term is described as a questioning and challenging approach to knowledge; it focuses on the evaluation of evidence to make a judgment (Moon, 2008), and is similar to the way Dewey (1910) defines the term reflection. Critical thinking is a skill use to discern if one should be sceptical or reasonably trusting of an idea. It is the detection of errors or fallacies in other people's thinking. It can be achieved by a learner when the following mental processes are used: paying attention, categorising, selecting and judging (Cottrell, 2005) and can be evidenced in a reflective journal (Smith, 2011).

Like reflection, the literature shows that critical thinking has inter-field variation (Ennis, 1989; Stassen *et al.,* 2011) due to the accepted nature of each discipline, for instance, the importance of statistical significance in the social

sciences by opposition to the accepted subjectivity in the arts which would be refuted in the sciences. Another similarity to reflection, is the great importance of good questioning, as the level and type of questions asked will directly influence the investigation depth, one question often leading to many more (MacKnight, 2000; Thomas *et al.,* 2007).

From a definition standpoint, Dewey and Ennis make it very clear that reflection and critical thinking are the same. However, other authors like Moon (2008) find slight differences between the two concepts, mainly based around the outcome of critical thinking being a judgment. Therefore, critical thinking can be considered a specific type of reflection but it is undeniable that the two terms have very close links and at the very least, as argued by Hughes-Miller et al. (2012), written reflection fosters critical thinking.

With regards to reflection related terminology it can be deduced from the literature that reflection encompasses critical reflection (highest reflection level) and critical thinking (a particular form of reflection), making the literature for those two terms relevant to the field of reflection.

Process models of reflection

The literature illustrates the considerable amount of research carried out with the aim to model the reflective process (Dewey, 1910; Vygotsky, 1986; Gibbs, 1988; Smyth, 1991) or learning process including a reflective stage (Kolb, 1984). Some models are fairly generic, for instance Gibbs (1988), others more discipline-based, such as Jay and Johnson (2002) which relates to Education. But so far there are very few attempts to model reflection through the identification of cognitive processes used during the thinking. Jay and Johnson (2002, p75) inspired by the work of Dewey (1933), Schön (1983) and Valli (1997) argue that during the reflective process 'Several common processes seem to take place, including describing the situation, surfacing and questioning initial understandings and assumptions…', in the same way, but this time related to cognitive processes used to form knowledge, Anderson and Krathwohl (2001) identified a list of cognitive processes used by learners such as *remember, understand, apply, analyse, evaluate and create*. This idea of defining and modelling reflection with cognitive processes used by learners, although at the embryonic level in Jay and Johnson's, is supported by this

thesis and Chapter 6 offers a new model of reflection teased out from learners' cognitive processes used during reflection. This type of modelling is appealing as closer to what reflection is in reality: messy and, at first, not structured. It is believed that it has the potential to clarify the meaning of the term *reflection* which is a necessity as it is a poorly understood and under-developed concept. Referring to reflection, Ixer (1999, p520) argues '*the problem is that we are now able to state what [the learners] need to be able to do, without ourselves knowing exactly how it is that people come to do these things or how they learn to do them better*' and this does not stop teachers assessing learners for evidence of this required competence.

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2.2. FACILITATION OF REFLECTION

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Issues with facilitation

Reflective tasks are usually daunting for learners as they judge them too vague to understand and therefore apply. Zhu (2011) and Findlay *et al.* (2010) report that their learners often engage in surface-level reflection often lacking in critical reflection. This problem is general in the sciences (King, 2002; Chalk and Hardbattle, 2007) and the common myth that some people cannot reflect (Moon, 2006) aggravates the situation and amplifies the necessity for the facilitation of the development of reflective skills. Indeed, reflection is a skill, even positioned as a transferable skill by Ixer (1999), that can be fostered if the right environment is set up (Dewey, 1910; Hatton and Smith, 1995). Therefore, if learners develop their reflective abilities in one domain, this cognitive process could be applied to other fields, albeit maybe with some nuances. Unfortunately, the complexity of the reflection concept, as discussed in section 2.1, exacerbates the issue of its facilitation (Bold and Chambers, 2009; Thorpe 2000).

In the Education discipline, Jay and Johnson (2002, p75) explain that '*a holistic view of reflection is difficult to teach. The tension between delineating specifics of reflective thought and preserving its complexity is one with which teacher educators constantly struggle*', moreover, it was put forward that teachers do not always have the relevant training (Ryan, 2010) although the literature

evidences that proper training for the pedagogy of reflection is highly desirable (Kuit *et al.*, 2001).

Importance of learning Environments

There are specific barriers which can hinder the development of reflective skills. First, the association of reflection with the discipline. Secondly, the learner's conceptualisation of his/her learning such as the natural, or not adoption of reflective approaches to learning and therefore associated value. Third, the number of opportunities provided to exercise and improve reflective skills (Hatton and Smith, 1995), making the learning environment (course design and assessment strategies) an important aspect of how learners will view and develop reflective skills.

There are two essential ingredients which can make reflection possible i.e. existence of prior experience on the matter and being faced with problematic and perplexing material (Dewey, 1910). These are viewed as the holy grail of reflection, the required environment that will allow a greater and more enriching thought process.

Timing of reflection

The timing of reflection within the learning cycle, driven by the course design, is of great importance and this topic is well covered in the literature highlighting different trends and thinking.

Schön's (1983) renowned publication '*The Reflective Practitioner*' has led to his well-known theory of *reflection-in-action*, simultaneously reflecting while doing, which could be defined as a practice-oriented approach aiming to help professionals deal with problematic situations whilst it can still benefit it. He emphasises the difference between novices (who would normally engage in 'reflection-*on*-action') and experts (who would 'reflect-*in*-action'). R*eflection-on-action* allows the learner to analyse a recent experience once this one is complete. Additionally, Cowan (2006) argues that it is also possible to *reflect-for-action.* In this case, the reflection relates to the planning of the action to be undertaking; it is done before starting a project or experiment. This is the case in Fekete *et al.* (2000) who want to see evidence that their Computing learners

engage in forward-planning including the identification of concrete objectives but also a systematic review of past plans.

Griffiths and Tan (1991) make an attempt to model the reflective process in a time-based sequence, where the three timings mentioned above are identifiable:

1. rapid reaction (instinctive, immediate);
2. repair (habitual, pause for thought, fast, on the spot);
3. review (time out to re-assess, over hours or days);
4. research (systematic, sharply focused, over weeks or months);
5. re-theorise and reformulate (abstract, rigorous, clearly formulated, over months or years).

Whether the learner is encouraged to reflect *for*, *in* or/and *on* action depend on the teacher, but, as discussed in the Chapter 1, there is a strong link between reflection and learning, therefore, it might be beneficial to make reflection the support for learning throughout all the experience, besides, the frequency of opportunities for reflection is important for the development of the skill (Facione, 2011).

An interesting case study in the Computing discipline from Babb *et al. (*2014) demonstrates when reflective practice was embedded in activities. It maps out Agile development with the concept of reflection-on and in-action.

Table 2.1 presents the methodology stages in relation to in-context reflection.

Learning and reflection opportunities in the Reflective Agile Learning Model (REALM).

Agile practices	Reflection-in-action
Release planning	Learning about the project, domain, and product
Collective estimation and iteration planning	Learning about each other's skills and areas of expertise, and the team's collective capacity to delivery (velocity)
Group programming	Learning new skills and expertise from each other
Pair-in-need	Novices learning about the team and project as they pair with experts; pairs learning a new technology or skill as they work on a challenging task
Project wiki	Capturing project-based learning about the domain and individual reflections (blogs)
Demo and acceptance testing	Learning from acceptance test failures that fuel refinements and guide product vision
Agile practices	**Reflection-on-action**
Daily standup	Reflection on action performed the previous day, planning for the day's actions, and highlighting impediments
Learning spike	Adapted practice that embodies reflection on action as some members devote exclusive time to new learning
Retrospective	Standard agile practice devoted exclusively to reflection on actions performed in previous iteration

Table 2.1 REALM Babb *et al.* (2014).

Although the REALM framework presented in Babb *et al.* clearly illustrates at which point of the development process reflection can take place, they observe that the working environment does not offer specific guidance on how to engrain systematic reflection. They make the pertinent point that practitioners might have to go through a behavioural change for the reflective process to become systematic if they were not used to it before. The process could be challenging to achieve as it might mean ceasing a detrimental habit.

One might question the positioning of some of the constituents of their REALM model. Indeed, Babb *et al.* have based their model on Schön's (1983, 1987) two concepts of reflection-in-action and reflection-on-action. Whereas it seems possible to categorise some of the model's constituents i.e. 'release planning' and 'collective estimation' under Cowan's (2006) concept of reflection-for-action which relates to the preliminary thinking required to plan actions.

There is a logical relationship between the *depth* of reflection that one can achieve on a topic and the *time* spent investigating this topic. Stone and Madigan (2007; p44), who investigate the integration of reflection in experiential Computing courses, explain that '*As the term progressed each reflection the students wrote was more insightful and had more depth than in the beginning*'. Stone and Madigan's results suggest that a continuing reflective approach throughout the module helped to grow their learners' metacognitive skills.

This work shows that reflection can support the full experience of a project from beginning to end, but the development of reflective skills takes time. Additionally, this section demonstrates that the evolution of academic thinking around the topic of reflection in Computing hints at a possible development of a *reflective computing practitioner* concept in the same way as the *reflective teacher practitioner* has now become the norm in other disciplines.

Use of reflective models

The use of reflection process models is fairly common to support learners with the development of reflective skills for instance Gibbs's (1988) and Williams *et al.* (2012). Gibbs's framework is widely used in higher education and can be considered fairly generic as opposed to authors such as Williams *et al.* who propose discipline-based frameworks to the learners and it is not rare to read about authors who have defined their own specific-to-their needs model to support their learners. For instance, Burrows (1995) suggests the following steps to help nurses write reflective journals:

- Describe significant events as you understand them;
- Explore affective responses to the situations;
- Answer the three following questions:
    1. What have I learnt from this experience?
    2. How would I behave given a similar situation?
    3. In what ways do nursing and related theories explain the situation?

However, there is a school of thought (Johns, 2009; Bailin, 2002), that questions the usefulness of the reflection process model. While they can be useful for novice learners, their structure should not be the only source of information that learners use to shape their understanding of what reflection is. Johns (2009, p6) argues *'[the models] threaten to impose an understanding of reflection that skims the surface of its potential depth and subtlety. At some point, the practitioner must break free from the shackles of models*.' When models are used, procedures included in the process need to be described in a very detailed way i.e. including explicit criteria which explain the critical dimension, otherwise one might apply the model and still not arrive at the

expected results, thus implementing the procedure in an uncritical way (Bailin, 2002).

Reflection is not a systematic process; it is rather messy (Jacoby, 2011). Therefore, a structured and sequential model might not offer a true representation of what is going on in people's head. Trying to follow a dictated structure might, in fact, be more constraining than helpful.

This thesis supports Johns's argument about the possible inefficacy of using step-by-step process models to formulate in-depth reflections and explores how a model based on cognitive processes could support learners (Chapter 6).

<p align="center" style="color:blue">Reflection to problem solve</p>

Chapter 1 highlights the importance of reflection and problem-solving skills in Computing graduates (QAA Computing benchmark statement, 2016; ACM and IEEE, 2014). It emerges from the literature review that reflection is an essential tool to solve problems, showing that reflection and problem-solving are bound together, reflection being the means and problem-solving the outcome.

Dewey describes reflection as a way to solve problems which Hatton and Smith (1995) also called *reflective action* instead of *reflective thinking*. It means that thoughts are directed toward action: a thoughtful cyclical process which leads to modified action. Schön (1983, 1987) certainly agrees with this interpretation of reflection, as he believes that practitioners should get used to testing and re-testing their interpretation when solving their ambiguous problems. The pragmatic *reflective action* concept proposed by Hatton and Smith is forward-looking and quite appealing as it implies a change or an improvement. Reflection is not viewed as an end in itself it is a platform for change, it is a transformative tool (Mezirow, 1990; Bel and Mallet; 2007) which has the potential to trigger deep inner personal changes impacting on the manner in which one solves problems, interacts and learns in the future.

Hazzan et al. (2003, 2005, and 2015) have investigated the use of reflective practice in Software Engineering. They argue that learners involved in eXtreme programming can effectively use reflection ladders to enhance the software development process (Hazzan et al., 2003). They have also noted the importance of reflection on the development of higher order cognition

processes in particular problem solving (Hazzan et al., 2015). The authors explain that reflection can happen before starting to solve the problem by planning the problem-solving approach. In this case, the approach is sourced from past experiences of working out similar problems or using similar algorithms. Then, reflection can take place while solving the problem and, in this case, they refer to 'inspection, control and supervision' of sources of mistakes or difficulties. Finally, reflection happens after solving the problem, which allows them to evaluate performance and draw conclusions for future improvement. Those three stages of reflection can be mapped onto the concepts of reflection-for-action (Cowan, 2006) and reflection-in-action and reflection-on-action (Schön, 1983) as discussed earlier.

It is encouraging to read success stories such as Hazzan *et al.'s* which show the potential benefit of using reflective practice in the Computing discipline to problem solve. They discuss how they involved the learners to identify the positive impact that reflection could have on their practice. Although the paper does not provide evidence of success, the authors manage to facilitate a reflective approach to learning in the Computing discipline.

Questioning

Schön (1983; p18) argues that '*professional practice has at least as much to do with finding the problem as with solving the problem found*'. Being able to demonstrate one's capacity to ask thoughtful questions to interrogate experience is the basis for the assessment of reflective learning (Bourner, 2003). Although, it is doubtful that novice learners have developed the aptitude to formulate their own searching questions, ultimately, they should become proficient at this. The formulation of the question is dependent on the problem under scrutiny. If a learner struggles to *discern* the appropriate problem, therefore question, this will have an impact on the overall depth of the work and problem resolution. Bowden and Marton (2003) wonder how teachers can undertake proper assessments of learners' capacity to solve new problems as they will face an increasingly unknowable future and need to be prepared for this. They argue that university assessments should, in part, 'test students' capabilities of discerning the relevant aspects of various situations in their field

of study and of handling those aspects simultaneously in order to define and solve problems in previously unseen contexts.' (p167).

The idea of being able to discern what is important to reflect upon is of great importance as reflection requires the learners to objectively distinguish what is trivial from what is relevant. Moreover, learners should, at all times, be focused on answering one question even though this question might change as they proceed (Cowan, 2014).

Several authors who discuss reflective practice use questions as a way to progress the reflection (Cunliffe, 2004; Lai and Calandra, 2010; Weimer, 2014; Hazzan *et al.,* 2015) and discuss their benefits.

Race (2002), in a research report entitled 'Evidencing reflection: putting the 'w' into reflection' and Williams (2009) suggest that most good questions have the letter *w* in the key interrogative word e.g. who, what, when, where, why. Race suggests that the 'What?' question is often used to set the context of the reflection then comes the more important questions such as the 'How?' and 'Why?' which might be followed by other questioning words like '…..else?' which, according to him, triggers 'even deeper thinking and reflection'. Race elaborates by providing extensive and categorised examples of prompts that encourage learners to get more and more profound in their thinking process. The prompts are categorised as *scene setting starter prompts,* then *probing or clarifying prompts.* Race warns the readers that a lot of thought needs to be put into the formulation of the prompts as the reflection will be as good as those trigger questions.

From an assessment point of view, although determining the amount of learning in reflection might be subjective (Bourner, 2003), the process of asking searching and in-context questions and answering them is not. This can be evaluated as it is about determining what learners have done with their experience, how well they are answering experience-based thoughtful questions and what they are taking away from the experience, besides, Kolb (1984) believes that learning should be looked at from a process point of view, not outcome. Thus, teachers should be more interested in the process of formulating searching questions and answering them, rather than the amount of learning taking place which cannot be accurately estimated. An interesting

approach in Computing, by Fekete *et al.* (2000; p147), shows that, in order to learn to code, novice learners have the opportunity to evaluate a code sample against predefined instructions such as, 'Assessment of the choice of publicly visible routines'. They are then offered multiple statements as possible responses 'Completely unable to solve specified problem' or 'Some holes, but on the right track' or 'Fully able to solve the problem'. The learners can check their statement choice against model answers. In this approach, the questions / statements are already formulated by tutors but they have the benefits to explicitly demonstrate to learners what is important to consider in their reflective approach to coding.

The use of good questioning, as the basis for reflection, seems to be agreed amongst academics. If the formulation of thoughtful questions is fundamental to trigger reflection, it can be deduced that if teachers want to develop their learners' reflective faculties, they should teach them how to formulate the questions first. The formulation of questions is not straightforward as there are elements of discernment essential to the formulation of the problem. Questioning, both to trigger reflection and to increase its depth, is evidenced as a fundamental aspect of reflection in Chapter 5 and 6.

2.3. ASSESSMENT OF REFLECTION

Assessment and grading

There are several issues with regards to using reflection in HE, but the debate with regards to its assessment has been thought provoking and a dominant issue. The poor definition of reflection and its complexity, emphasised in section 2.1, are the main cause for concern as this directly impacts on its value. Indeed, it is difficult to research the effects of reflection on learning (Rodgers, 2002). Ramsden (1992) urges teachers to define some markers of quality before the assessment of reflection. In a time where evidence of fair and reliable assessment is important, it is urgent to spend time exploring this topic further. Reflective assignments are part of most disciplines so the problem does not lie in their creation but rather their assessment, '*How do we place a fair and equitable grade on an assignment that has so many variables?*' (Hughes-Miller

et al., 2012, online). The lack of markers for the assessment of reflection has been seen as unfair as teachers' conception of reflection may vary from that of the learners (Tummons, 2011). The grading of reflection is an issue and not an exact science as it only seems possible to use grade brackets such as A, B, C etc when evaluating the work (Cunliffe, 2004) a more precise grading is challenging due to the complexity of what a piece of reflection could include. For instance, Cunliffe provides learners with an extensive indicative list of grading criteria but she finds it impossible to apply percentages to each element. Amongst others, she expects to see evidence of critical reflexivity, exploring possibilities, asking questions, drawing out insights, linking personal experience to ideas and theories etc.

Kennison's (2006) development of a Critical Thinking Scale (CTS) to evaluate objectively nursing students' reflective writing, may bring more precision and objectivity to the assessment of reflection. This tool consists of several statements based on six critical thinking skills from the American Philosophical Association Delphi study (Facione, 2011): interpretation, analysis, inference, evaluation, explanation, and self-evaluation. The teachers use Likert scales (scale of 5 to 1) to identify how well the learners have done for each skill. In the same way as Cunliffe, the list of criteria is extensive

Although both Cunliffe and Kennison assess reflection within the Nursing field and therefore at-times include discipline-based criteria such as Kennison's 'State results of care', similar assessment ingredients can be found and categorised in both criteria set. For instance, the two models take into consideration how the reflection is written (grammar, citations, plain language, no ambiguous meaning) but also if the argument is put across in a logical and convincing way. They also evoke the need for questioning and challenging orthodoxy as well as investigating if learners can link practice with ideas, responses or theories. Finally, they evaluate if learners explore different alternatives and can draw out logical conclusions and therefore demonstrate learning and self-improvement.

Kennison's approach to assessment might be more complete, although more complicated than Cunliffe's, as it also explicitly evaluates if learners have taken

own and others' ideas into consideration, and they stipulate the requirement for data analysis, not so obvious in Cunliffe.

This section shows that assessment of reflection is daunting and until reflection is clearly defined, its assessment is likely to lack vigour and may potentially be unfair. Some interesting assessment models are emerging but appear complex. There might be a lesson to extract from those studies which is that reflection and its assessment might be partly defined in a generic way and partly with discipline-based criteria, as there seem to be an identifiable pattern around this. Although assessment of reflection is not the main focus of this research project, there are some interesting outcomes linked to assessment in Computing that emerge from the findings discussed in Chapter 6.

Pros and cons of assessment

There is a school of thought that argues that reflection should not be assessed (Ixer, 1999; Zhu, 2011) and it is put forward that when reflection is assessed the grade becomes the focus for learning. It is constraining the free expression of learners' feelings and ideas which should be paramount to reflection. Learners feel pressured to cover course objectives rather than truly listening to their inner self. The assessment of reflection stops intellectual autonomy (Holmes, 1997). A certain type of control can also be recognised in the level of feedback provided to the learners. For instance, if the teacher focuses mainly on the structure or spelling of the journal then the learner tends to worry about the way the journal is written instead of the essence of its content. It seems that teachers' judgment of reflective work is a threat to the learners who will tend to narrow down their thinking, discovery and exploration. They want to protect themselves from teachers' varying degrees of acceptance and rejection inherent in judgment as this might have a direct impact on their grade (Holmes, 1997; Tummons, 2011). With a view to avoid this, feedback should be provided in such a way that it reinforces the dialogue between the learners and themselves instead of the learner and the teacher. Therefore, teachers ought to restrain themselves from using the first person in the same way that they should avoid suggesting own judgment. Instead, they ought to encourage learners to bring about their own judgements by clever questioning and pinpointing when more thinking would be appropriate.

Although Holmes' point has great value and should be taken into consideration, the context of this thesis only refers to assessed reflection. If reflection was not assessed, it is likely that it would be neglected by the learners (Bourner, 2003) therefore ultimately defeating the objective of them practising it.

It is understandable that when reflection is being assessed, it has to demonstrate learning outcomes, therefore not all reflective assignments will advocate the 'free expression' that Holmes (1997) refers to as it might serve a different purpose (Moon, 2006). Indeed, the assignment might encourage a deep analysis of a particular topic to help learners formulate a reasoned judgment. In this case, the reflection topic gives the focus for the learning, of course, it can be viewed as a constraint but a necessary one to fulfil learning outcomes.

<div align="center">Written reflection</div>

The process of writing develops and clarifies learners' understanding of data or experience therefore writing reflections down is a very powerful learning tool (Bolton; 2005) which allows the deconstruction and then re-construction of understanding (Yancey; 1998). But there is another less expected outcome of reflective writing which is that teachers can access learners' thought processes, which is not possible with other assignment types (Hughes-Miller *et al.,* 2012). It is one of the greatest benefits of reflection apart from the learning it can potentially achieve. Indeed, if teachers have access to learners' mental processes then they can, not only, provide targeted feedback but also determine flaws and gaps in the thinking process. Therefore, engaging in a dialogue with the learners, suggesting precise adjustments and further research, would allow them to progress their thinking further and develop their reflective abilities. Having access to learners' thoughts greatly outweighs the issues related to the usage of reflection.

To add to the already problematic definition of reflection, Williams *et al.* (2012) argue that even the name of reflective assignments can vary greatly depending on the discipline, although they all have *reflection* as the essence of the writing. The authors illustrate their point with the word cloud picture below (Figure 2.1) that demonstrates the different names associated with this type of assignment.

Diary Journal Learning log Reading log
e-Portfolio Reading portfolio Log book
Research log Field log Design report
Critical incident report Work placement diary
Practice portfolio Reflective essay

Figure 2.1 Williams et al. (2012) word cloud.

Indeed, assignments sometimes include the unspoken qualities of reflection even though the word *reflection* is not mentioned in the name or description. Instead, the assignment might provide criteria such as 'original interpretation', 'articulate and justify a point of view', 'analyse research findings'; 'relate to personal experience'; 'level of criticality'. This non-exhaustive list relates to qualities that an assessor would be looking for in learners' reflective work.

2.4. CONCLUSION

The relationship between reflection and learning is extremely tight. These are two concepts that might represent the same thing, although this has not yet been fully agreed upon in the literature. It seems that learning how to reflect is learning how to learn, whether they are the same thing or just strongly linked. Thus, if reflection holds such a significant place in the learning process, its development is paramount.

The literature review evidences that, throughout the years, many researchers have spent an incredible amount of effort trying to understand the reflective process. But, the complexity of reflection leads to misuse of the term, confusions with its related concepts and hampers its definition process, making facilitation and assessment of reflective skills a challenge.

The literature discussing models of reflective processes is considerable and informative but it also highlights that although helpful at times, the models do not systematically help the formulation of in-depth reflections. Their relatively rigid structures do not seem to match the more organic reflection concept. Although, few studies explore reflection in relation to learners' cognitive processes, it seems that the concept of reflection described by Jay and Johnson (2002) as a set of common processes might have more potential than the more rigid step-by-step frameworks which were criticised. A meta-model representing cognitive processes visible in written reflections, might offer learners a more realistic representation of reflection. It is possible that such a representation could provide learners with more flexibility on how to formulate in-depth reflections.

The literature indicates that it is very challenging to teach reflective skills and teachers often lack appropriate training to support their learners but it also demonstrates that there are some essential ingredients useful to facilitate the development of reflective skills. Indeed, the skill can be developed if given time to be nurtured. The *timing** of reflection within the learning process is an important dimension to consider as well as *learning environments** set up. A successful setting for reflection lies, in part, in the complexity of the materials the learner is confronted with i.e. the problem to solve, as well as in a good level of experience in the subject matter. Being able to accurately discern problems through thoughtful *questioning** is another essential dimension of the reflective process. Timing, learning environments and questioning are aspects that teachers can act upon to facilitate the development of reflective skills.

Concerns with regards to the assessment of reflective writing were exposed due to the challenge of assessing a skill which is not fully defined. The non-accuracy and possibly fairness of reflective assessments were discussed and emerging assessment criteria noted. It was also realised that the names of reflective assessments could be very diverse and at times confusing. Furthermore, the review emphasised that although assessing reflection might

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* Terms in bold refer to dimensions discussed in Chapters 4 and 5.

constrain learners' free expression, it was one way to achieve learning outcomes. The benefits of written reflection were stressed as the writing extend learning and construction of meaning in learners' heads. The processes of knowledge assimilation, interpretation and application are rarely visible to teachers. Reflective writing helps makes these processes more visible so that teachers can identify where and when support is required or times when it might be appropriate to challenge learners.

The literature review has highlighted some relevant case studies that demonstrate both how reflection can be embedded in the Computing curriculum and that reflection is an efficient tool for problem-solving in programming. It has also revealed that there is a dearth of representation of what constitutes reflection in Computing although reflection is an important transferable skill in the discipline. It is a generic professional disposition, essential to demonstrate in today's context when most people will change jobs several times in their career and where employees are expected to be lifelong learners. Unfortunately, learners are not well equipped to undertake it. The lack of appropriate models disadvantages Computing learners in triggering and formulating reflection, and teachers do not have a support tool to facilitate the development of reflective skills.

Therefore, this research project offers a novel contribution to advance the field of reflection in Computing as previous progress has been minimum. It investigates the novel concept of *reflective development* and proposes a framework which aims to support the development of reflective skills in Computing (see Chapter 5) and offers a model which aims to define reflection in the discipline (see Chapter 6).

The following Chapter 3 investigates appropriate methodologies to undertake this work, justifies data collection processes and elaborates on the project's ethical considerations.

CHAPTER 3.   RESEARCH APPROACHES

The preceding chapter teased out essential findings from academic disciplines more established in using reflection in HE than the Computing discipline. A lot of the papers studied in the literature review demonstrated practice-based lessons learned such as Cunliffe (2004) or Kennison (2006). It seems that the study of reflection is driven by practitioners' strong need to improve their practice.

Although there are several possible ways to approach this research project, Action Research (AR) was the chosen methodology implicitly linked to the critical education research paradigm (Callawaert, 1999) which aims to improve learners and teachers' actions. A key characteristic of AR is to allow practitioners to reflect on their own questions, beliefs and assumptions to develop their practice whilst at the same time influencing their institution (Rowell *et al*, 2015). This AR characteristic is very appropriate to this practice-based project's triggers (see section 1.1) which came from the realisation that although it was acknowledged that reflection was beneficial to the learning process, Computing learners at the University of Teesside had difficulties writing in-depth reflections and required more support before demonstrating reflective autonomy. Moreover, it was noted that the facilitation of reflective skills was troublesome due to a dearth of framework and models to both support the development of reflective skills and to define reflection in the discipline. These particular issues generated questions whose answers are necessary to improve learners and teachers' practice with regards to the development of reflective skills which, consequently, should influence the way the School of Computing manages assessed reflection.

As a result, AR was adopted as this project aims to create knowledge to improve the practice of the participants whether they are teachers (Chapter 4) or learners (Chapter 6) as, with AR, those experiencing the issue should be involved in the decision making (Cohen, 2011). AR places the researcher, in this case myself, in the centre of the problem to take an integral part in the

process, as opposed to being an observer. It is expected that the research focus is on transformative change of the participating community.

This chapter justifies the adoption of AR for this project and elaborates on the four cycles required to formulate the outcomes of the research. Furthermore, it elaborates on the data collection and analysis processes and pays attention to the ethical consideration of the research.

3.1. ACTION RESEARCH AND CRITICAL EDUCATIONAL RESEARCH

The positivist and interpretive paradigms were investigated as part of this research but discarded. Indeed, positivism focuses on the definition of the law of nature and tends to make abstraction of human beliefs, values, opinions and judgments. This focus was in contradiction with the essence of the research project which aims to gather views and opinions from teachers and learners to create knowledge. Interpretivism could have been an option for this research as it endeavours to understand research participants' views and beliefs to define social reality and emerging theories. But its lack of emphasis on the transformative aspect of the research was an issue. '*Critical theorists would argue that the positivist and interpretive paradigms are essentially technicist, seeking to understand and render more efficient an existing situation, rather than to question or transform it*' (Cohen *et al*; 2011, p32). Therefore, critical educational research was the paradigm of choice for this research as it has a transformative agenda, in this case the transformation of learners, but also, teachers with regards to their reflective practice and the educational context. The creation of social knowledge, whether it is the reflective development framework or model presented in this thesis, has an emancipatory role, it aims to support the intellectual growth of learners and teachers in order to gain more empowerment through developing thinking autonomy and therefore not relying on authority for action and opinions. The idea that reflection can be theorised and defined is appealing as this will have a direct impact on practice, it is not just the development of theories for the sake of it.

'*There is a strongly practical methodology implied by critical theory, which articulates with action research'* (Callawaert, 1999; in Cohen, 2011, p 34). AR impacts and focuses on improvement of practice based on evidential trail of data. It gives practitioners a voice to research their own institution. Although, Bernstein (1970) doubts the impact of AR on society at large, it is important to recognise that this research project is a small-scale investigation which impacts the local setting. In this case, AR is viewed as a stepping stone to further investigations (discussed in the concluding chapter).

In the Education field, AR is now recognised as a way to enhance the science of education although it had been struggling for legitimacy until the 1990s as it was only viewed until then as a powerful form of learning rather than an effective research methodology (McNiff, 2013). Now, however, it is a well-established methodology which has gone through a remarkable growth and is recognised for personal development but also for the production of knowledge for others to use. For instance, Noffke *et al*, (2013, p13) explain that AR is '*increasingly accepted as a legitimate research strategy for the doctoral degree'*.

During the scope of developing this doctoral research, while creating the framework and model of reflection, the design of a technical prototype to support the development of reflective skills was also investigated and the possibilities of using design science (Hevner, 2007) was considered as a potential methodology for the research. The technical prototype was later removed as an outcome of the research due to time constraint making design science a less attractive methodology. A factor in AR's selection as the chosen methodology was based on Stenhouse's (1979) suggestion that action research should contribute to both the researcher's practice, but also to educational theories available to other teachers, in this case, the main contribution to knowledge i.e. reflective development (framework and model).

Action research enabled the practitioner who has identified a practical problem to implement and monitor solutions as well as propose adjustments. O'Leary (2004, p139) defines action research as '*A strategy that pursues action and knowledge in an integrated fashion through a cyclical and participatory process. In action research, process, outcome and application are inextricably linked.'* Action research is a cyclic and evolving process in which change is expected.

Several action research models have been developed such as Kemmis and McTaggart (2000) 'action research spiral model' (see Figure 3.1), Elliot's (1991) 'action research model', O'Leary (2004) 'cycles in action research' and most of them evolve around the same fundamental stages suggested by Zuber-Skerritt (1996a) which have been used to shape this research project:
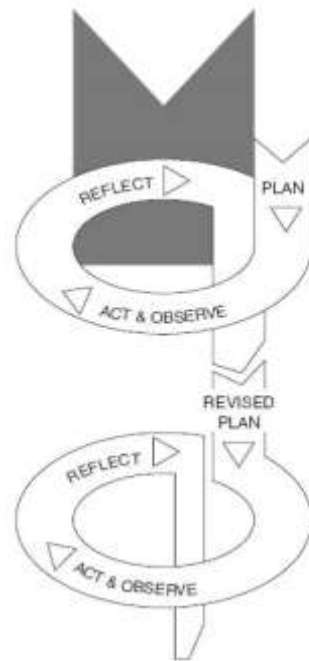
Figure 3.1 Action Research Spiral

- Strategic planning;
- Action (implementing the plan);
- Observation, evaluation and self-evaluation;
- Reflection (on the results of previous stages) and making decision for the next cycle of action research.

Accordingly, this research project has been carried out through four action research cycles as shown in Table 3.1. Cycle 1 was dedicated to teachers' interviews (Chapter 4) and the construction of the reflective development framework (Chapter 5). Then, cycles 2, 3 and 4 enabled the creation of the three versions of the reflective development model.

Action research cycle 1 (Chapter 4 and Chapter 5)	
Planning	Aims setting, choice of approach and sample. (Chapter 4)
Action	Carry out and analyse teachers' interviews. (Chapter 4)
Observation	Teasing out the main themes. (Chapter 4)
Reflection	Creation of reflective development framework. (Chapter 5)
Action research cycle 2 (Chapter 6 – reflective development model version1)	
Planning	Reflections from iteration 1 informing plan i.e. need to identify cognitive processes in learner's written reflective work.
Action	Analysis of learner's written reflective work.
Observation	Creation of the reflective development model version 1.
Evaluation	Learners and researcher 's evaluation.
Action research cycle 3 (Chapter 6 – reflective development model version 2)	
Planning	Reflections from iteration 2 informing plan.
Action	Categorisation of learners' reflections.
Observation	Creation of the reflective development model version 2.
Evaluation	Learners and researcher 's evaluation.
Action research cycle 4 (Chapter 6 – reflective development model version 3)	
Planning	Reflections from iteration 3 informing plan.
Action	Categorisation of learners' reflections.
Observation	Creation of the reflective development model version 3.
Evaluation	Learners and researcher 's evaluation, identification of future work.

Table 3.1 Action research cycles of work carried out in the research project.

3.2. DATA COLLECTION AND ANALYSIS

This section justifies the data collection methods chosen for Chapter 4 and Chapter 6 and highlights the type of data to be collected.

Chapter 4 collects qualitative data in semi-structured interviews. This method was chosen as it allows the exploration of participants' views in more depth than a survey but still targeting specific subject matter. Semi-structured

interviews allow flexibility in the questions' order and offer some freedom in what the participant wants to cover, but they are considered as *respondent interviews* as opposed *to informant interviews* (Powney and Watts, 1987 cited in Robson, 2002, p271). Respondent interviews mean that the interviewer stays in control of what is being discussed, consequently, the interviewer's agenda is what matters. Interviews are time-consuming both for the researcher and the participants but because it was necessary to get an in-depth understanding of the subject matter and because the number of persons being interviewed was small i.e. five, this data collection method was deemed appropriate. All interviews were transcribed and analysed.

Chapter 6 analyses learners' written reflections (mainly qualitative data with some quantitative data collected in section 6.4) and evaluates the different versions of the model of reflection through surveys given out to learners (mainly quantitative data with some open field comments) and feedback collected on the usage of the model of reflection (qualitative data). When appropriate Likert scales were used as '*they build in a degree of sensitivity and differentiation of response while still generating numbers'* (Cohen *et al.*, 2007).

In order to guide the data collection and analysis process Cohen *et al.*'s (2007) eleven steps of data analysis were followed:

1. Identification of the research questions to be addressed by the content analysis;

2. Define the population from which units of text are to be sampled;

3. Define the sample to be included;

4. Define the context of the generation of the document;

5. Define the units of analysis;

6. Decide the codes to be used in the analysis;

7. Construct the categories for analysis;

8. Conduct the coding and categorising of the data;

9. Conduct the data analysis;

10. Summarising;

11. Making specific inferences.

Chapter 4 highlights these steps in bold throughout the data analysis process.

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3.3. ETHICAL CONSIDERATIONS AND BIASES

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Ethics formed the foundation of this research project as the work involved people either as participants or recipients. This research is based on an exchange between myself and the people involved in the research; the project was designed with solving a problem for people in mind, with positive intention. The ethics for the project were considered in the early stage of the research and agreed by the School of Computing ethics committee (see minute of the committee in Appendix H). The outcomes of the research aim to be positive in the way that they were implemented with the intention of helping people by making the development of reflective skills more explicit. However, based on Gillies and Alldred's (2002) warning that action research can be problematic as it might intervene in people's life, I adopted a consent approach to participation in order to clarify matters and avoid potential issues.

In order to obtain participants' consent to be involved in the research, consent forms based on Diener and Crandall's (1978) four elements were designed. The four elements consisted of 'competence' to make correct decision, 'voluntarism' to take part or not in the research, 'full information' is provided about the research, and finally 'comprehension' to ensure that participants understand what the research entails.

The consent forms included the research's aims and purposes, how the data collection process would be performed and where and how the data would be stored. Participants were assured that participation was voluntary and that data would be made anonymous in the research outcomes. The consent form templates used are available in Appendices F and G.

The context of both the research project and data collection were made as explicit as possible throughout the thesis, observations and judgements were considered when they could be tainted by my own experience and personal

beliefs. Indeed, the interpretation of qualitative data is not an exact science, and I was constantly aware of the impact that my experience, values and beliefs could have on the interpretation of the data collected throughout the project. Corbin and Strauss (2008, p49) argue that:

> *'Though interpretations are not exact replications of data, but rather the analyst's impressions of that data, it does not mean that researchers should give up doing research.'*

I had to accept that my ideas might be wrong, called the '*sceptical dimension*' by Robson (2002, p18), which makes essential the involvement of others to test ideas. Being doubtful of one's own ideas and judgments is a requirement in the research field and the extensive literature review as well as the involvement of teachers and learners at different stages of the project enriched and changed some of my profoundly anchored assumptions such as:

- 'reflection is only another way to assess learners' instead of being viewed as a deep-approach to learning tool;
- 'reflection is what one's does at the end of a project' instead of throughout;
- 'reflection is easy to explain' whereas it is poorly defined therefore difficult to explain;
- 'assessment of reflection cannot be that difficult' this is evidently a great misconception.

The outcomes of the research, shaped around the methods and data analysis approach as highlighted in this chapter, contributed to the formulation of new, more correct and accurate mental pictures.

Other more specific ethical considerations, limitations and biases are covered in section 4.2 and section 6.2.

3.4. CONCLUSION

This chapter presented the different approaches taken for the implementation of this action research (AR) project. It justifies the choice for the AR methodology by emphasising that the project's research question was directly extracted from my practice where issues were identified with regards to the support and definition of reflection in the School of Computing of Teesside University. Knowing that reflection was a key skill that Computing learners had to demonstrate (QAA Computing benchmark statement, 2016), a practice change had to be investigated in order to enhance learners' reflections. This was a practical formative problem-solving approach requiring expansion of scientific knowledge in the Education field due to the lack of a support framework and model for reflection recognised in Chapter 2. These factors made AR an appropriate practice-based problem-solving methodology to use (Cohen *et al*, 2011) where the theoretical outcomes of the study aim to contribute to the participating community. The project has a critical purpose as it strives to be emancipatory for both the teachers and learners making this community the key participants in the project. These participants were involved at different stages within the four action research cycles of the data collection process, which is predominantly qualitative. In addition, ethical considerations for participants' consent and the impact of my own research analysis are discussed and actions justified. The four AR cycles and data collection processes were as follows:

AR cycle 1 - Chapter 4 focuses on teachers' views and perceptions of reflection and uses semi-structured interviews as a method of collecting data. Chapter 5, presents the data collected in Chapter 4 in a useful way to support the facilitation of reflective skills.

AR cycles 2, 3 and 4 - Chapter 6 focuses on defining reflection in Computing and therefore analyses learners' text-based reflections in order to formulate a model of reflection which versions evolved through three AR cycles. Although the analysis was mainly qualitative some aspects used quantitative data i.e. part of the analysis (section 6.4) and evaluation (sections 6.3 and 6.4).

CHAPTER 4. TEACHERS' PERCEPTIONS OF REFLECTION AT TEESSIDE UNIVERSITY

This chapter focuses on the second aim of the research 'Establish views and perceptions of Computing teachers with regards to using reflection with their learners'.

This chapter as well as Chapter 5 constitute the first action research cycle of the research approach explained in Chapter 3 and it focuses on the *planning, action and observations* stages of the cycle while chapter 5 emphasises more on its *reflections*.

4.1. METHODOLOGY

In order to gather the views and perceptions of Computing teachers with regards to reflection, it was decided to interview Computing teachers from Teesside University, analyse their comments and from these tease out the main themes. In order to guide the data analysis process, Cohen *et al.*'s (2007) eleven steps listed in Chapter 3 were used. These steps are marked in bold hereafter.

A semi-structured exploratory interview plan (Appendix E) was designed to provide some guidance during the session and help focus the discussion on particular matters related to reflection in the Computing discipline. The interviews aimed to establish the following **(Step 1)**:

- Teachers' understanding of what reflection is, as well as their usage of reflection in their teaching;
- Their expectations of what a piece of reflection should include;
- Their views on learners' difficulties with regards to writing reflections and developing reflective skills;
- Their opinions on the facilitation, assessment and feedback of reflection;

Of course, each interviewee was provided with the opportunity to discuss other aspects of reflection if they wished to do so.

Sample

It was crucial to identify a sample of teachers to interview who were accustomed to the usage of reflection in practice, therefore, the quality of the sample (their appropriate experience with reflection) came before its quantity (number of teachers interviewed) **(Step 2).**

A specific teacher profile was formulated for this study which helped choose the sample. The teacher had to:

- Have several years' experience of using reflection with his/her learners;
- The reflection requested from the teacher was expressed in writing;
- The reflection was assessed as part of a module;
- The teacher had a professional drive to enhance his/her practice with regards to the use of reflection with learners.

Five teachers from the School of Computing fitted this profile and consented to take part in the interviews. The details of the ethical consent process can be seen in the next section 4.2. **(Step 3 and 4).**

Data analysis

The sound files of the interviews were first transcribed which allowed for a first exploration of the text data. This led to a systematic annotation exercise for each script in order to extract the interviews' key ideas. All annotated transcripts can be found in Appendix A and an example is provided below in Figure 4.1.

At this point, the coding unit was defined. This initial review of the interviews suggested that the unit of analysis would be the number of words required in a sentence to capture one single idea. When the sentence or several sentences covered only one idea, the full sentence or sentences were attributed to the relevant category; whereas if the sentence covered several ideas, each idea would be categorised appropriately.

⑤

they are actually made to talk about what they have actually developed and what they can take forward for next stage. That came through this year quite strongly.

M   Do you think, you have 5 people teaching with you, the assessment of that particular reflective writing is fair – with 5 different teachers assessing it?

J   That is a very good point. We haven't done the moderating on the marking yet and I think that's something we're going to have to look at. What we can do about it at this stage, I don't know. I didn't find it too much of a problem last year, students still had to do the reflective writing and we've got most of the same tutors this year, we've only got one new person and I didn't find any huge discrepancies in the marking last year, although we had very little discussion about what we were looking for in the reflective piece of work. So maybe staff have a consensus in their heads that's never really been articulated about what were looking for in that piece of work.

M   Do you think that's a problem though to have something that is not articulated in our head because we can't really explain properly to our students?

J   Absolutely, how can we explain to our students if we can't articulate it? Even if you were giving feedback on it, you say they've got a D how then can you tell them what they need to do to get a B or a C or an A so we have to have a way to be able to talk about reflective writing and marking of reflective writing much better. When I used to do something with my masters students, on reflective writing, I went through agonies in marking this work; I had huge problems with it. I think I said to you when you first started looking at this for your PhD that you're going to have problems with this because it's such a personal piece of work, how the heck do you mark it, what are you looking for in it, what makes a good piece, what makes a bad piece.

M   That's right.

Handwritten annotations (margins):

J28 *RW made students realise their learning and its usage in the future, this seems to have come as a surprise to them.

J29 * Staff might have an implicit consensus of what they are looking for in a piece of RW

Note: Making this consensus explicit would help the students & make marking fairer maybe ?!

J30 * RW piece marked by different tutor has not been looked into closely, although no major discrepancies have been identified in marking.

J32 * Tutor went through agonies to assess RW for another class, because how do you assess such a piece of work when it is so personal ?

J33 * If marking can't articulate what they are looking for in a piece of RW, how can we provide good feedback on what the student should do to achieve the next grade up ?

Note: Really what we are looking for is a tool, which can easily illustrate an 'amount' of learning that took place during a specific time. Is RW the right tool to use in the computing discipline ???
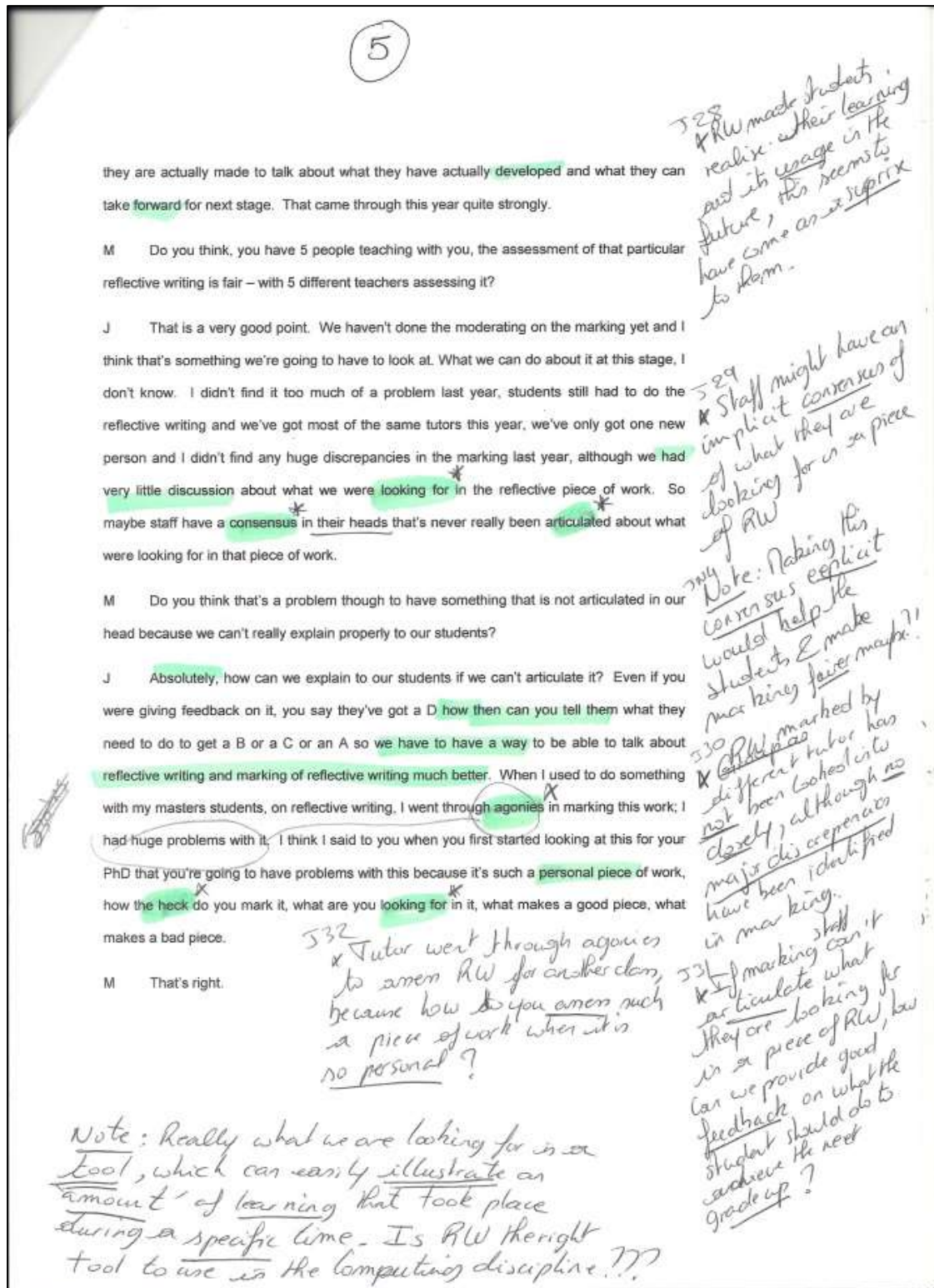
Figure 4.1 Example of an annotated transcript page.

Once all the transcripts were fully annotated, they were photocopied and each annotation was numbered to ensure anonymity and then colour-coded and cut to be used on a theme map (see Appendix B). The colour code allowed for each piece of datum to be easily traced back to its original position on the appropriate

transcript. During the formulation of the annotations, particular attention was paid to keep the same vocabulary as the one used in the interviews to avoid distorting the meaning of the original message. **(Step 5 & 6).**

Each transcript annotation was cut out and categorised on a large poster (see Figure 4.2 and Appendix B for a close-up view of the categorised annotations).

Figure 4.2 Transcripts annotations positioned on a large poster

The annotations were positioned in an area of the poster based on their individual meaning. For instance, the following three annotations (Appendix B, Figure 5) showed that the *timing* of reflection in term of its usage within a module or throughout different study *levels,* might be an important dimension to consider.

- B1 'T*eacher hopes that learners would reflect <u>all the time</u> in class and relate content to what they are doing*' and

- M7 '*Learning takes place at <u>different times</u> throughout a module, reflection is flexible enough to capture it when it happens'*

- S7 '*Teacher assesses reflection at Master and final year <u>levels'</u>*

These particular three annotations led to the emergence of Theme 4 'Progression and continuity of reflection'.

Placing all the annotations on a large poster allowed the identification of six main themes:

Theme 1: annotations related to teachers' understanding and expectations of reflection (see Appendix B; Figure 2).

Theme 2: annotations associated with benefits and aims of reflection (see Appendix B; Figure 3).

Theme 3: annotations linked to the formulation and breadth of reflection (see Appendix B; Figure 4).

Theme 4: annotations related to the progression and continuity of reflection (see Appendix B; Figure 5).

Theme 5: annotations associated with reflection's assessment and feedback (see Appendix B; Figure 6).

Theme 6: annotations connected to the support requirements with reflection (see Appendix B; Figure 7)

A second review of the scripts led to refining some of the data into sub-themes (see Table 4.1).

Theme 1: Teachers' understanding and expectations of reflection	
Theme 1 sub-themes	Diversity of views and expectations.
	Depth of reflection.
	Reflection or something else?
Theme 2: Benefits and aims of reflective writing	
Theme 2 sub-themes	n/a (no sub-themes identified).
Theme 3: Formulation and breadth of reflection	
Theme 3 sub-themes	Formulation of reflection.
	Questioning to focus the breadth and domain of reflection.
Theme 4: Progression and continuity of reflection	
Theme 4 sub-themes	n/a (no sub-themes identified).
Theme 5: Reflection's assessment and feedback	
Theme 5 sub-themes	Assessment - intuition and struggle.
	Assessment - grades, marking criteria and feedback.
	Learning environment.
Theme 6: Support requirements with reflection	
Theme 6 sub-themes	n/a (no sub-themes identified).

Table 4.1 Themes and subthemes from teachers' interviews

The process followed to achieved this was that raw data were copied across from the scripts to their themes in Appendix C and sample phrases were highlight in **bold** to illustrate why the themes or sub-themes were teased out from the raw data (see Figure 4.3).

The text highlighted in yellow in Appendix C shows the illustrative quotations used as part of the discussion thereafter (from section 4.3 to 4.8).

E- We split it between us, we have a stage set of processes we go through and **in the middle of that they are asked to reflect as a group**. **At the end** when they have finished the whole thing and they have actually had some feedback already, on pieces of work, on oral presentations, they reflect as individuals. So there are two points

E- **I definitely think it can happen right from the start [1st year]**

E - **It would be quite nice to have it so that they step up their level of reflection each level** until they get to the point where they are actually getting to engage with the literature as well and it would be much easier to do that if they had done reflection in first, second and third year instead of then suddenly in Masters'

E - I think **it should be something you experience at each level** but would **perhaps look for something different at each level** and try and progress it to the point where they get to

Figure 4.3 Appendix C example.

This proved a useful exercise as the sample phrases (listed in Appendix I and shown highlighted in bold in Appendix C) were used to facilitate the extraction of analytical observations for each theme/sub theme in Appendix I. An example of Appendix I is illustrated in Figure 4.4.

Sampled phrases (copied from Appendix C) to illustrate the theme	Analytical observations
Theme 1(a): Diversity of views and expectations	
- 'I expect to see a lot of themselves', - 'It's about getting over your experience', - 'your learning journey', - 'what they think they learnt', - 'what went wrong', - 'young men do not find that easy. Facing up to their feelings, their limitations', - 'structured action planning', - 'Some students are innately better', - '[reflection] is a skill, - 'what have you learnt from this lesson?' - 'that went well or that didn't, what went right with it', - 'how it relates to what else we have done',	- Tutors have different expectations of what reflection should include from 'your learning journey' to 'engage with the literature' or 'find extra resources not covered in class' - Reflection is a skill - Some tutors expect to see general, reactive reflections ("what have you learnt from this lesson?") whilst others expect a more structured higher-level reflection ("they have actually understood a theory, and how it's linked to the practice')'.

Figure 4.4 Appendix I example.

These analytical observations drove the discussion presented thereafter from section 4.3 and they were also used for the formulation of the framework presented in Chapter 5. **(Step 7 & 8)**.

Cohen *et al.* (2007) have indicated there are different ways to present qualitative data analysis including using per participant responses, per instrument used, and per issues. Instead of presenting the data according to the specific questions asked during interviews it was decided to adopt Cohen *et al*'s *per issues* approach and present them in this chapter per theme as they

represented the different important variables to consider when using reflection in Computing at Teesside.

This choice of representation also had the additional benefit to make the process of linking the empirical data to the literature review in Chapter 2 easier as some similarities in their headings were noted during the analysis phase, e.g. questioning, assessment, terms, learning environments.

Section 4.2 discusses and illustrates the interviews raw data for each theme and its sub-themes. The results are presented as part of a framework in Chapter 5. **(Step 9, 10 & 11).**

| 4.2. ETHICAL CONSIDERATIONS, LIMITATIONS AND BIASES |

In order to obtain the consent of teachers to participate in the interviews, a consent form based on Diener and Crandall's (1978) recommendations (see section 3.3) was designed.

Therefore, the reasons and aims for carrying out the research project were explained to each of the potential participants before the interviews took place in order to give them time to decide if they wished to participate in the study. The interviews could only proceed if their informed consent was given. Two teachers did not accept the invitation to participate in the study but the five others did. The consent form also warned participants that the interviews would be audio recorded but that their anonymity would be preserved. It also insisted that the audio files would be transcribed and destroyed on project completion. Furthermore, it explained that the original files would be stored in a secured place and it clarified how the outcomes of the research would be used, i.e. PhD thesis and possible publications. The detailed interviews consent form template can be found in Appendix F.

The close relationship between myself as a researcher and interview participants was seen as an advantage but also a concern. Indeed, all participants were my work colleagues who I had known for several years and, in some cases, we had taught together.

This relationship could be seen as an advantage as the participants trusted me and were confident in the value of the research and how their data would be used. Additionally, the existing trust formed the foundation for acquiring the fullest and most accurate data and avoided one of Oppenheim's (1992) causes of bias which is the poor rapport between interviewer and interviewee. It is recognised that while my relationship with the participants might have helped gain research consent, participants were not pressured to answer positively to the invitation; in the end, two teachers chose not to participate.

However, it was a concern that cross fertilisation of ideas and views during work meetings or friendly chats were to be expected. Although the interviews were aiming to get teachers' independent views of using reflection with their students, it could not be guaranteed that either my or a colleague's opinion had not, to some extent, shaped the participants' views of reflection. This had to be accepted as a limitation of the data collected during the interviews.

I recognised that, although I had years of experience of using reflection with my learners and therefore had developed my own views and approach to the subject matter, those views could not interfere with the data collection process. A constant and conscious effort was made to respect this throughout the academic dialogues which took place during the interviews.

Hierarchical professional positioning between myself and participants was also considered in order to make sure that the participants would not feel frightened by being interviewed by someone in a higher position than themselves. First, this was not deemed to be a concern at this point as the researcher was not in a hierarchical position of superiority compared to the participants. Although, when explored further, it was recognised that because I had spent a considerable amount of time exploring the issue of reflection, my positionality and experience on the subject could be seen as frightening to colleagues who might not want to admit to their own shortfalls. Indeed, '*the identities of both researcher and participants have the potential to impact the research process. Identities come into play via our perceptions, not only of others, but of the ways in which we expect others will perceive us*' (Bourke, 2014; p1), therefore, there was a possibility that the participants might assume I had more knowledge or had clearer views about the subject than them, which in itself could be a

limitation as the participants could be unwilling to display uncertainty or ignorance to a more junior colleague. Therefore, particular attention was paid to make sure that the participants could relate to the subject matter and had something to contribute to the study; in addition, the motives for the data collection were emphasised at the start of the process to avoid any misconception for the intentions of the work.

A *voluntary* sample bias was introduced as only teachers with experience of using reflection, therefore in favour of using reflection, were chosen to be interviewed. Although this decision meant that the views of the teachers not using written reflection with their learners would be omitted and therefore had to be accepted as a limitation of the study, it allowed for in-depth and rich discussions and data collection with the chosen experienced sample.

It was first recognised that the first level of data interpretation occurred at the transcription stage as it was inevitable to lose some aspects of communication such as voice tone when translating the audio files into text. Also, '*there is in fact no transcription notation system capable of providing to the researcher a completely accurate and comprehensive narrative of the original performance*' (Flick, 2014, p66) this was countered during the data interpretation stage by taking care to stay as close as possible to the data collected to avoid misinterpretation during analysis. Still, interview data is never complete and it can be looked at from different theoretical perspectives or focus on different features, making the analysis a partial representation of the data set (Flick, 2014), this needs to be recognised as a limitation.

Data gathered that fits into this theme illustrates three main key points. First, it highlights the *diversity of views and expectations* of teachers with regards to their understanding of what reflection in Computing should be focusing on. Secondly, the data reveals an important dimension which relates to the *depth of reflection* as a specific attribute. Thirdly, it was teased out from the data that the word *reflection* might not be the most appropriate description of what teachers expect from their learners. Each key point is detailed in this section.

Theme 1 (a): Diversity of views and expectations

The first key point emphasises the diversity of teachers' views with regards to what reflection is. For instance, Teacher 1 indicates that the School of Computing has a predominantly male learner population and reflection is certainly not something that comes naturally to most young males. This teacher argues:

> *'[reflective writing is personal and] young men do not find that easy. Facing up to their feelings, their limitations, their failures it's a touchy, feely, girly thing and we've got a predominately male population to try and get them to be more reflective; interesting challenge'*.

This teacher suggests that it might be difficult to get all the male learners to be fluent with reflection and maybe *'we may have to marry it up with [a] slightly more structured action planning approach as well'*. The views of Teacher 1 are that '*Some students are innately better at [reflection] that others'*, however, he/she argues that

> *'…. [reflection] is a skill. We talk (we in very general terms) about being reflective practitioners […] I think there are steps you could take to help [the learners] get there definitely. They may never be a great reflective writer but they could be competent one'*.

Therefore, the data suggest that reflection is a skill that can be developed however there is a complexity associated with Teacher 4's acknowledgement that:

> *'we [tutors] do have different ideas of what reflection is and what a piece of reflective writing should include'.*

The teachers interviewed were asked if they thought that the type of reflection they require from their learners was different to day-to-day type reflections that one might have. While two teachers thought they were similar,

> *'I could imagine myself having a bath and thinking if I was a student, 'what am I getting out of this module, what is the point of it' and hopefully seeing some relevance. So no, I don't think so [the type of reflection we ask our students to do is different to reflection you might do while in your bath]. I think last year when I had the specific models about IBL's and Skonul then that was more focused on 'had they understood the theory' and 'could they apply it in practice' and that to me moves a bit away from reflection how I normally use it.' (Teacher 2).*

Two others, Teacher 3 and 4, thought they were different. Teacher 3 explains:

> *'You develop your own little mechanisms, I don't think I evaluate how good they are at any point, and it's my own little way of doing things. So yes I think I expect a lot higher standards from my students' [reflection] than I probably carry out myself'.*

The view of Teachers 3 and 4 with regards to the higher order reflection, such as critical thinking, was that it needed to include evidence of researching a topic in more depth, in particular, engaging with the literature, which is not required in everyday reflection as Teacher 3 argues:

> *'Critical thinking is the higher order thinking that I am trying to get my students to do. And that is much harder to achieve. It is where you start to place your own learning in the wider context of the literature.'*

The data gathered at this stage infers that reflection in Computing might take different shapes which raises the concern of its definition and support (covered in Theme 6).

It is interesting to note that Teacher 4 strongly believes that '*if something has been reflected upon in depth then it is learnt*'. On the other hand, Teacher 1 believes that reflection is more about documenting the learning journey, as he/she argues:

'It's about getting over your experience, your journey, your learning journey rather that writing reflectively. I think from our point of view as lecturers, I think that's more of what we are trying to get at isn't it? The documentation of their learning journey'.

Although Teacher 1 also recognises that there are different types of reflections, he/she expects *'to see a lot of [the learners] as a person in [the reflection], I expect [the reflection] to be personal'*. However, these teachers still see reflection as a way to demonstrate one's learning:

'I would be expecting them to talk about what they think they learnt, what they got out of the process and possibly what went wrong, because I think you can learn an awful lot from what went wrong' (Teacher 1).

Therefore, the data suggests that all the teachers interviewed use reflection in the classroom as a personal development tool which allows learners to assess their own learning and enhance it.

Four of the teachers using reflection at final year or master's level claim that it is necessary to explicitly tell learners that they must engage with the literature in their reflection. Teacher 2 argues that:

'Really any final year module or masters module lecturer will be expecting students to engage with the literature but if you don't make it explicit […] the students probably don't even realise. I just find it slightly depressing that even in the final year and Masters we have to tell them what should be blatantly obviously by that time'.

Teacher 2 expects to be surprised and wants to read about things that they have not provided in class (additional research), as he/she explains:

'[I want to see that] they have shown some intellectual curiosity of their own, they're not just giving back to you what you have given them, they're going beyond that and that's partly about students' engagement with the module, it is about being a proper learner being at the top of the tree and having the intellectual maturity to go and work [it] out'.

Teacher 4 adds:

'I expect them to find extra resources not covered in class to emphasise the point that they are making. […] if it makes sense, maybe they could look at other tools or theories and see if all the things I haven't talked about in the module could have worked better or be expanding to their own work practice'.

The data suggests that engaging with the literature and demonstrating intellectual curiosity are requirements for academic reflection in Computing, especially for higher levels such as final years and Masters. The teachers expect *novelty* in the learners' reflection as mentioned by Teacher 5 *'I want to be surprised'* or Teacher 4 *'I expect them to find extra resources not covered in class'*. Novelty could be demonstrated by learners' own views and logic but also from referring to the literature that has not be covered in class. This would prove that learners can establish links between different authors and a topic under investigation. There is a very clear message here that engagement with the literature is compulsory at higher levels, and this should come through in the reflection. The only teacher who did not mention engagement with the literature as a requirement, was teaching second year learners which might explain why he/she does not consider it to be such an important requirement. All the other teachers were referring to final year undergraduates and master's level learners. Recognition that if a learner demonstrates intellectual curiosity by autonomously engaging with further literature than that provided in class, then he/she is being a proper learner able to achieve the highest level of critical thinking and demonstrating intellectual maturity. This leads to the assumption that if masters level learners are expected to fully engage with the literature then there should be other descriptors of expectations for lower levels to guide the learners (this is discussed later in Theme 4).

This part of the interviews also shows that one teacher sees reflection as the description of a personal learning journey where shyness and expression of ideas to their teachers can be difficult for learners (Tummons, 2011) and in particular male learners. However, other teachers tend to emphasise the importance of engagement with the literature rather than the self-centred learning evaluation. It is important to recognise that any assessment will also expose *personal* learning to the teacher, so only the emotional part of reflection

might be an issue, but as identified in Moon (2006) it is a myth to believe that reflection is always linked to emotions. Reflection does not have to be emotional in the Computing discipline, although it does not exclude it. Engaging with the literature, reflecting on theories, tools, algorithms etc. are ways to stay more *detached* from emotions, such as looking at team performance, as a whole, instead of the individual learner's performance.

The key finding from this part of the interviews is that teachers do not have the same idea of what reflection should focus on other than it demonstrating learning. Some of the teachers interviewed think that reflection should be self-centred and look at how to improve one's self which is very similar to the everyday reflections that one might have with self, such as Teacher 1 *'I would be expecting them to talk about what they think they learnt, what they got out of the process',* other teachers, such as Teacher 2 and 4 mentioned above, have unyielding views about its compulsory engagement with the literature which put this type of academic reflection aside to everyday reflections. According to Smith (2011), all those views are valid, as it all depends on the definition of the domain of reflection. At times, it might be appropriate for a teacher to expect their learners to produce, what Smith calls, a *personal* level of reflection, but at a different time a more *critical* approach to reflection might be favoured. The interviews have highlighted that reflection in Computing can focus on different possible domain of reflections, as per Smith (2011), so this can be adapted to assessment types and clearly explained to learners**.**

Theme 1 (b): Depth of reflection

The next point teased out from the interviews refers to the depth of reflection. The notion of reflection's depth is explicitly mentioned by Teachers 3 and 4:

> *'I expect the student to have reflected on the relevant content covered in class and activities undertaken and to have tackled them in-depth'* (Teacher 4).

> *'for what I'm asking them to do it doesn't have to be in-depth they can make it in-depth if they want'* (Teacher 3).

According to the teachers, the depth of reflection might be different depending on the class taught, but it seems that there is a consensus amongst teachers

as explained by Teacher 3 that masters level will be expected to achieve the highest one:

> *'At Masters level I try to get them to engage with the literature as well, so when they are reflecting they don't just engage with what I think happened and what happened to me but what others say about this, who went through this experience and how does that relate, so they are trying to engage with the wider world on this.'*

The teachers make it clear that the depth of reflection is the level of exploration that the learner reaches, for instance Teacher 3 explains:

> *'I do think you've got everybody reflecting in a certain way, but it's how much you push it "what have I done wrong?" it may be just a realisation that you've done something wrong but it's what you do about it, how you improve yourself, that's where the difference is.'*

What constitutes the highest level of reflection is explained by Teacher 3 who calls his/her assessment 'a reflective exercise', but what he/she really wants the learners to achieve is critical thinking:

> *'Reflection is I would say easier [than critical thinking] and can be done at any level. But critical thinking is the higher order thinking that I am trying to get my students to do. And that is much harder to achieve'.*

From his/her point of view, critical thinking:

> *'is harder because the students have to go and read extra material and that will take extra time. It's something they have to do on their own'.*

This section suggests that the depth of reflection expected by the teachers is a key attribute to take into consideration when setting a reflective assessment. It needs to be clearly explained to the learners as it links to the level of exploration that will be required by the learners to demonstrate an appropriate level of learning.

Theme 1 (c): Reflection or something else?

The third point that emerged during teachers' interviews was that the word *reflection* did not always properly illustrate what the teachers were asking their learners to do, which led the interviewees exploring maybe more appropriate

names. Indeed, when queried, Teacher 1 explained that he/she was asking the learners to produce a very personal piece of work and was happy to call it *reflective writing* although it was so centred around the documentation of their learning journey that he/she suggested calling it '*Your Learning Journey*' instead:

> *'That's a very good title – "tell me about your learning journey". reflective writing might scare them off but if you talk about; 'cos everyone goes through the journey, some people go further than others some people go faster than others and everybody's journey will be slightly different, everybody will take a slightly different path and it is documenting that.'*

Teacher 1 also suggested calling the assessment 'Critical Thinking', but, when explored further, argued that this concept was very different to reflection and also different to what he/she expected the learners to produce as he/she defined critical thinking as:

> *'a balance of arguments between two sides, it's never right or wrong, you've got to have put both sides forward, there's got to be evidence and then you come to a conclusion and that's what being able to think critically is. It's being able to see the other person or the other side of the argument, seeing the black as well as the white and sometimes the grey in between'.*

It was not as straightforward for Teachers 2, 3, 4 & 5 who all used the word *reflection* with their learners, but after some thoughts on the matter, realised that actually *reflection* might not be the most appropriate descriptive word to use. For instance, Teacher 2 highlighted that because he/she was asking learners to apply theories to practice in their *reflective* work, then:

> *'Perhaps I should have renamed it, that it wasn't a reflective essay or a reflective report, that it was about cognitive skills assessment or something!'*

In the case of Teacher 3 he/she was unsure what to call the assessment:

> *'Perhaps what I am asking the students to do is critical thinking, not reflection. I don't know, it's difficult'.*

Teacher 5 realised that the name *reflection* was sometimes confusing and might not be appropriate, as he/she explains:

> *'We do tend to use the word reflection but sometimes I don't and I have discussed this with [other tutor's name] as I am never quite sure'.*

Although all the teachers interviewed described part of the assessment for their module to be a reflective piece of work, it is very clear that the type of work requested from the learners can be very different from one module to another but still named the same. Should this work be called *learning journey* as this recognises the fact that the pace and length of the journey can be different from one learner to another as well as its path? Although *learning journey* could be a valid name for first and maybe second year undergraduates, it might be more accurate to find a name that encompasses both the *personal learning and development* dimension (developed in Theme 4) as well as the *reflection depth* dimension. As per Smith's (2011) *forms and domains of critical reflection,* critical reflection is the highest level of reflection; it is the examination of the political and social context of the practice. This reflection domain did not come across very strongly in the five interviews. Instead it seems that the highest level of reflection expected from the teachers overlaps both the contextual domain and critical domain but with the contextual domain being predominant i.e. questioning the knowledge structure of the practice domain, and only some elements relating to the political and social domain. Therefore, it was observed that the descriptive name 'reflection' was inappropriate for reflective assessments in the Computing discipline.

Theme 2 was teased out from data which referred to the clarification of reflective writing's benefits and aims. Firstly, the analysis demonstrates that identification of learning is one of the main aim for using reflection as it enables the teachers to gauge learners' understanding. The second aim is to find out individual contribution within a group setting but also to identify if learners can apply knowledge to practice in new contexts. Finally, it seems that one benefit of reflective exercises is to stimulate learners' transformation.

The teachers agree that reflective writing aims to tease out the actual learning that took place during project work. Teacher 4 explains:

> *'I use reflective writing as a way of assessing my students' learning on project work […] I believe reflective writing is a great tool to identify if a student has learnt and really understood the content, it is difficult to fake understanding with reflective writing'.*

Teacher 2 highlights the fact that reflection is a way of gathering feedback on what the learners have or have not learnt as he/she quotes:

> *'to some extend [the reflection is] shaped by what the lecturer herself wants to know about. It's a way of getting feedback of what the student has learnt, but then you have to put your other hat on and assess it.'*

This is echoed by Teacher 4 who argues:

> *'I think it is very useful when you can find a way to make these reflections explicit because from a teacher's point of view, I consider it being almost the only way to actually, truly understand what students have actually learnt, how they actually perceive things and why'.*

Teacher 2 adds:

> *'I'm not assessing their reflections as such, I am actually trying to assess their intellectual maturity'.*

This is an interesting assertion which may suggest that reflective writing has the potential to act as a *learning catalyst* that stimulates cognitive functions and helps shape learning.

Reflective writing also helps learners to realise the amount of learning which took place as argued by Teacher 1:

> *'I think, reading what the students wrote, it has done them good to go back and look and for some of them it's been a bit of a surprise when they are actually made to talk about what they have actually developed and what they can take forward for next stage. That came through this year quite strongly.'*

The above data suggest that written reflection reveals learning to the teachers which is extremely valuable in order to support the learning process, moreover, by going through the process, reflective writing helps reveal learning in learners' own minds and provide them with a springboard to identify future necessary learning. If this idea is explored further, it might also be recognised that the usage of this springboard needs to be recurrent to encourage repeated learning and continuous self-enhancement. All the teachers interviewed explicitly talk about using reflective writing to understand to what extent learning has been assimilated, this refers to the concept of the *Learnoscope*, a notion illustrated in Mallet and Bel (2008) where learning gaps are made visible to teachers. This is useful as it is then possible to revisit aspects of a course that were not understood before. However, this is only possible if there is time to do so, hence the importance of carefully ascertaining the most appropriate stage(s) of a module or course within which to integrate reflection, a concept elaborated upon in Theme 4.

In the case of group work, reflective writing allows the identification of individual contributions as well as how the group performed. Teacher 2 explains:

> *'I want to know something about what they personally contributed to the group work'.*

In the same way Teacher 3 adds that he/she wants to know:

'how they worked as a group, how they worked together and the skills they developed to work with each other as well as individually looking at my skills and how they have developed an enquiry based learning'.

It is interesting to note that reflective writing was used by four of the teachers interviewed in the context where group work was required in their modules. In this case, its partial role was to investigate how the group had performed but also the individual learners' contribution to the group work. As it is something specific that the teacher wanted to find out, it can be assumed that specific questions or areas of reflection with regards to group work and personal contribution would be given to the learners to determine how effectively they have engaged with them. For instance, Teacher 2 asks his/her learners:

'you should reflect on how you have developed or changed as a learner and an IT professional by doing this module. How what you have learnt will be carried forward into your Masters Project and dissertation'.

This shows that the teachers have a key role to play in the identification of the domain of reflection, they need to provide some information related to what they think is relevant to cover.

Several of the teachers interviewed use reflective writing as a way to ascertain that their learners can apply diverse research strategies, knowledge or theories in context and in different projects as Teacher 2 explains:

'I get them to reflect on what they have learnt […] I would ask them to take the same topic and how would they do it using a different research strategy to the one the group used, so they would then propose a different research approach, and there I am just trying to pick out if there are any who have just coasted along and what knowledge they have and they haven't just been hidden in the group.'

Teacher 4 argues that he/she expects learners to demonstrate:

'how [they can] link concepts or theories, how they can actually modify a theory to explain how they would put something into practice and it's all that type of thing and these are intellectual abilities, high level cognitive abilities.'

Because of its visibility, reflective writing is used to ascertain transferable learning such as application of theories to new contexts.

Finally, Teacher 4 argues that reflective writing can also encourage learners to be responsible, positive and encourage them to solve problems:

> *'I use [reflective writing] to drive 'student's responsibility', always encouraging them to take positive action in a project and not only relying on others to make things right. I want to see evidence of problem solving which is very valuable within the Computing discipline and that is definitely worth assessing!'*

According to this teacher, reflection has the potential to become a learner's inner transformation tool, a tool that helps oneself think and act in different ways this makes reflective writing an extremely flexible and versatile tool. If reflective writing can lead to making learners more responsible, surely it is worth investigating further. It seems that appropriate guidance on how to conduct reflective writing has the potential to spark learners' inner transformation for instance '*do not blame others for project flaws*' or '*emphasise on how you could solve the problem*' (Teacher 4).

Theme 3 was extracted from data which highlighted two key ideas. One emphasised the diversity of teachers' views with regards to the formulation of learners' reflections, and the other highlighted the importance of questions formulation in relation to the breadth and domain of reflection.

Theme 3 (a): Formulation of reflection

Teacher 1 admits that the best pieces of reflection he/she has read are natural, structured and there is a flow to them, they have not felt contrived, they are genuine. This teacher elaborates:

> *'I feel that you can tell the genuine from the fake, the person should shine through; you should almost be able to hear them say what you read and I think that's very difficult to disguise.'*

This teacher does not believe that:

> *'you have to be the world's greatest writer in terms of grammatical correctness to be a good reflective writer'.*

He/she argues that it is rather about being able to convey the essence of what was learnt and it should be written in an informal way because it is personal. Teacher 1 also describes the reflective work submitted by a learner who obtained a very good mark as:

> *'[The learner] came across as mature for a start and I think he gave mini examples, he embedded his writing within specific examples that he drew on from the module, things that had happened, particularly things that went badly.'*

It is interesting to see that this teacher, uses the word *mature* as a way to describe a good piece of reflection and it can also be noted that providing specific examples seems to be an important ingredient to good reflection as well as having a structured narrative as he/she recalls in the following quote:

> *'Most told a story and I think there was a narrative behind the good ones and a story should have a beginning, middle and end and that narrative flow came through in the good ones.'*

Contrary to Teacher 1 who believes that reflection cannot be written in an abstract way, Teacher 2 is always looking for more sophisticated language and abstract terms:

> *'You're looking for [the learners] to have those more abstract terms that they're able to pull out of the precise facts and skills that they have learnt'.*

However, both argue that the learners should include precise facts or specific examples in their reflection. Indeed, according to these teachers the provision of specific examples and precise facts is important to make the writing more meaningful and in context. Williams *et al.* (2012) explain that reflection needs to be backed up by appropriate evidence that might be drawn from the literature but also from the practice. Facts and examples are part of evidencing the ideas being discussed, whereas generic reflections have an unhelpful vagueness about them which does not enable the teacher to evaluate the learning.

The data collected in this sub-theme so far also suggest that teachers' expectations of how reflection should be formulated vary from teacher to teacher as demonstrated by Teachers 1 and 2 above. It can be very personal, concrete and using simple words to sophisticated, mature and abstract, most of the time engaging with the literature but not always. Due to the formulation diversity of reflection, it seems to be essential that teachers clarify their requirements to the learners.

Additionally, Teacher 3 explains that:

> *'[The learners] come to Masters and they think 'I shouldn't use "I", I shouldn't use the first person' and actually with reflection yes you do'.*

But the problem does not only lie with MSc leaners as indicates Teacher 1 who teachers second year:

> *'[The learners are] not sure of the style expected, "should I be writing formally, is it informal?"'.*

This array of possibilities for the formulation of reflections, also found in Cowan (2014), Moon (2006) and Van Manen (1991), could be very confusing to a learner if it is not well-defined right from the start. Most of the teachers interviewed seem to believe that being articulate and able to structure reflective

writing are skills required to convey the learning journey in a meaningful way to the reader. However, three of the teachers pointed out that Computing learners are not always articulate for instance Teacher 1 says:

'I think that is where some of our students suffer, they are not articulate'

making identification of their learning difficult.

Teacher 4 and 5 strongly believe that being concise is an important feature of a good reflective piece. Teacher 4 explains that:

'Some [learners] really struggle with the length of the reflection as they find it difficult to be concise'.

Teacher 5 adds that the reader needs to clearly get the main point that the learner is writing about.

'they need to be concise and they need to be pointed and directed and when I say to them it's not about the fact that I'm counting the number of words, I want to know what the point is that you have said and if I have read a thousand words and the main point is buried in there somewhere, I might not have got that main point, it may not stick in my mind, they are not selling it.'

According to these two teachers being able to write in a concise way is an important reflective writing skill as the learner needs to make his/her learning and points stand out in the text, unfortunately this is not always a skill that learners have, as illustrated further by Teacher 5:

'[The learner] explained that he had written 500 words, twice as long as asked for, and was unable to see what was wrong with it. He gave it to his girlfriend to read and she was able to point out where he was repeating himself, where something could be said more simply and what bits could be clearer. So somebody else looked at it because he couldn't and he boiled it down to 300 words and they were 300 really good words'.

Theme 3 (b): Questioning to focus the breadth and domain of reflection

To help learners identify what to cover in their reflective work, all of the teachers felt the need to prompt them with questions, more or less specific, that the learners sometimes choose to use as headings. Indeed, determining what to reflect about seems to be an issue for learners as explained by Teacher 1:

> *'I think [the learners] need guidance and structure "reflect on this module" it's too broad […] The structure (prompts) is very important. Partly because of this articulation of what do we mean'.*

Teacher 3 and 4 both agree that the learners really struggle with determining what is relevant to reflect upon and what to leave out. This is illustrated by the following quote from Teacher 4:

> *'most students struggle to identify what is important to talk about in their reflective paper. Some of them could easily spend 1000 words talking about something very trivial which will not materialise in a lot of reward points'.*

The learners might waste many words talking about something fairly trivial when other important issues or experiences did not trigger any reflection in the assessed piece.

The five teachers interviewed guide the learners with prompts which can be used as headings as Teacher 3 explains that:

> *'[The learners] have various questions that I ask them to answer, it's a quite structured piece so they have headings that should prompt them'.*

The prompts provide learners with an indication of what is appropriate to reflect upon in the module and they act as signposts to what needs to be learnt (linked to learning outcomes) which could contribute to shaping the reflection breadth.

In four cases out of five, prompts tend to be open and allow a large scope to be covered, as the following quote from Teacher 2 demonstrates:

> *'Marking them, quite a lot of them used these [questions] effectively as headings, which was reasonable enough, 'effectiveness of group', 'personal contribution' and then 'personal learning'.'*

However, Teacher 4 explains that he/she also provides prompts but those are more specific and focused around the course content, as he/she explains:

> *'I provide examples of questions that they can use in the ICA paper; they are quite specific questions such as 'How is our business proposal helping us plan for this project? Or 'In hindsight have we planned / cost our project appropriately?' and [learners] are encouraged to formulate their own too.'*

It is interesting to note that this teacher, who is teaching final year and MSc students, encourages the learners to formulate their own questions which means that the students had to carefully think of what was relevant in the project to reflect about.

The prompts used by teachers not only help identify and structure the work but they also make sure that the learners can demonstrate the learning outcomes. Teacher 2 clarifies that:

> *'...you could certainly see that they had thought about most of these questions, or at least the best ones had. So, I guess I've given them, […] a structure to what we were looking for'.*

The prompts provided could be precise or generic. Teachers' decision to use precise vs. generic guidance prompts might depend on the learners' experience of reflection as illustrated by Teacher 5:

> *'I used to be very open and say reflect on this and give them some vague areas to consider, but now I typically set some example questions to ask themselves, I guess I would definitely do that and probably break it down with first years to make sure they understood'.*

All five teachers discussed the identification of the content to cover in the reflection, or reflection breadth as named hereafter, suggesting that it is an important dimension to consider. Teacher 1 and 4 referred to it as the *breadth* of reflection as Teacher 1 illustrates '*I think that would answer it very well 'having the breadth […] to it'.*

The questions are helping learners discern what is important in their learning and what problem to solve for this particular module or project. As Schön (1983) explains, finding the problem is a key element of problem-solving therefore the

learners should demonstrate the ability to identify the problem by formulating efficient questions. If the teachers formulate the questions themselves and provide them to the learners they ensure that the learners will only reflect on what teachers want to know. The downside to this approach is that it does not help learners discern the important aspects of their learning or the problem, which, according to Bowden and Marton (2003), should be an essential graduate skill. If the questions are formulated by the learners, as encouraged by Teacher 4 above, then another dimension, and therefore difficulty, is added to the formulation of the reflection, as, now, the learners have to identify, by themselves, what is important to reflect upon from the trivial (Cowan, 2014; Jay and Johnson, 2002). Teacher 4's quote used above *'[learners] are encouraged to formulate their own [questions] too.'* infers that once learners have achieved a reasonable level of reflection (in the case of Teacher 4 final year or Master learners), they should have the confidence to formulate their own reflective questions or at least get less specific ones as insinuated by Teacher 5 above. In this case, some loose guidelines might be provided by teachers instead of focused questions.

Nevertheless, the data collected in this section show that teachers have a key role to play when it comes to identifying and clarifying the breadth of reflection.

The data gathered in this theme clarified the usage of reflection in relation to the academic levels, e.g. 1st year undergraduate or Masters, and also, more specifically, when reflection is used as an assessment tool within a taught module.

From the five teachers interviewed it is clear that reflective writing is used as an assessment tool across different academic levels as argued by Teacher 4:

'I have used reflective writing from level 4 to level 7. Based on my experience any level can reflect as long as they are provided with the right guidance'.

Moreover, the five teachers interviewed point out that because reflection is a skill it should be taught early in the curriculum; Teacher 1 explains:

'Yes I do [think that reflection should be taught earlier]. Because I think it is a skill. We talk (we in very general terms) about being reflective practitioners and that's not just in our discipline it's in many different disciplines [….] but for [some learners], it's awkward and difficult to do; I think there are steps you could take to help them get there definitely. They may never be a great reflective writer but they could be competent one'.

Teacher 4 explains that now this has been implemented in her/his courses:

'We have now managed to include one component of reflective writing at each level of the […] course so now the students can develop their reflective skills year after year.'

This teacher expounds on why this decision was taken:

'Students usually are not prepared to write reflectively; they do not seem to have experienced it much before joining my classes. Reflective writing is not a learning tool used much in the Computing discipline although it is slowly appearing as a way of assessing students learning' (teacher 4).

These quotes suggest that because reflection is a skill it should be taught early on in the curriculum.

It also comes through in this section, especially according to Teachers 3 and 4 that reflection's requirements could be different depending on study year; Teacher 3 argues:

'I think [reflection] should be something you experience at each level but would perhaps look for something different at each level and try and progress it to the point where they get to the highest level of reflection.'

He/she explains that when this is not in place, the learners reach Masters level and are suddenly expected to achieve the highest level of reflection without the opportunity to have practised it earlier on during their education. Therefore, the data emphasises the importance of having a staged approach to reflection's depth i.e. additional requirements for each year, as this would help the learners develop their reflective skills.

Moreover, there is an agreement amongst the interviewees who teach reflection at final year or masters level, that the development of reflective skills can only be done over time; Teacher 4 insists that:

'Reflection acknowledges the fact that learning takes time and students need time to reflect and enhance their practice, it sends the message that it is OK to make mistakes as long as one realises that there was a mistake made and that a solution needs to be tried out or thought of.

The data collected in this section suggests that it takes time to achieve a good depth of reflection, making *time* an essential ingredient to one's reflective practice development, therefore, it is inferred to integrate the practice of reflection early on in the curriculum; in addition, the next section shows how teachers value reflection *continuity* throughout a module or project.

The following part highlights practices where all teachers (apart from Teacher 1) have made space for the learners to reflect at different points within a module.

Teacher 1 has not implemented different reflection points in her/his classes he/she explains:

'[Reflection] is assessed at the end of [the] module [....] perhaps we haven't done enough about an ongoing process it is very much an end summary looking backwards'.

However, Teachers 2, 3 and 5 use group reflection partway through their modules. Teacher 3 clarifies that:

> *'we have a stage set of processes we go through and in the middle of that they are asked to reflect as a group. At the end when they have finished the whole thing and they have actually had some feedback already […] , they reflect as individuals. So there are two points'.*

Teacher 4 encourages his/her students to write their reflection throughout the module, but the full paper is assessed at the end of the module:

> *'Through a year-long project a lot of learning is expected in different areas. The students are experiencing a real project and their learning is taking place at very diverse times within the year therefore reflection is used as a tool to help them learn at their own pace the key aspects of the course. Reflection acknowledges the fact that learning takes time and students need time to reflect.'*

The data infers that teachers value the continuous reflective process at the module and project level as well as throughout the years of study. This is echoed by Eraut (2008) and Facione (2011). However, it seems that because the assessment of the reflective writing is only carried out towards the end of the module, some learners tend to wait until the last moment to formulate it; as explained by Teacher 2:

> *'I think [writing the reflective essay] can be one of those last-minute things, [the learners] are so focused on the group work and there is always the peer pressure when you are working in a group; you have to deliver what the group needs […] that I think the individual side of it might get left until the very end and probably it would be better to encourage them to do something earlier.*

Reflection for, in and on-action (Schön, 1983 and Cowan, 2014) allows learners to take the time to reflect (Facione, 2011) and learn throughout the project, therefore providing the flexibility of re-adjusting actions as required (making mistakes and correcting them). If reflection is only used towards the end of the module, this may leave no time to revisit learning materials or discuss problem-solving. Therefore, in order to reap the benefits of the reflective process it needs

to be carried out in a timely manner; reflection may represent a suitable learning evaluation and progression tool for teachers to use, as it allows them to intervene in the learning process in a timely way.

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4.7. THEME 5: REFLECTION'S ASSESSMENT AND FEEDBACK

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The assessment of reflection has prompted academic debates for a long time (Ixer, 1999; Zhu, 2011; Rogers, 2002; Hugues-Miller *et al.,* 2012); the data gathered in this theme clarifies the views, process and struggle of the five Computing teachers with regards to the assessment of reflection. It highlights the issue of marking subjectivity and intuitiveness, it emphasises on the usefulness of explaining the reflection's purpose to the learners but also the need for reflection to be assessed to ensure better engagement with the exercise. Additionally, this section unveils the fact that marking criteria are not always explicitly available to learners although there seems to be a common understanding of reflection expectations for each grade amount teachers.

Theme 5 (a): Assessment - Intuition and struggle

The assessment of learners' reflection is not an easy task and teachers often do not feel comfortable undertaking it. This feeling is also noted in Tummons (2011) when he talks about assessing reflection and he actually titled his paper 'It sort of feels uncomfortable' which provides some hints on the topic. While the teachers are convinced of its learning power, both conveying what reflection is and defining its assessment are daunting tasks.

All of the teachers interviewed assess learners' reflection with a colleague i.e. one does the assessment and the other moderates. The interviews have highlighted the fact that while there are very rarely discrepancies in the way reflection is marked, it appeared that assessment of reflection is very much *intuitive* especially for 1st and 2nd years. As Teacher 4 explains:

> 'It is funny that reflection can easily be assessed with 'intuition', you kind of know if this is an 'A' piece or 'C' piece, but it is much more difficult to develop assessment criteria that will enable a much fairer assessment.'

Teacher 1 adds:

> *'Last year [the assessment team] came up with fairly similar marks, how did we do that without having discussed it? There must be this unwritten definition of what we understand of reflection.'*

Teacher 2 explains that *'in terms of ability to reflect, I think I don't know how to assess it other than subjectively'*. The struggle to assess reflection is also visible in what Teacher 1 adds:

> *'You're trying to give a mark to the learning that has taken place and I think that is very difficult to quantify. I think writing reflectively is an art and marking reflective writing is an art – it's not an easy thing to do at all because it is a personal piece of work.'*

Teacher 1 and 2 have always felt uneasy about assessing learners' personal reflections as they did not think it was fair to judge and evaluate someone's way of reflecting. Teacher 1 confirms this by saying:

> *'I went through agonies in marking [reflective] work; I had huge problems with it.'*

In addition, Teacher 2 often used the word 'struggle' when describing the assessment process of reflective work, he/she argues:

> *'If their reflections are truly personal and it's about their reactions to the subject and what they have learnt, if it happens to be at a shallow level why should I criticise them for that? That's their personal level that they have reached, I start to get very uneasy about the whole idea of assessing reflections. If that's the best way they've got to express their thoughts on it, who am I to say 'you should be working your brain cells harder.'*

However, during the interview this teacher realised that actually, his/her *uneasiness* about the assessment of reflection was maybe not well founded as what he/she really assesses is not the learners' personal reflections but rather the learners' intellectual study skills and intellectual maturity, and he/she felt much happier about this as it is normal for a teacher to evaluate those skills. However, this teacher pointed out:

> *'I'm not assessing their reflections as such, I'm actually trying to assess their intellectual maturity. But it's interesting, we don't say that's what we're assessing, we ask for their reflections.'*

The data collected in this section suggest that reflection is assessed intuitively, and it is a daunting task, moreover the teachers realised that they need to clearly explain the purpose of the reflective exercise to the learners to avoid confusions.

Theme 5 (b): Assessment - Grades, marking criteria and feedback

As in Cunliffe (2004) and Teacher 4 above who explains '*you kind of know if [the reflection] is an 'A' piece or 'C' piece, but it is much more difficult to develop assessment criteria'*, the teachers seem to be able to differentiate, in a fairly accurate way, the grade of a piece of reflection but they are not always able to clearly articulate why the paper matches that specific grade. It is interesting to note that most of the time, the teachers talk about *grade* consistency between different markers not *marks,* highlighting a sort of vagueness in the assessment of reflection. This raises the question of the formulation of the marking scheme. Four of the teachers recognise that they have no specific marking criteria available other than checking whether the questions asked have been answered. One of these teacher, Teacher 1, explains that there is a definite need for clarification of what differentiate the grades, this is lacking at the moment:

> *'Even if you were giving feedback on it, you say they've got a D how then can you tell them what they need to do to get a B or a C or an A, so we have to have a way to be able to talk about reflective writing and marking of reflective writing much better.'*

Teachers 2, 3 and 5 evaluate students work based on what has been covered but Teacher 3 and 5 would worry about making marking criteria more specific as they could become constricting. Teacher 4, on the other hand, had developed some marking criteria, he/she argues that:

> *'It is much more difficult to develop assessment criteria that will enable a much fairer assessment. After several years I managed to develop a matrix that I publish to my students and that I use to assess their*

reflective writing but I can still note a 'vagueness' in this even though it is more structured than before.'

Although the practice is different, the interviews have highlighted the need for marking criteria but also identified the risk to make them too restraining; it was recognised that marking criteria would help eliminate some of the subjectivity mentioned by Teacher 3, as this teacher has got some reservation when it comes to the fairness of an assessment's pass mark. He/she reckons that is where discrepancies are likely to happen *'that's when it gets subjective'*.

It was also interesting to note that although, most of the teachers do not provide specific marking criteria for the assessment of reflection, there is some kind of implicit understanding of their expectations for each or at least some of the grades as shown hereafter, although again assessing middle grades is still a problem for Teacher 2 who says:

'I really don't know how I measure the difference between middle grades'.

Teacher 5 insists that 'A' grade reflections must surprise him/her and be critical:

'I want to be surprised; the really good marks will really show some insight into their thinking or make some points that hadn't occurred to me. Typically, they will also have been critical and balanced i.e. there is always two sides to every story, good points and bad points, things you could have done better and also recognise weaknesses.'

It is interesting to see that 'being able to surprise' the teacher is considered as a key element to a good reflective piece. This might infer that learner's intellectual curiosity and creative thinking is very much valued by the teacher. This would link to what Teachers 3 and 4 were saying about their expectation that an A grade reflection would demonstrate engagement with the literature, evidencing their intellectual curiosity.

The data also suggest that the amount of descriptive content in the reflection will have an impact on the grade as Teacher 3 explains:

'Sometimes you get patchy work where some bits they've really done well and other bits have gone descriptive, so if they've got some evidence of learning in there, that gets them to that C point.'

When it comes to assessing final year or masters level, Teachers 3 and 4 both have very similar marking criteria, although Teacher 3 does not provide the criteria to the learners this teacher can lists them and uses them for assessment:

> 'those are basically the criteria; if descriptive – it's not a pass, if you've got some evidence of that learning in there – it's a C, if you do it throughout – it's a B and if you've engaged with the literature as well it's an A.'

Indeed, how can the learners identify what the grades requirements are if teachers have difficulty articulating them?

One might argue that if teachers do not have specific marking criteria available, then it makes it difficult for learners to identify first what needs to be done and second understand how they are being assessed. Moreover, the lack of clear marking criteria does not facilitate the production of sound feedback as it might be more difficult to articulate how the learners can enhance their piece of reflection apart from highlighting the fact that they have forgotten to answer a question.

Theme 5 (c): Learning environment

Although, this theme was not obvious during the first data analysis phase as each piece of relevant data collected was already attributed to other themes i.e. Theme 2, 5 and 6, it became apparent that consideration of the learning environment was important for the teachers interviewed.

Vizcarro and Perez (2013) explain that a competence must be assessed to be achieved and this is echoed by the teachers interviewed, for instance Teacher 1 explains:

> 'I don't think [the learners] would engage with [reflection if not assessed], that's my gut feeling. I think the students as part of their PDP process are always encouraged to keep a diary of their learning [..] but experience suggests they don't do it, there's no mark attached to it so they don't do it.'

The data suggest that reflective skills can be developed if assessed but also practiced in a complex environment or through challenging activities. Indeed, Teacher 3 and 4 provide details of tools and activities that they use to get learners to both, reflect in a more in-depth way, and to guide them on what they should reflect upon to meet the module's learning outcomes. Teacher 3 says:

> *'I also give them self-evaluation questionnaires. Not for completing and handing in. The idea is that they use the questionnaires to give them questions to answer to help them reflect. It helps them understand what I am looking for.'*

These two teachers believe that learners should experience something to get them started on their reflective journey. It seems that those activities can be quite efficient to prepare them and make them understand teachers' expectations of what is relevant to cover in the reflection.

In addition, and as illustrated in Theme 2, it is interesting to note that reflective writing was used by four of the teachers in the context where group work was required in their modules This suggests that the complexity and challenge of the environment within which learning was triggered is important.

In conclusion, the data collected in this section show that the different approaches adopted by teachers with regards to assessing reflective work are problematic and not easy to solve, the data also highlights the importance of the learning environment to trigger reflection.

Theme 6 is teased out from the data referring to the main difficulties that learners and teachers encounter when writing or supporting the reflective process. The data provides a picture of the type of support that teachers have put in place to help their learners during their reflective journey. This ranges from providing a list of topics and using question words, but it also highlights the lack of an appropriate reflective model and the issue with regards to the excessive time taken to provide customised feedback on formative reflections.

Teacher 4 and 5 point out that learners seem to struggle to see the benefits of the reflective process, Teacher 5 explains:

> *'Students are not prepared to reflect. Some of them don't really understand what reflection is. Some of them will even say to my face, "that's the bit where I waffle". That's what they see it is and is exactly what they do – waffle'.*

This was also echoed by Teacher 3 who says that he/she is *'sometimes struggling to get more students to really engage with reflection and also see the benefit of it'*. This suggest that learners tend to have a misconception of what reflection is, additionally Teacher 1 argues:

> *'They're not too sure how to begin, they're not sure of the style expected, "should I be writing formally, is it informal".'*

It is understandable that learners struggle to start a piece of reflection and are not sure of the style, as several teachers mentioned that they expect the reflection to be written in a formal or informal way, there is no common practice.

Teacher 3 claims that if the reflection domain is not clearly identified by the teacher i.e. too open or vague, the learners, especially beginners, get very confused about what to cover and their reflections go in all sorts of directions, this was also noted by Teacher 4 who explains:

> *'Some are struggling to find out what's relevant or not, is one of the key issues. You find they just don't understand what is really relevant in the*

project they've just done, what to leave out of the reflective piece and what to include.'

Therefore, in the same way as it was suggested in Theme 3, the data once again infer that identifying relevant topics to cover in the reflective work is an issue for learners.

Several teachers identified that some learners produce reflections which are too short and lack depth as illustrated by Teacher 4:

'They find it difficult [to] understand how to make their reflection in-depth enough so they can achieve a good grade. I think this is the most difficult part really'.

The male-dominated student population of the school (85% male as identified in the introduction chapter) means that there are specific learning issues or support that will be required. As stipulated in Foster and Lefever's (2011) report, it is paramount that learners receive feedback that they know how to use. Therefore, the provision of personalised feedback on the written reflection is a way to achieve this but it is extremely time-consuming for the teacher. Teacher 4 explains:

'Some [learners] have got to go back to it again and again, you give them more feedback then they manage to get their grade up, they do struggle a bit more maybe because it's not as natural as others but they do manage to do it in the end'.

Therefore, the data suggest that it can take a lot of support and feedback to explain to learners what an in-depth piece of reflection is. The *depth* of reflection is an elusive word that teachers seem to struggle to explain to learners and consequently learners struggle to demonstrate this ability (Zhu, 2011; Findlay *et al.*, 2010). Teacher 3 says:

'Critical thinking is the higher order thinking that I am trying to get my students to do. And that is much harder to achieve. It is where you start to place your own learning in the wider context of the literature. [...] I struggle with how to guide students to do it. It's an area of my practice that I need to improve'.

Teacher 4 admits that:

> *'as a tutor it took me a long time to theorise what that means and what an in-depth piece of reflection looks like in order to explain it to my students'.*

As illustrated above both Teachers 3 and 4 admit that it is difficult to clearly explain to learners what an in-depth reflection looks like.

Several main difficulties with reflection have been highlighted including learners' misconception of reflection, the difficulties to start the reflection and identify its breadth, but also, the difficulties to reach an appropriate depth. In order to support the learners with regards to these difficulties, the teachers suggest a structured approach through identification of areas for reflection. For instance, Teacher 3 provides the two examples of 'groupwork' and 'oral presentation' as areas to reflect upon linked with questioning; he/she explains:

> *'From my experience the very open-ended stuff didn't work very well, having a more structured approach has worked much better. Although, I am now starting to think that some of those [questions] don't need to be there, I could be slightly less structured – it's getting that balance, but I do think it needed to have those specific areas to reflect on otherwise people missed them and didn't think about them.'*

This same teacher added:

> *'Giving [the learners a] structure on the key points to reflect vastly improved what we got.'*

In the same vein as Teacher 1, Teachers 4 and 5 have the same supporting mechanism i.e. provide main areas for reflection and sets of non-prescriptive questions that the learners might choose to answer. Teacher 5 points out '*I expect them to consider those areas but they can consider anything else they think appropriate*'.

As indicated by Teacher 3 above, it seems that finding the right balance in the structure provided to the learners is a common issue amongst teachers. The data suggest that the solution to '*getting that balance*' as argued by Teacher 3 while talking about teachers' provision of areas to reflect upon, might depend on the learners' experience with reflection, as Teacher 4 claims:

> *'In order to help beginners to reflect it is important to first [map out the main constituents of it / what is important to consider] and then as they become more confident with their reflection they can formulate their own.*

Teacher 4 explains that the use of a list of question words *'What, How, Why, Outcomes, Amendments'*, has helped some of the learners to deepen their reflection, moreover this teacher uses these questioning words to analyse existing reflective work:

> *'I tell them what reflection is not first, then […] I ask them to rate reflective post based on those words and explain why they gave that mark'.*

The data illustrating this section suggest that a lot of preliminary work is required by teachers to help the learners to be more proficient with reflective work i.e. provide an appropriate structure, tools, questioning words. Additionally, Teacher 3 refers to another issue related to the amount of support required by the learners to improve the standard of reflection. He/she admits:

> *'I do have a bit of a struggle with myself about how should I spoon feed, how much should I give them and point them, how much should I say "you are master level, this is all very personal, go and find out what's personal to you". As a teacher that's the bit I could do with more help with. Ways, tools, mechanisms to help them, without spoon feeding it to them, still giving them the flexibility to be their own journey, but getting more of them to do it and engage with it and see the benefit of it. That's a huge struggle for me as a teacher and for them for the process they have to go through and I still haven't cracked that, I'm still working on how I get that bit'.*

The data collected in this section infers that reflection is complex and the teachers' task is to propose to the class an appropriate reflection's structure within which learners can evolve; but gauging the amount of individual support required to let the learners blossom through their own learning journey is a problem for teachers as illustrated by Teacher 3 *'how should I spoon feed, how much should I give them and point them'*.

The teachers were asked if they were using any reflective models to support the practice of reflection with their learners. Overall, only 2 of the interviewees

responded positively to this question. Teacher 4 explained that he/she could not find any model that seemed adequate to teach Computing students and was therefore trying to develop his/her own way of teaching reflection with questioning words (mentioned in the previous section). Teacher 3 responded that he/she uses Gibbs's reflective cycle (1988) although this reflective model did not fully satisfy his/her needs. This teacher commented that one stage in the model was missing:

> *'Although the stage that is missing for me is the part where the students start referencing the literature on what other people found going through the same experiences'.*

Teacher 1 explained that the reflective part of the module is quite small, therefore it might not be required to go into that level of depth but he/she also honestly added that it might be because of her/his lack of awareness of reflective models. Teacher 3 argues that reflective models used in other disciplines like Health can be quite constraining and she is not convinced that they work for the Computing discipline.

Teachers' comments suggest that there is not an adequate reflective model that could support the practice of reflection in Computing. Reflection is a messy process, and it seems that structured and sequential reflective models can be more constraining than helpful (Jacoby, 2011). According to the literature, reflection models create a misunderstanding of what reflection really is and they do not really support learners in understanding how to create depth in their reflection (Johns; 2009).

4.9. CONCLUSIONS

The data collected in this chapter suggest that the teachers interviewed unanimously recognised that reflection is a very powerful tool to enable learners to develop higher order cognitive skills; they recognise that it might take time to develop such a skill to reach the highest level of reflection i.e. critical reflection, but with a good dose of perseverance through the continuous development of the skill and teacher's support, the learner can demonstrate an intellectual

growth. While the efficacy of reflection itself is not the goal of this research, the adequacy of the way it is put forward to the learners and the way it is assessed is.

Analysis of the interviews has allowed the identification of several themes/and subthemes essential to support and understand written reflection assessments taking place in the Computing discipline at the University of Teesside. The set of themes collected from the interviews counts as the observations stage of the 1st action research cycle.

It was interesting to note that some of the interviewees thought that it is not their role to intervene with the learning journey but this assertion can be critiqued. Indeed, it might be very appropriate for the teacher to intervene within the 'zone of proximal development' (Vygotsky, 1962), which is when help from a teacher can greatly support development of learning. The early visibility of written reflection to the teachers could make reflection a very transparent tool to identify when and how to support learners especially when reflective writing is viewed as a reflective development tool. It then become very appropriate to use it continuously throughout the learning process, as suggested by the data collected, in order to intervene with students' learning.

The analysis of the interviews suggest that teachers' support is paramount to help the learners reach higher reflective levels. It has also highlighted the fact that learners' intellectual maturity and practice of reflection is different, but regardless of the learners' starting level, it is important to help them develop learning effectiveness and provide them with time for a steady, continuous enhancement of their reflective processes.

This chapter has also established the issues relating to the usage of reflection in the School of Computing at the University of Teesside as well as the lack of an appropriate model of reflection that can be used in the Computing discipline to support learners with regards to developing reflective skills. This research project develops the model of reflection in Chapter 6.

The next Chapter 5 draws together the themes collected in Chapter 4 to propose a framework of reflection representing the key aspects to take into consideration when developing learners' reflective skills.

CHAPTER 5. REFLECTIVE DEVELOPMENT FRAMEWORK

This chapter introduces part of the main contribution to knowledge of the research project, namely the new *reflective development* concept and its *reflective development framework*. This refers to the third aim of the research: 'construct a framework of reflection that demonstrates all the key variables encompassed in the development of reflective skills'.

This chapter presents the synthesised outcomes of the first cycle of action research of this research project. It uses the raw data collected and analytical observations made during and as a result of the Computing teachers' interviews conducted (as included in Chapter 4) to propose a concise framework.

The aim of the framework is to contextualise, in a summarised form, each main variable (themes and sub-themes) extracted from the teachers' interviews and connect them to underpinning literature and illustrative examples in a reader friendly way. This work has provided the foundational context which leads to the model, as presented in Chapter 6.

5.1. REFLECTIVE DEVELOPMENT FRAMEWORK DEFINITION

The analysis of interviews undertaken in Chapter 4 has created a substantial amount of knowledge which allows a better understanding of the concept of *reflection* when used within the School of Computing. The themes and sub-themes teased out from the data are identified as the main issues related to the development of reflective skills but also include the benefits of using reflection as a learning tool in Computing. Analytical observations were extracted from the raw data (as presented in Appendix I) and it was noted that there was a relation between the themes from Chapter 4 and the literature findings in Chapter 2, showing a correlation between the raw data itself and themes present in existing literature. Therefore, in order to facilitate the formulation of the framework (Table 5.1), it was decided to recapitulate all key analytical observations drawn from the raw data into themes/subthemes and offer a

context-based summary of those points underpinned by relevant literature in Chapter 2 and illustrated by sampled quotations from the interviews.

ANALYTICAL OBSERVATIONS	CONTEXTUALISATION UNDERPINNED BY LITERATURE	EXAMPLE QUOTES
Theme 1: Teachers' understanding and expectations of reflection		
Theme 1(a): Diversity of views and expectations		
- Tutors have different expectations of what reflection should include from personal learning journey to engaging with the literature of resources not provided in class, - Reflection is a skill, - Some tutors expect to see general, reactive reflections, whilst others expect a more structured higher-level reflection, - Tutors are looking for evidence of comprehension and applicability of theories to practice, - Tutors tend to see reflection as an independent task, - Tutors believe that learners should question themselves on their learning, - Tutors value being surprised, - Thorough exploration of topics leads to learning, - It might not be easy for young men to do self-evaluation.	This theme recognises that although reflection is a skill teachers' views and expectations with regards to written reflection are very diverse and is therefore 'not something that can be neatly packaged as a set of techniques…' (Dewey, 1933, p9). The data collected suggest that in Computing tutors' expectations of reflective tasks tend to span from personal learning journey, a self-evaluation which might not be easy for young men, to structured reflections demonstrating evidence of comprehension and applicability of theories to practice and engagement with the literature. The variety of results is to be expected as it depends on the fulfilling purpose(s) of the reflection which can be numerous (Moon; 2006), however, they all have enhancement of one's learning at their heart. It appears that the process of reflection is often carried out independently, however there are other case studies in Computing which show examples of valuable teams' reflection, for instance Hazzan and Tomayko (2003) in eXtreme programming.	*'It's about getting over your experience, your journey, your learning journey'.* *'I would be expecting them to talk about what they think they learnt, what they got out of the process and possibly what went wrong, because I think you can learn an awful lot from what went wrong'.* *'Any final year module or masters module lecturer will be expecting students to engage with the literature'.* *'It is where you start to place your own learning in the wider context of the literature'.* *'I expect the student to have reflected on the relevant content covered in class and [ ] to find extra resources not covered in class'.*

		'[reflective writing is personal] young men do not find that easy. Facing up to their feelings, their limitations, their failures it's a touchy, feely, girly thing'.

Theme 1(b): Depth of reflection		
- Depth of reflection is a dimension mentioned by more than one interviewee, - Depth of reflection relates to the level of exploration of a topic and seems to link with engaging with the literature for higher education levels, - Depth of reflection should be stepped up each academic year, - Expectation of depth of reflection varies from tutor to tutor, - Descriptive reflection does not demonstrate learning, in-depth reflection does, - In-depth reflection is challenging there is a need to develop this skill over the years and levels of learning, - Masters students are expected to achieve an in-depth level of reflection and demonstrate intellectual curiosity.	Depth of reflection has been explicitly mentioned by Computing teachers, this dimension refers to the level of exploration of a particular topic. It is the demonstration of intellectual curiosity required for academic reflection in Computing in particular for higher levels. Gibson *et al.* (2017, p2) 'characterise depth of refection as a shift from a descriptive style of mere impressionistic reporting of events, through to a more critical style that focuses on integrating, analysing, and restructuring experience'. It is suggested that depth of reflection enhances the quality of the learning as the more in-depth a learner explores a topic, the greater the learning and comprehension of that topic. In the case of Biggs (2003), learning is an outcome of critical reflection which itself is the ultimate, and certainly, the most challenging level of the reflective process (Hatton and Smith, 1995; Jay and Johnson, 2002). Although the expectation of depth of reflection might vary from tutor to tutor, it was recognised that it takes time to master this challenging dimension and therefore, it is suggested to incrementally step up the depth of reflection level each year.	*'You might have different expectations of how in-depth the reflection is and what we require of [the learners]. At Masters level I try to get them to engage with the literature'.* *'For what I'm asking [the learners] to do it doesn't have to be in depth they can make it in-depth if they want'.* *'I expect the student to have reflected on the relevant content covered in class and activities undertaken and to have tackled them in-depth'.* *'It would be quite nice to have it so that they step up their level of reflection each level.'*

Theme 1(c): Reflection or something else?		
- Reflection is different to critical thinking, - Tutors seems to struggle to name the 'reflective' exercise, - Reflection was not the name of choice for this type of exercise, - Tutors want to see the learning through the assessment of cognitive skills.	Teachers realise that none of the terms they use to describe the reflective work assessed in the School of Computing is quite satisfactory as they do not fully support the axiomatic view that reflection is associated to learning, as suggested in the 'Aims and benefits of reflection' theme. Smith (2011) acknowledges the word *reflection* is now too vague due to its confusing meaning. The development of reflective skills takes time as acknowledged in the 'Progression and Continuity theme'. The thesis, therefore, recommends that the reflective exercise in Computing is referred to as: **_Reflective Development._** Reflective development translates the belief that effective learning is first and foremost a process of reflection. If not, it remains a mere succession of tasks, possibly leading to some kind of processing, but superficial, rather than to a real fundamental change in the learner which is the main outcome of critical reflection. Mezirow (1990), Bel and Mallet (2007) call it *transformative learning*, making reflection essential for any learning to be deep and meaningful, not only in terms of task performance and outcomes, but above all, in terms of the quality of a learner's mental processes.	*'perhaps I've been calling it the wrong thing. Perhaps what I am asking the students to do is critical thinking, not reflection. I don't know, it's difficult'.* *'We do tend to use the word reflection but sometimes I don't and I have discussed this with [other tutor's name] as I am never quite sure'.* *'That's a very good title – "tell me about your learning journey". [ ] cos everyone goes through the journey, some people go further than others some people go faster than others and everybody's journey will be slightly different, everybody will take a slightly different path and it is documenting that'.*

Theme 2: Benefits and aims of reflective writing		
- Learners realise what they have learnt, - Is used as a personal development and inner transformational tool, - Explicit reflections make learning and intellectual maturity visible to tutors, - Is a tool of choice for the evaluation of individual contribution in the context of group work, - Reflection is used for peer review during group projects, - It challenges learners to deepen their learning.	Several important messages came out of this theme. According to the Computing teachers, one of the key benefit of reflection, also shared by Hughes-Miller et al (2012), is that it reveals thought processes and intellectual maturity to teachers. Furthermore, reflection has the potential to spark learners' inner transformation and the reflective process contributes to making the learner aware of their own learning gains and gaps. This provides the inquiring mind with a great tool for personal development and the possible identification of further learning steps, called reflective action in Hatton and Smith (1995) and described as a thoughtful cyclical process which leads to modified action. Finally, action research has highlighted that it seems to be standard practice to use reflection for individual assessment in a teamwork context, especially for the identification of individual contribution and peer-review as in Clark (2005).	*'you should reflect on how you have developed or changed as a learner and an IT professional'.* *'It's a way of getting feedback of what the student has learnt',* *'I'm not assessing their reflections as such, I'm actually trying to assess their intellectual maturity',* *'to make these reflections explicit [is] almost the only way to actually, truly understand what students have actually learnt, how they actually perceive things and why'.* *'I use [reflection] to drive student's responsibility always encouraging them to take positive action in a project and not only relying on others to make things right. I want to see evidence of problem solving'.*

	Theme 3: Formulation and breadth of reflection	
	Theme 3(a): Formulation of reflection	
- Tutors value genuine reflections where the learner shines through, - Some tutors value abstract terms and articulation, while others are happy with simple English as long as the essence of learning is apparent, - Recognition that Computing students are not always articulate, - The reflection should be structured and have a narrative, - Reflection can be written in first person and be fairly informal, - Reflection should include precise facts and examples, - Being able to write in a concise way is important.	The theme suggests several main trends that can be put forward as accepted practice in Computing for the formulation of written reflective work. First, there is an emphasis on the need for the inclusion of specific facts and examples to support the reflection's narrative. Second, as in Stone and Madigan (2007), highlights the importance of writing in a concise manner and therefore being able to discern content which is not essential and can be removed. Finally, it seems that reflective exercises can be written in a fairly informal way as long as it is genuine, but it is interesting to see that tutors have different views with regards to the use of words i.e. plain English vs. elaborated terms. It can be noted that several case studies found in the literature (Kennison, 2006; Cunliffe, 2004) demonstrate that tutors consider the formulation of the reflection important and often include criteria related to this in the assessment.	*'I feel that you can tell the genuine from the fake',* *'I think that is where some of our students suffer, they are not articulate',* *'you're looking for them to have those more abstract terms that they're able to pull out of the precise facts and skills that they have learnt',* *'he gave mini examples, he embedded his writing within specific examples',* *'My personal feeling is reflective writing should be fairly informal',*
	Theme 3(b): Questioning to focus the breadth and domain of reflection	
- Topics to cover in the reflection are identified as the breadth of reflection,	This theme recognises that the preparation of appropriate questions helps define the breadth of reflection. The teachers often choose to	*'I think that would answer it very well* *'having the breadth and depth to it',*

- Learners struggle to identify topics important to reflect about, - Tutors play a key role in defining the breadth of reflection appropriate for the module, - Tutors indicate the breadth of reflection by providing list of questions, - The specificity of the questions provided to learners varies, - Learners are encouraged to formulate their own questions.	provide a set of questions to guide learners on relevant issues they want them to think about but they also encourage more experienced learners to formulate their own enquiries, practice also shared and valued by Bourner (2003). It is recognised that targeted questioning is difficult to achieve and requires practice. As Schön (1983) argues, problem definition is the key to problem-solving. Problem discernment and definition have much to do with accurate questioning.	*'they need guidance and structure "reflect on this module" it's too broad'*, *'most students struggle to identify what is important to talk about in their reflective paper'*, *'They have various questions that I ask them to answer'*, *'good reflection is determined by how the person maps out the main constituents of it / what is important to consider'.*
Theme 4: Progression and continuity of reflection		
- Tutors value the continuity of the reflective process, - Some tutors expect the learners to reflect throughout modules but this is not always the case, - Reflection is assessed at the end of modules with the occasional group reflection mid module, - All tutors believe that written reflection can be experienced at any academic level, - Some tutors believe that a progressive approach to teaching reflection over the	This theme acknowledges that reflective skills are difficult to conceptualise; consequently, learners need time to develop them to a proficient standard. Therefore, it is suggested that the development of reflective skills be integrated within the curriculum from year one up to the last year of study; a progressive approach to teaching reflection over the years would be beneficial. At the module level, it is recommended that explicit reflection takes place throughout a project or module. Although it is not always the case in practice, it is believed that this process would be truly beneficial. Indeed, if reflection is continuous i.e. for, in, on-action, it is used as a vehicle for learning (Facione, 2011) in a situation where	*'Students usually are not prepared to write reflectively; they do not seem to have experienced it much'*, *'[reflection] is assessed at the end of module we haven't done enough about an ongoing process'*, *'I want the students to be [reflecting] as we go along'*, *'[reflection] should be something you experience at each level but would perhaps look for something different at*

years would be beneficial as learners are not well prepared at the moment.	mistakes are possible, alternative solutions tried out and conclusions drawn. Only in this case, a good depth of reflection can be achieved (Stone and Maligan; 2007) and the development of reflective skills and therefore learning supported to their full potential.	*each level and try and progress it to the point where they get to the highest level of reflection'.*

Theme 5: Reflection's assessment and feedback

Theme 5(a): Assessment - intuition and struggle

- Some tutors note that they intuitively know how to grade learners' reflection, therefore there are no major discrepancies in team assessment, - Assessment of reflection is subjective, - Tutors acknowledge the need for a better formulation of what is expected during the reflective exercise to support the provision of feedback, - Some tutors find the assessment of reflection a challenging task which makes them uneasy. - The assessment of learning taking place is troublesome.	This theme suggests that the task of assessing reflective work in Computing is troublesome for teachers, this view is shared by teachers in other disciplines, such as Tummons (2011). Ixer (1999) and Zhu (2011) argue that reflection should not be assessed as it constrains the free expression of the learners. Although, it seems to be possible to assess reflective work fairly with intuition, Computing teachers acknowledge the need for a better formulation of their expectations which would be useful for the provision of feedback. Ramsden (1992) urges teachers to define some markers of quality before the assessment of reflection. The data show that some of the Computing teachers are trying to evaluate the amount of learning that has taken place, which is extremely difficult to estimate, but there are useful case studies in the Computing discipline for instance Stone and Madigan (2007) which could be used to inform the development of an expectation matrix.	*'I went through agonies in marking this work; I had huge problems with it'.* *'trying to give a mark to the learning that has taken place and I think that is very difficult to quantify but you could it and I think writing reflectively is an art and marking reflective writing is an art'.* *'it might not be the same criteria in our head maybe but we do seem to know somehow where the marks fit in. It is funny that reflection can easily be assessed with 'intuition'.*

Theme 5(b): Assessment - grades, marking criteria and feedback

- Assessment practices vary, some tutors have marking criteria others don't, - Marking criteria are difficult to formulate and might need to be customised per academic year, - Marking criteria developed are still vague but the ones that are too detailed would be constraining, - Marking criteria could remove some of the subjectivity and improve fairness, - An A grade could be answering all questions or might need to demonstrate engagement with the literature, some learning for C grade, learning throughout for B grade, - Low grades would include a lot of descriptive content demonstrating no obvious learning, - Feedback provided tends to be specific and personal and provide ideas of other topics that could have been covered, - The formulation of personal feedback is demanding on teachers.	This theme unveils tutors' varying practice in the use, or not, of marking criteria to assess reflective work. The tutors who are using marking criteria recognise the difficulty to formulate them which is understandable as argued by Hughes-Miller (2012) that it is extremely difficult to decide on a fair grade on something that has so many variables. Teachers' comments show that formulated marking criteria can be a bit vague but if they were more detailed they could be constraining, however they are useful for the assessment fairness and they remove some of the subjectivity that comes with the assessment of reflective writing. It was put forward that a different set of marking criteria based on year of study would be useful. The empirical data suggest that teachers in Computing formulate personal feedback including enhancement suggestions related to possible topics to cover moreover, Gibson *et al.* (2017) stress the importance of actionable feedback to support reflective writing. However, some of the interviewees recognised that this practice is demanding on teachers.	*'I managed to develop a matrix that I publish to my students and that I use to assess their reflective writing but I can still note a 'vagueness' in this',* *'it took me sometimes to come up with [marking criteria] that made sense for my modules',* *'No [I do not have marking criteria], other than a personal, subjective feel',* *'I think you would be looking for different things at different levels',* *'Some people have got to go back to [their reflective writing] again and again… give them more feedback'.*

Theme 5(c): Learning environment		
- Formal assessment of reflective work is the reason learners engage with the task, - Some tools or activities provided to learners act as reflective triggers, - All the teachers have used reflection to assess group work,	In this theme, some of the teachers made it explicit that the assessment of the written reflection is paramount to engage learners in the exercise as also noted by Bourner (2003). It is interesting to note that all the teachers interviewed use assessed reflection in the context of groupwork. Some of them design learning activities that truly promote reflection. This section emphasises the need for a learning environment that fosters reflection (Dewey, 1910). Indeed, a module's assessment and teaching strategies will drive, or not, the development of reflective skills.	*'I don't think they would engage with [reflection if not assessed], that's my gut feeling',* *'If you think about the final year project [ ] part of it is keeping a diary, but experience suggests [learners] don't do it, there's no mark attached',* *'They do group work and then you have to tease out what was the individual contribution',* *'I also give them self-evaluation questionnaires. [ ] The idea is that they use the questionnaires to give them questions to answer to help them reflect'.*

Theme 6: Support requirements with reflection

- Learners need to be reminded that genuine concise reflections and use of examples are expected,
- Some tutors expect to see conclusions drawn from learning,
- When required, the need for engagement with the literature needs to be spelt out,
- The provision of tools and activities to trigger reflection is beneficial,
- Feedback and guidance provided to learners is essential for their reflective development although the practice of guidance and explanation varies between tutors,
- Reflection needs to be introduced early on to allow time for improvement,
- Tutors struggle to support the development of reflective skills in their learners with regards to engaging with the literature and amount of spoon feeding,
- The understanding of the depth of reflection needs to be supported by tutors but is complicated to theorise,
- There is a need to educate learners on the benefits of reflection to avoid poor conception,

As acknowledged in the 'Diversity of views and expectations' theme reflection is a complex concept to grasp for learners and therefore requires a considerable amount of guidance. However, this theme highlights that gauging the amount of feedback to provide to a learner is at times problematic.

The first point of support teased from this theme is the need to educate learners on the benefits of reflective writing in order to encourage a meaningful engagement with the exercise. The Computing learners are not exposed to reflection very frequently (see the Progression and Continuity theme), Hatton and Smith (1995) see this as a possible barrier to the development of reflective skills.

Secondly, teachers' comments recognise the need to support their learners with regards to the formulation of the reflection and specific points have been identified (see theme: Formulation of reflection) as important: genuine, concise, engage with the literature (when appropriate) and draw conclusions.

Thirdly, it was acknowledged that the depth of reflection was a difficult dimension to master (see theme 'Depth of reflection') but needed particular attention as it is a determinant of the learning quality. The main issue is that some teachers struggle to theorise it to support their learners. Ryan (2010) argues that teachers do not always have the relevant training to support the facilitation of

'I do have a bit of a struggle with myself about how should I spoon feed, how much should I give them and point them',

'Students are not prepared to reflect. Some of them don't really understand what reflection is. Some of them will even say to my face, "that's the bit where I waffle". That's what they see it is and is exactly what they do – waffle',

'As a teacher [encouraging learners to go in more depth] is the bit I could do with more help with. Ways, tools, mechanisms to help them, without spoon feeding it to them, still giving them the flexibility to be their own journey but getting more of them to do it and engage with it and see the benefit of it'.

'Students usually are not prepared to write reflectively; they do not seem to have experienced it much',

- Learners struggle to identify what is important to reflect about, tutors offer guidance and structure by providing a list of questions, - The list of questions provided by tutors can take different shapes, i.e. vague to specific, it is not always prescriptive and might be education level dependent, - Existing models of reflection are seldom used as they are not adapted to the Computing discipline or too theoretical.	reflective skills although Kuit *et al.* (2001) maintain that it is highly desirable that they do. Fourthly, the teachers are providing lists of questions to help learners identify what is important to focus on in their reflective work, however the theme 'Questioning to focus the breadth and depth of reflection' bring to the fore that being able to identify the problem / important aspects to cover is essential for problem solving. As believed by Bourner (2003) and shared by some of the Computing teachers, proposing that the learners formulate their own question will guide them on the path of independence. Finally, the lack of a model of reflection appropriate to the discipline is hindering the support that teachers can provide.	

Table 5.1 Reflective Development Framework

The reflective development framework adds to the body of knowledge a new proposition to support learners in the Computing discipline by bringing to the fore all the important variables to take into consideration for the development of learners' reflective skills.

The concept of *Reflective Development* acknowledges that learning takes time and that different type of help, questions and activities are required depending on the learners' progression through the learning spiral. Chapter 2 reported that reflection is believed by many (Kolb, 1984; Gibbs, 1988) to have to happen at some key point in the learning process to make sense. The thesis posits that reflection is definitely not just an exercise carried out after a project or module, such as reflection-on-action (Schön, 1983). Although it is important to recognise that reflective development can also include reflection-on-action, to reap its fuller benefits, it ought to take place throughout the project as well. It happens within learners *as* they are learning, to such an extent that it should underpin the whole development process. Thus, it is believed that the term *reflective development* translates much more explicitly the idea of reflection for, in and on-action (as discussed in Chapter 2) and a sustainable journey towards an intellectually-enhanced outcome of learning.

While the framework emphasises all the main constituents to take into consideration when facilitating the development of reflective skills, it does not define what reflective development is. It is suggested in Chapter 2 that reflection is made up of different types of mental processes (Jay and Johnson, 2002), though these do not all happen at once or in just one reflective instance. Different processes or questions will occur at different points in time including whilst planning, evaluating, or memorising. Here lies the essence of reflective development.

Next, Chapter 6 will investigate the cognitive constituents of reflective development and defines it by offering a new reflective development model.

CHAPTER 6.   REFLECTIVE DEVELOPMENT MODEL

The work carried out in the previous chapters suggests that there is scope for a new way of thinking about *reflection* in computing where the term *reflective development* was argued to be more appropriate than other descriptions such as reflection, critical thinking or critical reflection.

Accepting Ixer's (1999, p521) argument that '*if reflection is to be regarded as a core facet of individual professional competence, then there is a need to know far more about its structure, substance and nature before we can safely assess it*', this chapter investigates the substance of reflective development which refers to the fourth aim of this research project 'Design and evaluate a novel model of reflection targeted at aiding inexperienced computing learners to formulate written reflections.' It refers to the action research cycles 2, 3 and 4 explained in Chapter 3 (section 3.2).

This part of the research is driven by the need to understand better what constitutes and defines *reflective development* from a learner's point of view in order to optimise their learning. A clear definition of reflective development will provide learners with a supportive reflective development model to grow their reflective skills.

To achieve this, an extensive qualitative analysis of existing written reflections from three different cohorts of learners was carried out. It builds on Jay and Johnson's (2002) beliefs that reflections are constituted from common mental processes, therefore this thesis posits that the analysis of reflective work would provide a picture of these common processes which are called in this chapter *development patterns*. The name was chosen as an analogy to software engineering patterns elaborated upon in Gamma *et al* (1995) and further explained in section 6.5.

This chapter emphasises the difficulties encountered and decision-making processes required during the elaboration of the new reflective development model to arrive to a logical and user-friendly model.

6.1. METHODOLOGY

The work carried out in this chapter executed action research cycles 2, 3 and 4 as follows:

- AR cycle 2: reflection development model version 1 (section 6.3)
- AR cycle 3: reflection development model version 2 (section 6.4)
- AR cycle 4: reflection development model version 3 (section 6.5)

It builds upon the work done in the first action research cycle (Chapters 4 and 5).

Learners' written reflections from three different cohorts (one for each cycle) were analysed. Each cycle was constituted of the typical four stages of action research i.e. planning, action, observation, reflection.

6.2. ETHICAL CONSIDERATIONS, LIMITATIONS AND BIASES

The research project was based on an action research approach therefore learners' engagement was key to the process. In order to obtain agreement from learners to use their text-based reflective work, a consent form was designed and disseminated to them (see Appendix G). Authorisation of using learner's reflection was initiated once their work had been fully assessed and feedback sent to them to avoid pressurising them to answer positively to the request. No one objected to the use of their work to inform this research project.

It is important to note that the researcher was teaching the learners sampled for the development of the three versions of the models. This meant that she was an active participant in the research. Therefore, her understanding of what reflection was evolved with the progression of this research project. Hence, her involvement in the modules automatically had an impact on both the way she was teaching reflection as well as the type of feedback provided to the learners, therefore, somehow shaping learners' reflections. Also, the choice of the sample can be recognised as a limitation to the study as it only demonstrates the constituents of reflective development for learners studying these modules.

Qualitative data categorisation is subjective to the researcher's positionality. In the case of this project, the researcher undertook to analyse text-based reflections in which an accurate understanding of the meaning of the text was essential for its categorisation into common mental processes i.e. development patterns. This was recognised after version1 of the model was produced therfore the decision was made in the following versions to systematically test any new development patterns identified within the text against its dictionary definition. This greatly helped the categorisation of further identical patterns based on a recognised and accepted source of meaning.

It can be noted that the actual standard of learners' reflections under investigation was not taken into consideration. For instance, when a learner had included a reference to the literature to evidence a point, the researcher was not evaluating the appropriateness of the link between this reference and the matter under discussion nor the reliability of the reference in the context to the text. The researcher only took into consideration that an attempt had been made in using evidence from the literature to emphasise a point. Of course, unlike the researcher, the teacher who assessed the reflection evaluated its standard and consequently attributed an appropriate mark to the work.

6.3. ACTION RESEARCH CYCLE 2

PLANNING

The main objectives to be addressed in this iteration were as follows:

- o *Identify the main constituents used in reflective development;*
- o *Create a first version of a reflective development model from the data analysis;*
- o *Evaluate the model.*

The module under scrutiny for this part of the research project was at Masters level and involved 35 learners. The sample is convenient as the researcher was the module leader and therefore had easy access to both the learners and their written reflections produced as part of a digital-technology challenge, linked to a 'real-life' business situation.

The learners were required to provide evidence that they had engaged with the breadth of expected Computing-specific knowledge areas covered during the module. They were also made aware from the start that project process, in the form of reflections (70%), and product (30%) were assessed. The focus on personal reflection, was completely new to most learners.

The reflection offered them a medium in which to *scaffold* (Vygotsky, 1962) the development of their thoughts and understanding. As importantly, it encouraged them to externalise their thoughts as regularly as they wanted and therefore, learn to develop a consciously and explicitly evaluative approach to their construction of knowledge, something which they may not have had the motivation, the opportunity or the time to do before.

Throughout the module, learners received targeted input from the teacher in small-group tutorials and large-class lectures about how reflection could support their learning. In these sessions, learners were introduced to the concept of 'reflective practice' in Computing and, more specifically, they were given advice about how to link theory and practice explicitly and express reflective thoughts.   The teacher reminded learners regularly that reflection does not simply equate to description of their own work, but that evidence of engagement with a range of sources of information, personal thinking and critical evaluation of action must be provided and synthesised.

Reflective posts produced by learners throughout the academic year were posted online on the university virtual learning system. The teacher, when necessary, provided guidance and feedback to learners, suggesting new lines of progress in their work, or, at times, intentionally withdrawing to let learners invent their own paths.

In order to determine what constituted reflective development, it was decided to analyse reflections of successful learners only. Therefore, 69 reflective posts from learners who achieved at least a grade D in the reflective exercise were anonymised and used for the analysis.

ACTION

The set of posts was listed in a document and each post was carefully reviewed to identify the main cognitive dimension, *development pattern*, used in the text.

Figure 6.1 shows an annotated post in which the learner has used *questioning* as the main drive to the reflection, the annotation was highlighted in yellow:

What would I do differently if I did this project again? I would try to ensure the timescale in the project plan left time to reflect. In this way the urgency to get things done early on might be higher. Also, I would look for ways of addressing reluctance in the team to accept and adapt to suggestions made that would change some of our ideas. Formulating questions to elicit information.

Figure 6.1 Example of an annotated reflective post (see Appendix J).

The 69 posts which represented the full set of data analysed were annotated (see Appendix J) in the same way as Figure 6.1 where a description of the main recognised development pattern was annotated and highlighted in yellow after the post. One main development pattern could be identified for each post; therefore, each post constituted the baseline for the data unit of analysis.

The following seven development patterns emerged from the analysis:

Observing, Anticipating, Doing, Questioning, Theorising, Creating, Intuiting.

A second check was carried out where each development pattern's dictionary definition (Penguin Complete English Dictionary; 2006) was used in order to cross reference the post against and ensure its appropriate positioning. Table 6.1 below offers a summary of the development patterns identified included their associated dictionary definition as well as the number of posts from which the patterns emerged.

Observing	10 posts identified
Dictionary definition: Notice or perceive something by concentrated attention and register it as being significant.	
Anticipating	9 posts identified
Dictionary definition: To foresee and deal with something in advance. Something regarded as probable; something expected or predicted.	
Doing	10 posts identified
Dictionary definition: To effect, perform or carry out an action.	
Questioning	16 posts identified

Dictionary definition: Expressing a sentence so as to elicit information. Expressing a doubt about the truth or validity of something.	
Theorising	10 posts identified
Dictionary definition: The formation of a belief, policy or procedure establishing the basis for action.	
Creating	7 units identified
Dictionary definition: Demonstrate the ability to create / produce or cause something. To make, design or invent something.	
Intuition	7 units identified
Dictionary definition: Quick and ready insight. Power of attaining direct knowledge without evident rational thought.	

Table 6.1 Emerging development patterns as per their dictionary definition

A description of each development pattern in relation to the literature review was formulated below in accordance to observations made during data analysis. An illustrative example is also provided with each definition. It is useful at this stage to note that, for any given post, there could be some degree of overlap between categories therefore a particular learner's contribution could, sometimes, be attached to more than one development pattern.

Development pattern - *Observing*:

This development pattern shows that the learners can observe events and can describe them, albeit at a basic level. They can discern aspects of the project that they feel important to reflect upon; skill identified as being very important according to Cowan (2014). The following post illustrates the learner's observation skill with regards to team effectiveness:

'For once, we worked very efficiently in the team; there was full cooperation and no waste of time. The final product is not bad compared to what I thought we might get. I knew what we were supposed to get; I had read things about it; but as I had never done any before, I was not

very confident to do it. Nonetheless, I was a bit surprised that we worked so efficiently!'

Development pattern - *Anticipating*:

The *anticipating* development pattern illustrates how learners are able to link their reflections on a current event to past experiences and to assume what might happen in the future. This reinforces Dewey's (1910) argument discussed in Chapter 2 that reflection can only happen if learners have some kind of prior experience to base their reflections upon. This is demonstrated in the following quote where the learner reveals his/her confidence with regards to the implementation of the system based on past experience:

> *'I am quite confident that I will be able to design the e-learning part of the solution. I have carried out research in the particular area as a final-year student for my dissertation, and also in my work placement as an e-learning consultant; and I enjoyed it. What I am not sure about yet is the implementation of that part, but it will be clearer after discussing it with the rest of the team.'*

Development pattern - *Doing*:

Doing is a development pattern which allows a learner to explain how engagement in a learning task triggered reflective processes about the wider project work and its progression. This is aligned to the concrete experience stage described in Kolb's cycle (1984) which informs further reflections, although, in this case, the *doing* development pattern is not only about the description of the experience but also the realisation of the progress accomplished due to the action.

> *'In the lecture today we did an exercise on visual metaphors. The task involved drawing (metaphorically) how we would like our team to be viewed by others. Although not the most artistic, I made the most of the task and it helped me to think differently, not only about how we as a team are representing ourselves but about the visual design for the client solution.'*

Development pattern - *Questioning*:

Here, the learners offer some insight into the value of questions to start a personal analytical process and evaluate one's own and others' approaches to thinking and learning. The identification of q*uestioning* as a development pattern does not really come as a surprise as it was revealed as key to the reflective process in Chapter 2 (Bourner, 2003; Cunliffe, 2004; Jacoby, 2011, amongst others), Chapter 4 (identified as a sub-theme) and consequently Chapter 5 where *questioning* has an important place in the reflective development framework. The quote below is a good example of the *questioning* development pattern:

> *'What would I do differently if I did this project again? I would try to ensure the timescale in the project plan left time to reflect. In this way the urgency to get things done early on might be higher. Also, I would look for ways of addressing reluctance in the team to accept and adapt to suggestions made that would change some of our ideas.'*

Development pattern - *Theorising*:

As part of the *theorising* development pattern, the learners demonstrate a good understanding of content and experience and can extrapolate lessons to other areas of their future practice. This development pattern can be found as the last and ultimate level of Griffiths and Tan's (1991) five time-based sequence of reflective practice. According to them, *theorising* takes place after a length of time; it is not a spontaneous and rapid reaction. This is demonstrated in the following quote

> *'The guest lecture was very interesting, especially the section about the role of project developers. I really liked the example given by the guest speaker: instead of doing his normal role of analyst/developer, the developer just sat on a table with his clients and asked them what they really wanted, then he listened to what they had to say and that's it. His role was like that of a business consultant. I think that in project development even if your role is project manager, developer, designer*

or whatever, you should not restrain your work only to your unique role but you need to have an open mind about what's going on as a whole in order to gain knowledge and assurance about what to build to have a successful system.'

Development pattern - *Creating*:

The development pattern *creating* evidences learners' abilities to generate some personal, original and imaginative ideas and opinions based on their analysis of information synthesised from various sources. *Create* is considered to be a high-level cognitive process by Anderson and Krathwohl (2001) and it is likely to lead to intuition-based practice (see the *intuition* development pattern covered next). The quote below illustrates creativity in the formation of an opinion:

The success of a team does not only depend on how skilful the members are, but also on their ability to work together and to understand each other's differences. Indeed in a team some people may feel shy and not willing to take decisions. I think it was one of my problems at the beginning of year. I was afraid to step up and take decisions because I thought I had not enough computing knowledge. But, finally, I realised that although I could not contribute a lot in a technical aspect of the project, I could help on the research data aspect, the legal issues and the documentation report and the business aspect. My example shows that everybody can contribute in team work according to his/her abilities and expertise area.

Development pattern - *Intuiting*:

Of all the development patterns, *intuition* is possibly the most difficult one to characterise, as it presupposes that the learners have internalised and digested some learning and although they demonstrate learning consciousness, this is not grounded in facts. It is difficult to really estimate the actual learning that took place from such a post, but they are still useful learning components as demonstrated in the following post:

'This module has provided me with a wealth of knowledge and practices that I can take forward into real-world situations that I may encounter in the future. I realise now the importance of building the right team with all the necessary skills to achieve the objectives of a specific project and know how to go about doing so. I have also learned the importance of producing a realistic project plan and setting time limits for the completion of each stage of the project, and the importance of sticking to these completion times. My project management skills have now progressed to such a level that I feel capable of undertaking any project in a methodical time and cost oriented manner.'

The following step to the analysis of learners' posts and the establishment of the contextual definitions of the development patterns was to formulate a meaningful visual representation of reflective development to help its understanding. As it was established in Chapter 4 (Theme 4) that reflection is something that can be developed and grows overtime, a flower was used as the basis for the metaphorical representation of this concept, as it also grows and develops as per its biological constitution. The model was called the 'learning flower' (see the Figure 6.2 below).
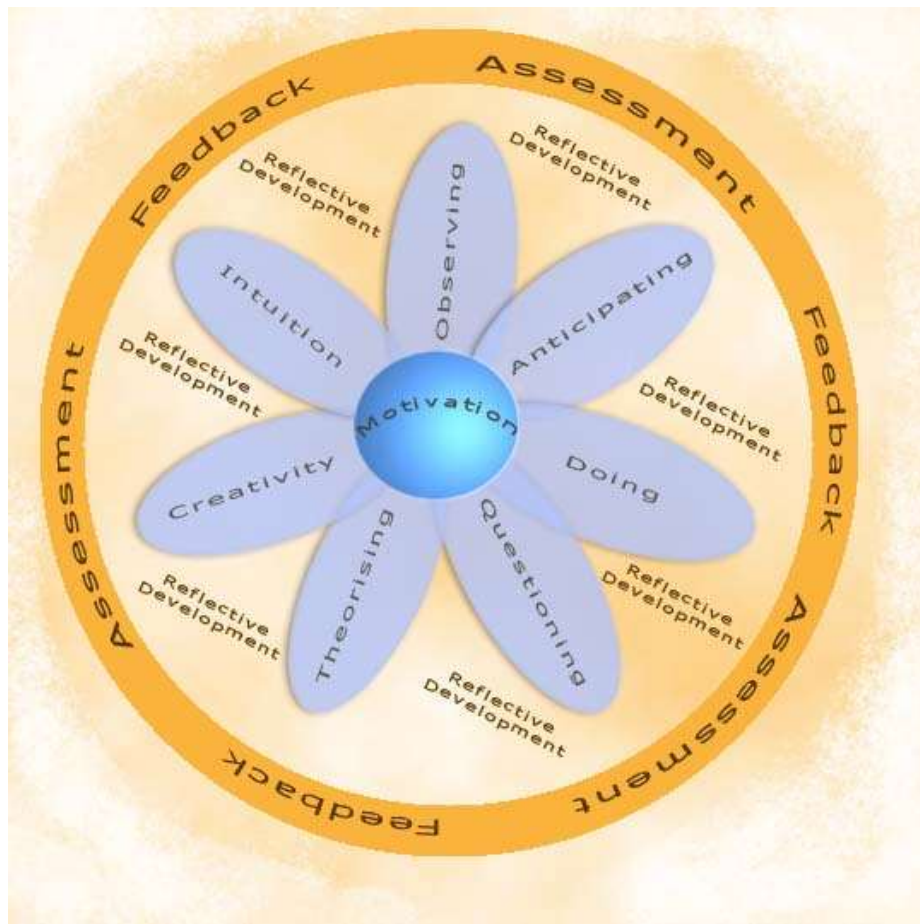
Figure 6.2 Reflective development model version 1: The Learning Flower.

The main constituents of the model, described below, are the *petals*, the *motivation* and *assessment & feedback*. This is the visual representation of the first version of the reflective development model.

The petals

The model shows seven *petals of reflection* equivalently positioned in a circular system, where *motivation* radiates from its centre, and *assessment* and *feedback* rotate on its circumference. The seven overlapping petals of the model reinforce the ideas that, while reflective development is constituted of distinct components, each of them may, at times, merge with others.

Assessment and feedback

As argued by Fry *et al* (2003), Brown (2004) and backed up by data collected in Chapter 4 (Theme 5) assessment is the drive for learning, it is a pre-requisite to motivate the learners in the formulation of meaningful reflections. Formative and summative assessment of learners' reflective development, represented

on the outside of the learning flower, allows the teacher to identify what Meyer and Land (2005) calls *threshold concepts* or *troublesome knowledge*, and to feedback expert advice that is timely, progressive and therefore, adapted to individual needs. The need for learners' support over time was recognised in Chapter 4 (Theme 4 and 6).

These findings supported the decision to include *assessment* and *feedback* in the model as continous gravitational components around learners' reflective development.

Motivation

Finally, *motivation* holds a central position on the model, demonstrating its importance. Although motivation is also a learner's responsibility, Biggs (2003, p13) argues that *'motivation is a product of good teaching'* clearly placing motivation under the teacher's responsibility. Motivation is the drive for learners' engagement and deep approach to learning and is often triggered by the learning environment set by the teacher. The importance of the learning environment was teased out from Chapter 4 (Theme 5.c).

OBSERVATIONS / EVALUATIONS

While version 1 of the reflective development model is a good foundation for further development, it was acknowledged that it could be improved. The evaluation discussed below was twofold; first, the researcher's evaluation took place followed by one from the learners which focused on the model's usage and helpfulness. The two evaluations highlight some interesting points taken into consideration in the next action research cycle.

Researcher's Evaluation

At this stage several aspects of the model were identified for enhancement based on the following limitations:

o It was realised that other important development patterns were overlooked in this version of the model as the unit of analysis considered i.e. paragraph, could only be linked to one development pattern. It is anticipated that splitting the unit of analysis down further would highlight some new development patterns.

o Some of the patterns seemed a bit ambiguous or were difficult to conceptualise for instance 'Intuiting'. Therefore, further work was required to determine if these development patterns had to be categorised differently.

o During the data analysis, it was realised that an investigation to determine possible links between development patterns and grades attributed, would be very useful to support learners. This was carried out in the third action research cycle (section 6.3).

Learners' Evaluation

The model of reflective development version 1 was evaluated on a cohort of final year learners who had very little or no previous experience of reflective writing. The learners had to be assessed on their reflective journal (called review diary which counted for 70% of the module mark), made of a collection of several text posts that evidenced the learner's learning processes. They were encouraged to use the version 1 of the model of reflective development to help them with the formulation of the work, therefore were provided with the visual

model (Figure 6.2) as well as the contextual definitions of each development patterns explained in section 6.3 above.

A module evaluation questionnaire was sent to sixty-two final years on the Client-Focused Business Solutions module. The questionnaire included two targeted questions collecting learners' views on the helpfulness of the reflective model version 1. Thirty-eight learners participated in the questionnaire equating to a 60% response rate.

In order to ascertain their level of expertise with reflection, the learners were first asked:

'Were you familiar with the type of reflective assessment used in this module?'

35 (92.1%) respondents confirmed that they were not and only 3 (7.9%) said they had experienced it in the past, one of them was repeating the year, therefore, had experienced this same assessment in the module before. These figures also confirmed that reflection was not a widely used assessment tool in the School of Computing especially in 1st and 2nd year.

The learners were also asked:

'Have you used the reflective flower model to understand the Review Diary requirements and how helpful was it?'

Figure 6.3 shows that 34.2% (13 participants) did not use the model, 15.8% (6 participants) tried to use it but it was not helpful, 18.4% (7 participants) used it and found it a little bit helpful, 26.3% (10 participants) used it and found it helpful while 5.3% (2 participants) used it and it helped them a great deal.
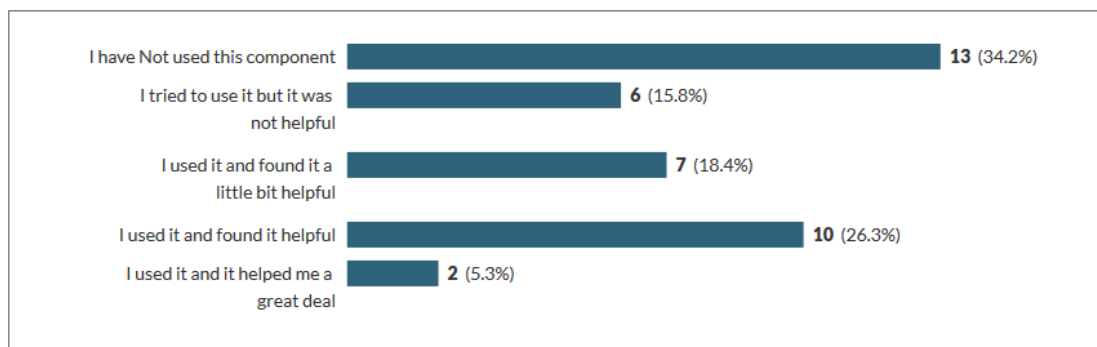

Figure 6.3 Helpfulness of the reflective development model version 1.

Overall, 50% (19) respondents did not use or did not find the model helpful, and the other 50% (19) found the model from a bit to a great deal helpful.

One of the learners who found the model helpful commented that:

> *"It shows in a very easy way how to reflect on a certain topic and what stylistic elements you have to use to make it really reflective."*

Version 1 of the model seemed to have helped half of the learners, but it is interesting to note that six learners tried to use it but they reported that they did not really benefit from it. This might be down to the complexity of the model and its heavy reliance on understanding the development patterns' meaning; this issue was taken into consideration in the next version of the model.

REFLECTIONS ABOUT MODEL VERSION 1

The formulation of this model partially addresses the iteration's objectives set out earlier which were:

- o *Identify the main constituents used in reflective development,*
- o *Create the first version of a reflective development model from the data analysis,*
- o *Evaluate the model.*

This action research cycle demonstrates that the analysis teased out some constituents of reflective development as seven *development patterns* were identified from the sample of reflection analysed. They come in the form of cognitive processes and action words such as *Observing* and *Doing* which offer an extrapolated but concise description of the data units under scrutiny. From this, the first version of the model was formulated and linked to additional, but essential, ingredients i.e. motivation, feedback and assessment, extracted from the literature review (Chapter 2) and primary data (Chapter 4).

The evaluation of the model was useful to define a plan for the action research cycle 3 discussed in the next section.

The first version of the reflective development model was a valuable first iteration to conceptualise reflective development in Computing. To refine it, it was decided to use a different set of learners' reflections to identify if any new development patterns emerged from the data and to validate or rationalise existing ones.

PLANNING

The main objectives to be addressed in this iteration were as follows:

- o *Identify if any new development patterns emerge from an analysis based on smaller data units of reflection;*
- o *Clarify the model by altering ambiguous development patterns and explore the possibility of categorising them further;*
- o *Create version 2 of the model;*
- o *Determine if a link exists between usage of development patterns and grades attributed by teachers;*
- o *Evaluate the usefulness and clarity of the model and its development patterns.*

The set of text-based reflection used in this cycle came from a class of 42 final year learners taking the Client-focused business solutions module in 2013/2014. The learners were involved in a teamwork-based project for a real client throughout the academic year and had to produce an assessed piece of reflection counting for 40% of the overall mark, the module's context was similar to the module used for the data generation of the previous action research cycle in section 6.3. This was a convenient sample as it provided easy access to learners' reflections to use for analysis and an in-depth understanding of the data collection context.

Teachers' interviews (Chapter 4, in particular theme 5) as well as the literature review (Chapter 2, section 2.6) suggested that it is difficult to assess reflection accurately. Therefore, reflection tended to be assessed as matching a particular grade. Therefore, to recognise potential links between grades and development patterns usage, which was one of the aims for this cycle, it was decided to

select the written reflection sample based on grade achieved. In order to make the possible links more obvious, written reflections which were spread apart by around 10 points per grade clusters were chosen e.g. A:72, B: 62, C:52.

A total of 20 anonymised learners' reflective work were selected according to their grade (5 per grade). Table 6.2 illustrates the clustering of the sample (usually the low end of the grade) and shows the learners' unique identifier (for anonymity) and their corresponding grade and points achieved.

ID	A1	A2	A3	A4	A5
A Grade	74	78	74	73	72
ID	B1	B2	B3	B4	B5
B Grade	61	63	62	62	61
ID	C1	C2	C3	C4	C5
C Grade	53	52	52	51	50
ID	D1	D2	D3	D4	D5
D Grade	42	42	40	40	41

Table 6.2 Selected sample with associated grades.

It is important to note that each piece of reflection had a suggested length of between 2,000 and 2,500 words, so this provided a considerable amount of written reflection to analyse.

It was easy to identify clustered reflection pieces for grades A, B and C, however, there were only two pieces of reflection available for the D grade in this cohort of learners. It was, therefore, decided to choose an additional three pieces of reflection fitting the 'low D' grade area from the previous academic year 2012/2013 as the learners' profiles and module requirements were very similar. The only difference which could have had an impact on the data analysis was the suggested length of the reflection which was 3,000 words (instead of 2,000 to 2,500 for the cohort under scrutiny). To counter this, these three pieces of reflection were analysed until the 2,250th word was reached, which was the average of the expected length of the reflection for cohort 2013/2014. Of course, it was recognised that the truncation of the D grade

scripts could have an impact on the data analysis as the learners could have kept the best reflection in the concluding part of the scripts which were not going to be analysed. To make sure this was not the case, each D grade script from the 2012/13 cohort was read thoroughly. This allowed to ascertain that the standard of reflection was kept at a lower level all the way through, which meant that script truncation would not have an impact on the data analysis.

Furthermore, no learner failed the reflection part of the assessment, so it was not possible to identify a sample below the D grade.

ACTION

One of the objectives for this action research cycle was to allow for a smaller unit of analysis than a full post or paragraph. An initial review of the reflection pieces suggested that the unit of analysis could, indeed, spin from one sentence to a full paragraph depending on the amount of text relating to one single development pattern. It was decided to highlight each development pattern identified in the scripts and attach a comment including its name (see full annotated set in Appendix K), Figure 6.4 provides an example.
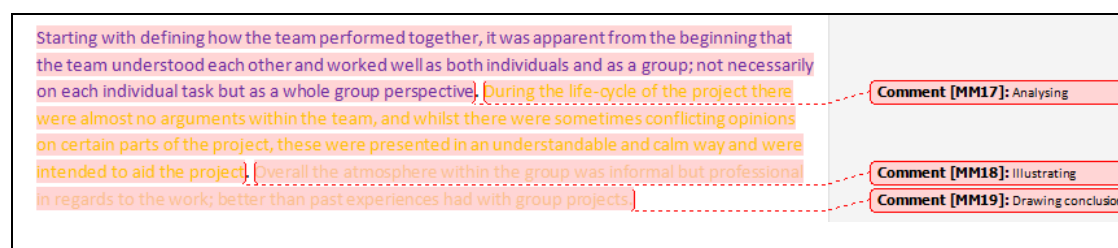

Figure 6.4 Example of highlighted and annotated development patterns.

This approach was possible when learners' work was submitted as a Word document, when a PDF document was submitted then hand-written annotations were used.

The main data analysis steps followed were:

1. Analyse and annotate scripts,
2. Recognise, or otherwise, development patterns from iteration 1,
3. Identify new development patterns,
4. Define each new development pattern based on data collected,

5. Identify possible data categories.

A second detailed review of the 20 scripts demonstrated that using a smaller data unit for the analysis enabled the identification of 23 new development patterns. The numbers of patterns emerging from the data analysis were summed up and systematically added to a spreadsheet. This allowed for a quick visualisation of the frequency of each development pattern across all scripts which varied greatly from 0 to 109; this suggests that learners tended to use certain development patterns more than others. They are represented in Figure 6.5 below including their frequency:
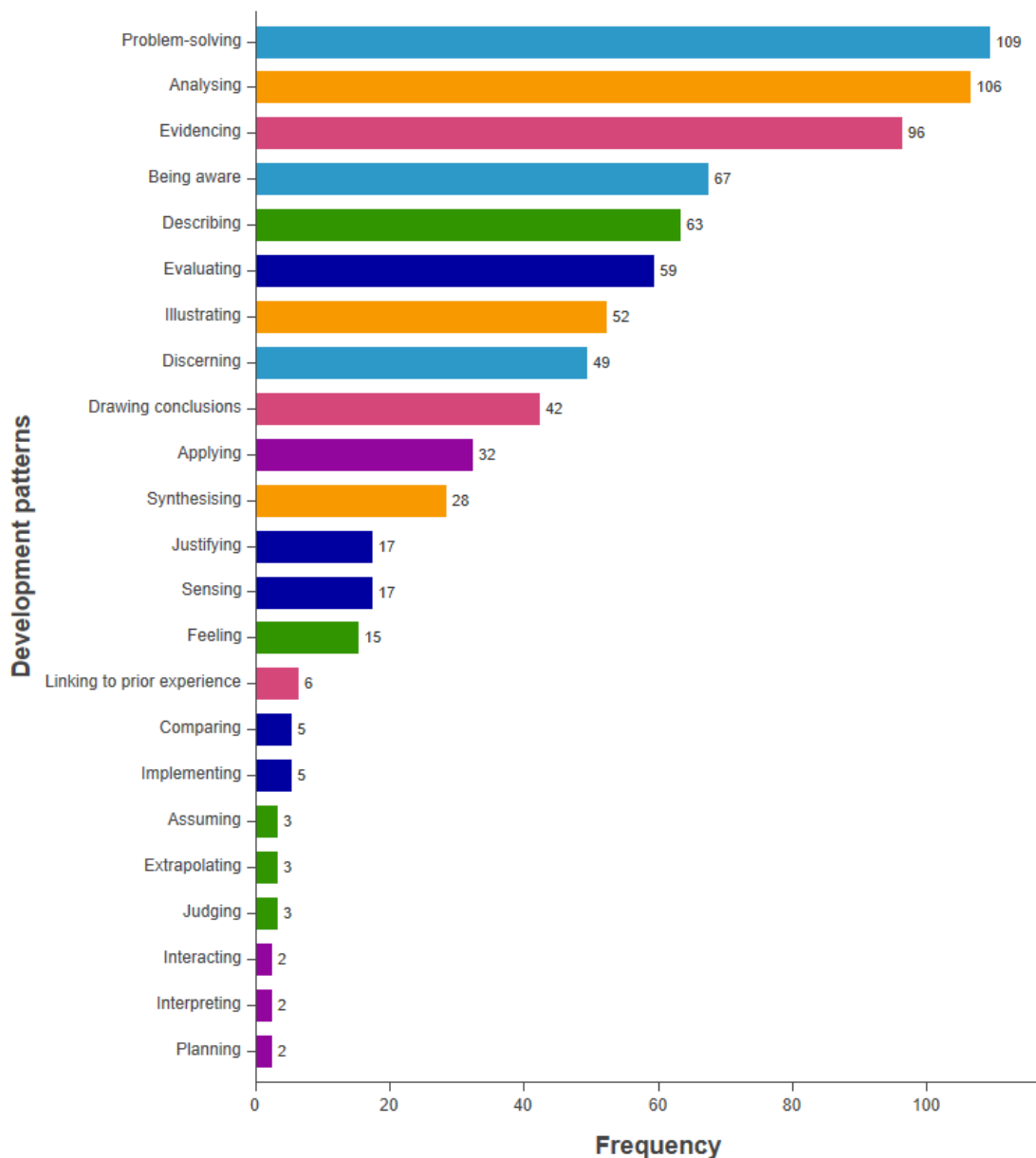
Figure 6.5 New development patterns frequency.

Several modifications of the reflective development model version 1 took place as new patterns emerged:

- *Intuiting* was replaced by *awareness* in iteration 2 as this definition fitted better the reflections found under this label,
- *Creating* seemed to be too generic as a lot of reflections could have been linked to it, e.g. creating an artefact (*Implementing*?), creation of a theory (*Extrapolating*?), creation of an action plan (*Planning*?), therefore it was decided to include more precise development patterns instead of using *Creating* as one.
- *Doing* would be better named *Implementing* as its meaning fitted the data collected better especially in the Computing discipline where people frequently talk about the *implementation* of an artefact, and where implementation is a key stage of a well-known, amongst computer scientists at least, development methodology called the Waterfall method.

The four other development patterns from version 1 were recognised in this new cycle, here is their frequency:

Observing (49), *Anticipating* (9), *Questioning* (69), *Theorising* (1).

In total 27 distinct development patterns were counted (23 new and 4 existing). Each development pattern's definition was checked against both Penguin Complete English Dictionary (2006) and online English Oxford Living Dictionaries to make sure that any mismatch between the dictionaries' definition and the researcher's own understanding of the word was eliminated (see Appendix L). Sometimes, a development pattern had several possible definitions depending on the situation, only the appropriate one was chosen in context of the research. For instance, *Apply* could mean 'spread paint on a surface' which is not a relevant definition in the context of reflective development therefore 'put something into operation or practical use' would be used as its definition.

The descriptions and categorisations of the development patterns revealed links between them and therefore possible groupings. Table 6.3 provides explanations with regards to the grouping of the patterns. The underlined text

shows the main common aspects between the patterns. Illustrating examples are available in Appendix L. Table 6.3 also shows a number following each pattern, this indicates its frequency for instance *Questioning* (69), means that the development pattern *Questioning* had been found 69 times in the scripts. The development patterns in bold are the highest frequency patterns for each group.

	Development patterns grouping	Explanations of their association
1	Describing (63) **Being aware** (67) Total= 130 dev. patterns	Both patterns are illustrated by straight forward <u>recall of information</u> which could be actions, tools, theories. They demonstrate acceptance of usage (for tools and theory) or decisions taken.
2	Observing (49) Discerning (49) **Questioning** (69) Total= 167 dev. patterns	These patterns demonstrate that the learner has paid some attention to the work environment and can <u>identify / differentiate the importance of certain aspects of the project</u> compare to others. The formulation of questions evidences this.
3	Implementing (5) **Problem-solving (109)** Interacting (2) Total= 116 dev. patterns	These three development patterns evoke <u>past or future actions in relation to the progression or improvement of the project</u>. It usually includes some kind of explanations that support the reason for the action.
4	**Analysing (106)** Evaluating (59) Applying (32) Comparing (5) Total= 202 dev. patterns	All the patterns in this group demonstrate the <u>creation of new meaning</u> grounded into data or experience. The learner demonstrates that he/she can break down parts of materials and identify how they fit in the bigger picture with the aim of understanding or clarifying outcomes or behaviours.
5	Synthesising (28) **Drawing conclusions (42)** Theorising (1) Total= 71 dev. patterns	The three development patterns lead to the <u>generalisation of a concept or learning</u> defined from a known data set and with the aim of widening its application to future applications.
6	Planning (2) Extrapolating (3) **Anticipating (9)** Linking to prior experience (6) Assuming (3) Total= 23 dev. patterns	These patterns evoke a <u>forward projection into the future</u> most of the time based on pre-experience knowledge.
7	**Judging (3)** Interpreting (2) Total= 5 dev. patterns	The two patterns relate to <u>opinion forming</u> based on careful consideration of criteria, literature, actions or decisions.
8	**Sensing (17)** Feeling (15) Total= 32 dev. patterns	The two patterns are <u>intangible emotions</u> part of the reflective and learning process.
9	**Evidencing (96)** Illustrating (52) Justifying (17) Total= 165 dev. patterns	The three patterns prove that meaning, analysis and actions are <u>grounded in reliable sources and experiences</u>.

Table 6.3 Explanations of development patterns groupings.

It was noted that presenting the model as nine groups, instead of 27 development patterns, would make its understanding easier. Therefore, it was decided that the visual representation of the model should only display development patterns which had the highest frequency in each group (indicated in bold in Table 6.3) as it would offer a better representation of that group.

The reflective development model version 2 was derived from the above and is illustrated next:

1	Being aware:	Describing
2	Questioning:	Observing, Discerning
3	Problem-solving:	Implementing, Interacting
4	Analysing:	Evaluating, Applying, Comparing
5	Drawing conclusions:	Synthesising, Theorising
6	Anticipating:	Planning, Extrapolating, Linking to prior experience, Assuming
7	Judging:	Interpreting
8	Sensing:	Feeling
9	Evidencing	Illustrating, Justifying

It is important to note that the numbers used in the model do not provide any information other than allowing the listing of the different categories of the model; they do not prioritise them.

The fundamental elements of the visual Learning flower model version 1 have not changed, the development patterns *petals* are still overlapping, and *motivation* is still the centre of the model recognising that without motivation, reflective development cannot be achieved. Figure 6.6 is an updated version of the reflective development model incorporating the new set of development patterns identified in this third action research cycle.
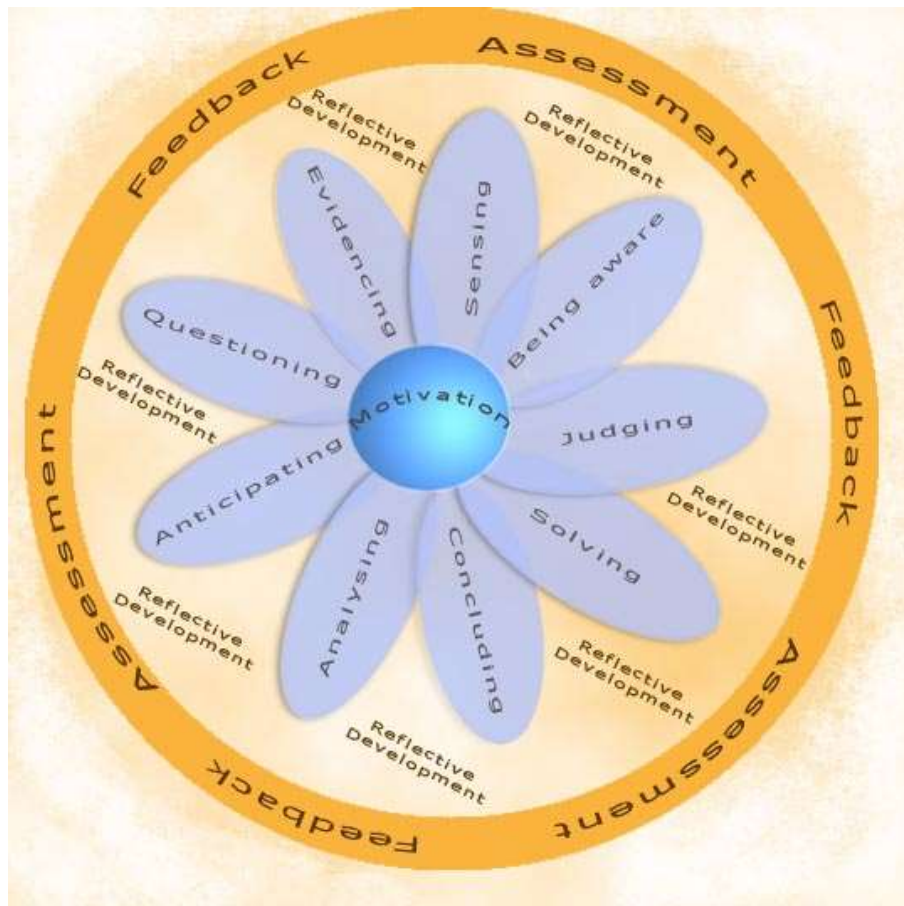
Figure 6.6 Reflective development model version 2 – The learning flower.

The analysis of the 20 scripts undertaken has allowed to map out each data unit against at least one of the 27 development patterns of the reflective development model. At times, it was noted that some of the data could fit in several categories; when this was the case, the researcher's judgment was used to identify the category that fitted the data best.

ACTION (IN RELATION TO GRADES)

One of the aims of this action research cycle was to determine if there was a link between the usage of development patterns and the grades attributed. Indeed, several observations could be made in relation to the grades attributed to the 20 scripts.

Table 6.4 illustrates the total number of development patterns found per group but this time distributed across the different grades; the results offer some interesting insights.

Grades / Development patterns groups	A	B	C	D	Number of dev. patterns identified per group
Being aware	19	27	44	41	130
Questioning	37	37	50	43	167
Problem solving	48	34	19	16	116
Analysing	59	66	29	48	202
Drawing conclusions	25	21	10	15	71
Anticipating	8	8	5	2	23
Judging	4	1	0	0	5
Sensing	7	7	9	9	32
Evidencing	82	32	31	20	165
Total number of dev. patterns identified per grade	289	233	197	194	913

Table 6.4 Development patterns distributed across grades.

The first observation was that the number of development patterns identified in the scripts of similar length decreases with the grade. Indeed, the A grade scripts counted 289 patterns compared to 194 for D grade scripts. This suggests that in-depth reflections used more intertwined development patterns (see Figure 6.7) compared to lower standard reflections which tend to be written in big chunks of the same development pattern (see Figure 6.8).

Figure 6.7 'A grade' reflection abstract: intertwined development patterns.

The learners who are able to write in-depth reflections seem to be very comfortable with the reflective patterns linkage. Their thoughts flow from one to the other in a logical non-contrived manner.

Figure 6.8 'D grade' reflection abstract: development patterns chunks.

The second observation was the high number of development patterns (82) being attributed to the '*Evidencing*' category for 'A grades' scripts; this number decreased as the grade got lower as per Table 6.5.

	A grade	B grade	C grade	D grade
Number of data units identified for the *Evidencing* group.	82	32	31	20

Table 6.5 Number of data units for the *evidencing* development pattern.

The 82 patterns in this group were split as:

- *Evidencing* (from the literature) = 51
- *Illustrating* (examples)= 24
- *Justifying* = 7

This finding demonstrates that referencing the literature is valued in the reflective process. This was also noted in the teachers' interviews (Chapter 4).

The third observation (Table 6.6) was the high number (48) of development patterns attributed to the *Problem-solving* group in 'A grade' scripts, number decreasing with the grade.

	A grade	B grade	C grade	D grade
Number of data units identified for the *Problem-solving* group.	48	34	19	16

Table 6.6 Number of data units for *problem-solving*.

The 48 patterns of the group were split as:

- *Problem solving*: 46
- *Interacting*: 1
- *Implementing*: 1

Problem solving seems to be a very well used development pattern, but this did not come as a surprise considering that problem-solving is a key skill to demonstrate in the Computing discipline (QAA Computing benchmark statement, 2016).

The fourth interesting observation was the greater number (44 and 41) of *Being aware* patterns used respectively in C and D grades compare to a lower usage of this pattern (19) for A grades. Although it is recognised that descriptive reflection is useful (Jay and Jackson, 2002; Hatton and Smith, 1995), the learner should be encourage to engage with more challenging development patterns to produce in-depth reflections.

OBSERVATIONS / EVALUATIONS

This section presents an evaluation of version 2 of the reflective development model using a focus group of eight final year undergraduate learners.

An email was sent to all the 82 learners from the Client-Focused Business Solutions module cohort 2014/2015 (same module and context as the one used in other sections) asking for volunteers to take part in the evaluation of the model. This particular class was chosen as all the learners were asked to

complete a piece of reflection counting for 40% as part of their assignment. Therefore, it was believed that their experience on this topic would be beneficial to evaluate the model.

The focus group participants were determined to understand and evaluate the reflective development model with the expectation that it could support them to produce better reflection and, therefore, grade.

All of them were asked to bring in a piece of reflective writing that they produced as part of the module. The focus group lasted one hour and included the following activities:

- o Presentation of the model: how it was designed, definitions of its constituents, explanations of key findings from the data analysis as noted in the previous section.
- o The participants were then given some time to read a handout consisting of the definition of each development pattern's group followed by examples illustrating each development pattern in the group (see Table 6.7 for an example of the *Evidencing* group).

	Definition
Evidencing	Proving that meaning and actions are grounded in reliable sources and experiences. Demonstrate evidence-based knowledge that relates to specific examples.
	Quotes that illustrate the development patterns
Evidencing	*"The McGregor theory identified reasoning for these issues known as the Theory X and Theory Y management. Theory X managers have limited regard for people and do not believe individuals are capable of producing without being pushed. They are in essence authoritarian and pushy. The Team Leader tended to be a Theory X manager the team were mostly indifferent to his approaches routinely complaining about being pushed and not being trusted to do their tasks well."*
Illustrating	*"During the implementation stages there was as it were a war raging because changes were continuously being made to the site which others did not agree with but no-one was speaking to each other. There came a point where this had to be resolved and a way was found to have individuals voice their concerns and assurance sought that their input would be taken into consideration."*
Justifying	*"In regards to writing up minutes, Bruce Lewis advises to "Start immediately after the meeting to understand what you wrote" (Lewis, 1997). In response to this, the notes took during each of our team meetings were written up immediately. As a result, nothing was lost in translation and all of the notes made during the meeting made complete sense when writing them up."*

Table 6.7 Extract of learners' hand out used for the focus group.

- o The learners were then asked to identify if they could improve the piece of reflection they brought in with the help of the reflective development model handout. They were given time to do so in this session.
- o Finally, the participants were asked to complete a short survey which aimed to understand the model's usefulness and gauge its clarity when it came to using it to improve reflections.

The survey (Appendix D) had six questions. Five of them were based on a four-point Likert scale and one was an open question to allow the participants to elaborate if required.

Answers to the questionnaire were written on paper then placed in a stack at the end of the session in order to keep them anonymous.

The first question was:

'How useful was the reflective development model to evaluate your reflection?'

As shown in Table 6.8, all the participants reported that the model was either 'useful' or 'very useful' as they could use it to improve their *existing* piece of reflection.

Not useful	A little useful	Useful	Very useful
0	0	6	2

Table 6.8 'Usefulness of model to evaluate reflection?'

It is interesting to note the learners' responses to the second question which related to the usefulness of the model to start a new piece of reflection.

'How useful would the reflective development model be to start a new piece of reflection?'

Table 6.9 demonstrates that their answers were even more encouraging as five of them predicted that this model would be 'very useful' and two 'useful'. One participant did not respond to this question.

Not useful	A little useful	Useful	Very useful
0	0	2	5

Table 6.9 'Usefulness of model to start a new piece of reflection?'

One participant commented:

"It would be extremely useful to have this model before writing the reflective blog as it is hard work trying to make the blog fit [the model's] criteria after it is written. Also, it helps the students get into good habits of writing".

Another added that this model would be very useful when starting a piece of reflection as:

"You can say to yourself I need to include 'x problem solving' and 'y evidencing' and plan a report that way".

This supports the idea that the model has the potential to help learners with a way to first plan, and then shape the reflective writing work as it evolves.

Although, it is important to ensure that the learners do not see the model as too prescriptive such as having in mind to include a *specific* (x) number of problem-solving. The reflection needs to flow instead of following an approach that might be too systematic.

The next section of the questionnaire referred to how understandable the development patterns wording was.

<div align="center">

'Were the words describing the development patterns clear e.g. Extrapolating?'

</div>

Table 6.10 shows that two learners found the descriptive words 'very clear' out of eight of them and five thought they were 'mostly clear'

Not clear	A little clear	Mostly clear	Very clear
0	1	5	2

Table 6.10 'Clarity of the development patterns?'

However, there was one participant who seemed to be struggling with some of the descriptions, he/she explained:

> *"The examples provided [for each development patterns] are good but I felt that definitions of all the sub-patterns may be useful too."*

The aim of the following question was to determine if any specific development pattern's descriptive word had been identified as difficult to understand by the participants. The statement was:

<div align="center">

'If there were any development patterns word description that you could not clearly understand, please write them here:'

</div>

One participant specifically highlighted the two following patterns, *Synthesising* and *Discerning* and another one felt a bit confused with regards to the difference between *Describing* and *Implementing*.

A third participant explained that although all the main categories were clearly defined, he/she would find it beneficial for each development pattern to have its own definition as well as being illustrated by an example. This observation fits with a comment from a fourth participant who adds that he/she found it difficult to understand the development patterns during the first few reads.

The fifth question was:

'According to you, how informative were the examples provided to illustrate each development pattern in your hand out?'

As Table 6.11 shows, all the participants found the examples 'Mostly informative' which, on one hand, is positive but on the other hand highlights the existence of some *ambiguity* about them, or, at least, some of them.

Not informative	A little informative	Mostly informative	Very informative
0	0	8	0

Table 6.11 'Clarity of the development patterns examples?'

Finally, the participants were asked:

'How would you rate this reflection model as a tool to teach students what reflection is in Computing?'

Not useful	A little useful	Useful	Very useful
0	0	2	6

Table 6.12 'Usefulness of the model to teach reflection to learners?'

Six participants thought that the model was 'Very useful' and two 'Useful' (see Table 6.12). One of the participants commented that:

"Reflection should be looked at earlier at University."

This comment is an interesting message also shared by teachers in Chapter 4, Theme 4: *reflection progression and continuity*.

This concludes the evaluation from the learners' point of view, but it is also interesting to take into consideration the researcher's difficulties in producing the model as listed below:

o Difficulties to produce a definition for each group that applies to *all* the development patterns within that group,

o Challenges to find the right words to illustrate each development pattern,

o Hesitation with regards to grouping the development patterns in the appropriate category.

It was also recognised that having a name to describe each group instead of using a development pattern's name would avoid any confusions.

The next section reflects on the work achieved and reviews the aims of the action research cycle.

REFLECTIONS ABOUT MODEL VERSION 2

The development of the second version of the model was very valuable, especially with regards to the usage of smaller data units as the basis for the analysis. Indeed, this allowed the identification of several new development patterns but also the refinement of existing ones from version 1 which tended to be too generic or ambiguous. It was recognised that while the positioning of the data unit within one of the nine groups was deemed accurate, it was harder to position each unit accurately in a particular development pattern within that group.

With regards to the second aim of the cycle, the focus group provided interesting insights about the model and how to improve it. The learners recognised that the model is a useful tool to develop their reflections, as commented below,

> *"[The model is] useful to improve all aspects of academic reflective work, although it would work to improve the quality of real world work too!"*

However, there are areas for improvement when it comes to the description of the development patterns. Indeed, there was always some worries about learners' level of comprehension of some of the development patterns' names as their comprehension requires a good mastery of the English language without which they might not be self-explanatory to all learners. Therefore, tt could be beneficial to offer a clear definition for each development pattern, and maybe avoid having the title of the groups as development pattern themselves.

In relation to the usefulness of the model to teach reflection to computing learners, the results gained are very encouraging as they demonstrate the need for a model that supports reflective development but also shows that the model presented has potential. One of the participants provided the following comment about the visual representation of the model:

"I find the overlapping of the development patterns very interesting and useful as it makes the patterns flow instead of having rigid patterns."

This notion of development patterns *flowing* is a good illustration of how to imagine them intertwined and linking / feeding into each other to produce a powerful piece of reflection which demonstrates *learning*.

Finally, the last aim of this iteration was to determine if a link exists between the usage of the development patterns and grades attributed as this aspect would help identify what is considered a good reflective piece for this module.

Several key points were extracted from the analysis undertaken, which suggest that there are indeed links identifiable between the development patterns that learners use in their reflections and the grade that they obtain.

The next section describes how what has been discussed and experienced in the action research cycle 3 enabled the production of an enhanced model version 3.

PLANNING

Version 2 of the model was a good progression from version 1 as it confirmed some of the development patterns identified in version 1, revealed some new ones and allowed their groupings. However, the model could be enhanced as per the previous evaluation. Therefore, the following aims were decided:

- o *Find a name for each group that does not use a development pattern's name,*
- o *Include definitions for each development pattern to support learners better,*
- o *Amend visual representation of the model accordingly,*
- o *Get learners' feedback on their usage of the model.*

It was decided that no new written reflection would be analysed in this cycle as it was more important to rationalise the existing model before testing it again against a new set of reflections.

ACTION

The two first aims of this section were undertaken simultaneously as defining each development pattern was required to extract an encompassing group name. Instead of using the main development patterns as titles for the groups it was decided to label each group with a *concept* name*;* this seemed appropriate as each group related to an abstract idea, adding to the definition of reflective development. To fulfil these two aims, the following was undertaken (see Table 6.13 for an example):

- Step 1: identify data unit in learners' reflective work,
- Step 2: provisionally attribute a development pattern to the data unit based on its meaning,
- Step 3: check if data unit fits with the dictionary definition of the allocated development pattern, if not choose a different development pattern and go back to step 2,

- Step 4: formulate a new definition of the development pattern based on both observations made during the data units' review and its dictionary definition; this definition should support learners to understand the development pattern,

- Step 5: formulate a new definition which represents the group of development patterns i.e. concept.

- Step 6: choose a key word based on the definition created in step 5, which illustrates the concept.

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
Identification of data unit to allocate	Attribute a development pattern…	Development pattern's dictionary definition	New development pattern definition	New concept definition	New Concept name created
"At the beginning of the project, the team was introduced to the client and learnt about what the company was about, how the company started and a brief outline of what they wanted to achieve from the project."	Describing	Give a **detailed account** of something in words. An account intended to **convey a mental image** of something experienced.	Sets the context or provide a **detailed account** of what was done during the project. No evaluation or personal opinion provided. It is a straightforward description that provides **a mental image** to the reader with regards to what is discussed.	This concept demonstrates that the learner can recall information, usually in a logical order, for instance, to provide the context of the reflection or to complement information already provided. This is often illustrated by straight forward recall of actions, recollection of the usage of tools and theories as well as **acceptance** of decisions taken. Note: there is also evidence of **acceptance** of what a tool or theory is used for and **acceptance** of context.	Acceptance
"The term, project management refers to the process of planning, organising, directing and controlling (etc.) a production; it is an application of the process, method, knowledge and skill needed to achieve project goals."	Being aware	**Knowledge** of a situation or fact. Having kept oneself informed.	Refers more to tools or theories covered in the course and it demonstrates that the learner has **knowledge** of them. On their own, these quotes usually do not relate to the project.		

Table 6.13 Example of the step process used for the creation of the model version 3.

A summarised version of the model (Table 6.14) and its visual representation (Figure 6.9) are presented below. The visual representation only includes the concepts instead of the development patterns they, alongside motivation, assessment and feedback, define reflective development.

Concepts	Development patterns
Acceptance	Describing, Being Aware
Differentiation	Observing, Discerning, Questioning
Action	Implementing, Interacting, Problem solving
Comprehension	Evaluating, Applying, Comparing, Analysing
Generalisation	Synthesising, Theorising, Drawing conclusions
Projection	Planning, Extrapolating, Linking to prior experience, Assuming, Anticipating
Opinion	Interpreting, Judging
Sensing	Feeling, Sensing
Proving	Evidencing, Illustrating, Justifying

Table 6.14 Reflective development model version 3.
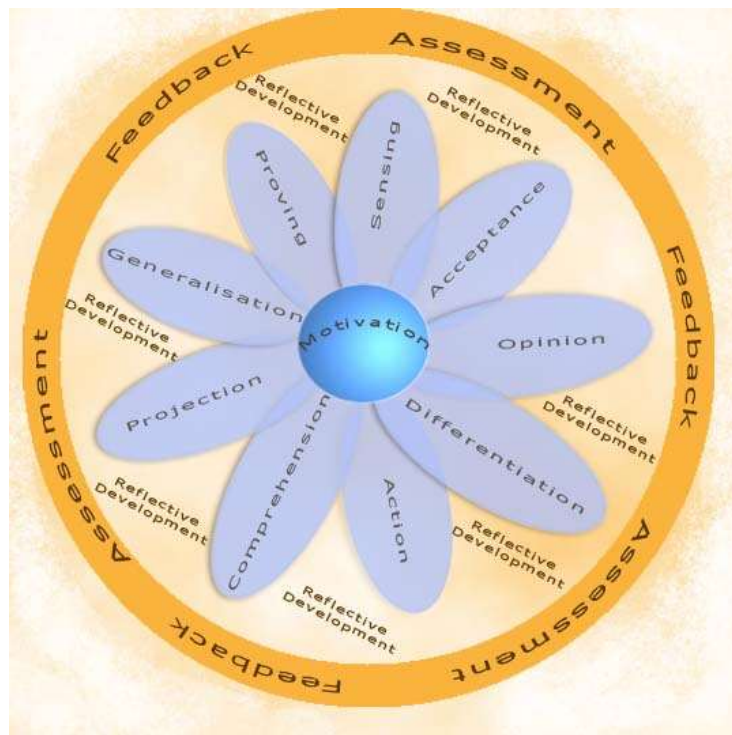
Figure 6.9 Reflective development in Computing - The Learning Flower

Table 6.15 presented next is the outcome of this AR cycle, it offers a detailed version of reflective development including definitions for each development patterns and concepts based on illustrative examples extracted from learners' reflection. This level of detail aims to be helpful to define reflection in Computing and support the development of learners' reflective skills.

	Definition of the concept	Development Patterns	Development patterns definitions	Development patterns examples
Concept A: Acceptance	**Face value acceptance, no evaluation or personal opinions.** This concept demonstrates that the learner can recall information, usually in a logical order, for instance, to provide the context of the reflection or to complement information already provided. This is often illustrated by straight forward recall of actions, recollection of the usage of tools and theories as well as acceptance of decisions taken.	✓ Describing	Sets the context or provide a detailed account of what was done during the project. No evaluation or personal opinion provided. It is a straightforward description that provides a mental image to the reader with regards to what is discussed.	*"At the beginning of the project, the team was introduced to the client and learnt about what the company was about, how the company started and a brief outline of what they wanted to achieve from the project."*
		✓ Being aware	Refers more to tools or theories covered in the course and it demonstrates that the learner has knowledge of them. On their own, these quotes usually do not relate to the project as illustrated by the example on the right-hand side.	*"The term, project management refers to the process of planning, organising, directing and controlling (etc.) a production; it is an application of the process, method, knowledge and skill needed to achieve project goals."*
Concept B: Differentiation	**Differentiation of constituents.** This concept demonstrates that the learner has paid some attention to the work environment and can identify - and therefore differentiate if necessary - the importance of certain aspects of the project compare to others. The learner can point out aspects and constituents that made a positive or negative impact on the project and ask targeted questions.	✓ Discerning	The learner can distinguish or discriminate between different key aspects of the project especially if those are not obvious.	*"Consultancy and its success hinge mainly on being able to listen effectively to what clients need and being able to generate ideas in order to solve the client's problem."*
		✓ Observing	This is very similar to *Discerning*, but this time, it demonstrates that the learner has noticed aspects of the project that deviate from the norm e.g. low attendance to meetings, which is likely to be less significant than aspects identified in the 'Discerning' pattern.	*"Another problem I noticed was that we almost never had a full team in meetings; there was always someone missing".*
		✓ Questioning	Although the data in this development pattern could easily fit in other categories as well, it always triggered by an explicit question leading to some kind of	*"Could the Belbin's team roles be recognised within the team?[ ] The team would have greatly benefited if it included a Shaper which is an individual who questions others and*

Table 6.15 Reflective Development model in Computing (continued…)

			analysis. The learner demonstrates that he/she can ask pertinent queries driving to the creation of new meaning which can be used for different purposes such as opinion forming, problem-solving or application of theories.	challenges the team consistently [ ] as at times it felt that ideas were thought upon but not questioned and just put straight into practise and having that Shaper on the team would have looked at ideas from all angles and perspectives"
Concept C: Action	**Action taken with the aim to improve or progress a project.** The concept evokes actions or communication during the project. This could be in relation to the progression or improvement of the subject matter or relates to the usage of a process in context of the project, for instance, to analyse it or mapping out experiences to theories. It refers to the implementation with regards to something key to the project and it includes explanations that support the reason for the implementation.	✓ Implementing	Provides a description of a specific aspect of the project that was implemented as well as an explanation with regards to why it was implemented. This demonstrates project's progress and learner's understanding of action.	"The team developed prototypes in the form of live websites or screenshots from design stages and they were presented to the clients in the various meetings during the project. This allowed the clients to deliver feedback on what had been achieved to date".
		✓ Problem solving	This is initiated by the recognition of an issue and it either explains how the issue has been dealt with during the project or it demonstrates that the learner has thought of a mean of effectively dealing with the problem in the future.	"Meeting minutes should have been made available to all team members on a more regular basis following meetings. Especially for people like me, it's difficult to maintain concentration in meetings, and tend to daydream a lot completely subconsciously".
		✓ Interacting	This refers to inter-persons communication in relation to project's progress.	"We had face to face meetings in which all team members had to be present in order to consult with the client and extract the information needed to determine in which direction the project should be heading at".

Table 6.15 Reflective Development model in Computing (continued…)

Concept D: Comprehension	Creation of new meaning grounded into data or experience. In this concept, the learner demonstrates that he/she can break down parts of materials and identify how they fit in the bigger picture with the aim of understanding or clarifying outcomes or behaviours.	✓ Analysing	This refers to the creation of new meaning with the aim of understanding or clarifying matters under discussion.	"Everyone felt better connected when we worked as a team, and so by starting out with the baseline for the project being created as a group it helped set out a team mentality that would last the entire project life-cycle which was important to keep the group connected".
		✓ Comparing	This illustrates evidence of creation of new meaning based on comparison made, for instance between methods used, tools found, experiences etc	"We kept a traditional method of using a Gantt chart to give us a specific time frame, we didn't always get things completed by the times that we thought were possible but we edited our Gantt chart accordingly, we ended up with multiple charts, with our final one being very different from our first, this shows that we had underestimated our time keeping and we learnt a lot about judging timescales for work through the use of the Gantt chart."
		✓ Evaluating	This provides evidence of creation of new meaning based on evaluation of data or practice but not from one's opinion. The learner estimates similarities or dissimilarities between aspects of the project or experiences.	"As a team, we used tools such as team effectiveness surveys and team diagnostics to evaluate how we were performing. The results of the first team effectiveness survey showed a low score of 22 for the statement "The group does an effective job of sharing responsibility among its members". This low score highlighted the team's belief that the workload and work tasks were being shared out unevenly and thus some team members were completing a lot more work than others".

Table 6.15 Reflective Development model in Computing (continued…)

		✓ Applying	This development pattern demonstrates that the learner has more or less understood a process / theory and is able to use it or refer to it in the context of the project. Although this pattern might not evidence as much 'creation of new meaning' than other patterns belonging to this category, it greatly demonstrates the comprehension of key tools and theories relevant to the project.	"Belbin's nine roles were put to use when selecting the project manager and team leader. The 'Coordinator' role mentioned by Belbin has the characteristics of a good leader who is mature and confident, this helped [our team] in its choice of picking the project manager and team leader".
Concept E: **Generalisation**	**Generalisation of a concept with the aim to potentially expand its application or learning to other projects.** This concept can take the form of extraction of project conclusions or combining different ideas into lessons learnt. This development pattern is usually a strong demonstration of learning from experience.	✓ Synthesising	The 'Synthesising' development pattern shows that the learner can extract key lessons learnt from the practice and possibly apply them to future projects or stages of this project. Those lessons learnt are usually extracted from the whole project meaning that they are more generic than for the development pattern 'Drawing conclusions'.	"Although the team still functioned and produced an extremely good product, the general progress of the project could have been improved if the plan was more closely followed / reviewed. This was a good lesson in the importance of team planning".
		✓ Drawing conclusions	The 'Drawing conclusions' pattern is the extraction of lessons learnt from the practice but extracted from specific aspects of the project	"Although some tasks did take longer and others less [...] PERT provided a good realistic cost evaluation. Next time we will be more experienced so some of the times will change slightly but for a first attempt a good estimation was made"
		✓ Theorising	Theorising shows that the learner is able to extract rules and formulate suggestions from project experience.	"In future the roles need to be spelt out and ground rules set beforehand so that everyone is clear on expectations and courses of action which could be taken in the event that there were deviations."

Table 6.15 Reflective Development model in Computing (continued…)

Concept F: Opinion	Expression of own judgment. This concept relates to opinion forming with regards to the quality of something taken into careful consideration against a set of criteria or the literature. This concept can also demonstrate personal judgment of actions or decisions. These are formulated from the learner's belief or opinion or from data collected.	✓ Judging	This pattern confirms that the learner can draw personal opinions from his / her own experiences and therefore learn from them.	"Sometimes an assumption was made by myself that [my team mates] wouldn't reply so I didn't bother getting in contact at all. This was wrong of me and is a poor way of working."
		✓ Interpreting	The 'Interpreting' pattern demonstrates that the learner can either interpret data from the literature in order to put it into practice in the project (**), or interpret the practice with the aim to ground it in the literature often to justify good practice (*).	**"The actions of our project manager and the actions of the team to help [our developer] with his workload demonstrated leadership and backup behaviour which are two core components of effective teamwork discussed by Michael A. West in Effective Teamwork. This also demonstrated how well we were working as a team and how effective we had now become."
				** "Forbes, (2013) [ ] states great advice and rules to follow to aid in becoming a good consultant. Number one states "A consultant is a safe pair of hands" which means do what you say you will".
Concept G: Projection	Future prediction. This concept evokes the reasonable likelihood of something happening based on pre-experienced knowledge. It can also be the expression that something will happen although there is absolutely no proof. It is the forward projection of potentially organised opinions or ideas. A way to predict and plan for the future.	✓ Anticipating	This development pattern shows that the learner is able to foresee what could have happened during the project or he/she can predict outcomes of actions or decisions.	"The roles were clearly defined for each member; this was a great move by the team as potential changes to the roles later down the line could result in catastrophe in terms of completing the work as there would be too much confusion over who is in charge of which piece of work"
		✓ Extrapolating	The learner shows that he/she can extend the application of a known method or conclusions to an unknown situation by	"All team members were familiar with this methodology. We followed each stage to ensure a professional standard was created this helped us

Table 6.15 Reflective Development model in Computing (continued…)

			assuming that its application will deliver the same trends or benefits. He / she can predict something by extrapolation of known data.	by setting each stage and not moving on until the current stage was completed as many people tend to get ahead of themselves and if developers do not use methodologies it possibly can increase the failure rate".
		✓ Linking to prior experience	This pattern enables learners to draw from their past experiences to predict or plan for the future. It demonstrates that the learner is assimilating past lessons learnt to avoid future mistakes or make a process more efficient.	"The need to utilise what has been learnt in the past years, with regards to engaging with different categories of clients in different ways and according to their knowledge base, is important."
		✓ Assuming	The 'Assuming' development pattern demonstrates that the learner can make a supposition that something is true without any proof. The learner can also admit that he/she wrongly assumed something.	"If [the consultant] can't offer explanations to technical jargon, then it becomes difficult to trust [him]. Also, the fact that I didn't say much may indicate to the client that I have no real interest in the subject."
		✓ Planning	This pattern illustrates that the learner can arrange key aspects of a project in advance, and understands the value of doing so.	"The team was also able to produce PFD, PERT and PBS documents that would underline what exactly the project is planning to deliver in form of diagrams and tables and what the cost for services is going to be".
Concept H: Sensing	Recognition of inner senses triggered by experience. This concept recognises that experiences trigger personal senses and feelings which might not always be based on evidence or rational thoughts but they can still be	✓ Feeling	The 'Feeling' pattern shows that the learner can recognise inner emotions experienced during the practice and he /she is usually able to offer an explanation for its cause.	"This was at times frustrating as during meetings that team member would not be up to date with what had been said over the chat and sometimes did not know what the team was discussing".

Table 6.15 Reflective Development model in Computing (continued…)

	acknowledged as their recognition can greatly help the learning process.	✓ Sensing	The development pattern 'Sensing' is a way for the learner to express awareness of something without being able to define exactly the causes.	"This was beginning to cause a slight conflict and it was negatively impacting the team chemistry".
Concept I: Proving	**Validation of subject matter** The *proving* concept can be observed in different ways. For instance, proving that meaning, analysis and actions are grounded in reliable sources such as experiences and literature. It demonstrates evidence-based practice that can be sourced from examples. It has the purpose of giving more weight to what is being said in an attempt to convince and explain actions.	✓ Evidencing	This gives the learner the opportunity to use a body of facts or information, usually from the literature, to indicate whether a his/her belief or proposition is true or valid.	"The McGregor theory identified reasoning for these issues known as the Theory X and Theory Y management. Theory X managers have limited regard for people and do not believe individuals are capable of producing without being pushed. They are in essence authoritarian and pushy. The Team Leader tended to be a Theory X manager the team were mostly indifferent to his approaches routinely complaining about being pushed and not being trusted to do their tasks well."
		✓ Illustrating	'Illustrating' enables the learner to provide explain and make something clear - and more specific – by using examples usually drawn from practice.	"[Verbal style of data gathering] affected the decision making after client meetings, for example we initially failed to understand the basic requirements such as addressing the clients USP's on the website".
		✓ Justifying	This development pattern helps the learner to find reasons and justifications to prove that practice or actions were (or not) right and reasonable.	"This was done once at the very beginning of the project, but due to a lack of organisation or possibly laziness, this didn't continue. In hindsight, the secretary was never reminded to complete this task so it was maybe just a case of forgetfulness, so better communication could have prevented this".

Table 6.15 Reflective Development model in Computing

As mentioned previously, it was sometimes difficult to attribute data units to only one pattern. Indeed, the quote below, positioned in the *Theorising* development pattern, is a good example of a possible multiple positioning as it could have been placed under *Drawing conclusion*:

> *'In future the roles need to be spelt out and ground rules set beforehand so that everyone is clear on expectations and courses of action which could be taken in the event that there were deviations.'*

This quote demonstrates that the learner is extracting and generalising learning under the form of a procedure or rules with the aim of using it in other projects. He/she is also justifying the reason for its necessity.

The difficulty of differentiating between data units falling under the pattern *Theorising* and *Drawing conclusions* was noted during the review. In a way, this quote fits the dictionary definition of *Theorise* which is '*The formation of a belief, policy or procedure establishing the basis for action*'. However, it could also be associated with *Drawing conclusions* from experience where *Conclude* is defined as '*To arrive at a judgment or opinion by reasoning*' as the learner's opinion is expressed and there is evidence of reasoning in the script that led him/her to this opinion.

If one compares the meaning of the quote above (categorised under *Theorising*) and the meaning of the two quotes below (categorised under *Drawing conclusion*), there is evidence that learners' opinions (*judgements*) stem from similar reasoning:

> *This not only allowed us to keep the client involved and interested but helped us to actually collect information from them.*

Or

> *As in every project mistakes were made and time was wasted, now looking back at the project these mistakes have been identified and more training and teamwork events will be used to pull [our team] closer together in the future and stop the same mistakes being made, hopefully saving the client and [the team] money.*

This example shows that, while every effort was made to appropriately allocate development patterns to the reflection data unit, there is still an element of subjectivity to take into consideration. It is possible that attributing the data units to the appropriate development patterns, although important, might not be essential, as long as they belong to the appropriate concept.

In the same way that software engineering patterns are constituted of four main elements i.e. name, occurring problem, solution and consequence, which can be used to solve common problems (Gamma *et al,* 1995), the reflective development model is also constituted of four elements i.e. a concept name, associated development patterns, their definitions and illustrative examples. In the same way that Alexander *et al* (1977) argue while talking about patterns in general 'you can use this solution a million times over, without ever doing it the same way twice.', the development patterns can be used over and over again to support own's reflections in different context.

EVALUATION

To evaluate version 3 of the model it was given to the learners of the Client-focused business solutions module cohort 2015/2016 as their assignment included a reflective piece counting for 40% of the overall module.

At this stage, the learners were not given the flower model, they were provided with the document 'Reflective Development in Computing - Guidelines' (see Appendix M), which is the detailed model presented in Table 6.15 plus a set of guidelines extracted from the data analysis carried out in the previous cycle and findings from the research. These guidelines are listed below:

- *Choose a topic and question for your reflective post (a future activity, something you are working on now, or past activities)* – This was encouraging reflection for, in and on action discussed in section 2.2.
- *Each one of your reflective posts should include several development patterns from the list below (it does not have to include all of them!)* – This was an outcome of the data analysis for iteration 2 of the model.
- *Avoid using the two development patterns 'Describing' and 'Awareness' too much as your reflection will not be in-depth enough –*

This was also revealed during the iteration 2 but also noted by Chalk and Hardbattle (2007) as well as in Chapters 4 and 5.

- *Best reflective posts are made of intertwined development patterns (instead of big chunks of text relating to the same development patterns)* – This was observed during iteration 2 of the model.

- *'A' grades reflective posts must include the development pattern 'Evidencing' with references to the literature* – This refers to the highest level of reflection i.e. critical reflection (Smith 2011), where it is expected that the learner engages in the wider context and closely examines key issues relating to the Computing discipline and reasons for adoption etc. Referencing the literature was pointed out as key in Chapter 4.

All learners were offered the opportunity to comment on their impression of the reflective development model and how they had used it to produce their reflections. The intention was to keep the comments as open as possible to capture every thought and opinion. Indeed, a survey can, at times, be restrictive as it is based on the researcher's perceptions of what is important to find out, it was deemed inappropriate at this stage.

The first comment to consider came from a learner who decided to compare the grades he achieved in his reflective work in the previous year (created without using the model) to the grades he was awarded in his final year (using the reflective development model). He explained:

> *'I used [the model] extensively throughout all modules and was waiting to receive my grades in order to compare them to last year. I found your guide really useful in all modules, mainly refreshing myself with the correct terminology to use whilst writing my reflection and reports.*
>
> *I have compared my points scored with the previous year's [reflective work] and you can easily see a marked improvement this year. I would recommend that all future students are encouraged to adopt this [model] as I am sure they would find it very useful.*

It is interesting to note that this learner did not only use the reflective development model for the formulation of reflective pieces but also for more

standard report writing. He realised that the model helped him improve his marks by a full grade between the 2nd and 3rd year.

Another learner commented on the different aspects of the model that he found useful:

> 'There were several parts of the model that I found useful. 1 - The way it is laid out in a table made it very easy and clear to understand. 2- Having an example for each pattern allowed me to compare it to my own work. 3 - The description of each concept allowed me to understand what the model was referring to from the project. 3 - The clear instructions at the beginning on how to use the model.'

According to this learner, the table layout used to present the model was clear and he seemed to appreciate the additional definitions that learners in iteration 2 were missing. Although a different learner argued that:

> 'I think that's a really valuable resource, however it is quite "heavy" on text. I've heard the same from other people too, so I'm not sure if there is a way for you to refine it/include images.'

Another comment suggested:

> 'the only feedback that I have for the reflective writing document is that if the definition of concept content were bullet-pointed, this would have improved it and helped more because it would have given me a fast introduction and understanding of what is required of me to do.'

The model seems to have reached a point where it is well defined and can be used by learners but its presentation could be improved. This learner continues by saying:

> 'To be honest I have written the majority of the reflection using [the model], however I've also used other resources as guidance [attached Gibbs' reflective model diagram]. I personally prefer looking at a simple, straightforward image with a few different examples, so it might just be me. Apart from that I'd say it was very useful. I really like how you've provided examples, it helped to generate some ideas around my topics.

This quote shows that the visual representation of the model could be used as the basis to represent reflective development, but more thoughts are required to display the other elements of the model.

It was interesting to receive the last comment which evidences what Johns (2009) warns about in Chapter 2 and which is supported by the author i.e. learners should not only rely on a model of reflection to understand what reflection is; models should be considered as guides and by no mean be restrictive. This learner explains:

> *'I did use [the model] to begin with but I found it to be too restrictive for a reflective piece. Maybe I didn't fully understand it but I found it did hinder me when I was writing because I was more concerned about getting the aspects of the model into what I was writing. Personally, when I reflect I like it to have a bit more of my personality in it and I let my experiences come out naturally. The model made it feel like I had to write as if I was writing a report and what I was writing just didn't flow for me. I think I didn't use it as much or as well as I should have and this probably shows in the reflections you've read.'*

This quote, which also echoed one in the evaluation of the previous cycle, demonstrates that, if followed too closely, a model might appear constraining, of course, this was not the objective but it could be seen as such by learners. The reflective development model is an attempt to define cognitive processes visible in reflections to help novices understand what constitutes a good piece of reflection; its role is not to be prescriptive.

REFLECTIONS ABOUT MODEL VERSION 3

In conclusion, although version 3 of the model is usable and helpful, the way it is presented to learners could be improved to avoid misconceptions. Indeed, a very clear message needs to be sent to learners with regards to its usage i.e. the aim of the reflective development model is to be helpful and should be seen as a form of guidance and not as a constraining tool. Reflective development should be established throughout the project based on what is happening, the decision to take, etc. it is not something that can be precisely planned. It is also important to realise that any model of reflection would be entirely redundant if

the learner was used to practising in-depth reflective exercises. In this case, such a learner would not need guidance and can let his thoughts flow to the highest level of critical reflection.

The four aims set for this cycle have been met. Indeed, the model is now presented as concept groups and includes a definition for each development pattern. The visual representation has been amended according to the modifications undertaken and learners feedback has informed ways to display the model as well as providing caveats on its presentation to the learners.

6.6. CONCLUSIONS

The reflective development model version 3 developed through the action research cycles makes an attempt to define reflective development in Computing. Its formulation is sourced in data produced and evaluated by learners in the Computing discipline. According to the feedback received, the model not only offers a definition of reflective development, which was its original purpose, but also, and maybe even more importantly, has potential as a classroom tool to teach and support learners' reflective development. This accomplishes the fifth aim of this research project which was to 'Design and evaluate a novel model of reflection targeted to aid inexperienced computing learners to formulate written reflections.'

The reflective development framework presented in Chapter 5, put forwards the essential variables to take into consideration for the development of good reflections e.g. *breadth of reflection, depth of reflection* and *questioning*.

Questioning, whether it is explicit or not, is paramount to the formulation of reflection (as identified in Chapter 5), it also appears as a development pattern in the reflective development model under the concept *Differentiation,* alongside *Discerning* and Observing. These patterns are closely linked to the identification of the breadth of reflection where the learner is expected to tease out what is important to reflect on by questioning, discerning and observing.

The other concepts, and therefore attached patterns, refer to the depth of reflection. They create learning paths which learners choose to initiate in order to deepen their learning. These patterns are flexible and associated constituents, meaning that they can be linked to each other in a very flexible way only chosen by the learners.

The data analysis of this chapter has suggested that reflections that demonstrated a deep approach to learning (recognised as A grades by the teacher) included a superior number of development patterns than reflections associated with a surface approach to learning (low grades). Therefore, in the same way that the literature mentions surface vs. deep approach to learning, it is now possible to identify surface vs. deep approach to reflection. Moreover, there is an associated matrix to recognise it. Indeed, the number of development patterns used within the reflection could provide an indication of the approach to learning. A deep approach to reflection would, therefore, be expected to lead to a deep approach to learning.

Next, the concluding chapter summarises the work achieved during this research project and elaborates on possible future work.

CHAPTER 7.   SUMMARY AND CONCLUSION

The final chapter of this thesis offers a summary of the work which has been carried out explaining the reasons for its undertaking as well as elaborating on its outcomes. It continues with a review of the main contributions made to the body of knowledge and determines the direction of future work in the Computing discipline. The chapter concludes with the author's personal reflections on the overall research project.

7.1. SUMMARY

This research project was initiated by the realisation that learners in the Computing discipline struggle to write in-depth reflections although the demonstration of critical reflective skills is essential for Computing graduates (QAA Computing benchmark statement, 2016; ACM and IEEE, 2014). An additional motivation was the realisation that reflection is a poorly defined concept in Computing, although an essential ingredient to learning, and therefore difficult to comprehend and support. This led to the formulation of the following research question:

How can reflection be defined and supported in Computing?

The research undertaken investigated different aspects of reflection to answer this question and satisfy four different aims. A summary of the research is proposed below based on these aims.

Aim 1: Investigate existing definitions and practices with regards to the use of reflection in higher education in general.

A review of the literature was carried out in Chapter 2 which demonstrated that although there are very interesting case studies related to how reflection is used with learners in the Computing discipline, this area would benefit from further investigation. This examination also emphasised the complexity of reflection as

a concept even though it was apparent that disciplines such as Social Sciences and Health had more mature practices than in the Sciences.

Several gaps in knowledge were identified from the literature review.

First, the term *reflection* in general is confusing (Moon, 1999) and poorly understood by both learners and teachers. This is exacerbated by the confusion around the definition of other terms such as critical thinking and critical reflection associated with the concept, therefore, there is a need for a term that can be used in Computing to represent the notion of reflection.

Secondly, the uncertainty with regards to the term reflection, as highlighted above, has led to the issue of support and facilitation of reflective skills development. Although Computing learners need to demonstrate these skills, teachers struggle to support them on their journey to becoming reflective practitioners (Fielden, 2005; Bold and Chambers, 2009; Thorpe, 2000; Ryan, 2010). This emphasises the necessity for an investigation in order to clarify the key variables to take into consideration when supporting the development of reflective skills.

Thirdly, procedural and sequential models examined during the literature review, although helpful to start with, can quickly become constraining as they do not offer a true representation of the organic nature of reflective processes, themselves not neat and logical. Therefore, there is a requirement to define reflection in terms of cognitive processes which consequently would provide a closer to reality representation of reflective processes useful to clarify the meaning of reflection in Computing.

The identification of these gaps led to the next aim which is to:

Aim 2: Establish views and perceptions of Computing teachers with regards to using reflection with their learners;

The research being clearly situated within the Computing discipline meant that the understanding of how reflection was used in this discipline as well as its issues and requirements were essential. The triggers for this research were practice-based, therefore requiring a practical formative problem-solving approach leading to the formation of theories which in turn could be used by

others i.e. teachers and learners, for their own enhancement. Consequently, it was deemed appropriate to use action research (AR) within a critical education research paradigm to implement the project's aims.

Semi structured interviews were used as part of the first AR cycle (Planning, Action and Observations) as a way to carry out an in-depth investigation of what constituted the key variables of reflection. This investigation provided very useful insights into the domain of reflection in the Computing discipline at Teesside university and highlighted both the lack of consistency in teachers' understanding of what reflection means and the difficulties associated with its facilitation and assessment (a trend also recognised in the literature review). The data analysis drew together 11 themes and subthemes, each associated with a set of analytical observations, which were considered important to take into consideration for the development of reflective skills. These themes were used to meet the following aim:

Aim 3: Construct a framework of reflection that demonstrates all key variables encompassed in the development of reflective skills.

Chapter 5 was pivotal in using the data analysed in Chapter 4 and formulating the framework but also in suggesting a new name for the concept of reflection in Computing. Indeed, it was acknowledged in Chapters 2 and 4 that the use of the word *reflection,* to describe reflective exercises that computing learners are involved in, did not correctly represent the development of reflective skills. Therefore, the thesis posits that reflection in Computing could be called *Reflective development.* This name aims to capture the essence of the findings in Chapter 4.

The work undertaken in Chapter 5 constituted the last part of the AR cycle 1 (Reflection stage). It contextualises the analytical observations identified previously in Chapter 4 (Appendix I) and links them to underpinning literature and illustrative examples. The formulation of the framework highlighted the issue that although depth of reflection was possibly a determinant factor of learning quality, learners, and some teachers, were struggling with the theorisation of the concept. It was therefore decided in Chapter 6 to examine closely the constitution of reflective development in pursuance of the

elaboration of a model which would define the concept of reflective development in Computing. This was encompassed in the following aim:

Aim 4: Design and evaluate a novel model of reflection targeted to aid inexperienced computing learners to formulate written reflections.

The three versions of the reflective development model evolved through three AR cycles and are grounded in learners' written reflections. Indeed, a significant amount of reflective text was analysed and categorised into development patterns for instance, describing, comparing, evidencing. The definitions of the development patterns supported their association to nine reflective development concepts: Acceptance, Differentiation, Action, Comprehension, Generalisation, Projection, Opinion, Sensing and finally Proving, constituting the new reflective development model called the 'Learning flower' (Figure 7.1).
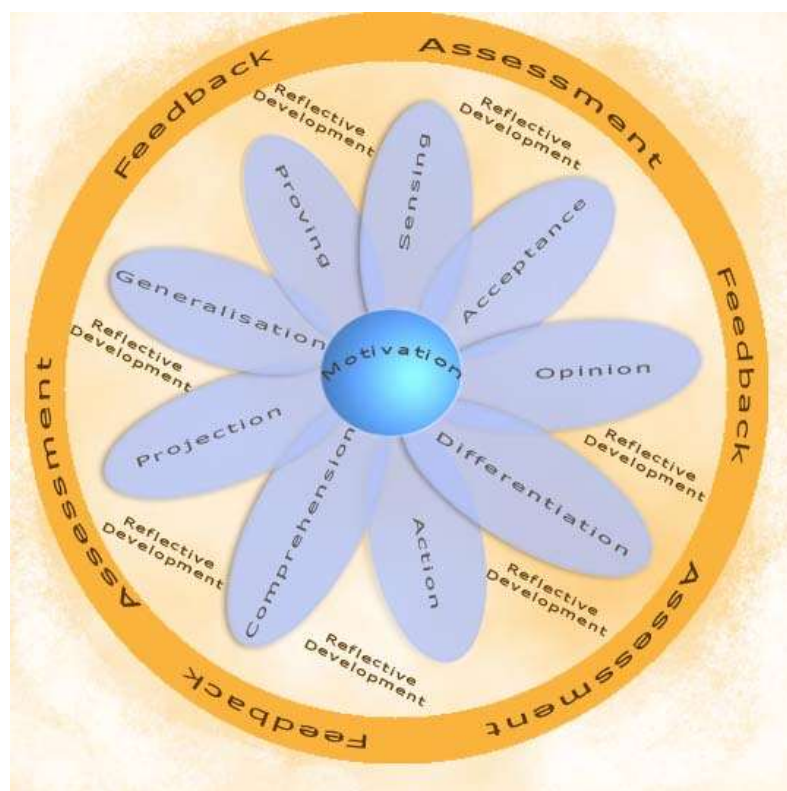

Figure 7.1 Model of Reflective Development – The Learning Flower.

The model was evaluated by learners and, consequently, its representation was refined. The feedback collected highlighted the potential that this model has in supporting learners through their reflective development. The data analysis enabled the formulation of the following attributes of good reflections in Computing:

- More development patterns are used throughout the reflection;

- Development patterns are intertwined;

- There is a strong emphasis on the *proving* concept;

- The *Action* concept is used extensively especially the *problem-solving* development pattern;

- The *Acceptance* concept is used less than in poorer reflection pieces.

7.2. CONTRIBUTION TO KNOWLEDGE

First and foremost, the work carried out in this project is the first in-depth study which aims to delineate the concept of reflection in the Computing discipline. It relied on both the participation of teachers in the discipline to elicit key variables required for supporting the development of reflective skills as well as the written reflection and evaluation from learners in Computing to formulate a definition of reflection. This thesis is a contribution to the body of work associated with Education in the Computing discipline.

Creation of the new *reflective development* concept

This thesis introduces the new concept of *reflective development* in Computing. The words *reflective* and *development* used together leave no doubt to the necessity of developing reflective skills over a length of time. Furthermore, *development* also implies that an appropriate amount of support is required to facilitate the process. In the case of Higher Education, this makes the teacher a central enabler for the development of reflective skills.

As earlier asserted in this thesis, reflective development translates the belief that effective learning is first and foremost a process of reflection. It entails one's own transformation and growth, a profound and inner meaningful change which is beneficial, not only to the learners themselves, but also to society. The reflective development process should not stop when university studies are complete; therefore, if learners in Computing get into the habit of learning and developing in a reflective way, one hopes that reflective development will be ingrained into the person and foster life-long learning.

Creation of the new reflective development framework.

This thesis supplements existing literature on reflection by considering the predominant aspects of reflection's support in Computing in order to propose a new reflective development framework. It extracts sets of essential explicit variables which, on the one hand, illustrate the complexity of reflection but, on the other, proposes a concise and organised list of constituents. Indeed, reflective development necessitates that support is orchestrated so that learners can be nurtured. The framework offers a comprehensive view of what teachers should endeavour to focus on when they aim to facilitate the development of learners' reflective skills.

This thesis posits that there is a need to integrate reflective development into curriculum development throughout the years of study and within modules (Progression and Continuity theme). It indicates that the link between reflective development and learning is so strong (Ixer, 1999; Moon, 2006; Jacoby, 2011) that this fundamental aspect of the curriculum cannot be ignored.

Development of a new reflective development model

While previous research projects in fields such as Education and Social Sciences have endeavoured to understand reflection as a process and succeeded in offering process models, there have been far fewer attempts to define reflection in terms of cognitive processes, especially in the Computing discipline, making the work presented in this study original.

The new reflective development model presented in this thesis offers a close-up representation of what reflection in Computing is constituted of. It was not formulated to present reflection as a step-by-step process, which is too often the case; instead, it provides a detailed picture of the development patterns and high-level concepts which constitute reflective development. It is an innovative way of illustrating to learners what to consider in order to adopt a deep approach to reflection. The model is a response to Ixer's (1999, p521) plea which argues that '*if reflection is to be regarded as a core facet of individual professional competence, then we need to know far more about its structure, substance and nature before we can safely assess it.*' Indeed, there is now scope and

usefulness in assessing the degree to which each concept from the model has been achieved in learners' reflections.

The strength of the reflective development model lies in the emphasis on an epistemological representation of reflective development rather than a hierarchical or chronological arrangement. The creation of the model led to the promotion of a paradigm shift in the comprehension of how learning and reflection are linked, to encompass all nine concepts making up the model described in Chapter 6. Each concept should be considered in its own right, as a key element of what makes learning *effective*.

<div style="border:1px solid #000; padding:8px;">7.3. LIMITATIONS, BIASES, ETHICS AND FUTURE WORK</div>

This thesis has established a firm foundation for further research on reflective development in Computing. At this stage, the research findings can not be generalised as they only apply to one set of modules from the School of Computing at Teesside University. The fact that a small sample of teachers participated in the interviews, that written reflections were selected from modules taught by the researcher and that data was analysed by one researcher only, are accepted limitations of the study. In the same way, the cross fertilisation of ideas between teachers interviewed and positionality and experience of the researcher toward reflection were also agreed boundaries of the research.

Although a voluntary sample bias was introduced to collect pertinent views of teachers with regards to the usage of reflection, Robson's (2002) sceptical dimension was taken into consideration to avoid data interpretation predispositions. This also justified the involvement of participants to provide fuller and more accurate pictures of the topics under investigation. As the research was reliant on participants' contribution to collect data and formulate evaluations, a consent approach to participation was adopted. A conscious effort was made throughout the interpretation stages to stay close to the data collected, for instance using dictionary definitions to ascertain meaning of text

in Chapter 6, in order to avoid distortion of meaning which would result in impacting research outcomes.

As a consequence of the limitations discussed above, such as small case study sample, it is suggested that future work is required to refine or test the reflective development framework and model as follows:

> For the framework: it is suggested to develop a 'Guide to reflective development in the Computing discipline' to help teachers better understand how they can support their learners in the development of reflective skills. The guide should be evaluated for its usefulness and gaps by Computing teachers in UK universities to ascertain or otherwise the relevance of the variables of the framework.

> For the model: it is proposed to collect learners' written reflections from modules not taught by the researcher to confirm or otherwise the concepts and development patterns of the model. Ideally, these new sets of data would be issued from the School of Computing at Teesside University but also Computing departments from other institutions. It would be beneficial to involve different researchers to undertake the data interpretation using the same theoretical framework than in this study to increase the model reliability. It is anticipated that once the model has been further tested as explained here, assessment criteria guidelines could be issued to support teachers as they recognised that the assessment of learners' reflections is a daunting task. It is expected that the relevant body of knowledge relating to the evaluation of critical thinking skills, Kennison's (2006) critical thinking scale (CTS), will inform this work.

As practically is at the fore front of this research, I intend to apply for research funding to support the development of an online platform which would support both teachers and learners in the development of reflective skills in Computing. A proof of concept has been explored based on this study's outcomes, therefore, it would be valuable to further develop the ideas in light of the tested framework and model as mentioned in this section.

There are a number of relevant journals where the outcomes of this research could be published. These include: Journals of, the 'Journal of Systems and Software' which takes into consideration 'Human factors and management concerns of software development' by Elsevier seems very appropriate as well as a possible paper presentation at the yearly Higher Education Academy STEM conference (Higher Education Academy, no date) which includes a Computing strand.

7.4. RESEARCHER'S PERSONAL REFLECTIONS

Banner and Cannon (1997; ix) once said: *'…for those who pursue it seriously, teaching is a calling, a summons from within; that it is among life's noblest and most responsible activities.'*

Since I started teaching, I have always believed, albeit intuitively, that reflection is a powerful and unique way to formulate deep understanding, as it requires taking the time to analyse what has happened, what is currently happening and what is to come, with the aim to improve oneself. I now have the daunting task of supporting students in the essential development of their reflective skills. The realisation of my own shortcomings in this area made this task, initially, a difficult challenge. I truly agonised with trying to make sense of what reflection really is and what constitutes *good* reflection in order to define it, first for myself, and ultimately to explain it to my students.

I now realise that the struggle I had at the time was an extremely positive trigger, as it initiated this research project.

I see the writing up of this thesis as a tremendous reflective exercise on its own. Putting the ideas and words down was so much more powerful than just thinking about them. The act of writing made it richer, more innovative and very rewarding. It convinced me, even more, that learners' reflections needed to be made explicit, not only for assessment purpose but more importantly for their own learning. Based on my experience of reflection, tacit reflection, albeit useful, does not offer the same deep outcome. There is something unique happening during the transfer process from tacit reflection to linked words

forming a narrative and therefore becoming explicit reflection. This opinion is also shared by other academics such as Bolton (2005) and Yancey (1998). It is at this stage that effective learning truly happens, it is what Papert (1991, p1) calls *constructionism*, when a learner (me in the case of this research project) is '*consciously engaged in constructing a public entity*'. So, until I, or someone else proves me wrong, reflection will be a learning tool of choice. I want my students to experience the same excitement that I get when ideas and learning slowly emerge from my mind while I write down my thoughts. These eureka moments, would certainly not be happening if I had not stopped and put down my thoughts explicitly. Moreover, these explicit reflections are now shareable, they can be read by others, discussed, questioned, calling for more learning to take place.

Throughout this research project I endeavoured to keep a practitioner's journal and skimming through it now makes fascinating reading. It is obvious that the poor foci of my research towards the beginning of the project, led to time being used in an inefficient way, difficult affordance when doing a PhD part-time alongside a full-time job and family. Having said that, what can be seen as *wasteful time* might actually be a normal requirement and even maybe an essential step to determine what was really essential to the research. If doing a PhD is considered as a substantial reflective exercise, which I believe it is, then it is evident that the breadth of reflection, referred to in the reflective development framework (Chapter 5), is, this time, not set by a teacher, nor are the research questions. I have realised that I needed to demonstrate I could define appropriate boundaries of the research (reflection breadth) but also that I was able to investigate the topic in great depth by asking the right questions; in a word, demonstrate *reflective development* efficiency. In fact, the PhD exercise could be viewed as the ultimate critical reflection work that one can achieve over a long period of time (Progression and Continuity theme 4 in Chapter 4) with the assistance of the community of practice, supervisors and research participants (Support requirements theme 6 in Chapter 4).

Genuine reflection can be uncomfortable at times, as it reveals gaps in knowledge and understanding which are sometimes difficult to admit and often confrontational in ideas or assumptions. This has been the case in this research

project in particular in identifying research paradigms and methodologies. Due to my past education and scientific field of work, positivism tended to be second nature in the way I understood the world. I quickly came to the realisation that such a paradigm was not appropriate for this preliminary investigation of reflection and I had to open my mind, and consequently sit outside my comfort zone, to possible new ways of understanding the topic.

Overall, this research project has been an eye-opener, as I now see my teaching role moving away from being an expert in my field, to something much more challenging. Although conveying my passion for my subject is still essential, I am not assessing students' knowledge or their project processes, I am facilitating their learning processes. I am helping them to identify what development patterns and broad concepts can be used to improve their learning, I am helping them with asking the relevant questions, I am encouraging them to analyse their learning processes from a different angle; in a nutshell, developing their discipline-free learning skills. It is a scary endeavour. What if I have it all wrong? Dewey (1910) argued that reflection required two key ingredients: uncertainty and enquiry. This thesis certainly triggered a myriad of enquiries but also uncertainties and although clarifying the essence of reflection answered some of my questions, I still have countless more that I would like to investigate. As a teacher/researcher, I feel this is my responsibility to keep investigating this field and reducing uncertainties to deliver a robust reflective development platform to my students and help them become reflective practitioners.

This research project made me extremely humble in the realisation that I knew so little and there was still so much more to discover. I am now eager to find out more, to work with other researchers interested in the subject, and to contribute to the development of a *reflective development* community in the Computing discipline.

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