The development of a new systematic method based on Activity Systems that analyses the activity of learning programming

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Abstract

The activity of learning programming languages is a difficult and complex process. During this complicated procedure, many problems and difficulties might occur. A straightforward and clear approach, which can help to break down the numerous interacting processes into a series of simpler components, would appear useful. Therefore, the main aim of this research is to design and develop an appropriate method that can meet these criteria. The new method offers a new systematic approach for collecting, modelling and analysing data to discover difficulties within the activity of learning programming.

Thus, to achieve these aims, the research work commenced with an investigation into the existing variety of frameworks and methodologies, which have been used in Information Technology (IT). The initial research showed that there are many suitable approaches that have been previously used in the IT field. However, most of these do not offer any clear pathway for collecting and analysing the data from beginning to end of the research process. To address these issues, Activity Theory (AT) has been chosen to be used as an initial framework for the study. AT has been selected due to the nature of the topic being examined. There are several communities involved in the process of learning programming, including students, lecturers, technicians and teaching assistants. AT allows for a holistic consideration of the multiple perspectives involved. In addition, the solid ontology of AT assists with the breakdown of complicated environments into simpler units. However, AT does not specify any particular research methodology that should be used. As a result, an appropriate approach has to be identified and coupled with AT in order to create a new systematic method. The following research methodologies are considered: Action Research (AR), Grounded Theory (GT) and Phenomenography (Ph). It is concluded that GT offers the best approach to complement the use of AT in the context of examining the activity of learning programming languages.

Consequently, an initial method has been created by combining AT and GT, which has been used to collect and analyse test cases to investigate whether this combination is effective. After using this initial procedure, changes and improvements were made to create a revised method which has been used to collect and analyse a larger set of data. The results of this research, using three type of case studies of responses from the individual students, focus groups including staff, and observation of the activities in workshop sessions, demonstrated the benefits of the method developed. It was found out that this systematic approach facilitated the process of collecting and analysing the data. In turn, this enabled the discovery of contradictions within the activity of learning programming and the proposed of shifts to solve them. Although this method was tested on first-year students at Kingston University, it is potentially generic, allowing it to be considered for use in other similar domains.

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Completing a PhD is truly a marathon event, and I would not have been able to complete this journey without the aid and support of countless people over the past four years.

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List of Glossary

Action Research

Action Research (AR) is an introspection forward-looking research method that constantly looks to solve a problem. AR was founded by Kurt Lewin a German-American psychologist in 1944.

- **Activity Systems**

  Activity Systems (ASs) are Series of triangles that illustrates the relationships between different elements of AT's ontology. ASs help to show a whole picture of the event is a snap shot.
- **Activity Theory**

  Activity Theory (AT) is a psychological framework used to understand human activities, which was first born within Soviet Psychology. Vygotsky founded AT in the early 1920s and 1930s in Russia. Engestrom Introduced Activity System to the framework on 1980s.
- **Community**
- A Community is a group of individuals and teams that work together to achieve the goal/objective (outcome) of the activity and they share the same Object
- **Division of Labour**

  Division of Labour shows the distribution of the actions and work among the community, which includes the transformation of the Object to a desired Outcome
- **Grounded Theory**

  Grounded Theory (GT) is an inductive qualitative research method, which uses a systematic approach that constantly compares collected data and analysis. It was first introduced by Glaser and Strauss in social science on 1960 by publishing a book called "The discovery of the Grounded Theory".
- **Information Technology**

  Information Technology (IT) is a branch of engineering dealing with the use of computers and telecommunications equipment to store, retrieve, transmit and manipulate data. It deals with the study, design, development, application, implementation, support or management of computer-based information systems.
- **Object**

  The Object stimulates the activity that could be the purpose of the task or the activity. Different activities are distinguished from each other with different Objects.
- **Objective/Outcome**

  An Outcome is the desired goal of the activity, which motivates taking actions towards achieving a goal.

- **Ontology**
  Ontology is the philosophical study of the nature of being, existence, or reality, as well as the basic categories of being and their relations. Traditionally listed as a part of the major branch of philosophy known as metaphysics, ontology deals with questions concerning what entities exist or can be said to exist, and how such entities can be grouped, related within a hierarchy, and subdivided according to similarities and differences.
- **Phenomenography**
  Phenomenography (Ph) is a qualitative research method that focuses on peoples' experiences and how they experience, understand and discern the same phenomenon in different ways. Ference Marton a Swedish educational psychologist developed Ph in the 1970s.
- **Programming Languages**
  Programming Language (PLs) are artificial languages designed to communicate instructions to a machine, particularly a computer. Programming languages can be used to create programs that control the behaviour of a machine and/or to express algorithms precisely.
- **Rules**
  Rules are sets of conditions that help to determine how and why individuals act, and consider social relations inside a Community by mediating the relationship between the Community and the Subject
- **Subject**
  The Subject is a person or a group of individuals (participants) involved in the activity.
- **Tools**
  Tools are the artefacts that can be used in the process of an activity, which have an influence over the interactions between the Subject and the Object. Tools can be abstract/subjective (not tangible such as logic, thought) and objective (material objects such as computers, books, lecture notes).

Abbreviation

AR	Action Research
ASs	Activity Systems
AT	Activity Theory
CL	Change Laboratory
DC	Distributed Cognition
DoL	Division of Labour
GT	Grounded Theory
HCI	Human Computer Interactions
HE	Higher Education
ICT	Information and Communication Technology
IDEs	Integrated Development Environments
IS	Information Systems
IT	Information Technology
KU	Kingston University
LPLs	Learning Programming Languages
Ph	Phenomenography
PLs	Programming Languages
VE	Virtual Environments
VS	Visual Studio
ZPD	Zone of Proximal Development

Chapter 1 – Introduction

This chapter provides a context for this research and covers basic information upon which this study has been based. Therefore, the first section introduces an overview of the study, such as what methodologies have been chosen and what areas will be discussed. The second section identifies the aims and objectives of the research. The third and fourth sections explain the choice of the framework. The fifth section reviews the boundaries of the study followed by an overview of the background work and research that has been undertaken to review the changes that were made during the first year of the study to improve the quality of the research. Finally outlines of each chapter are offered in the last section of this chapter.

1.1. Overview of the Thesis

Learning programming languages (LPLs) effectively and training relevant new skills to the novice programmer are vital issues in Higher Education. Consequently, workshops of LPLs are a complex environment, which pose challenges on identifying, understanding and solving the problems in this environment. Complexities of a LPLs workshop comprise of: Interactions between different parts of the community (students, lecturers, helpers and technicians), understanding the technologies available, selecting which technologies to use, logging on to the computer systems and networks, finding and accessing the right resources, the structure of the instructions and assignments, etc. These are the complexities that every student is facing when entering a LPLs workshop before even starting to learn programming and developing any code. When students start to write a programme then

they have to understand the concepts, syntaxes, variables, objects, classes, functions, etc. To break down these complicated layers, in a LPLs workshop, one needs a robust framework with specific ontology that can make the description and explanation of these events easier. This thesis uses Activity Theory (AT) as a framework to consider how students learn programming languages in the first year in the School of Computing and Information Systems in Kingston University (KU).

This research identifies ways to expedite learning more effectively. Conceptually this study requires an understanding of what learning is, what programming is and what research methodologies provide. These three strands are studied in parallel. AT has been selected due to the nature of the subject being examined. There are multiple communities involved in looking for the same outcome, passing an assessment.

AT allows for a holistic consideration of the multiple perspectives involved. However, AT does not specify any particular research methodology to be used. Therefore, an appropriate approach has to be identified. Having reviewed related work in this area (Nardi, 1996; Alsop and Tompsett, 2001; Allan, 2003; Dick, 2003; Silverman, 2004; Warburton, 2006 and Seamen, 2008), the following research methodologies are considered: Action Research (AR), Grounded Theory (GT) and Phenomenography (Ph). It is concluded that GT offers the best approach to complement AT. An evaluation of how AT and GT can work together has also been undertaken and a new method has been designed to improve both the clarity of the process of collecting data and its analysis. Data has been collected from Students and

Staff via focus groups and open-ended questionnaires, observations have also been undertaken during 3 years from 30 programming workshops, and the researcher's experiences have been assimilated by using the new designed method.

The next section indicates the aims and objectives of this research in more detail.

1.2. Aims and Objectives

The principle aim of this thesis is to create a new method to use and find out what are the problems and difficulties in learning programming for novice programmers and how these can be solved. This will be complemented by a series of further aims:

2nd aim: compare the existing methods available and choose the most suitable.

3rd aim: Test the designed method on initial data

4th aim: Use the designed method on all of the data to show the value of the new method in identifying and solving problems

In order to achieve these aims; the following research objectives have been identified:

- Choosing Activity Theory as the main framework and comparing it to other qualitative methodologies such as Ethnography to examine the framework's strengths and weaknesses

- To review potential methods that can complement the AT framework to create a new method
- To investigate how to collect data from the students and the staff involved in the process of learning and teaching programming to illuminate problems, difficulties and issues.
- To provide a detailed description of the learning programming process that will assist to understand the collected data.
- Deign a method to be used on the collected data which will makes the process of collecting, analysing and using data more transparent and clear.

In addition, the designed method has been used to analyse and collect data to understand the issues, and use the knowledge gained, to suggest potential solutions. These have been achieved by:

- An investigation of negative experiences to find and describe the problems in the process of learning programming
- An investigation of positive experiences to find and explain potential solutions

1.3. The choice of framework

As Alsop and Tompsett (2002) suggest, the methods that researchers use to collect data seems unimportant to students and stakeholders, such as lecturers; however, to achieve accurate and reliable data, the choice of methodology is critical.

Activity Theory has been chosen as the main framework for this research, while Ethnography has been used to show the strengths and the weaknesses of AT. Both of these methodologies are qualitative cultural – social research methods, which study human activities in everyday life, work, educational environments, specific events to understand what is happening and why it is happening.

Ethnography is a cultural- social qualitative research method that studies a group of individuals selected from a society that represents a specific objective event or an issue and describes these in a rich context. An Ethnographer tells the story of the community from their perspective by observing and interviewing individuals from that community. The community's culture, behaviours and customs are vital in the process of an Ethnographic study. (O'reilly, 2009; Fetterman, 2010)

Activity Theory (AT) is a qualitative theoretical framework that studies human activities as a complex social- cultural phenomenon to understand relationships between the Subject, Object and the Tools used in a goal-directed activity. AT also goes deeper and studies Rules, Communities and the Division of labour in the activity. The unit of analysis in AT is an activity instead of specific actions; therefore, AT studies the whole picture of an activity to understand it instead of focusing on separate actions which might not present the whole purpose of the activity.

Activity Theory has the possibility to study the history of the activities by looking at their past, present and possible future, which makes it a stronger candidate for this research, which is looking to study the activity of learning

programming. The following paragraphs will compare Activity Theory and Ethnography, and it will be indicated why Activity Theory has been chosen as the framework of this research.

O'reilly (2009) argues that Ethnography is an "iterative – inductive" research method. However, Fetterman (2010) indicates that an Ethnographic study starts with a theory, model or series of preconceptions about an idea or a problem. Therefore, the O'reilly's argument suggesting that it is an inductive method does not fit completely. It could be said that Ethnography is a combination of inductive and deductive reasoning, which could be both open-minded and have preconceptions about the object that have been studied.

Fetterman (2010) clarifies that a professional ethnographer has to maintain their distance from their participants despite being involved deeply in their community and even living in the same environment. However, maintaining the distance and keeping the objective view of the event is highly difficult when interacting with other members of the community closely (O'reilly, 2009). In addition living in a community to observe their activities requires time and resources, which might not be an ideal choice for all kinds of research. AT does not require living in a community to study their activities. The subjects can be observed in their place of work or study without the researcher being too involved in their life.

According to O'reilly (2009) to have a successful Ethnographic study, an ethnographer needs a high level of experience and knowledge to deal with the spiral and iterative-inductive process of Ethnography analysis. A spiral and iterative analysis means that the process of collecting and analysing data

might be repeated several times to reach a solid understanding of a phenomenon. O'reilly called this non- linear process "the messy business of making sense of it all". The lack of a firmly written ontology does not help to make the process of analysis any less difficult. O'reilly (2009) argues there are some parts of the collected data that are not obvious and need exploring. Thinking and theorising without having any specific ontology (vocabulary) to refer to is a daunting and messy process. In addition, the lack of specific vocabulary makes the interpretation of the collected data hard too. However, AT offers a robust ontology that helps novice researchers to focus on specific elements that will assist them to analyse their data.

According to O'reilly (2009) Ethnography attempts to "narrow the scope of the enquiry to the most significant issue". However, the qualitative analysis tries to include every single response to the research whatever small or insignificant the issue is. The aim in qualitative analysis is to include every single response to the theory of the generalisation. Shank (2006) called the process of Ethnography "abductive" instead of "inductive". While, AT does not deduct any information from the collected data, instead it illuminates different elements rising from the collected data by studying all aspects of an activity.

One of the main aims of Ethnography is to discover frameworks or patterns in the data. Reliability of the new emerged pattern in Ethnography needs to be applied, tested and justified each time. In addition, there is no guarantee that an emerged pattern from one set of data is going to work on another set of data because it has not been generalised. However, AT already has a strong

and agreed framework that does not need to be justified, as it has been used over and over again in different fields. Therefore, the lack of a firmed framework in Ethnography makes it difficult for the novice researcher to use it effectively.

The need for fixed questions in Ethnography limits the possibilities of answers. It will suggest some ideas and assumptions in the participant's mind, which should be avoided in any inductive research method. While AT does not suggest any specific questions to be used, instead it will study the activities to understand different layers of actions that are happening during the activity. In addition, the ontology of AT will be used later to find out information and phenomena from the collected data. Despite the fact that AT has a robust framework to describe events, AT does not clarify any systematic approaches for data collection and analysis.

Ethnography is time-consuming. It requires lot of time to develop trust between the participants and the ethnographer, which is not ideal in all research fields. In addition, the researcher needs to "live a life" with the participants to understand their environments, society and culture. (O'reilly, 2009) In addition, O'reilly (2009) suggests that over time an Ethnographic research will be more developed, focused and directed in terms of questions and collecting data, which all requires more time and work for the ethnographer. Moreover, to gain participants trust the ethnographer needs to work and live with them in their own society to achieve a willing group that will truly participate in the research. This time-consuming process also might have an effect on the number of cases which will be studied, and therefore,

make it less suitable for "comparative analysis" and generalisation. This research is studying the ways that learning programming can be enhanced. Therefore, it needs comparative analysis, which is possible in AT, because AT looks at the history of an event and illuminates problems, issues and possible solutions for the matter. Nevertheless, ethnography seems to be a perfect applicant for the research that are focused in a limited number of participants and objects which do not require comparison and generalisation.

Ethnography requires breaking rules and passing social taboos to find out the truth about an activity and realities behind all social boundaries, which make Ethnography distinctive form other research methods (Heyl, 2001). This needs a deep relationship with the participants as well as well-developed trust between the participants and the researcher, which according to Heyl (2001) is needed to explain complex human experiences. She argues that the "up close and personal" nature of ethnography well addresses this need. She indicates that "ethnographic interviewing" which requires trust and deep relationship between the ethnographer and the participants is the key element that distinguishes ethnography from survey, open-ended questions and other methods of collecting data in qualitative research. In this research, it is not possible to develop deep trust between the students and the researcher as the students are moving to a different level each semester, therefore the sample for this research is changeable which makes it difficult to use Ethnography.

Heyl (2001) notifies the ethnographers to be aware of the limitations facing the collected data that the knowledge emerging from the data is only partial and the complete truth might not ever be attained.

Barley (1983) suggests that using Ethnography requires being imaginative with the participants and the collected data. This might introduce the danger of being too imaginative and therefore interpret something that might not necessarily be true and coming directly from the data. However, AT's ontology assists the researcher to stay closely tied to the information that is coming from the collected data without the need to imagine, which is actually one the aims of this research, to avoid the researcher bias as much as possible.

Ethnography is selective in its used of subjects to achieve rich and useful data. Therefore, there is a danger of not selecting the right groups of people who are truly representing the group which will show all of the ideas and opinions of their group. Because of the time limitation it is no possible to interview large groups of individuals to minimise this danger, unless that there is access to unlimited time and resources. AT can cope with both kinds of data, selective and a large sample of responses of an activity.

Emerson et al (2011) argue that Ethnography needs "Systematic Open Coding" to reduce the overwhelming process of open coding. He explains that having systematic written Fieldnotes providing a series of distinct phases helps to have clear and consistent documentation for the analysis of the data. He continues by clarifying that the written systematic coding will guide and instruct clearly the new researchers on how to do the open coding. Nardi

(1996) also refers to this problem by arguing that lack of a specific ontology in Ethnography makes it difficult to describe different levels of human activities. This problem is well dealt by AT, as it has a specific set of terms to be used in the process of open coding.

1.4. Why Activity Theory

AT was selected because of the nature of the subject, learning and teaching programming. There are multiple communities involved in looking for the same outcome: passing an assessment. In the process of the activity of learning programming the communities involved are students, staff (including lecturers and technicians) and the university in the broader sense. AT allows for a holistic consideration of these multiple perspectives. Its ontology requires different research methods depending on the aspect of who are involved in the specific activity being studied.

For instance, to study the process of the activity of learning, data needed to be collected from students to understand their perspective. Certain documents, such as module guides needed to be read to understand the rules of the module, like attendance and assignment submissions rules, also to understand the roles of different members of the community who are involved in the module. Observation needed to be under taken to perceive the relationship between the communities and to investigate how students learn programming and to detect what tools they use to learn. In particular the choice of methodological approach to study the subject's activity is key, as the students use certain tools to learn programming such as an Integrated Development Environments (IDEs), books and lecture notes. The case

studies of students and staff have particular characteristics that need considering. These include:

- The nature of the subjects being examined. Thus different aspects needed to be studied, such as tools that students and staff use in the activity of learning and teaching programming;
- The number of participants involved being relatively small (109 students and 8 staff) Therefore qualitative research methods could help to "provide a rich description of the students' behaviours" during the research (Alsop and Tompsett, 2002);
- The sample changes during the research life-cycle, students change modules each semester; and
- The multiple communities involved in looking for the same outcome, passing an assessment, which are students, the staff and the university.

Nardi (1996) highlights the use of AT in HCI and how this framework focuses on practice, consciousness, mediation, human activity, concern with the development of mind and it studies the relationship between people and tools they use in the process of activity. This research aims to study the process of learning programming for first year students at Kingston University, who are part of the community, use tools and need to develop to be better programmers. Therefore, AT seems to be a perfect candidate for this purpose. According to Nardi a variety of the levels and stages in AT and AS facilitate a strong description tool for HCI research by providing a dynamic

movement among the levels of an activity (Nardi 1996). Dynamic movement between levels means that any simple change in one of the elements of the activity can have a direct impact on other elements. This factor has been described as "knotworking" by Engestrom (This will be described fully in chapter 2). These dynamic movements enable the study of the process of an event in depth to understand why different activities occur.

As discussed above, there are other methods, which describe human activity, such as Ethnography, however, one of the principle reasons to choose AT over ethnography is that ethnography does not have any specific ontology to be employed. It just uses the researcher's personal vocabulary to describe different levels of the human activity and does not offer any consistent deductive framework to the data. While, AT has a strong ontology that represents history and culture in human activity by studying changes and the development in the process of learning.

Despite all of the strengths of AT as a robust framework by having a stable ontology to construct and keep a solid vocabulary throughout the research , AT does not specify any specific methods to be used to collect and analyse data. Therefore, this will be discussed in chapters 2 and 3 along with the reasons and possibilities of combining other methods with AT to create and design a new method that will be used in this research.

1.5. Research scope

This research is conducted to design a new method based on Activity Theory (AT) as its framework and Grounded Theory (GT) as a complementary approach to AT. GT is an inductive qualitative research method which uses

a systematic approach to constantly compare collected data and analysis. Inductive means that there are no hypotheses to start with; therefore, the researcher has to be as open minded as possible and design the research questions carefully that do not suggest any pre-conceptions. GT works closely with data, therefore any possible hypothesis or theory is driven from the data in the later stages of the analysis which called conducting theories[1]. GT also works in harmony with AT which will be explained fully in chapter 3.

This work is not designed to be a review of technologies, Programming Languages or be a review of the current research on learning programming. Neither, it is to evaluate the tools and technologies used in learning programming. The purpose of this research is to design a systematic approach based on combining AT and GT. The reason is that AT is not sufficient in offering a clear approach to collect and analyse data.

In addition, this thesis is concerned with finding an effective way of learning programming from the students and staff's point of view without having any preconceptions about the assumptions that already exist in this domain.

1.5.1. Discarding a literature review and the use of quantitative research methods

Although this research is based on qualitative methodologies, In the beginning, before it was decided what methodologies would be used for this research, two preliminary studies were undertaken, a literature review of

[1] Different researchers call this process differently. For example, Glaser and Strauss 91967) called it discovery of the theory, while Charmaz (2007) and Corbin (2008) call the process theory conduction.

learning programming languages (LPs) and three questionnaires for quantitative data analysis. However, when AT and GT were chosen and it was decided that qualitative research would be more suitable, the need of these studied were discarded.

The reasons not to go any further with the literature review of LPs are as follow:

- Studying previous research in LPs would create background knowledge that could prevent the researcher from being open-minded and preventing focusing on the evidence appearing from the collected data.
- Literature review on LPs would not help the purpose of designing a new method to collect and analyse data more effectively.
- For this specific research, first year students (studying programming in Kingston University at SEC faculty) and their points of view become the focus of the research.
- GT methodology encourages the researchers to focus on the case study without having any preconceptions about the subject.

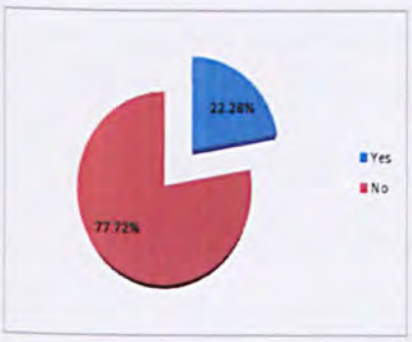
Although, the literature review of LPs was dismissed from the research, a literature review of research methodologies continued, which had a great impact on the new designed method. Nevertheless, the researcher already has some sort of experiences on LPs which could not be ignored, as Dey (1995) argued "open-minded but not empty headed". The researcher had to be conscious of the existing knowledge in the process of this research and aimed not to use any preconceptions.

The reasons for not using quantitative research methods are discussed below by way of illustrating the initial quantitative approaches and results.

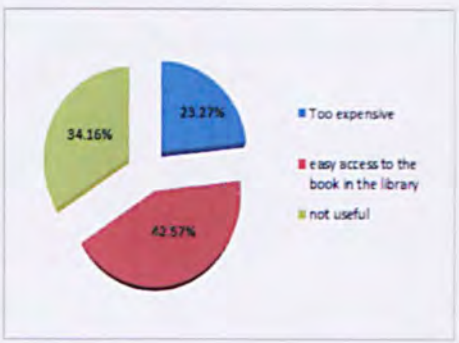
In the first semester of 2008, a questionnaire was designed to understand what students do to learn programming. The questions included what books did they used, what websites did they visited, any other resources that they used to learn programming. They also were asked if they have installed Java compiler and TextPad in their computers and did they have any problems in the process of installing it and using it. Additionally, students were asked to explain how easy or difficult they found the course, as well as their previous experiences in terms of learning programming (please see appendix 3, for the questionnaire). 202 completed answers were collected and analysed. The following figures (1, 2 and 3) show some of the results. This is followed by a discussion that illustrate why a qualitative approach was requited.

Figure 1

1) Have you bought the textbook?		percentage
Yes	45	22.28
No	157	77.72
total	202	



2) If the answer to question 1 is no, what were the reasons?		
Too expensive	47	23.27
easy access to the book in the library	86	42.57
not useful	69	34.16



For example, figure one shows that just around 22 percentages of the participants bought the recommended textbook, and the majority of 77%

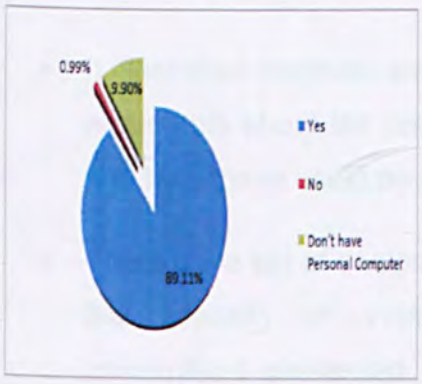
preferred not to buy the textbook. One of the reasons came out to be the high availability of the textbook in the library, not useful and being too expensive came second and third respectively.

Figure two shows that around 90% of the students used other resources to learn programming such as visiting related websites and sources available online, however around 10% reported that they do not have access to a personal computer. Also around 85% of the students installed Java compiler and TextPad to study Java in their personal computers.

Figure 2

3) Did you use any other resources. E.g, other textbooks, websites, etc. How useful and why?		
Yes	180	89.11
No	2	0.99
Don't have Personal Computer	20	9.90

4) Have you installed Java compiler and Textpad on your home computer?		
Yes	172	85.15
No	10	4.95
Don't hav	20	9.90



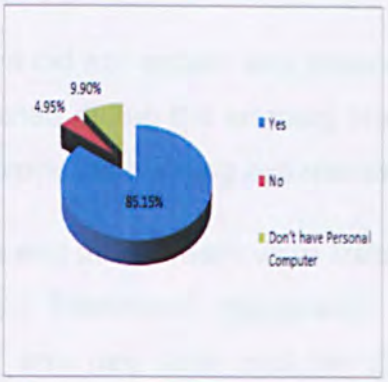


Figure 3

7) How easy did you find the course?		
Very easy		
easy	108	53.47
difficult	94	46.53
very difficult	0	

8) If the answer to the question 7 is easy or very easy, does it relate to any of theses issues?		
Previous knov	53	26.24
work exper	7	3.47
high quality o	34	16.83
High motivati	39	19.31

Although it was easy to collect quantitative data from the students, the analysis and the results showed that quantitative data would not answer all the questions regarding to the problems and difficulties of learning programming from students' perspective. The two fundamental reasons are:

- It illustrated numbers and figures but it did not explain any reasons or arguments about the problems happened during the learning process and how these could be solved to improve the learning experiences.
- There were set of designed questions and the answers were limited to the capacity of those questions. Therefore, hypothesis and conceptions prevented discovery of any new idea and the actual reasons of learning boundaries.

Thus, it was decided that there is a need of more detailed information and direct responses from the students that would explained the problems and difficulties. For the above reasons quantitative data was dismissed from this research and qualitative research methods were replaced.

1.6. Outline of the thesis

This thesis is organised into seven chapters:

Chapter 1 provides an introduction to the report, an overview of the research, as well as the aims and objectives that are vital for this study. This chapter also includes the core research topics, and central research structure. The research is then justified and described in terms of approaches and methodologies used as a framework for the research, the collecting of data and its analysis.

Chapter 2 includes a literature review on to Activity Theory as the framework of the research. In addition, it reviews Vygotsky's theories about education and pedagogy. Additionally, Leont'ev works that continued Vygotsky's theories have been reviewed here too.

Chapter 3 introduces three candidatory complementary methods that potentially could be coupled with Activity Theory to design a method to collect and analysis data. In addition, an explanation of why these selected methods and approaches work together well is offered. Finally, the reasons for the chosen method are discussed in detail.

Chapter 4 presents the case study for the research. In addition, it goes into some components about the data collection, such as what samples have been chosen and who is involved. Furthermore, the way that the data has been gathered and managed is explained.

Chapter 5 offers the process of designing a new method for the research. Moreover, an initial analysis of the two samples from the case study is

offered to test if the created method works well with the collected data. Finally, the method will be completed and finalised to be used in the full data analysis.

Chapter 6 presents the data analysis. This chapter provides in depth details of the process of the analysis and clarifies all the necessary steps undertaken to analyse the collected data from the three different perspectives of the students, the staff and the researcher (through observation notes).

Chapter 7 concludes the thesis by providing a summary of the research's aims and objectives. It reviews principle findings of the study such as how and why the new method has been designed. In addition, a conclusion of the research's finding has been indicated as well as recommendations and possibilities for future work.

Chapter 2 – Activity Theory

2.1. Introduction

This chapter introduces the Activity Theory (AT) framework and the main concepts of AT will be reviewed including its ontology. Vygotsky's theories will also be considered in this chapter to understand the theoretical background and origins of AT. Moreover, a literature review of AT has been undertaken.

2.2. Activity Theory

Activity Theory (AT) is a psychological framework used to understand human activities which was first born within Soviet Psychology. Vygotsky founded AT in the early 1920s and 1930s in Russia. Leont'ev (1903-1979), Lurija and Rubinshtein (1889-1960) continued Vygotsky's work further for educational studies. Thereafter, many researchers have used AT in various subject areas. Hassan et al (1998) used AT in organisational behaviour in Information Systems (IS), Hashim and Jones (2007) reviewed AT as a qualitative framework to analyse data, Kuutti (1995) and Nardi (1996) used AT as a potential framework for Human Computer Interactions (HCI) and transforming work in IS. Scanlon and Issroff (2001, 2002, and 2005) specifically utilized AT on the use of technology in Higher Education (HE). Engestrom (1999, 2000, 2010) employed AT to examine individual and social transformation and also developed an Activity System (this will be explained later) to illustrate AT. Karasavvidis (2009) used AT as a "theoretical framework" to examine teachers concerns about using new technologies in their classrooms. Bottino et al (1999) applied AT as framework for design and

reporting on a project on ICT in mathematics education in a primary school. Roussou et al (2008) used AT as a tool to evaluate interactions in Virtual Environments (VE) for children aged between 7 to 12. Oliver and Pelletier (2006) used AT to develop an analytical methodology in digital games. These are considered in depth later.

According to Nardi (1996), Activity Theory examines the development of human consciousness and suggests a series of human activities as well as using certain concepts to describe those activities. She continues by arguing that AT is a very strong "descriptive tool" instead of being predictive. In addition, to have a successful outcome, one has to be conscious of the needs of the subject of the activity. This consciousness will be understood over the time by more practise and experiences. She explains that consciousness is not just a series of decision-making acts rather it is assigned to everyday actions and operations. As she express "you are what you do" (Nardi, 1996, p.4). In other words, consciousness is the awareness of a person about the purpose, the goals and the actions taken toward achieving those goals in the process of an activity.

The next section reviews the ontology of AT.

2.3. Ontology of Activity Theory

As the name of AT suggests, the ***Activity*** (my emphasis) of humans is a primary factor of this theory and as Nardi (1996) states, an activity is the unit of analysis in AT. Any actions that an individual takes to achieve a goal during an activity is important to be observed, defined and explained in AT, to do so, there is a specific ontology that has been used and developed by

different researchers such as Kuutti (1995) and Engestrom (2000). In the following sections, all elements of this ontology are explained. These elements are Subject, Object, Tools, Rules, Community, Division of labour (DoL) and Outcome (Objective). However, in AT starting point of the activity, as Engestrom 1987 explains, there is an animal form of activity, which does not have Tools, Rules and DoL, these three further elements have been introduced to the system in the transition from animal to man. Tool making has emerged to ease the process of an activity, and DoL to divide the actions between the members of the community and the sharing the responsibilities as well as the outcome of the activity (such as sharing food). Engestrom (1987) uses hunting as such an example of an activity.

Below, a more detailed level of AT elements is offered.

2.3.1. Subject

The Subject is a person or a group of individuals involved in the activity. The Subject is in a direct relationship with the Object and Tool. The Subject produces, consumes or uses the Tool as well as taking actions to achieve a goal, which could be the desire Outcome (See Figure 4).

2.3.2. Object

The Object stimulates the activity that could be the purpose of the task or the activity. Different activities are distinguished from each other with different Objects. For instance, the same Subject can use similar Tools toward different Objects that shape different activities (Issroff and Scanlon, 2002).

2.3.3. Tool

Tools are the artefacts that can be used in the process of an activity, which have an influence over the interactions between the Subject and the Object. Tools can be abstract/subjective (not tangible such as logic, thought) and objective (material objects such as computers, books, lecture notes). According to Kuutti (1995) a Tool can be whatever a Subject uses to achieve an Outcome.

Figure 4

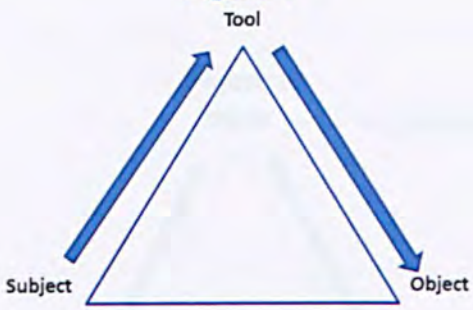


Figure 4 indicates the relationship between Subject, Tool and Object. These three elements are in a direct relationship as explained above.

2.3.4. Outcome or Objective

An Outcome is the desired goal of the activity, which motivates taking actions towards achieving a goal. In this process, a series of Tools may be used, a Community might be involved and Rules might be applied. The whole result of an activity is shown in the Outcome or Objective of the Activity (Kuutti, 1995) (In this research the term Outcome has been used throughout the whole thesis- figures 5 and 8).

2.3.5. Rules

Rules are sets of conditions that help to determine how and why individuals act, and consider social relations inside a Community by mediating the

relationship between the Community and the Subject (Issroff and Scanlon, 2002).

2.3.6. Community

A Community is a group of individuals and teams that work together to achieve the goal/Objective (Outcome) of the activity and they share the same Object. The DoL also has an effect on the way that different members of the Community interact toward achieving the desired Outcome (This is shown in figure 5).

Figure 5

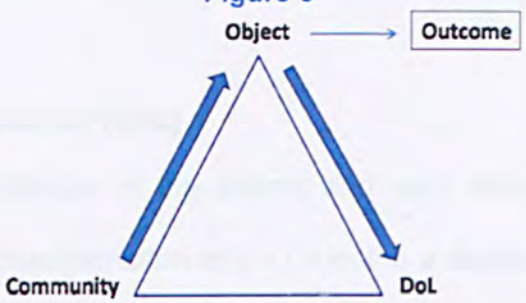
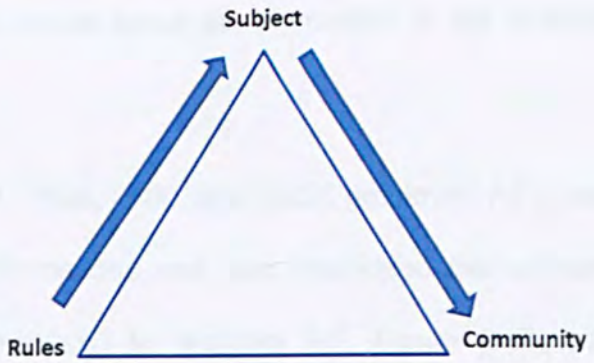


Figure 6 shows the relationship between the Subject, Rules and the Community. Rules have a direct impact on the Subject and the Community. However, the Rules might not have any effect on the Tool used in an activity. The Community may also need to follow certain Rules to achieve an Outcome.

Figure 6

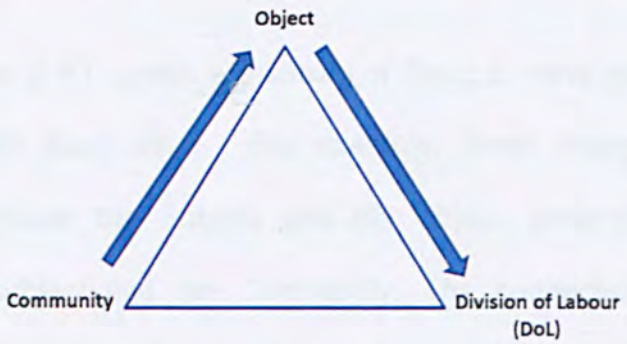


According to Hardman (2007), the context of the Community and DoL has influence on the subject's situation and the engagements toward achieving an outcome.

2.3.7. Division of Labour (DoL)

DoL shows the distribution of the actions and work among the community, which includes the transformation of the Object to a desired Outcome (Kuutti, 1995). Figures 5 and 7 illustrate these relationships.

Figure 7

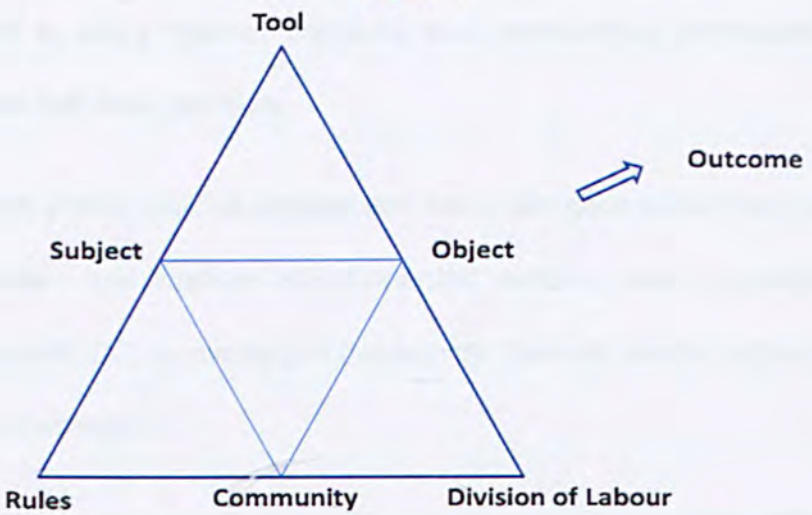


A Subject interacts with an Object and in the process of doing an activity some transformations and changes happened that are called internalisation. Kuutti (1995) explains internalisation by stating that all activities have two sides, internal and external, which influence the relationships between

different elements of an activity. He explained that if any assets of an Object change, it would cause some transformation in the Subject's mind. This is internalisation.

Engestrom (1987, 1999, 2000, and 2008) employed AT to examine individual and social transformations and also developed the concept of an ***Activity System*** (my emphasis) to illustrate AT. Figure 8 illustrates the generic Activity System developed by Engestrom (1987).

Figure 8



All the elements of AT, which are shown in figure 8, have relationships and connections with each other. For example, Tools always mediate the relationship between the Subject and the Object, while Rules intervene between the Subject and the Community. The connection between the Community and the Object is possible through the Division of Labour.

As Kuutti (1995) points out, different Objects distinguish differences between activities. The reality of an activity is understood by the motivations and goals of the Subject, which will be transformed into an Outcome. Kuutti (1995)

argues that changes in motivation and the Object during the process of an activity are highly possible, because most of the changes happen during the process of the actual activity. Activity Theory is very helpful in this situation in showing the history of the transformation. In addition, Engestrom (1996) introduces the idea of "network relations" which is about the history of Activity Systems. He argues to understand a single Activity System one has to understand the whole history of the series of Activity Systems.

Kuutti (1995) also points out that AT can be used in any discipline as it has the ability to study "human practices and development processes" in both social and individual contexts.

Engestrom (1996) divides actions into two main parts which are "short-lived goal-directed" and "durable object-oriented" actions, and, if a machine, such as a computer/PC, is involved in the activity, there is another action called an "automatic operation".

In the process of any activity problems, clashes, breaks and difficulties are very likely to happen. Engestrom (1987), Nardi (1996) and Roussou et al (2007) called these disturbances "contradictions". The analysis of data in Activity Theory helps to identify and clarify these contradictions and how they can be solved to make the process of the activity smoother. To solve these contradictions Engestrom introduces "Modelling", which happens after analysing and formulating the result, to design a new framework. This is called "modelling of the new solution", "new instrumentality" or a "new pattern of activity" (Engestrom, 2000). In addition, Nardi (1996) argues that because

AT looks at a specific Object and under specific circumstances the discovery of contradictions is made easier.

Engestrom (1987), Kuutti (1995), Blackler et al (2000), Turner and Turner (2001), Murphy and Manzanares (2008) and Foot and Groleau (2011), explain four different levels of contradictions: Primary, Secondary, Tertiary and Quaternary levels.

Primary contradictions happen within elements of an ASs, when the phenomena have a dual contraction. For example, Engestrom (1987) use a medical doctor work to explain this dual contraction. In one hand for healing the patient in order to relieve the pain and in the other hand for source of income, which could create a primary contradiction when these two side of the work does not work in harmony.

Secondary contradictions occur between elements of an ASs, when two nodes are in conflict with each other's. Engestrom explains, for example, if there are some rules that would get in the way of treating a patient properly, such as spending just 15 minutes for visiting each patient because of the policy of the clinic, therefore these might create secondary contradictions between the ASs' nodes.

Tertiary contradictions appear when a new Object has been introduced to an ASs, which will create a new ASs and therefore some contradictions might be occurring between these two ASs. For instance, when the policy of a clinic forced or required a doctor to spend just 15 minutes visiting a patient, and to solve this contradiction, a new nurse is assisting the doctor. Therefore, a new

Object has been added to the system and might create new contradictions (Foot, 2001).

Quaternary contradictions arise between central activity system and neighbouring activity systems. It happened when "a new form of practise is employed based on a reformed and/or expanded Object" (Foot, 2001). The example could be conflicts between healthcare system and insurance company.

As Turner and Turner (2001) explained, any of these contradictions can specifically happened when different individuals perform and implement the same series of actions to achieve an Outcome for various motivations.

In the next section the history of how AT developed has been reviewed by introducing Vygotsky and Leont'ev; two Soviet Psychologists who founded AT in 1930s.

2.4. Vygotsky and Leont'ev

In this Section, the fundamental ideas of Vygotsky (1896- 1934) and Leont'ev (1903- 1979) in "learning" and "education" will be reviewed. Leont'ev continued to work on Vygotsky's theories after his death and further developed AT.

Vygotsky was a Soviet Psychologist, after graduation in 1917; he worked on Cognitive Development, Child Development and Education. He sadly died at the very early age of 38 and Leont'ev (1903- 1979), a colleague of Vygotsky, continued his work. In this section, the educational theories of Vygotsky and Leont'ev will be reviewed.

The cultural/historical development of an individual is vital in Vygotsky's theory. Vygotsky's Social Historical Theory considers this relationship between an individual and the society that the individual lives in. He introduced the reality that these two (the individual and their society) cannot be separated from each other. In the process of development, they each might be "self-contained"; however, they have "shared existence" and in the system of development, a new word of "participation" is necessary (Daniels, 2004).

Vygotsky believes that thinking happens from "outside-in" because thinking is a social cultural affair. He argues that learning happens by interacting with our environment and that learning pursues development. (Bidell and Fischer, 1992)

"Development stages" (Bidell and Fischer, 1992) might be one of the common terms that one can hear in the learning and development theories, however, Vygotsky does not directly mention actual mental development stages and does not divide learning into separate age groups. However, Duncan (1995) argues that Vygotsky talks about a transformation from an interpsychological process (development of mind that happens when a child is in a society and s/he influenced by the culture) to an intrapsychological process (a development stage that happens inside the child's mind), transforming from natural to social/cultural process (Duncan, 1995). Glassman (1995) categorises the development stages of Vygotsky into "prespeech/primitive thinking, instrumental thinking, and internalised thinking". (p.479)

"Leading Activity" is a framework introduced by Vygotsky and developed later by Leont'ev which Duncan (1995) calls a set of a "kind of global stage sequences". Duncan (1995) continues by dividing these leading activities into three levels which are "play, school and work". He argues that Vygotskians believe that even knowledge exists before experience. However, it cannot easily be just studied from the psychological point of view and it needs to be seen as part of a bigger relationship in society.

Another important factor in the learning process is "developmental readiness" (Duncan, 1995). Vygotsky argued that there are certain concepts outside of a student's region of understanding when new knowledge is shaping for the first time. He believes that when individuals face new knowledge, which is out of reach of their existing knowledge, they will need help from other more experienced individuals. These more experienced individuals can be groups of adults who are expert in the subject or other groups of students/children who are more able peers. According to Vygotsky, adults are more knowledgeable/experts than peers, and therefore, they are more able to help/support/guide children in the process of development. An adult's encouragements forces a child to move forward (Duncan, 1995). Vygotsky called this process the Zone of Proximal Development (ZPD), which will be explained later. Vygotsky focuses on how proper instruction from a mediator/teacher/expert raises someone's ability to learn new knowledge.

Vygotsky argues that to understand the development of a Subject, it is necessary to observe the Subject from the beginning and follow the changes to understand how its knowledge has been gained. Therefore, to understand

a Subject, the study of the history of the changes is necessary. In addition, he pointed out that human psychological development in adults, when compared to children, is completely different. He indicated that there are vital effects from society that influence the individual's development process (Duncan, 1995). He used Dialectical reasoning which is a theory that argues that events occur due to social conflicts and these are the result of a series of contradictions and their solutions. The conflicts are caused by material needs. (Spirkin, 1983)

According to Glassman (1995) Vygotsky, like Engels, believed that human need causes activity, and activity leads thinking, which Glassman believes, is the central idea of Vygotsky.

According to Vygotsky's theory, understanding happens in the interaction with society and artefacts/tools, and he believes that a child cannot learn individually as much as s/he can learn from a more capable peer in the society with use of suitable artefacts (Translated by Cole and Wertsch, 1996).

According to Cole and Wertsch (1996) artefacts/tools - which are generally historical, social and cultural - profoundly form and adjust mental processes instead of only mediating them. In addition, they argue that the meaning of actions and context are not separated, especially in the analysis and interpretation of an action, social/historical/cultural factors have to be involved. Another point they made is that the development of mind is not happening only in the head – as part of genetic development – rather it is

structured culturally, historically and socially as well as being mediated by artefacts/tools. (p.253)

The following section will review Vygotsky's work on Education and especially the Zone of Proximal Development (ZPD).

According to Vygotsky (1978), the activity of learning includes two levels: internal and external. The internal level includes the action of thinking and understanding the concepts, while the external level causes interaction with society, because of this, learning is a historical activity with embedded cultural and social factors.

"In Vygotsky's view, mental functioning in the individuals can be understood only by examining the social and cultural processes from which it derives...he calls on the investigators to begin the analysis of mental functioning in the individuals by going outside the individuals." (Wertsch and Tulviste, 2005)

Wertsch and Tulviste (2005) argue in terms of understanding Vygotsky's views, and comparing them to the western psychologists, some of the terms that have been used in his theories need to be modified because, in western psychology, terms such as "cognitive", "memory" and "attention" are directly related to an individual's behaviour. However, in Vygotsky's theory these terms have been used on the "social Plane". Therefore, different researchers such as Hutchins (1991), Middleton (1998) and Resnick (1991) have introduced new terms of "socially shared cognition", "socially distributed cognition" and "collective memory" (p.61).

Vygotsky believes, as Wertsch and Tulviste (2005) argue, that to understand human development, it is necessary to study the whole process of

development instead of just focusing on the final product of development. To study the history of development both *description* and *explanation* are vital *(emphasis added).* Vygotsky explains that description means analysing current object properties and showing clearly, what is happening in the present time. Vygotsky and Lewin (1940s) call the description "phenotypic" and the explanation "genotypic".

Vygotsky claims that evolution happened when primitive humans started to use tools, language and signs to communicate. Cultural tools, which mediated social organisations, developed human mental functioning, which means culture has a direct relationship with intermental functioning. Vygotsky argues that by mentioning cultural development, the 'social plane of development' has been introduced too (Wertsch and Tulviste, 2005, p.65:66).

"Everything cultural is social." (Vygotsky, 1978)

Wertsch and Tulviste (2005) believe that one of the problems of Vygotsky's approach is that he or any of his followers did not really developed the category of 'culture', he paid more attention to the social part, even though his school was called "cultural- historical school". They argue that Vygotsky's system was more concentrated on "mediation" rather than culture.

However, Vygotsky used the context of the culture into social analytic. This means in his opinion culture does not exist outside social boundaries. This might be one of the reasons that he concentrated on the relationship between the Subject and the Tool used by the Subject to achieve an Outcome. Wertsch and Tulviste (1992) do mention that Vygotsky worked on

"cultural Tools", which transformed human functioning in their activities. They argue that Vygotsky "understood culture in terms of sign systems" such as language, counting and symbols.

In the following section, the Zone of Proximal Development is reviewed.

2.4.1. Zone of Proximal Development

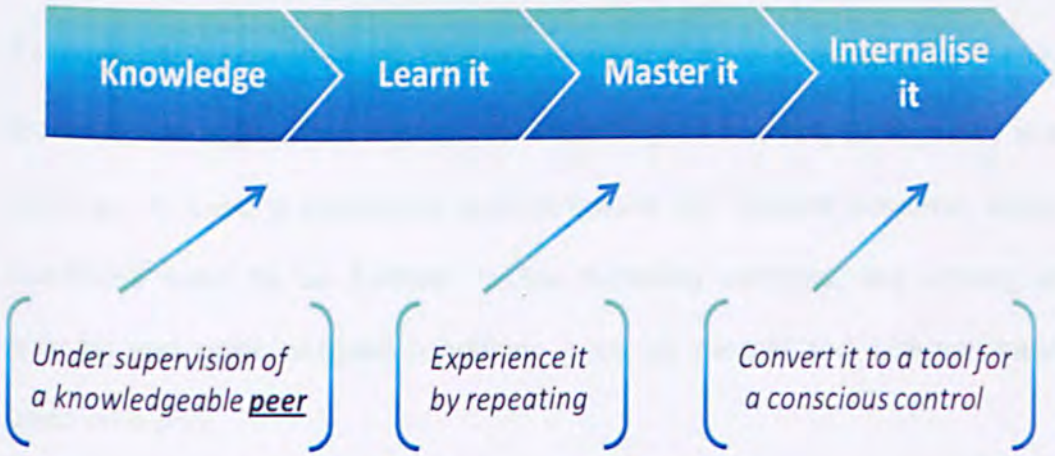
Vygotsky introduced a new theory widely known as *"Zone of Proximal Development"* (ZPD) which simply means next step of the learning process. It focuses on what is the distance between the things that an individual can learn independently and what they can learn with help from a more experienced person. According to Vygotsky, this process of learning might be true regardless to the age, level of knowledge or level of education.

Vygotsky argues that in the ZPD there are two different levels of development, the actual level and the potential level. These two levels are distinguished by the ability of the Subject to solve problems. The gaps between these two levels can be shorten by receiving assistance from a "more capable peer". Wertsch and Tulviste (2005) continue this argument by adding that an actual level and a potential level, that Vygotsky declared, have a relationship with "intermental" and "intramental" performances. They argue that the ZPD is not just a simple formula to increase someone's performance; it is a strong means of transferring someone's ability to someone else.

Figure 9 illustrates the steps of the ZPD. It shows that an individual needs to receive the knowledge first, learn it by help of a more capable peer, master it

by repeating the learnt knowledge in the real world and, finally, internalise it and use it consciously in the future.

Figure 9



Bruner (1985) points out three levels in the ZPD: "props", "processes" and "procedures". "Props" are helps and supports from the "more capable peers" which one needs to go further from the current level of development to create a new level of consciousness. Human responses to transactional learning, which Bruner (1985) calls "vicarious", adaptably and sensitively are processes. Finally, procedures are the ways that the "more capable peers" choose to make the learning process for the learners less intense. Burner argues that it is not hard to see that these three levels are the common acts of everyday formal learning and teaching. Hedegaard (2005) also believes that clear instruction in the procedure level is vital to develop new knowledge, and it depends on understanding the current development level of learners. Instruction is a mediated tool to introduce new concepts, which pursues development. Therefore, the absence of an effective instruction may make the process of learning and development vulnerable.

As Hedegaard (2005) argues, it is important to distinguish between knowledge that students already have from the Object and the knowledge that is needed to be taught in a certain activity. He argues that the culture and social context are also equally important to the ZPD.

As it was discussed, from the Vygotskian point of view, learning is an activity that a person undertakes to gain new knowledge. According to Vygotsky and Leont'ev, to have a successful activity toward the desired outcome, some conditions need to be fulfilled. In the following sections, the activity of learning and some of these conditions, such as internal and external, have been reviewed.

2.4.2. Activity of learning

In this section, the focus is on some of the key ideas of Vygotsky that have been developed by Leont'ev (1959). These include the activity of learning, conditions, goals and motivations, consciousness and the personal/ objective meaning of the learning. In this section, learning is referred to the activity of learning. Leont'ev worked further on Vygotsky's idea of learning and he divided the activity of learning into two areas, internal and external, that have specific conditions.

2.4.3. Internal Conditions

Mental images, memories, experiences and individual personalities all have effects on our activities, actions and goals. These elements might confront consciousness and reality in our behaviour towards learning. Leont'ev argues that these mental images – which can be true or not when doing an activity have a real reflect on how she/he anticipates the result of the activity, while

the result of the transformation that happened in reality might not be the same as anticipated. The level of consciousness and awareness plays a vital rule in this process. He continues that consciousness goes through historical development when a subject discovers different sides of an activity and takes part in distinctive actions to do a specific activity.

2.4.4. External/Social Conditions

In terms of learning, there are always social and external conditions that affect the process, such as the communities involved, financial aspects, political views and career opportunities.

"The activity of every individual depends on his place in society, on his condition of life" (Leont'ev, 1959, translated in English 1977 and 1978).

Social conditions might even change the motivation of learning. For example, higher education might mainly mean having a better/higher level in society, which might undermine the principle purpose of gaining knowledge, and instead the main purpose changes to achieve a mark, pass and graduate.

2.4.5. Goals and Motivations

Some activities can be similar to each other and one may not see the difference between two activities. However, Leont'ev pointed out that the only difference between those two similar activities are their objects and the motives behind the activity. He continues that no activity would be possible without a motive. However, the motivation might be hidden subjectively and objectively. He argues that the basic units of any activities are actions that separate those activities from each other. Every action has a conscious goal, which is related to the activity directly, and the result of that specific action

shows in the society as well as in the subject's life. Actions of people who are working together in a society shape the division of labour. These actions of working together fulfil the needs of a society that an individual cannot do alone. Sharing products between individuals make "Social relationships" and this is one of the processes of a being part of a society. (Leont'ev 1978)

Direct goals and motivations of some actions/activities might not be clear enough to be recognised easily. For example, to obtain food, one may not directly catch or hunt any animal as food but one might produce tools and weapons for hunters in exchange for money or food. Chains of actions in human activity can be seen in this simple example (Leont'ev 1978). He argues that an activity is extremely "dynamic" and continually causing ***"transformations"*** (emphasis added).

The term "transformation" that Leont'ev uses here is one of the most important terms that have been used by majority numbers of the researchers who used AT in their research. This will be explained in depth later.

2.4.6. Tools and Communities

Both human and animals share an adaptive activity, while Productive activity appertains only to human, which leads to the production of tools by an individual or group being part of society. Language is one of the most important tools that people use to communicate in producing a product. These communications and contracts between individuals develop and establish societies. Being inside a society and being part of it might explain one of the reasons of human existence (Leont'ev 1977). According to Leont'ev (1977) while the creation of tools expands and develops then the

direct link between "people's consciousness" and their "practical labour" is reduced and fundamental transformations occur.

2.4.7. Objective Meanings or Personal Meanings

Leont'ev (1977) indicates that in the early stage of human activity (for example hunting for food) individuals have common goals and motivations and taking similar actions to obtain an objective to fulfil their needs. However, in a more developed society each individual starts to think separately and distinguish goals and motivations begin to appear. In this stage objective/personal meaning for each subject takes place. These individuals' consciousness could have different sources. For instance, it could be social or individual need or assumptions. Sometimes the subject might not be aware of their motives for doing specific actions/activities. In doing it to satisfy their needs that find out that it is useful to do the activity. In the early stage of development, a subject may do an action or activity just because they are interested to do it, while in further development they find a new goal and motive to do the same activity. For example, sportsmen/women exercise because they enjoy doing it, but when they become an athlete they do it to achieve a new record, medal, recognition or even financial motivation. In linguistics, the term "objective meaning" came first and then could be driven to a more "personal meaning". For instance, for a child the word "mother" means feeding, protection, and for an adult these meanings change dramatically (Leont'ev 1978). As Leont'ev explains

"...Man's consciousness, like his activity, is not additive. It is not a flat surface, nor even a capacity that can be filled with images and processes. Nor is it the connections of its separate elements. It is the internal movement of its "formative elements" geared to the general movement of the activity which effects the real life of the individual in society. Man's activity is the substance of his consciousness." (Leont'ev 1978)

The next section offers a literature review of AT in the IT field.

2.5. Literature review of Activity Theory

In the next section work by Nardi (1996), Kuutti (1995), Issroff and Scanlon (2001, 2002, 2005), and Engestrom (2000) are appraised. All of these authors are all working in an educational context and they have applied AT in different areas such as Human Computer Interaction (HCI), organisational practice, Information Technology (IT). However, Nardi is reviewed due to her discussion of research approaches.

Nardi (1996) compares three research approaches: AT, Action Research (AR) and Distributed Cognition (DC) to find out the advantages and disadvantages of these for designing technology. She explains that because the users of a designed system are part of a social group and they are using an artefact (tool), "individuals are not the centre of the analysis" any more but the relationship between the individuals and tools should be studied which she calls it "the study of the context". She argues many studies from various disciplines indicate that it is not possible to understand how individuals learn without observing the relationships between the communities they are involved with and the tools they use in the process of learning. Nardi points out the vital aspects of system design for HCI studies such as detailed analyses to judge the values of design decisions by emphasising the

relationships of tools and individuals in the society. She discusses the problem of generalisation in HCI studies when very specific situations have been examined to collect data. She considers the three approaches to find out what tools each method offers to manage the study of the context in HCI. Nardi highlights a very important aspect of AT which is the object of the activity is not fixed and can change during the activity. The concept of "*mediation*" (Nardi's emphasis) is introduced as a key direction of AT. She quotes from Kuutti (1995) that a tool presents specific culture and history "through time and space". Nardi gives an example of three people going for a nature walk, a bird watcher, an entomologist and a meteorologist. These three individuals are in the same situation but they are following different objects. Nardi compares their activities with all of the approaches and points out that AT is the most accurate approach of these three. To point out the differences of each method, Nardi explains if the bird watcher and the meteorologist both were videotaped their behaviour might be the same as each other when they are looking at sky. In situated action research, the difference between these two individuals would be missed by studying the videotapes. However, in AT which studies the objects of the activity the difference will be seen easily. She claims that it is almost impossible to generalise any activity in situated action research because of looking for a specific situation.

She states,

"Activity theory gives us a vocabulary for talking about the ... activity in meaningful subjective terms and gives the necessary attention to what the subject brings to a situation" (p.44).

Nardi (1996b) concludes that AT conveys "A research time frame long enough to understand users' objects", "Attention to broad patterns of activity", "The use of a varied set of data collection techniques" and "A commitment to understanding things from users' points of view".

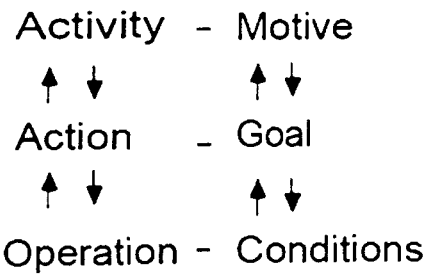
Kuutti (1995) points out the problems of applying existing frameworks for analysing activities in HCI, both in work and educational environments, and examines AT as a potential framework to use. He argues that activities are the unit of analysis in AT which are dynamic and undergo "continuous changes and development". Therefore, each activity has their own history. Thus, an historical analysis of the activity is needed to understand the real situation.

Kuutti argues that relationship between the elements of AT are not direct but mediated. In addition, he discusses that tools (artefacts) have their own history of existence and development as well as carrying a culture within themselves. He continues by demonstrating the use of AT's framework. He proposes that the object and the objectives of an event undergo changes during the process of the activity. Kuutti raises that the tool can restrict and empower the subject equally at the same time by enabling the subject to interact toward the object and also be restricted by the limitation of the tools. He points out that the "multi-levelness", "Studying interaction embedded in social context" and "Dealing with the dynamics and development" are three of

the most important features that AT offers to solve the problems related to Information Systems (IS) (p.22).

He also points out the different levels of an activity by arguing that each activity includes a series of actions and operations which are related together by the same object and motivation. (Figure 10)

Figure 10



Hierarchical levels of an activity borrowed from Kuutti (1995)

The subject or participants of the activity are aware of their defined goal and might follow a certain routine to achieve that defined goal (objective). He explains that sometimes the desired Outcome cannot be reached immediately; rather it will be achieved in series of steps toward the final goal. (Figure 11)

Figure 11

Activity Level	Learning to drive a manual car
Action Level	- Ease the gas pedal - Push the clutch pedal - Move the gear level to a new position - Release the clutch pedal slowly - Give more gas again
Operation Level	- Smooth gear-changing - Corner turning - Lane changing - Maintaining the distance

Examples of activities, actions and operations inspired by Kuutti (1995)

Kuutti considers contradictions as unfitted external forces that disturb the balance between the elements of the activity. He continues by saying that when a contradiction happens, shifts are needed to transfer the contradictions toward the desired outcome. In this step, development comes next to solve that contradiction. Later he explains the relationship between an activity and Information Technology (IT) in that how IT can be used as a tool, as well as by automating human actions, it can become part of human activity. (Kuutti, 1995, p.27, 28)

Issroff and Scanlon (2001, 2002, 2005) in three articles evaluate the use of AT in HE by comparing AT with existing frameworks that are currently being used in HE, and discussing if AT can help to understand the issues around improving learning technologies. They divide the existing framework into three different types: formative which looks at the "design changes of software", summative which "examine the finished product of educational

software", and the final type which includes the "interaction between students and teachers, available resources, the student's expectations of the technology" and their understanding of the purpose of the activities in learning (p.431). In their papers they look toward the popular use of AT in Human Computer Interaction (HCI) field. They used two case studies of teaching and learning in HE, one studying use of IT in a postgraduate study of science and the other one studying a history course and their use of web to find resources. They argue that AT helps them to understand the inter relationships between factors that influence the evaluation of learning technologies. In 2001, they start by introducing the ontology of the AT, explaining their case studies very clearly and representing their samples. In 2005, they use Engeström's Activity System to understand organisation, to show collaboration, to describe development and express learning experiences. They have considered the contradictions and changes that might appear in the community of higher education in the UK. For instance, they talk about the contradiction between different students' views about using a technology in 2001 and the contradiction of seeing DoL differently between the students and the tutors' view in 2005. They have used Breen et al (2001) list of factors to evaluate the learning situation according to the AT perspectives. They argue that there are two types of educational theories, one that helps to design learning technologies and the other, which helps to understand different learning circumstances, and they categorise AT in the second group. However, they do not suggest that the second group is any less important than the first group. Their aim is to show that AT is a useful

instrument to study and examine learning environments by describing the situation clearly and clarifying the Outcome.

Engestrom (2000) used AT to point out the changes that are happening in an industrial environment in terms of communication boundaries and research frameworks. He identifies continuous changes, contradictions and therefore a need for development in Activity Systems, which he calls, transformations. He explains that transformations are possible by constant doubting of the current practice, collecting data, analysing the data, designing a visual model, examining the model, and finally applying the new model to the practice.

Engestrom (2000) gave an example about a junior hospital Physician that is dealing with a patient. During this process the physician is deciding which further actions that he would not do before because of hospital regulations. After examining a patient, instead of calling for a senior physician, he called for a specialist that has been mentioned in the patient's documents. He shows the changes in activities, subject, object and outcomes by using the Activity System diagrams. For example, change in the subject from physician to lung specialist, the shift in the object from lung specialist to the patient; therefore the outcomes are going to change as well (p.961-963).

Engestrom (2000) discusses the difference between "short-lived goal directed action" and "durable object-oriented activity". The former happens when a short-term action needs to be executed to achieve a longer or durable activity. For instance, in the example of the junior Physician, the short-lived object is a patient's record and the test result, while the durable

object is the patient and his health (in this case because the patient is a child, his father too is part of the object). In addition, he talks about the motivation, which provides meaning to an activity. He points out that the object of the activity embeds motivation. It could be argued that the subject of the activity has an equal effect on the motivation of the activity as the object. Later in the paper, Engestrom concentrates on the new model suggested for the practice, and when considering the data analysis he points out that the staff doubt the new model. The Staff argue that the new model proposes more work and responsibilities for the community; therefore, they have their own reservations and worries about that. However, one of the staff, a nurse, suggests some changes and, the others then find it more flexible and simple enough to be put in practice. The improvement, changes and alterations in the practice was called an "expansive learning cycle" by Engestrom in his paper. He introduces a new type of organisation work as "knotworking".

"The notion of knot refers to ... collaborative performance between otherwise loosely connected actors and activity systems. A movement of tying, untying and retying together seemingly separate threads of activity characterizes knotworking ... The locus of initiative changes from moment to moment within a knotworking sequence. Thus, knotworking cannot be adequately analysed ...as an additive sum of the separate perspectives of individuals or institutions contributing to it. The unstable knot itself needs to be made the focus of analysis." (Engestrom, 2000)

In other words, "knotworking" refers to the firm relationship between the elements of an Activity System, which means that any changes in one of the elements have a certain impact in other elements of the Activity System. Thus, none of the elements can be analysed separately from one aspect of the system. He explains that increase of "knotworknig" is connected with continuous changes in the organisations and the work.

2.5.1. Change laboratory (CL)

The CL method, developed in the Activity Theory Centre and Developmental Work Research in University of Helsinki, is based on AT framework, which supports organizational and social transformations (Engestrom et al, 1999; Engestrom, 2008 and Virkkunen et al, 2006). Engestrom (2008) explains that CL "is a method that develops work practices by the participants in dialogue and debate among themselves, with their management, with their clients and the interventionist researchers."

As CL is a method for the practitioners to develop their practices, therefore it encourages participants (Subjects of the activity) to find and analyse the contradictions (disturbances) themselves inside the community. Virkkunen et al (2006) argue that CL would help participants to understand the contradictions, which will help and support their learning potentials in the community. They also discuss that finding these disturbances will help the community to understand the history of the changes in their AS and will support the potential changes in the future to solve the contradictions, or in other words will find out about the potential shifts for the future. Researchers will then interpret the finding and analysis to "mirror" the community work and eventually to design a new practice that will solve the disturbances.

Virkkunen et al (2006) points out three essential aspects of the CL method, which are "

- Using videotaped practices as a "mirror" for assessing current activity,
- Generating ideas and tools (e.g., charts) that help to asses past, present and future activity, and

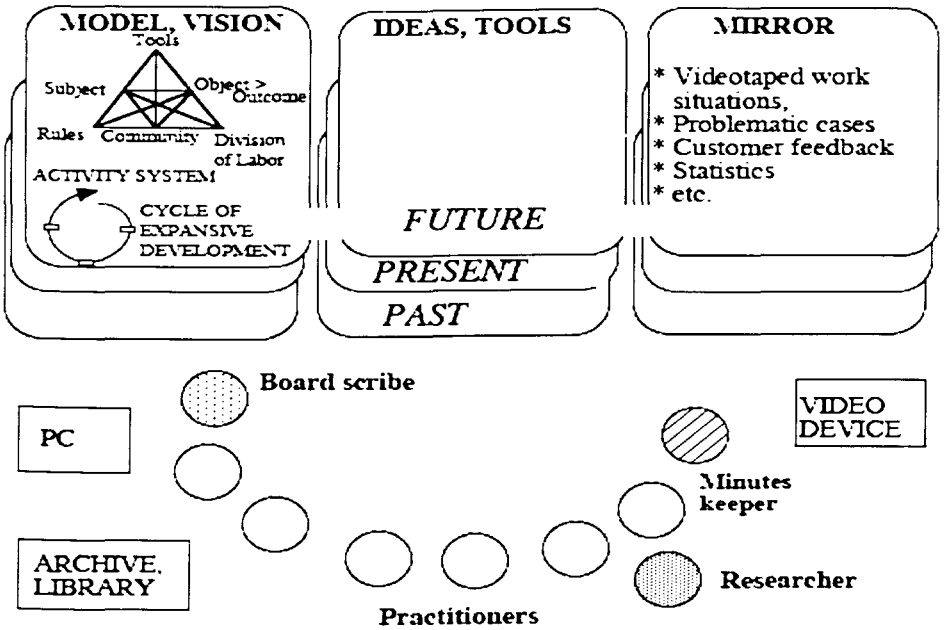
- Modelling present practices by using activity-system analysis." (Virkkunen et al, 2006)

They also mentioned that in workplace archives and libraries might help the community to analyse historical development of the activities.

Engestrom et al (1996) clearly argue that CL needs an actual physical space in the observed workplace that can be used to analyse contradictions that are happening in the workplace, which also can be used to design and construct a new model for the practice that can solve the contradictions. The researcher in the process of CL is just a help to the work unit/team, and finding disturbances/contradictions are the responsibilities of the participants, not the researcher. It is also argued that CL method needs regular meetings by the subjects to discuss the disturbances.

Figure 12 shows the 3x3 surfaces of CL by Engestrom 1996. The first surface which called Model Vision, shows ASs and the cycle of changes and relationships between different elements of AS. The second surface illustrates the historical developments of the tools and ideas of the developments. The third and final surface that called Mirror presents feedbacks and experiences of the participants and studies the disturbances and contradictions. The bottom part of the figure represents the relationship between participants, researchers and the tools that are used to observe the activity.

Figure 12



3x3 surface of CL by Engestrom (1996)

CL method seems to be ideal for workplace activities, which have actual physical environment with participants (practitioners) are present at the workplace and they are mostly familiars and aware of the problems/disturbances. Also the participants can be involved closely in the process of the research, and in fact run the whole research by supervision of the researcher. However, CL method might not be useful as much in an educational environment such as universities for learning developments. The following reasons might prevent the usability of CL method in learning developments:

Students as participants of the activity (Subject) are not always keen to be involved directly in a process of a research. Specially, regular meeting that

needs to be hold between the subjects are hardly possible with students (as the Subjects of the study).

It is problematic to have a one physical space to observe students, as they are moving from one lab to a lecturer and vice versa. In addition, the actual sample size is changing form one year to another (students pass and move to the next level.)

Videotaping students' activities in the way of learning is quite impossible, because they learn in different ways, use different tools, which might not be limited to the classroom, workshops and lecturers.

There are limited archive library from the students activities available to be studied.

Furthermore, CL method is quite similar to Action Research (AR) and Ethnography, in terms of collecting data in a controlled environment with quite intense observation, fully collaborated participants and their direct involvement in the process of the research. It has been discussed earlier the points that why these are not suitable for this study, such as unwilling students to participate directly in the research. Also, CL method does not solve the problem of analysing the collected data clearly with a systematic step-by-step guidance. CL method mostly clarifies the process of ASs, such as focusing on historical pathway by studying past, current and future activities. In addition, CL studies the iterative nature of AT by mirroring the feedbacks, difficulties and revealing the contradictions. However, as

discussed before, it does not suggest any clearer pathway to analyse the data than AT itself.

Engestrom et al (1996) claim that "As the participants move between the experiential mirror and the theoretical model/vision, they also produce intermediate ideas and partial solutions, to be tested and experimented with". However, it does not add anything to the previous process of AT, as this steps has already been discussed in AT by finding and studying contradictions and then suggesting potential shifts (solutions) for the contradictions.

They also discussed "The vertical dimension of the surfaces represents movement in time, between the past, the present, and the future. Work in the Change Laboratory typically starts with the mirror of present problems." It is also completely similar to the initial discussion of AT and nothing has been added to the previous discussion. The series of ASs triangles are illustrating the historical development on the activity by studying the past, present and future.

2.5.2. Deciding if a new method will help clarity of AT

The above examples are a subset of many others (Kaptelinin, 1995; Lewis, 1997; Roschelle, 1998; Bottino et all, 1999; Barthelmess and Anderson, 2000; Halverson, 2001; Daisy, 2001; Lim and Hang, 2003; Daniels, 2004; Waycott et all, 2005; Berglund, 2006; Crawford and Hasan, 2006; Hashim and Jones, 2007; Liaw et all, 2007; Benson et all, 2008; Karasavvidis, 2009 and Sancho-Thomas et all, 2009) that use AT in their research. These studies show the suitability of AT in the IT and IS disciplines. However, the

majority of these do not explain why they have selected Activity Theory, nor the reasons for their choice of methodologies and approaches to gather data and information.

Although CL has been introduced to help clarifying pure AT, by pointing out how to collect data, such as videotaping and using of archives. It seems that the data collection suggestions are not thoroughly helping AT; instead, it might limit the wide possibilities of the choices. However, Virkkunen et al (2006) pointed out that other methods such as interviews and observations can be used as well as videotaping. CL method might answer the question of how to collect data, yet does not answer how to analyse data in practice. In addition, there are not many clues either for analysing the collected data.

2.6. Conclusion

The literature review section, studied the work of Nardi (1996), Kuutti (1995), Issroff and Scanlon (2001, 2002, 2005), and Engestrom (2000). The conclusion of these works is as follow:

Engestrom (2000), as discussed above, does not explain why AT is chosen and does not explain how the data about the physician's activities has been analysed (which is important to be able to follow and better understand his conclusions). However, he does explain that patients were followed, videotaped, and interviewed to gather the data and the contradictions (page 965). None the less, Engestrom explains the shift and changes in the case very clearly. Also by introducing the activity system and use of triangles, he illustrates the different levels of activities offering another dimension to using AT. For example, he discusses the relationships and mediations between

different elements of AT. He also highlights the important aspect of social psychology in AT by discussing group work and the impact of the community in the process of learning and working in groups.

Nardi's article (1996) is a good example of a review and comparison between three different research approaches. However, she is not examining AT as a framework for any specific case study in this article. Therefore, there is no opportunity to consider the methods and approaches to collect data or analyse it. However, she mentioned the use of videotapes to gather data for the example of nature walkers. Kuutti (1995) on the other hand, has an example of a software team that programmes a system for a client, but again there is no clear identification of the methods that has been used to collect the data about the software team and their activities during designing the system. However, it could be discussed that the paper is not about the research approaches but it is about clarifying the relationship between AT and IT and how these two can work together.

Issroff and Scanlon (2001) are the only ones to mention the methods of collecting data. First, they point out classroom observation and later videoing, interviewing and using questionnaires for both students and teachers involved in the process of the project. Through their paper, they explain their case studies and the sample size they used. In addition, they took snapshots of each case study and explain them with the use of AT. However, the use of activity systems and illustration of some triangles that could really help to understand the situations are missing. The lack of using activity systems has been solved in their later paper on 2005 by illustrating a figure in page 433

for the use of technology in HE. Still some more detail and more levels of activity systems could be added. For example, they talk about the contradiction and changes in higher education in the UK, while they do not illustrate these factors in an Activity System. Use of Activity Systems could help to describe the whole situation in a snap shot, as well as clarifying the Outcome of the activity clearly. In another example, Issroff and Scanlon (2005) argue that the expectation of the students and tutors vary in terms of controlling the teaching and learning environment, which could be solved with some changes in the DoL. They are suggesting some shifts here; however, an AS of the shift is missing too. They continue to say that they found Activity Systems useful in terms of understanding and highlighting interactions between the elements, but still do not use any Activity Systems to indicate this positive feature of AT. In addition, they do not explain why they choose AT, or their methodological approach to collecting and analysing data. However, they discuss one major criteria about AT, which is that AT does focus on contradictions and sometimes the positive aspects of an activity are dismissed because of this. (Issroff and Scanlon, 2001)

In the most of the published studies that have used AT, little consideration is given to show the process of data collection and analysis. To address this problem this research aims to find a method to clarify the process of data collection and analysis to achieve a transparent pathway for data analysis using AT.

As discussed before, this chapter aimed to introduce AT, indicated the ontology of AT, explain the history and background of AT by discussing

Vygotsky's theories and idea. In addition, the strengths and weaknesses of the framework have been discussed in the literature review of AT. It was concluded that AT lacks transparency in terms of showing a clear pathway of how to collect data; and, thus needs to be instrumented by another method that does offer a strong and transparent outline of how to collect data and analysing it. Therefore, in the next chapter three different methodologies: Phenomenography, Action Research and Grounded Theory, that offer a clarity in data collection and analysis, will be introduced and compared with the aim of selecting one of these to be coupled with AT.

Chapter 3 – Selecting a complementary method for Activity Theory

3.1. Introduction

As discussed in chapter 2, despite the strong and justified framework, AT lacks transparency in terms of how to collect data. In addition, it does not clarify the process of analysing the data. Therefore, there is the need to couple another method to AT to develop a more transparent way with a systematic step-by-step approach.

Hence, In this chapter three methodologies are reviewed, Grounded Theory, Phenomenography and Action Research, to find a suitable approach which will work in harmony with AT.

3.2. Grounded Theory

Glaser and Strauss first introduced Grounded Theory (GT) in social science almost 50 years ago and wrote the book "The discovery of the Grounded Theory" together. However, later they each took different directions toward how to develop and use GT in further research. Regardless of their split, generally GT is an inductive qualitative research method, which uses a systematic approach to constantly compare collected data and analysis. "Inductive" means that there are no hypothesises to start with. Therefore, researchers have to be as open-minded as possible and design research questions carefully that do not suggest any possible responses. As Taber (2000) explains, the data should not be selected to fit the preconceived categories that have been in the researcher's mind.

Strauss and Corbin (1998) highlight that because theories are grounded from the data directly it improves understanding of the data and express profound perception of the data.

According to Alsop and Tompsett (2002), GT is a methodology that concentrates on the "Subject's perspective" as well as being flexible enough to recognise the researcher's point of view. However, the researchers are advised to be aware of their interpretations and make sure that their interpretation is clearly pointed out from the participants' responses. (Glaser and Strauss, 1968; Strauss and Corbin, 1998 and Alsop and Tompsett, 2002)

The following sections present a more detailed overview of GT's methodological levels. It is necessary to be noted that these levels are generally presented from the researcher's understanding of the GT methodology and a general overview of 'Glaserian' and 'Straussian' is followed. In addition, a brief literature review of GT is undertaken.

3.2.1. Open Coding

This is the very first process of analysis (after read and rereading the responses several times to ensure early familiarity with the data) to discern concepts from the data. It is called open coding.

As Graham Gibson in his recorded videos (Available in YouTube- accessed in May 2011) explains, by the end of open coding, all the data has been coded and "everything has been looked at, nothing has been left out".

Strauss and Corbin (1998) highlight that open coding should remain a "dynamic and fluid process" which means that when more data has been

collected and reviewed it might change the previous concepts that have already emerged from the data.

3.2.2. Categorising

After open coding and identifying concepts, it may be that several concepts are sharing some properties and attributes with each other. As these attributes in the concepts become very similar categories being to shape. Strass and Corbin (1998) use a very explicit example to explain the concept of categorising. They use the example of a person observing different objects in the sky. They could see a bird, an airplane, a kite etc. the single attribute that these objects all have in common is the ability of flying. Therefore, they all could be classified under the category of flight.

"Grouping concepts into categories is important because it enables the analyst to reduce the number of units with which he or she is working. In addition, categories have analytic power because they have the potential to explain and predict." (Strass and Corbin, 1998)

Since categories are distinguished, these can be developed and expanded it terms of their attributes and properties which create the sub-categories. The subcategories are similar to the categories. However, these are not standing for a new phenomenon rather they are describing and explaining the attributes of a phenomenon. In other words, the sub-categories answer the questions about the phenomenon. (Strauss and Corbin, 1998)

Strauss and Corbin (1998) explain that in the beginning of the analysis, the researcher might not be sure about the concepts, categories and subcategories, but it will become more explicit as the coding progresses.

3.2.3. Axial coding

Relating categories and sub-categories together is called axial coding. In the process of open coding data is broken into pieces, in the process of axial coding these broken pieces are related together to make sense of a phenomenon (Strauss and Corbin, 1998). In addition, Strauss and Corbin (1998), point out that when categories are related together, in Axial Coding, differences and similarities between categories are shown more easily by comparison, which "uncover relationships among categories"(p.127). They continue by arguing that categories that are separated will reveal why a situation happened but when they are in a relationship together it will show how the event happened too.

In axial coding, "conditions" would be emerging from the related categories. As Strauss and Corbin (1998) explain, problems and difficulties in an event create "conditions" about a phenomenon, which can explain the situations. These conditions can be identified from the data by analysing the data carefully.

They suggest that labelling conditions should be the next step of the axial coding, because various conditions can be emerging from the data in the cycle of data collection. As a variety of conditions appear in the analysis, concepts seem to be related together, which could form a series of hypothesis driven from the data. However, when more data is collected these hypotheses might be in contradiction with the new incoming data. Strauss and Corbin (1998) indicate that these contradictions do not necessarily reject

and decline the hypothesis and it is important to find out whether the new incoming data represent an extreme/ specific situation.

3.2.4. Core Category

The Core Category is the "constant comparative method" (Strauss and Corbin, 1998; Hallberg, 2006) in GT, which consciously compare part of the data with all other parts of the data. It looks for similarities and differences, which provides emerging new data and help the researcher to study, explore and understand the data. (Hallberg, 2006)

In this process, one or two core categories are selected. During categorising, many different categories are identified and further along in the process of analysis some of these categories relate to similar phenomenon, which later could be merged together to present a single category.

3.2.5. Theoretical Sampling

Theoretical sampling happens after the initial analysis of the collected data and provides a guide for how and where to collect further data. It can be started as soon as the initial concepts begin to appear from the data by asking questions such as how and why a specific event happened. Alternatively, as Strauss and Corbin (1998) suggest, missing crucial concepts in the process of comparing data can also be a starting point for theoretical sampling. In addition, they argue that variations, dimensions and properties in the conditions can also be a starting point for theoretical sampling. They use an example of observing patients in a hospital to show how to start theoretical sampling in this case. They explain that, if "work flow" is one of the major categories and it differs significantly from one hospital ward to another,

then the next step, to collect data, is observing more wards at a different time of the day to understand why and how "work flow" might be different. When the data has been collected, the "making comparison" would increase the possibilities of identifying these variations (Strauss and Corbin, 1998, p.201).

In initial sampling, researchers collect as much data as possible to conduct varieties of categories, while, after creating categories, in theoretical sampling, researchers intend to collect data toward developing and expanding existing categories. However, it does not mean that all the collected data will fall into those categories; it is possible that more categories will appear from the new data (Strauss and Corbin, 1998, p.203). Sensitivity, according to Strauss and Corbin (1998), towards the collected data is one of the major factors to finds concepts that are truly driven from the data. The more sensitive the researcher can be, the more accurate the concepts will be.

According to Alsop and Tompsett (2002), the validity of the axial coding and core categories can be tested in the theoretical sampling. The existing concepts and categories are used as a base for searching for new concepts to be added to the current categories to develop the open coding. These new concepts might create major changes to the categories and might even change the core category (Alsop and Tompsett, 2002).

3.2.6. Theoretical saturation

In the process of comparing categories, generating concepts and collecting more data, as soon as no more categories and concepts can be emerged from the data, then theoretical saturation has happened. This means that

new data cannot provide any new concepts. (Strauss and Corbin, 1998, p.212)

Thomson (2011) summarised theoretical sampling in three points, which are:

"(a) no new or relevant data seem to emerge regarding a category, (b) the category is well developed in terms of its properties and dimensions demonstrating variation, and (c) the relationships among categories are well established and validated".

3.2.7. Generating theory

This step is one of the most challenging parts, which divides researchers into different groups. For example, Glaser (1978) believes that theory should be discovered only from the data without any interpretation from the researchers. However, Strauss and Corbin (1998) clearly believe that the researcher's point of view can be treated as part of the data. Charmaz (2000, 2008) argues that theory cannot be discovered from the data, but it could be constructed from the data.

As Glaser (1978) highlighted, generating theory is never completely finished and it is an on-going business; however, at some point the researcher needs to decide that it is time to share the result with others and publish it.

3.3. Literature review of GT

GT offers a clear pathway, which provides a detailed analysis of the data by minimising pre-conceptions before the analysis, as Glaser and Strauss (1968) suggest:

"...clearly, a GT that is faithful to the everyday realities of the substantive area is one that has been carefully induced from the data."

While Glaser and Strauss (1968) believe that new concepts and reality can be discovered from the collected data, Corbin (2008) argues that there is no reality out there waiting to be discovered, rather there are concepts and ideas that can be invented. She continues that humans do not discover reality by quoting from Schwandt (1998) that "constructivist" indicates that people are creating and building something instead of discovering and finding it. In the time, that people experience something they begin to invent related concepts, schemes to that experience and will tested towards new experiences.

Charmaz (2006) seems to be agreeing with Corbin that theory is constructed from the data rather than being discovered. She argues that GT commences the comparison between a set of data to create a theory and then tries to search for new concepts in that theory, which might change the existing theory entirely and start a new concept. Thus, GT is more about inducting and reasoning to explore concepts, rather than discovering something new.

The jump from individual cases to general may cause some problems, such as how many individual cases are needed to conclude a generalization. However, this problem can be solved with the idea of theoretical sampling. According to Hood (2007), qualitative analysts describe their samples in so much detail that other people can decide whether it can be generalized or not. Therefore, the decision they make " are theoretical rather than statistical" (Hood, 2007).

Even though Glaser and Strauss (1968) advise researchers to avoid literature reviews too close to the subject that is been investigated, they

recommend researchers to compare their findings to the literature review after a theory has been developed from the data to prove the generalization.

Although it is good to have proofs from other research that the generalization of the collected data is genuine, Glaser and Strauss argue that a theory that had emerged from collected data cannot be refused or replaced by more data because it is linked too closely to the data. Also Corbin and Strauss (2008) argue that if researchers read all of the possible literature in their field there is a danger that they will become "literally paralyzed" and there would be no need to do qualitative research in the subject they are investigating. However, Urquhart (2006) argues that most of the experienced researchers already have a plenty of information about the subject that they are researching. Therefore, they need to be self-aware not to mix their knowledge into collected data until the theory has not been emerge as soon as the theory is discovered or constructed then comparison with existing data is allowed.

Glaser and Strauss (1976) and Hood (2007) insist that GT is a systematic approach and all the steps of the analysis should be followed exactly as it is been classically introduced. While, Corbin and Strauss (2008) argue that no researcher should be obsessed with the process of coding and should use the techniques as tools not directions, be flexible and relax and try to understand data and experiences rather than mechanically just following the structure of the methodology step by step. On one hand, having clear steps of analysis are one of the advantages of using GT, because it decreases the possibility of being overwhelmed by the data. If there are no obsessions with

reading, coding, categorising and re-joining the data together, there is a danger to misunderstand the data. On the other hand, as Strauss and Corbin (1998) discuss, the GT's procedures are designed to be used "creatively and flexibly by the researchers" and they advise to dismiss the idea of being dogmatic.

Glaser (2009) advises new researchers to be aware of the danger of "pure description" or pure guessing about data, which he calls it "immaculate conjectures", instead it should be a combination of both description and understanding. Charmaz (2006) explains that even the phrase "everything is data" is correct, but we have to keep in mind that it does not mean "data is everything". Researchers have to understand data and use their imagination to generalize and expand their situations. Corbin and Strauss (2008) discuss that there is always more than one story in data. Different researchers look at data with different perspective, even time has influence over the interpretation of data depending on the situations that researchers are in that specific time.

"Different researchers tend to focus on different aspects...data talk to them in different ways. What is different about each study is the level of significance accorded to each of the different phenomena and how they are put together in a study." (Corbin and Strauss 2008)

As Corbin and Strauss explain, participants use specific words to describe their experiences during an activity that they have been involved in; therefore, concepts are coming out of data in the interpretation of data. Some of these concepts are shared between participants and can be used to make and drive groups and categories. However, to understand and interpret each

object, different aspects of the object have to be understood under different conditions, to develop real understanding of the experiences, actions and problems described in the data. Corbin and Strauss (2008) divide these concepts into three levels of "basic-level", "low-level" and "high-level". The lower and basic levels provide the detail which is necessary for the higher level concepts to be shaped (Corbin and Strauss 2008).

"The cohesiveness of the theory occurs through the use of an overarching explanatory concept, one that stands above the rest, and that, taken together with the other concepts, explain the what, how, where, when and why of something." (Corbin and Strauss 2008)

3.3.1. Different opinion on how to do the coding in GT

Coding is the first step of analysing the data (after reading the data carefully to understand the context) in GT. Different researchers have different types of applying coding which might be different from what Strauss and Corbin (1998) suggested which is "open-coding , axial coding and selective coding". Glaser (1978) suggested "open-coding, selective coding and theoretical coding". Charmaz (2006) uses a combination of both suggested ways, with Strauss and Corbin (1998) and Glaser (1978) which is "open-coding, focused coding, axial coding and theoretical coding".

Miles and Huberman (1994) divided coding into three groups of "descriptive codes", "interpretive codes" and "pattern codes". Breaking down the data to meaningful smaller units, which are labelled to different concepts called descriptive codes. The researcher understanding of the concepts that are reported by the participants and attempting to discover the uncertain concepts coming from the data, called interpretive codes. Finally, the pattern

coding is finding similarities, regulations, exceptions and uniqueness in the data. (Miles and Huberman, 1994; Goulding, 1999)

The main point of the above discussion is that all of these alternative ways of coding are there to understand data, and find relationships between categories (This are the basic factor of axial coding, and theoretical coding). Urquhart (2006) explains that, as far as relationships between categories are understood, it does not matter which coding methods researchers choose to generate the theory. The use of memos and diagrams also help to understand the relationship between data in the process of comparison (Urquhart 2006, Charmaz 2006, Strauss and Corbin 1998).

Open coding seems to be the first and only part of the coding that all GT experts such as Glaser, Strauss, Corbin, Charmaz and others have in common. Corbin and Strauss (2008) suggest that before starting open coding, it is best to read the data without doing any writing, making memos or underlining. The reason is to get familiar with the data before starting any interpretation. This will help the researcher to experience the event as the participants experienced it.

After the first reading open coding can be started by dividing the data into different chunks. If the quantity of responses are large and have different concepts, the researcher can start to read more carefully to "identify all the concepts from the data" (Corbin and Strauss, 2008). In the other words, this could be labelling data with specific words and terms, managing memos and annotations, starting comparison and investigating ideas that appear in data.

Urquhart (2007) argues that biggest problem of GT is related to generating "low-level theories" which make it difficult for a final generalized theory to emerge. That is why Glaser and Strauss (1968) suggested developing only one or two "Core categories", which would make it easier to relate those categories to the final theory.

Reichertz (2007) argues that GT is not an inductive method after all and this has been proven by Popper and Kelle (1994, 2005) and Strubing (2004, ch27). He continues to say that this confusion has always been the case from the beginning of introduction of GT. He indicates the split of two directions of GT and the pre-knowledge that Strauss (1987, 1990) pointed out and this disagreement with Glaser (who insists that all codes and categories are coming from the data and pre-knowledge) does not affect the inductiveness of GT. Reichertz (2007) argues that if GT is the same as abduction (founded by Charles Peirce, 1839-1914) in the later edition of Strauss (1990) then that inductive approach is just a way of generalizing existing knowledge in collected data to a newer version, nothing more. However, abduction discovers new ideas by the interpretation of collected data; and, because something new has been founded in the data, which has not been discovered before, it is a discovery and something not adhered to previous knowledge.

The way Reichertz (2007) indicates "abduction" is related to chance, guess and "serendipity", instead of interpreting and discovering ideas and theories. He insists that abduction should not have any "specific procedural program", or pressure, or indeed any structure to be followed; however, it is part of a situation. If something is part of a situation; therefore, it has specific

circumstances and in other words, it is tied to a structure. He quotes from Peirce (1973) that no goal should be in mind and it should be like daydreaming, no logical mind and calculation should be involved. No goals and hypothesis is insisted for Glaser, Strauss, Corbin and Charmaz's work too, but not following any logic in the process of analysing will cause a chaotic environment and everything will depend on pure chance.

However, when it comes to the actual analysis of data, Reichertz (2007) argues that use of "useful" tools to analyse data is allowed and thinking towards the next step. Therefore, he suggests that use of tools and logic (to find out what should be done next) is allowed in discovering the theory. This is in contrast with what he was indicating earlier. In addition, it seems that as soon as a new surprising idea has been found, then creating rules is allowed to explain the surprising find. He concludes that GT is parallel to abduction (that simply means, in his view, that these two methods are similar if not the same) and this fact is more transparent in the later edition of GT by Strauss (1990). He claims that Strauss possibly knew this fact very well, but he did not directly point out this similarity in his work. However, it seems that Reichertz (2007) misses the point of inclusiveness in GT, which simply means everything is included in the analysis without being selective or looking for exceptions. Abduction in contrast, means deleting the parts that are not in the interest of the researcher. He argues, "Theories quasi emerge by themselves from the data (without any previous theoretical input)". Plainly, this is far from reality. Theories emerge from the considerable amount of

rigour, constructive and systematic analysis in the very last step of GT after reading, familiarizing, coding and categorising the data.

GT mostly has been used in Social Research and the use of GT in IS is recent. Urquhart (2001, 2004, 2006, 2010) indicate that the use of GT should be prized in IS even if it has not been used purely. An adopted version of GT in IS works rather smoothly to "generate concepts about the technology if not building theory" (Urquhart, 2006). She highlights the discussion of flexibility and adaption of GT in a conference panel with other researchers in IS such as "Bryant, Hughes, Myers, Trauth and herself" in 2004. She refers to her article in 2006 that shows four common myths about GT. "The researcher as blank slate, GT is inflexible, GT produces low level theories that don't do much, and GT is positivist/interpretivist." (Urquhart, 2006) Urquhart (2006) refers to Hughes and Howcroft (2000) who also recommended a "tailored" use of GT regarding to the situation of the research. However, she does emphasise that the researchers, who use GT in IS, should understand the adaptation system weil enough to develop the process of analysis and be aware of which part of the process they are using, why and which parts they are missing and show as much as detail as possible in their research about the analysis. She uses an example of the work of Lings and Lundell (2005) for adapting GT in their research and listing their adaptations clearly. In addition, she argues that the adaptation of GT has worked in other disciplines such as health, which generates concepts but did not develop any theories. Corbin and Strauss (2008) seem to be agreeing with Urquhart (2006) by pointing out that generating concepts and pure description in any research

will be acceptable by using GT. However, it needs to be clearly highlighted in the research that readers do not get confused between generating concepts and generating theory. Urquhart (2006) mentions combining GT with other methods, such as Baskerville and Pries-Heje (1999) who used GT in combination with Action Research. She also recommends the use of memos to clarify dimensions in the data and diagrams to show relationships between categories by referring to Charmaz (2006) and Strauss and Corbin (1998).

"Adaption of grounded theory in information systems show us that grounded theory method - GTM - can be applied in innovative ways to varied IS phenomena. Examples include fusing GT with Action Research (Baskerville and Pries-Heje 1999), using GTM for a software pre-evaluation framework (Ling and Lundell, 2005), and applying GTM to ontological analysis of scientific articles (Lamp 2006). Of course, an adaptation of grounded theory requires knowledge of what is being adapted, so the adaptation can be accounted for and analysed with regard to the strengths and original purpose of GTM." (Urquhart, 2006, 354)

Elliott et al. (2002) argues that GT approaches can improve HCI research by explaining the process of the development and changes which will consequently improve the design of the products of the research.

From the above reviews, it shows that GT is a solid method with a set of strong systematic steps that can help the analysis of any qualitative data; however, it is clear that applying the GT method requires a great deal of experience.

In this section, Grounded Theory was reviewed by outlining the different steps of the method. In addition, a literature review of the methodology was offered. The next section reviews Phenomenography, which is another candidate for complementary use with Activity Theory.

3.4. Phenomenography

Ference Marton a Swedish educational psychologist developed Phenomenography (Ph) in the 1970s. Ph is a qualitative research method that focuses on peoples' experiences and how they experience, understand and discern the same phenomenon in different ways. As Marton (1981) suggests, Ph should focus on the rich description and analysis of the experience that is explored in detail to understand the distinctive aspects of individuals' experiences.

"Ph is a research, which aims at description, analysis, and understanding of experiences; ...In Phenomenography, we suggest, we would deal with both the conceptual and the experiential, as well with what is thought of as that which is lived... also deal with what is culturally learned and with what are individually developed ways of relating ourselves to the world around us" (Marton, 1981,p.4&5).

Marton and Booth (1997) dispute that Ph is about the internal relationship between the subject (an individual) and the object (the world that the subject is experiencing) thus this relationship is always a unique experience. The description of the experience without the person who experienced it would not make sense; these two should always be described together. They argue that one should be clear that Ph is not the same as psychology. Psychology concentrates on the mental state of the subject, while Ph concentrates on the subjects and their experiences.

"What is experienced and how it is experienced are in focus, ... We are... interested in the way in which phenomenon is experienced (structurally and referentially), irrespective of whether it is reflected in the way a problem is solved or in immediate perception or in acting or in remembering...in Ph...you cannot deal with learning as you can in psychology" (Marton and Booth, 1997, p.114&115).

Berglund (2006) use the "Way of experiencing something" as a unit of description in Ph and "variation" as the object of Ph. He argues that data needs to be consequently collected in the way that shows the variations. Therefore, accurate planning and formulated questions need to be designed to maximize the outcome of the variations in the participants' responses. Also the interviewed participants needed to be selected in order to have different backgrounds and experiences to assure variation in the data. While, Marton and Pong (2005) introduce "conception" as the unit of description in Ph. They continued by saying Ph is about "different ways of understanding" a phenomenon by individuals, thus conceptions are presenting categories in the analysis of the descriptions (p. 335). The relationships between these categories show the degree of the complexity in the experiences, and the result of the Ph research creates the outcome space (set of categories of description which are logically related to one another) of ways of experiencing the phenomenon (Marton and Booth, 1997, p.121).

Berglund (2006) argues that categories have to be in close relationship with the phenomenon and distinguish the differences between each experience; these also need to be related to each other logically, which might create an inclusive structure. A phenomenon is described in a category by investigating the variation of experiences related to the same phenomenon. Additionally, having a fewer categories as possible to see all critical variations in the data is recommended.

Marton and Pong (2005) argue that the differences, in people's experiences, cannot be seen if there are not any variations for the comparison. They use

an example of a ventilation system. If it is always on, then not until it is off can the noise be heard. The different ways of experiencing a phenomenon will become clear when those experiences have been compared against each other, which is possible when categories are shaped and compared (p.336).

Figure 13

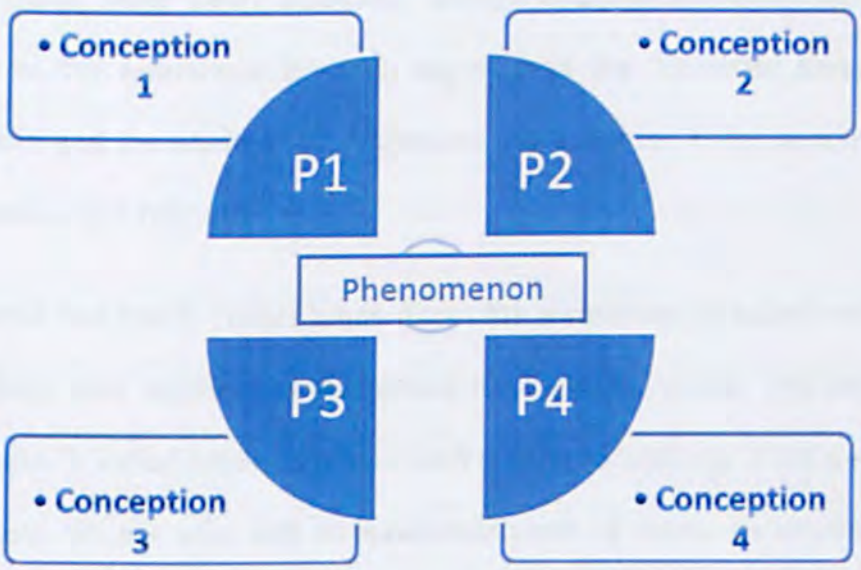


Figure 13 illustrates the general idea of Ph. There is a central phenomenon, four different individuals who called p1, p2, p3 and p4 are having different conceptions of the phenomenon, and Ph shows the variations.

Marton and Booth (1997) refer to two terms called the first-order perspective and second-order perspective. In the former, statements are made about the world, phenomena and situations. In the latter, statements are made about the ways of experiencing the world, phenomena and the situations. They argue that in the latter there are no judgments about the ways people experience the world, only validation that is allowed to compare the ways of

experiencing against each other to shape categories and variations. Ph uses a second-order perspective.

Marton and Booth (1997) explain that people, who are experiencing an object, might not be fully aware of how they are experiencing it (the way of experiencing) even though there are fully aware of the object. Whereas, in in second-order perspective, because data has been fully compared (experiences have been analysed, categorised against each other) the degree of the awareness is much higher than the first-order perspective. Variations and the study of the variations are essential in the second order perspective. (p.118&119)

As Marton and Booth (1997) argue about the awareness in experiencing the world, they also explain that awareness has different layers. The degree of awareness is varied between people and different situations. If the degree of awareness did not exist and all individuals were as aware as others, these different experiences would not exist either. (p.123)

Berglund (2006) reviews Ph to research learning in computing and he points out that Ph does not define how the individuals learn, although Ph summarises the differences between how the individuals experienced the learning.

Alsop and Tompsett (2006) point out three differences of Ph with any other research method that contains:

- "Data collections objectively" which means the collected data are presenting the subject's point of view and the variety of the data are more important than quantity of the data.

- "Hierarchy structure of the Outcome" that means the source of each part of the Outcome of the analysis should be referable to its root.

- "Specific characterization of the individuals' experiences" which signifies that every phenomenon is understood in different ways by different individuals.

3.4.1. Phenomenography (Ph) is different from Phenomenology

Ph and Phenomenology sometimes are mistaken as a same terms however, these two should be distinguished from each other. Larsson and Holmstrom (2007) explain that Ph focus on understanding the variations of people's experiences of a phenomenon, while Phenomenology concentrates on understanding the meaning of the phenomenon itself.

"Phenomenography and phenomenology share the term "phenomenon" which means "to make manifest "or "to bring to light". Phenomenography, with the suffix -graph, denotes a research approach aiming at describing the different ways a group of people understand a phenomenon (Marton, 1981), whereas phenomenology, with the suffix -logos, aims to clarify the structure and meaning of a phenomenon (Giorgi, 1999)." (Larsson and Holmstrom, 2007)

Both Ph and Phenomenology have individuals' experiences as their objects of the study. However, the first most fundamental difference is that Ph is not a research method or research theory but merely it is a way to study the answers, given to the designed questions about understanding individuals' experiences of the world and how those experiences are different from each

other (study of variations). While, Phenomenology has inseparable methods and theories that guide every step of the research. (Marton and Booth, 1997, p.116).

Marton and Booth (1997), Larsson and Holmstrom (2007) and Ornek (2008) point out another difference between Ph and Phenomenology which is Ph uses a second-order perspective, which explains the world as it is understood. While Phenomenology uses a first-order perspective, which indicates the world as it is.

According to Marton and Booth (1997) Phenomenology draws a clear line between experience and conceptual though, but Ph does not draw any line between the meaning of a phenomenon in experience or conceptual thought. In addition, Phenomenology's target is to depict a rich description of the experience, while Ph aims to categorise different experiences in a logical manner to find critical aspects of experiencing the world from different points of views (Marton and Booth, 1997, p.117).

Finally, as Marton and Booth (1997) argue "Phenomenography could be legitimately seen as a child of the Phenomenology family." (p.117)

Table 1

	Phenomenography	Phenomenology
1.	The structure and meaning of a phenomenon as experienced can be found in pre-reflective and conceptual thought.	A division is claimed between pre-reflective experience and conceptual thought.
2.	The aim is to describe variation in understanding from a perspective that views ways of experiencing phenomena as closed but not finite.	The aim is to clarify experiential foundations in the form of a singular essence.
3.	An emphasis on collective meaning.	An emphasis on individual experience.
4.	A second-order perspective in which experience remains at the descriptive level of participants' understanding, and research is presented in a distinctive, empirical manner.	A first-order perspective.
5.	Analysis leads to the identification of conceptions and outcome space.	Analysis leads to the identification of meaning units.

Table 1 from Ornek (2008) illustrates that how Ph differs from Phenomenology.

In the next section, Action Research as another complementary methodology to Activity Theory is reviewed.

3.5. Action Research

Action Research (AR) is an introspective forward-looking research method that constantly looks to solve a problem. According to Ehrhart (2002) AR has two fundamental differences with conventional research methods, first, the researcher is active in the community that s/he is working, and second, the knowledge obtained from the research is directly used to change the practice and solve the problem. AR was founded by Kurt Lewin a German-American psychologist in 1944. He explains, in one his earliest papers called "Action Research and minority problems" in 1946, to start an AR a problem needs to be identified first. However, according to Dickens and Watkins (1999) quoting from Argyris, Putnam, and Smith (1987), Lewin never formulated the process

of action research and left it to other researchers (such as Cunningham, 1993) to complete the process. The following steps have been developed in AR such as "diagnosis", which is identifying problems and have to be accomplished by an empirical comparison between other similar situations. Knowing the exact current situation is the second step of AR, for doing this fact-finding about the current situation is very important. The other steps are: planning how to solve the problem, taking actions toward solving the problem, having a standard evaluation for the progress, changing the plan if needed by considering evaluations, and, finally taking the second action toward solving the problem. Figure 14 shows the steps of the AR cycle. Dickens and Watkins (1999) indicated that because there are several forms of AR, each researcher or group of practitioners might select all or parts of these steps to achieve a discovery and improvement.

Figure 14

The researchers are divided into two groups around one of the fundamental elements of AR. One group of researchers such as Elliott, 1978; Kemmis and McTaggart, 1988; Kemmis, 2007; believe AR should be undertaken in an organisation, a school or any other communities with the members of the

staff in the same community, and that no professional researcher/analyst should come from outside and research the community as objects of the research. *"AR is a form of research carried out by practitioners into their own practice"* (Kemmis, 2007, p.167). On the other hand, another group of researchers such as Dickens and Watkins, 1999; Melrose, 2001; argue that professional analyst/researcher can be involved in the process of AR as long as they do not treat participants as the objects of the research and become part of the community that they are observing.

However, Ehrhart (2005) highlights that becoming a part of the community that the researcher observes is not quite so simple. According to him, many members of the community do not believe that the researchers have the same interest as them to solve the problem without having their own individual interest. Until the researchers really obtain their trust, the problem will stay unchanged.

"...what I learned from people ... was affected by the fact that I was neither indifferent nor unresponsive to, but instead open to and active in furthering, their concerns and agendas. For example, campesinos provided me with sensitive information because they trusted that I would not use or let it be used against them. Perhaps more importantly, individuals and institutions were willing to make time to learn with me because my research focused on issues of pragmatic interest to them." (Ehrhart, 2002, p.3)

Another problem that might happen during an AR process, is how knowledgeable the non-professional researchers inside a community are in terms of being able to produce valid research? As it was noted before, the focus of the AR is about finding a problem inside a practice, finding a possible solution and changes some elements of the practice to improve the

situation. Thus, the practitioners need to be experienced and have a good knowledge of the specific situation that they want to change and improve.

As Melrose (2001) suggested, AR can be started by one of the following points: "a problem, a hypothesis, an issue, a concern or a conflict" and AR could be used to enhance the reaction between people, work groups, communities inside organisations. She believes that AR would help researchers to be involved in the community that they are aiming to improve and the researchers have to work inside the organisation as a member of the staff and be part of the group as much as possible. They should not treat the individuals of the organisation just as case studies and objects of the research.

Melrose (2001) points out that both qualitative and quantitative research methods can be used with AR, because of the nature of AR, it pays attention to changes and improvements; however, she thinks that qualitative methods are more common for the reason that language explains the problems far more better than numbers.

Dickens and Watkins (1999) argue that since AR can use both qualitative and quantitative approaches and does not have any particular method to be used, that this, therefore might be a disadvantage. They also argue that sometimes the duration of the research does not match the duration of the organizational problem, thus a meaningful outcome of AR research might not be possible. (p.131). However, they also point out two very important advantages of using AR, which are experimenting in a holistic situation and not controlling the experiment as tightly as traditional science does. (p.130) In

addition, Dickens and Watkins (1999) highlight another difference between traditional science and AR, which is the level of knowledge. They argue that in AR, researchers/participants start with little knowledge about the specific situation and then observe, follow and perceive the situation to change and improve the circumstances. While in traditional science, researchers begin with a larger amount of hypothesis and knowledge about the situation and examine the facts to prove or disprove their hypothesis. In addition, they cited that not all other research methods necessarily desire to solve a problem, while AR attempt to discover the problem and solve it with a practical solution that can be applied in practice.

In AR, it is essential to discover a problem first and then to solve the problem, therefore Dickens and Watkins (1999) argue that any AR research has two steps of discovery and solution. To do so, the researcher needs to be involved in the situation to find the problem with the participants and also to improve the situation by taking actions toward solving the problem (p.132). The cyclical nature of AR helps to recognise the actions, plans and flexible changes that suit the environment to enforce the changes (p.132).

Lewin (1946) mainly points out that AR works well to study a group of individuals who work together in the same environment and when a problem is diagnosed in that environment, by interviewing members of the group, plans are drawn toward solving the identified problem. He emphasised that AR should not focus on generalising the solution, but focusing on the individuals in the group to solve the problem in that specific situation.

Carr and Kemmis (1983) argue that AR should be divided into three separate groups which they called "Technical AR", "Practical AR" and "Emancipatory AR". The aim of technical AR is to improve the facilities used in an organisation, and practical AR to encourage the groups working in an organisation to understand each other better. Finally, emancipatory AR, which is similar to practical AR, intends to solve a specific problem to liberate the organisation from their difficulties and the research works with a moderator in that situation.

Melrose (2001) points out that an AR research could start in one of the Carr and Kemmis (1983) phase such as technical AR and continues to another phase such as emancipatory.

Dickens and Watkins (1999) and Cunningham (1993) discuss the possibility of various versions of AR and point out that each researcher might take a different direction on emphasising AR. According to Cunningham (1993), some researchers might be more interested in indicating experiments; others might like to discuss learning, feedback and planning.

All of the above researchers show that to use AR there is a need of a "problem/issue" as a starting point. However, not every research is based on a problem/issue to be solved. Some research is just discovery of a phenomenon or description of a situation to view for a deeper understanding of the situation.

3.6. Selecting Grounded Theory

By choosing AT as the framework, the need of an appropriate approach, which is compatible with AT, and would also work successfully with the case in hand, is essential. Three different methods have been considered GT, AR and Ph. The nature of the case has significant impacts on different aspects of the research, such as, the ways of collecting data, analysing data and use of the data in the future. There are other factors that influence each of these aspects, such as role of the researcher, number of subjects/ participants in the research, what the expected outcomes of the research are and what data is available. (Alsop and Tompsett, 2001)

Both GT and Ph allow the researcher to add their understanding of the collected data (the researcher's interpretation) to the data analysis, but it needs to be transparent so that the reader can see where the researcher's opinion has been added to data. However, minimizing that bias, which increasing the awareness of the analyst, should be followed during the process of analysing data (Alsop and Tompsett, 2006 and Booth, 1997). Another similarity between GT and Ph is 'theoretical sampling'. Theoretical sampling is a process of gathering data to generate the theory by analysing data and thinking where and how to search for new data to develop the theory (Glaser and Strauss, 1968, p.45). However, this process is delayed in Ph until the end of the cycle of collecting data. (Alsop and Tompsett, 2006, p.244)

On the one hand, the main purpose of Ph is to understand "how" different individuals in a similar situation experience a specific phenomenon in

different variations. On the other hand, the main purpose of GT is to understand "why" a specific event happened. The former focuses on describing the event from different people's experiences and creating different categories of these variations. The latter concentrates on understanding the reasons of an event from the participants' points of view, it also attempts to find a theory, which emerges from the data. This study examines students' activities toward learning programming, and aims to understand the problems and issues that might be getting in the way of learning programming. The purpose here is to understand that "why" instead of only describing "how" an event happened, therefore, GT fits more closely to the purpose of this research.

AT has the advantage of also studying the relationships inside a community. GT allows for the design of questions for this purpose, everyone involved in the process of an activity can explain why and how an event happened, and if the relationship inside the community had any impact on the activity. However, Ph does not allow this. Ph concentrates on the different ways that individuals experience a phenomenon, therefore it just focuses on one person's view about the phenomena and compares it against other views. It does not study the relationships between different members of a group involved in an activity. For example, a tutor, a student, a mediator or even a technician can explain what happened in a classroom or workshop and give their opinions about the relationship inside the community.

Additionally, Ph allows the questions of the interview to be planned carefully to cover variations. This could be a disadvantage of using Ph since one of

the aspects of the research has been not to suggest any possible answers to the participants. GT also gives more opportunities to design a study that meets the needs of AT's ontology (such as subject, object, tools, etc.). On the other hand, both GT and Ph examine stories and open-ended questions instead of 'structured answers' (Osteraker, ?). Both AT and GT are based on non-preconceived hypotheses and theories that do not force the data to have desirable Outcomes, instead these methodologies have an open manner to collected data and to shape it into a theory (Rivers et al, 2009). Seaman (2008) summarizes the similarities of AT and GT into three points:

- "Non-predictive theory", AT has defined vocabulary; however, it does not encouraged any preconceptions. GT also avoids any assumptions, which helps emerging concepts naturally form the data.
- "Symbolic and interactionism", both AT and GT study the social elements of an event.
- "Complementary ambiguities", both AT and GT provide a good environment for interacting carefully with data.

Categorising and sub-categorising are common in both GT and Ph to find similarities and differences in the collected data. However, in Ph modelling is strongly prohibited as Alsop and Tompsett (2006) and Marton & Booth (1997) argue, Ph does not aim to provide any model of human ability to learn. However, one of the purposes of GT is generating a theory from the data or producing a model for future learning. This aspect of GT well accommodates the purpose of AT research to find shifts (as solutions) for the contradictions.

Another difference between GT and Ph is that, all data needs to be collected in one-pass occasion for Ph and analysis in not allowed until all the data has been collected. While, in GT the process of analysis can be started straight away and the process of collecting data can be repeated as many time as needed to reach saturation. This aspect of GT meets the need to study the history of the activity in AT.

Ph expresses experience and experience is coming from having knowledge (Ornek, 2008). First year students starting to learn programming do not have enough knowledge of the programming, therefore they might not be the best candidates for Ph research. However, Ph could be used to observe the students instead of interviewing them, and the problem of limited knowledge of the subject would be solved, although another problem would be added, because one of the aspects of this research is to understand students' perspectives of the process of learning and how that can be improved. Also, observation might not be the best method for Ph research either, since Ph aims to reflect on individuals' experiences from their point of view not from the research's perspective. While, GT is mostly a method that guides to collect data, how to analyse the data and can work on any sample.

GT deals well with generalization during the process of the research, every time that a gap starts to appear because of the cycling process, a researcher will go back to collect more data, will have the ability to look at the history of the research and compare the findings with the secondary data and fill the gaps. However, generalization is a problem in AR, which just looks at the current situation on a specific group of people and intends to solve a specific

problem that happened during the research life, it makes AR limited to the local situation (Dick and Swepson, 1997; Dickens and Watkins, 1999). In addition, because AR has to have a problem to start with and solving that problem is one of the main interests of AR, this makes it difficult to use in the case study of this research, because there is not necessarily a problem to solve here. For example, in this research, the activity of learning Java or the activity of learning any kind of programming is not a problem to solve, instead one of the missions of this research is to find out which tools can improve the state of the learning Java or any other programming. One might argue that some students do not learn programming as well as other students, which could be potentially a problem, which need to be solved. However, the purpose of this research is not to study why some students learn better than others.

Another advantage of GT over AR could be the involvement of the researcher and participants in the research. The involvement in AR is very restricted for both researcher and participants. For example, researcher in AR needs to be involved in the Activity instead of researching on it and be part of the process of the activity. In this research the activity is learning Java, it would not be appropriate, neither possible, for the researcher. For example, in this case study, the researcher is already familiar with Java programming, therefore learning Java is not an activity that the researcher can be involved in at the same level as the participants (students).

AR gives co-researcher status to Subjects. This means that there has to be constant re-agreement on how data is collected and interpreted. This is

problematic for this context because the sample is changing (students differ from one semester to another semester). GT does not have this co-researcher requirement and allows the sample to change/grow. Table 2 summarises the differences between GT, AR and Ph.

Table 2

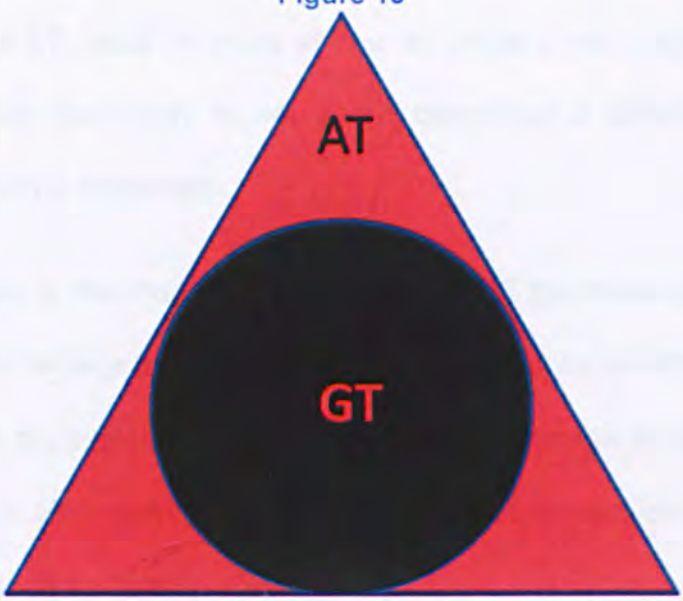
	GT	AR	Ph
Starting point	An inductive research approach that develops a hypothesis by collecting and analysing data, rather than starting with a hypothesis and testing it.	It starts with a practical issue that needs a solution and collects feedback to inform iterative changes to establish a solution.	Seeks to explain/describe how different people experience the same problem or phenomena.
Sampling	Theoretical sampling could be started right away after the first data collection.	The focus is not on developing a theory, but solving a problem	Theoretical sampling delayed until end of the cycle.
Generalisation	Through growing the data and resulting models generalisation can be achieved.	Generalisation in AR is not possible. The outcome is limited to the local situation only.	The outcome might be generalisable, but this is debatable.
Focus of the Research	The main question in GT is why a situation happened.	The focus is on solving a problem.	Identifying the differences in experience.
Research Scope	Involvement of the Researcher aims to be neutral. They might not be directly involved in the activity, but need to log their thoughts and experiences to allow an audit trail through their analysis	The participants become co-researchers in the process. In some situations, researchers are the participants and research on their own actions. (Dickens and Watkins, 1999)	The researcher is separate from the subjects, and makes decisions on the data from a 'higher' hierarchical position to the subjects.

Finally, GT allows the researcher to read about the subject in the process of 'theoretical saturation' and it would help the researcher to understand the situation better. AT also examines subjects in different levels of study and a subject could change from time to time (AT studies history of changes in the

activity). However, both AR and Ph concentrate on one specific situation and do not follow a history of events.

In this research, GT has been used as a complementary method to Activity Theory (AT) framework and it is embedded in the AT. Therefore, not all of the steps and levels of GT have been followed. The following diagram (figure 15) aims to show this relationship.

Figure 15



AT is the main framework of this research. GT is framed by AT and surrounded by the ontology of AT, it means that not all steps of GT have been followed purely. In addition, collecting data has been undertaken according to the AT's ontology, however with enlighten of the GT's methods, questions have been asked in a very open manner that does not suggest any specific answers. The only element of the AT's ontology that has been used is the "Tool". The students have been asked what tools they have used during their experiences. However, they have been encouraged to use their

own language to describe an event. These initial steps are the base of the new method, which will be explained and designed in chapter 5.

3.7. Conclusion

This chapter has presented a review of the selected methods, their suitability and flexibility for this research.

In addition, it has summarised that why GT has been selected. For instance, GT studies why a particular incident had happened which is quite similar to the purpose of AT, while Ph looks at how an incident had happened instead of why, which this study is not about describing a situation but more interested in why it happened.

Another reason is the matter of generalisation. GT generates generalisation clearly with the emerged theories, however AR does not provides any kind of generalisation because it focuses on a specific situation in an exact time and environment. It also normally begins with an issue or problem, which might not be the case in an Activity Theory study.

One of the reasons that GT was considered to be a complement method for AT is that AT does not offer a clear structure of how to collect data, while GT offers a clear approach for collecting and analysing data. Furthermore, AT has the advantage of studying the relationships inside a community. GT allows for the design of questions for this purpose, everyone involved in the process of an activity can explain why and how an event happened, and if the relationships inside the community had any impact on the activity.

The next chapter will illustrate and explore the case study of learning programming, data collection process as well as presenting a clear structure of the data and explaining what kind of data has been collected for this work.

Chapter 4 – Case Study

4.1. Introduction

This research is based on a case study of students learning to programme at first year undergraduate level at Kingston University (KU). The aim is to discover the problems/difficulties that exist in the process of learning and teaching programming languages and suggest potential solutions to solve these. As discussed before in chapter 2, these difficulties are called "contradictions" in AT. The term "contradiction" will be used in this thesis to describe these problems. Moreover, the term "shift" is used to describe potential solutions that would transfer the contradictions towards a desired Outcome.

This chapter introduces the case study and its different elements by reviewing, who is involved in the process of learning, and what aspects will be studied in this research. In addition, the selected samples and the process of data collection will be explained.

4.2. Learning Programming

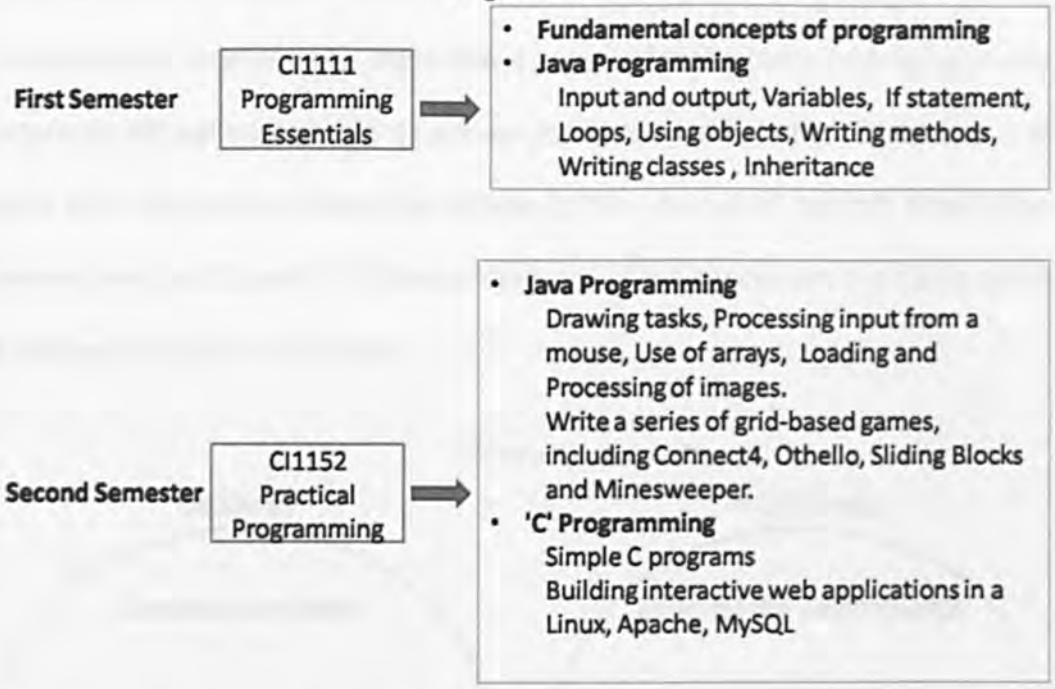
This research took place over 3 years. It involved studying how students were taught and learnt programming. The students cover learning the basic concepts of Java for the first semester in a module called Programming Essentials. In the 2nd semester students either progress their knowledge of Java and learn some C or learn Ruby on Rails in a module called Practical Programming (this research just covered and observed the Java and C elements). Both modules have been taught using Lectures, Workshops and Online discussion forums through a learning management system -

Blackboard. Lectures consist of face-to-face presentations of new material, as these are supported by online videos for the first semester. Workshops offer more hands-on practical sessions in which students use computers in the University's computers laboratories to complete an assignment each week. Members of staff, including the lecturer, technicians and teaching assistants, are present during the workshops to help students to complete their assignments. Students also have access to all materials via Blackboard and online access to the Internet. If the students have questions about the assignments, one of the staff helps them to understand what is required. If errors in the code occur, they will get help. If students have any questions that have not been answered in the lectures or workshops then they have the opportunity to raise those in the online discussion forums, which are answered by staff (normally by the module leader).

Currently, for Java assignments, "TextPad" is in use in the workshops as a development tool, however, a Java compiler also needs to be installed on the computers in use to compile the programs written by the students. Other tools that the students can use to help them to learn Java include their textbooks, online materials available in Blackboard and the wide range of websites available online such as Sun Java.

Help is also available through extra sessions either with the module leader or with other lecturer assistants during a specific advertised time each week. In addition to all this, students need to study in their own time as well as attend their workshops and lectures. Figure 16 shows a diagram of the modules and the concepts taught.

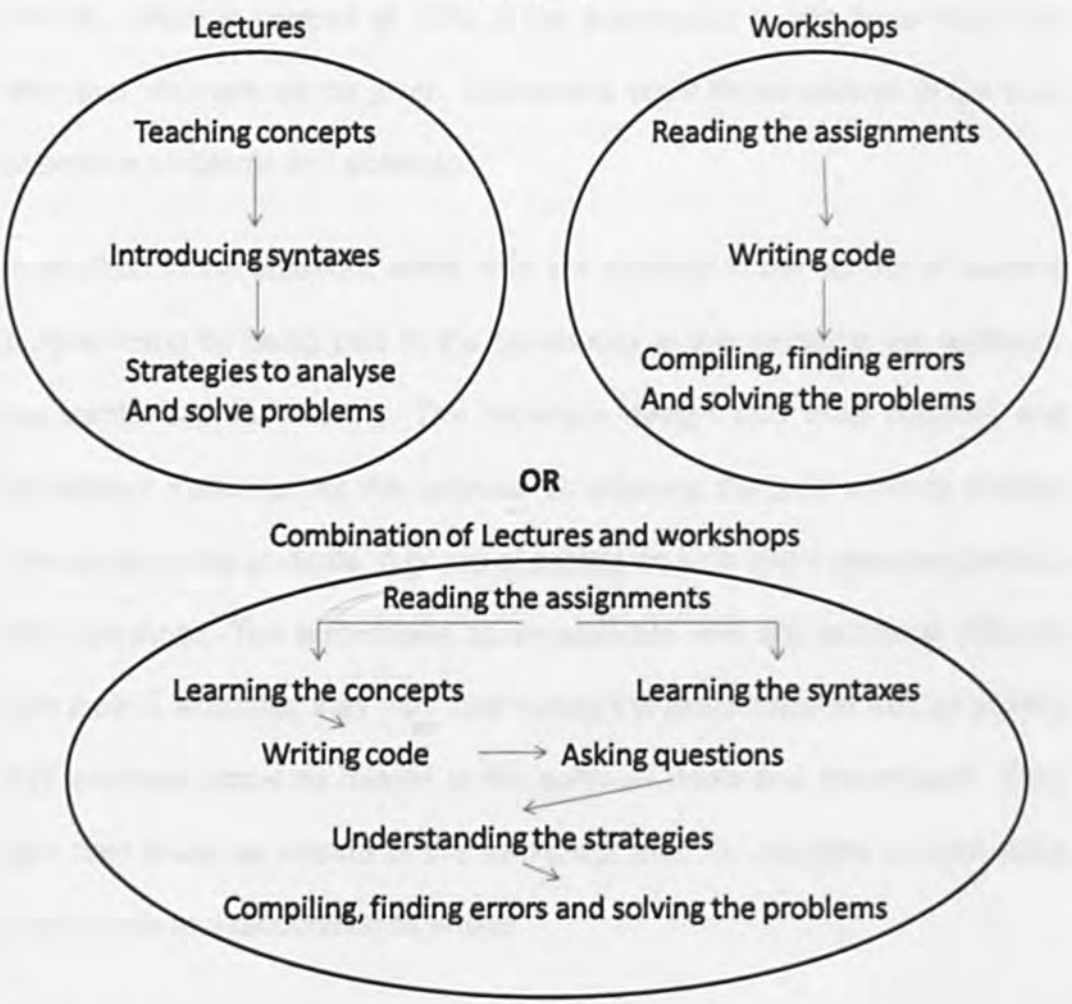
Figure 16



The modules are full time and students are involved in various activities. For example, students can access their course materials, such as lecture notes, Java code and their marks online through Blackboard. In addition Students can use books that are available in the library and have access to online tutorials about Java, both are recommended by the lecturers; and their own favourite tutorial websites. Indeed, they can use any kind of materials that they please to learn Java. In these two modules that have been observed by the researcher, the concepts of the programming and the structure of syntaxes will be introduced to the students in the lectures. They also have two-hour workshops each week, which allow them to practise writing programs using TextPad on the theories they have learnt from the lectures. Students will be challenged by a series of assignments related to the concepts that they have taught. They need to write a program to solve a specific problem, test or compile their code and solve any errors they receive to ensure that the final program works according to the initial requirements of

the assignments. Lecturers and Lecturer Assistants are helping the students in workshops. Additionally, there are a group of technicians to help with any technical difficulties that might happen during the workshops. Of course, it is likely that they also collaborate outside of the structured contact time using various means. Figure 17 shows a diagram of the processes that take place in the lectures and workshops.

Figure 17



The Programming Essentials Module, in the first semester, assesses students by a combination of assignments and a final in-class test. Assignments are marked each week and are worth 50% in total of the final mark. Students can access their marks in Blackboard. The remaining 50%

represents the in-class test. The Practical Programming Module in the second semester assesses students in the same way as the first semester except the final mark is made up of a combination of both C and Java and the students' assignments. The Ruby on rails component is not studied in this research. To achieve the full mark for their assignments, students have to meet their deadlines. However, if they fail to do so, they still might be able to submit their work but it will be subjected to the Late Work Policy of the Faculty, which is capped at 40%, if the submission is late for a week and after that, no mark will be given. Exceptions might be considered in the case of serious problems and sickness.

In addition to the students, staffs who are involved in the activity of learning programming by being part of the community in this research are lecturers, assistants and technicians. The lecturers design and write lectures and workshops materials, for the modules considering the programming abilities of majority of the students. A group of assistants help and support students in the workshops. The technicians assist students with any technical difficulty with their IT accounts they may face during the workshops as well as solving any technical problems related to the software, tools and the network. They also help students outside of the workshop time, for example by answering phone calls and responding to emails.

4.3. Data Collection

Initially focus groups were designed to collect data from the students and emails were send to 200 students registered on Practical programming module in 2008-2009 second semester and four different times and days

were suggested which was chosen according to first year students availability. However, no responses were received in a month. In the second attempt, emails were sent to the same group of students and asking them to participate over lunchtime with food, no responses were received this time either. In addition, in couple of workshops, students were asked to volunteer as participants for the research, but no one was willing to participate. After four unsuccessful attempts, a change of plan was necessary.

After long discussion with the staff involved in teaching programming at Kingston University, instead of focus group for students, two open-ended questions (appendix 1) were used to collect data from workshops with the help of module leaders. Students were asked to answer two questions about their best and worst educational experiences during learning programming in first year at Kingston University. They also have been asked to summarize their responses into less than five words. The same questions were used for the first and second semester of 2009-2010 as well as re-sit exams (appendix 1). Although, it still was quite hard to encourage students to answer the questions, open-ended questions helped to get students more involved in the research. During 2009 until 2011, in 6 semesters, questions were distributed between at least 600 students. The numbers of students that returned almost completed answers to both questions summed up to 109.

After the first series of the analyses of the students' responses, the result of the analysis showed that to achieve a higher level of understanding of the events described with the students, a greater deal of data is needed. Therefore, it was decided to collect data from the staff in KU, who are

involved in the process of teaching programming, and observe the programming learning workshops. In addition, the analyses also revealed that some of the elements of the AT's ontology such as Rules have not been described in either students' responses nor in the staff's responses. Thus, studying core modules' documents seems to be necessary. As a result, four different types of data have been collected for this research, which are as follow:

- Individual responses from students (109),
- Staff views through focus groups (8),
- Core modules documents for CI1111 and CI1152, and
- Observations of the two modules' workshops (the researcher's notes and memos of the events in the workshops – approximately 30 workshops).

As discussed before, the activity of learning programming to achieve an outcome is carried out by a community, which includes Staff and Students, who are vital to the process of learning and teaching. However, information from focus groups and individual responses did not cover all aspects required by AT's ontology, therefore observation and document analysis was needed. These four types of data and the way that these have been collected are now explained.

4.4. Focus group of staff

Focus groups were used to collect data from staff. A process designed by Tompsett and Alsop 2003; was used to collect the data (The reason to use a focus group instead of questionnaires was to ensure that the data being

collected is in the language of the subjects and not the researcher). The process has four steps: Firstly, staffs were asked to describe their two best and worst specific educational experiences they had had in the past years of using tools to teach programming. The second step was to summarize their stories into a single word or a brief phrase. Then, they reviewed each other's stories in the group by circulating their stories, as they read each other's stories they noted any important points that came to mind. Finally, they summarised each other's stories. When they all finished reading and summarising each other's stories then they discussed all the summaries and looked to come to a common agreement, in the terms of an overall summary. Also if they still had time, they were asked to discuss any further issues that they thought had not been included.

4.5. Individual responses from students

To collect data from students, two open-ended questions were used in the workshops of modules CI1111 and CI1152 with the help of module leaders in 2009-2010 and 2010-2011. Students were asked to answer two questions about their best and worst educational experiences. They were also asked to summarize their responses in less than five words. After the first initial analysis the questions were changed for the first semester of 2010-2011 to also ask which tools were used. In addition, one of the lecturers involved in the process of collecting data suggested shorter questions by deleting some of the explanations to make it simpler for the students to read. Also in autumn 2010, the same group of students from module CI1152, who had passed their exam and started another programming module in their second year,

were asked to write their positive and negative stories again about the previous year.

It is clear, that no hypothesises was introduced in these questions to maintain the key aspects of GT. However, the initial analyses showed, there is a need to use some language that aids the information being gathered to be aligned towards AT's ontology. Hence, the word 'tool(s)' was used.

Students needed to be sufficiently willing to provide feedback, but, ethically, they could not be forced to do so. Therefore, the questions were distributed among the students in the workshops, and the students that have decided to answer the questions returned the completed forms (109 out of proximity 500 students in five workshops).

4.6. Observation

The researcher has observed both modules during five semesters from 2008-2011. The researcher has been involved in the workshops of both modules as well as drop-in clinics - sessions run on a one-to-one or small group basis where the researcher consults the students about their difficulties with Java programming. Notes have been taken during the workshops related to how students accomplish their assignments, what tools they use to learn programming and what actions they take when facing problem/errors in the process of learning programming. In addition, on a single occasion the staffs, who ran and assisted the workshops, were asked to observe and record – writing down - the common mistakes that the students made during the workshops.

4.7. Documentation

The researcher has studied module guides, lectures notes and workshop instructions, in order to understand the Rules, the Communities involved and the Division of Labour in the modules.

The module guides specify the lecture topic schedule, assignments, the workshops, teaching hours and self-study hours required to complete the module successfully. In addition, they contain the rules for submitting assignments and taking the exam, the Communities involved in the process of teaching in the lectures and assisting in the workshops.

The lecture notes explain the topics and provide examples for the taught concepts. The workshop instructions guide students, step-by-step, to accomplish their assignments and solve the problems introduced.

4.8. Conclusion

The process of data collection and the sample groups that have been involved have been identified. The four groups of data that have been collected include: individual responses from the first year students learning programming, focus group of staff teaching programming to the first year students, observation over 3 years and finally module documentation.

The next chapter presents the design of the new method. The method will then be tested on test cases.

Chapter 5 – Developing a new method

5.1. Introduction

As reviewed in chapters one and two, AT did not offer any clear pathway of how to collect and analyse data, therefore it was argued that AT would benefit from a complementary method to be coupled with it (it was previously concluded that GT would be the appropriate choice). In this chapter, the initial analyses will show that AT alone does not offer a viable solution for analysis, therefore a new method based on AT will be designed.

5.2. Developing the method – A combination of Activity Theory and Grounded Theory

Collecting data is the first step for almost any research that depends on primary data from real participants. However, as discussed before, AT does not offer any clear pathway of how to collect data; however, it does provide a defined ontology.

Therefore, the first step is to use GT as a method to collect data, which has a clear established process. GT advises the researchers not to have any preconceptions about the topic, issue or the area that they are trying to collect data about, at the same time, as Dey (1995) argues, to be "open-minded but not empty headed". Researchers will have some sort of information and knowledge about the subject; however, they have to be aware enough not to use it. GT allows for the use of, for example, open-ended questions, interviews, focus groups, observation, recording video and voices for data collection. However, the questions should be designed very carefully so that they do not suggest any hypothesis and do not propose any

idea to the participants as an answer. Therefore, for this research, two open-ended questions (developed by Tompsett and Alsop, 2003) were used. These questions asked students about their positive and negative experiences that they had during learning programming in the past in a specific event. Students were asked to describe their experiences in their own language and, by end of their description, add a single word, or at most 5 words, to summarise their story.

Through a process of iteration on a sample of data, a new method was developed. Therefore, 12 responses were selected from the students' data set. The process began by reading original version of the students' responses without taking any notes or underlining the text.

Figure 18 represents an example of the students' responses. After reading the responses a few times to get familiar with the data, the next step was to find a way to analyse the data as close as possible to the students' language. At the first iteration, the researcher analysed the initial collected data with the use of AT's framework. ASs were drawn by hand for each responses to illustrate the activity that was described in the student's response. From this initial analysis, it was clear that more explanation and interpretation was necessary to understand what was happening in reality. In addition, it becomes clear that AT alone does not visibly advise how to do the analysis. Therefore, it was decided that another qualitative methodology needed to be considered. As explained in chapter 2, GT was chosen to be used.

Figure 18

A Case Study using the framework of Activity Theory to examine the tools used by students towards their assessments outcomes on 1st year programming module(s) in Higher Education.'

Study A. Initial Grounded Theory Question 1 – Worst Experience

s8

Question

You will have had a range of experiences in using various tools to learn programming. Some experiences will have appeared more helpful, some less helpful, some challenging or satisfying and some others less effective, confusing or even frustrating.

I would like you to concentrate on what you, personally, could identify as a single occasion which you consider as the occasion (or one of the occasions) *which was the worst educational experience* when using one of these tools.

I would like you to tell us about this event. Please write about 8-15 sentences in the space below that outline the details of how the event occurred.

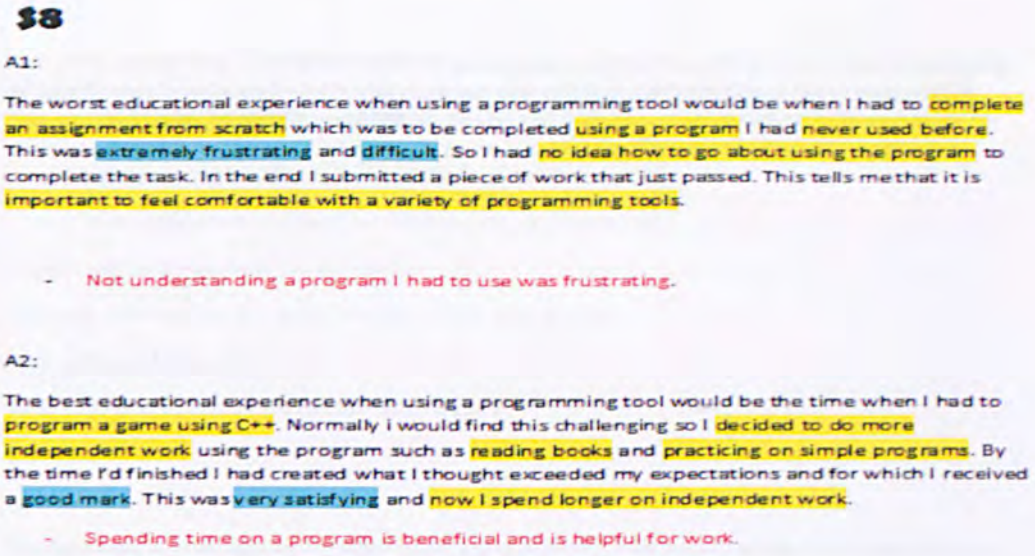
Your Story

The worst educational experience when using a programming tool would be when I had to complete an assignment from scratch which was due in & to be completed using a program I had never used before. This was extremely frustrating & difficult as I had no idea how to go about using the program to complete the task. In the end I submitted a piece of work that just passed. This tells me that it is important to feel comfortable with a variety of programming tools.

– Not understanding a program I had to use was frustrating

In the second iteration of the analysis, a word template document was designed and used for retyping and common formation for al responses. This insured that writings were understood. In addition, the text was marked with different colours to emphasise the key points that the student made in the text. Figure 19 shows an example of highlighting the key points.

Figure 19



$8

A1:

The worst educational experience when using a programming tool would be when I had to complete an assignment from scratch which was to be completed using a program I had never used before. This was extremely frustrating and difficult. So I had no idea how to go about using the program to complete the task. In the end I submitted a piece of work that just passed. This tells me that it is important to feel comfortable with a variety of programming tools.

- Not understanding a program I had to use was frustrating.

A2:

The best educational experience when using a programming tool would be the time when I had to program a game using C++. Normally I would find this challenging so I decided to do more independent work using the program such as reading books and practicing on simple programs. By the time I'd finished I had created what I thought exceeded my expectations and for which I received a good mark. This was very satisfying and now I spend longer on independent work.

- Spending time on a program is beneficial and is helpful for work.

The next step was to identify any terms of AT's ontology in the text. An example of the second iteration step is illustrated in figure 20 In this specific response, some of the language used by the Subject is difficult to allocate to AT's ontology. The Object (completing the assignment), the Subject (Student) and outcomes (not understanding the program in use) are clear, while the Tool, the Community and Rules might not be mentioned directly. However, when it is considered that the data has been collected in a specific workshop, it could be guessed that what tools for example s/he has used. To be on the safe side, not making any consumptions that are not included in the data, and after reading and studying other responses, the general word of IDEs was used wherever the name of the specific programming Tool was missing (Figure 21).

Figure 20

S8

The worst educational experience when using a programming tool would be when I had to complete an assignment from scratch which was to be completed using a program I had never used before. This was extremely frustrating and difficult. So I had no idea how to go about using the program to complete the task. In the end I submitted a piece of work that just passed. This tells me that it is important to feel comfortable with a variety of programming tools.

- Not understanding a program I had to use was frustrating.

Object: writing assignment from scratch

Problem: not knowing the tools/ program/ how does it work?

Frustrating and difficult

Need to know the tool to be comfortable to use it

A2:

The best educational experience when using a programming tool would be the time when I had to program a game using C++. Normally i would find this challenging so I decided to do more independent work using the program such as reading books and practicing on simple programs. By the time I'd finished I had created what I thought exceeded my expectations and for which I received a good mark. This was very satisfying and now I spend longer on independent work.

- Spending time on a program is beneficial and is helpful for work.

Object: design a game in C++

Satisfaction and good mark

Working on independent work

Motivation because of the good result → my opinion

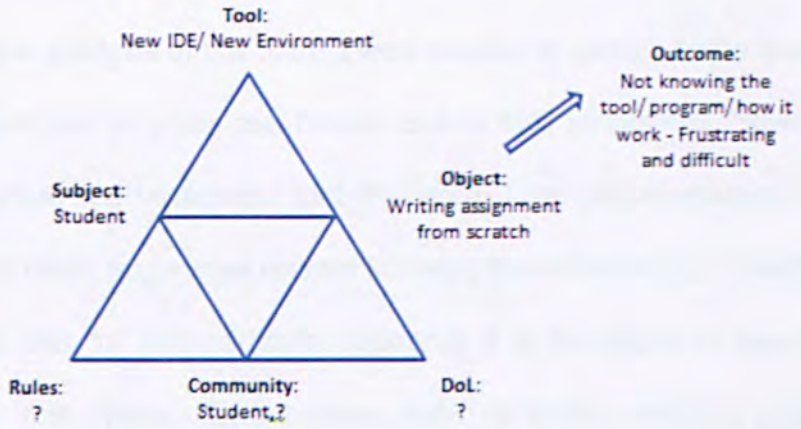
The next step was to draw ASs of the activity to examine the context to study any possible contradictions that prevented achieving the desired Outcome (Figure 21).

The contradiction in this example happened when the students did not know how to use the IDE that had to be used to write the program. The student is clear about was caused the problem, while s/he does not point out if s/he asked for any helped or clarification from the staff, neither it is clear that any other members of the Community were involved in the activity or not. Although, in this example the contradiction is clearly has been emphasized by the student as "not knowing the environment (the new IDE)".

Figure 21

S8

The worst educational experience when using a programming tool would be when I had to complete an assignment from scratch which was to be completed using a program I had never used before. This was extremely frustrating and difficult. So I had no idea how to go about using the program to complete the task. In the end I submitted a piece of work that just passed. This tells me that it is important to feel comfortable with a variety of programming tools. - Not understanding a program I had to use was frustrating	Subject: Student Object: writing assignment from scratch Outcome: not knowing the tools/ program/ how it work - Frustrating and difficult Tool- New environment – new IDE Need to know the tool to be comfortable to use it



After drawing ASs for each activity described in the students' responses, it showed that the whole picture of the activity in one large AS might be hard to understand. Thus, it was broken down to three smaller ASs that would show more detailed elements of AT which would made it easier to interpret contradictions.

The 12 selected responses went through all three above iterations' steps. These iterations allowed for changes to occur in the process of the analyses and a new method to be developed.

During the first analyses processes, a qualitative software was considered for data analysis. This is in general called Computer Assisted/Aided Qualitative Data Analysis (CAQDAS). Therefore, the researcher attended two conferences that introduced CAQDAS such as ATLAS, Nvivo, MAXQDA and HyperRESEARCH. After studying this software Nvivo was chosen for this research. To learn and understand Nvivo in its maximum potential, the researcher attended two full day sessions of introduction and advance Nvivo courses. All the data was coded and imported to Nvivo.

Moreover, for the analysis of the data, it was needed to design some queries to show, for example, who has mentioned Java in their responses. However, it would just return the paragraph that the word Java has mentioned in it, which could not make any sense without knowing the whole story. Therefore, it was decided that for this particular research it is beneficial to keep the analysis away from Nvivo. Nevertheless, Nvivo is quite useful to analyse large quantity of data that involves processing, managing and grouping images and videos. The reason is that videos can be divided to different sections, which make it easier to be analysed (like video time frame).

The next section describes the new method. This method will be applied in the next chapter.

5.3. Description of the new method

As described above, the first step is to read the response thoroughly to understand the student's point of view, without taking any notes or memos. After getting familiar with the data, the next step was to mark up the key points and take notes from the data according to AT's ontology. The

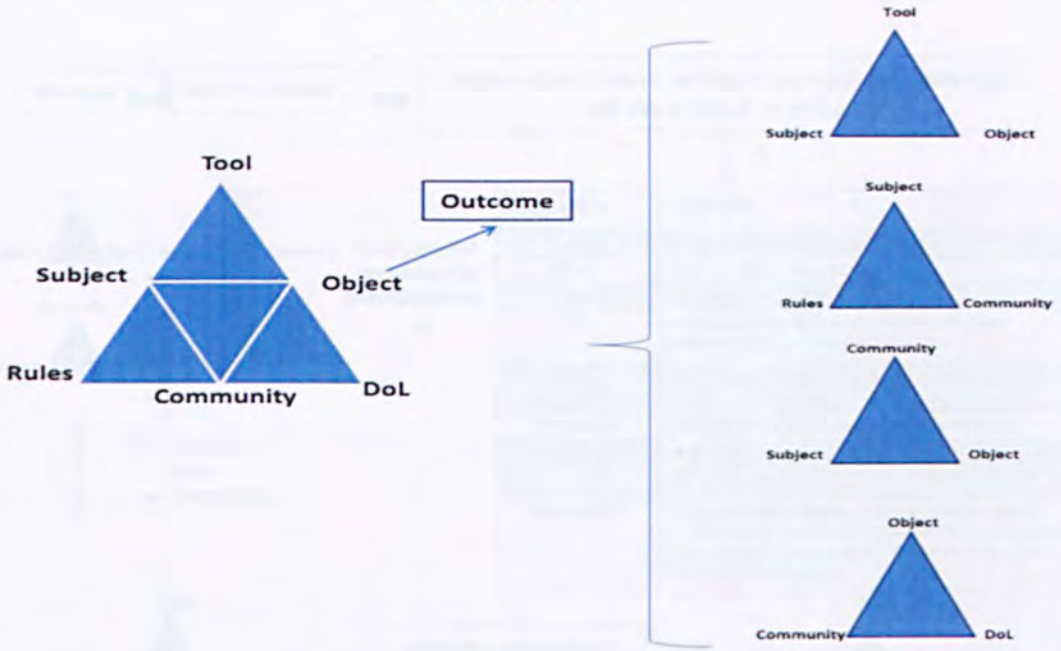
researcher had to examine the data for all elements of the ontology: Subject, Object, Tools, Rules, DoL, Communities and the Outcome of the activity. If the Outcome is different from the desired Outcome, then a contradiction would had taken place and this needed to be recorded. Finally, the researcher's interpretation was added, by writing down the possible reasons of why a contradiction happened and what the potential shifts to solve the contradiction were. A table was used to organise all of the elements of the AS in one place, which is illustrated in table 3.

Table 3

AT's ontology	Explanation
Subject	Who is the subject of the activity?
Object	What is the object of the activity?
Tool	what tools are used in the activity?
DoL	Actions that any members of the community take toward transforming the object to the desired outcome
Rules	Norms, conventions that the members of the community need to follow
Community	Any individuals and groups who are involved in the activity
Outcome	IS the outcome same as the desired outcome, if not what are the contradictions (what elements prevent the desired outcome)?
interpretation	Find contradictions in the data, which prevent having a desired outcome – interpret as close as possible to the data – when adding your own idea which are not coming from the data, make sure to make it clear and transparent

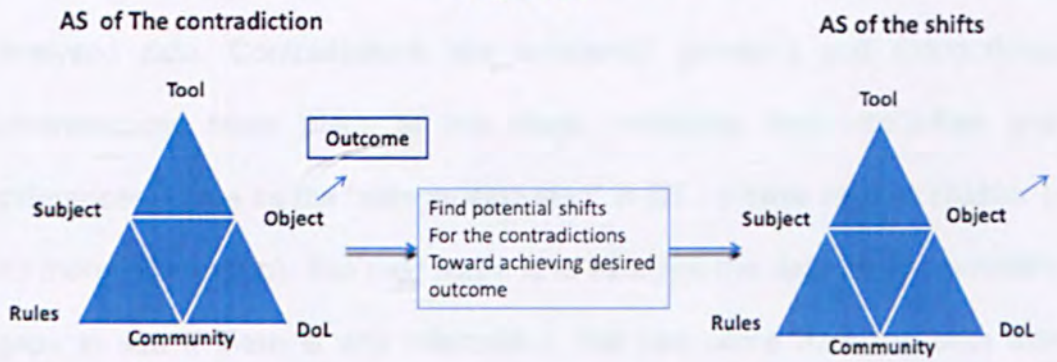
The next step is to draw an overall AS triangle to illustrate a whole picture of the activity in one glance and breakdowns ASs of the activity for a more detailed overview. (Figure 22)

Figure 22



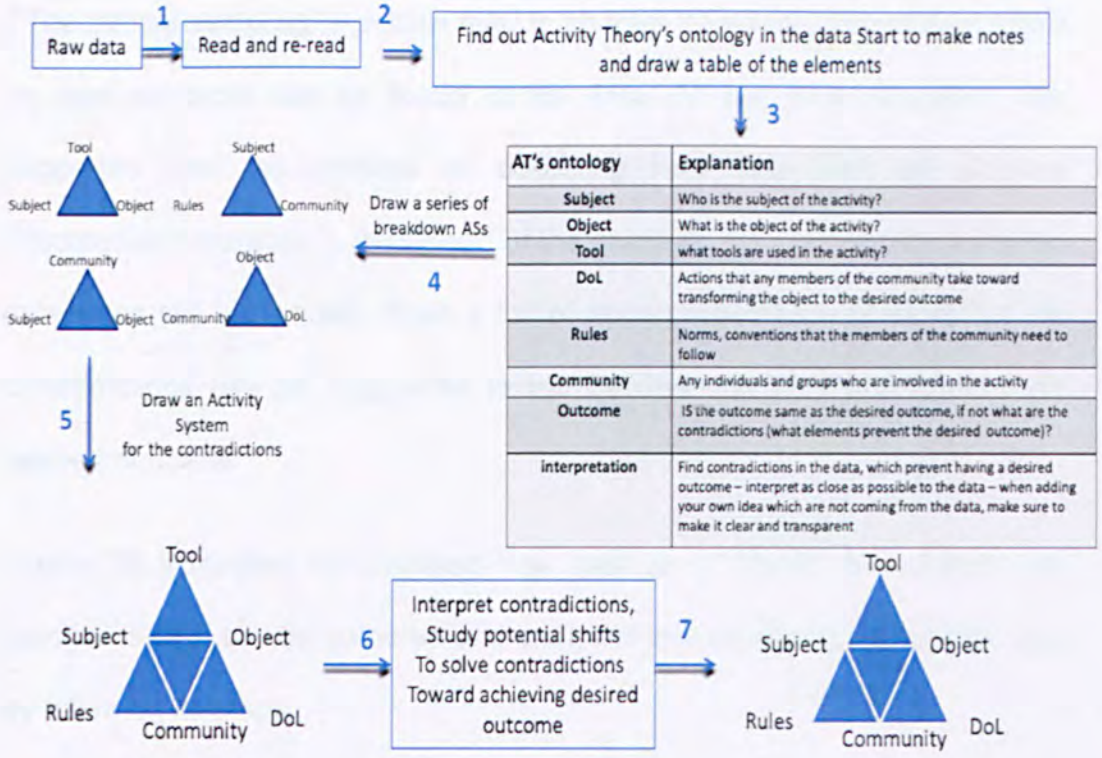
In addition, finding potential shifts to solve the possible contradictions occurring in the activity. (Figure 23)

Figure 23



The first step of the analysis required the above steps to be repeated for all the collected data according to figure 24.

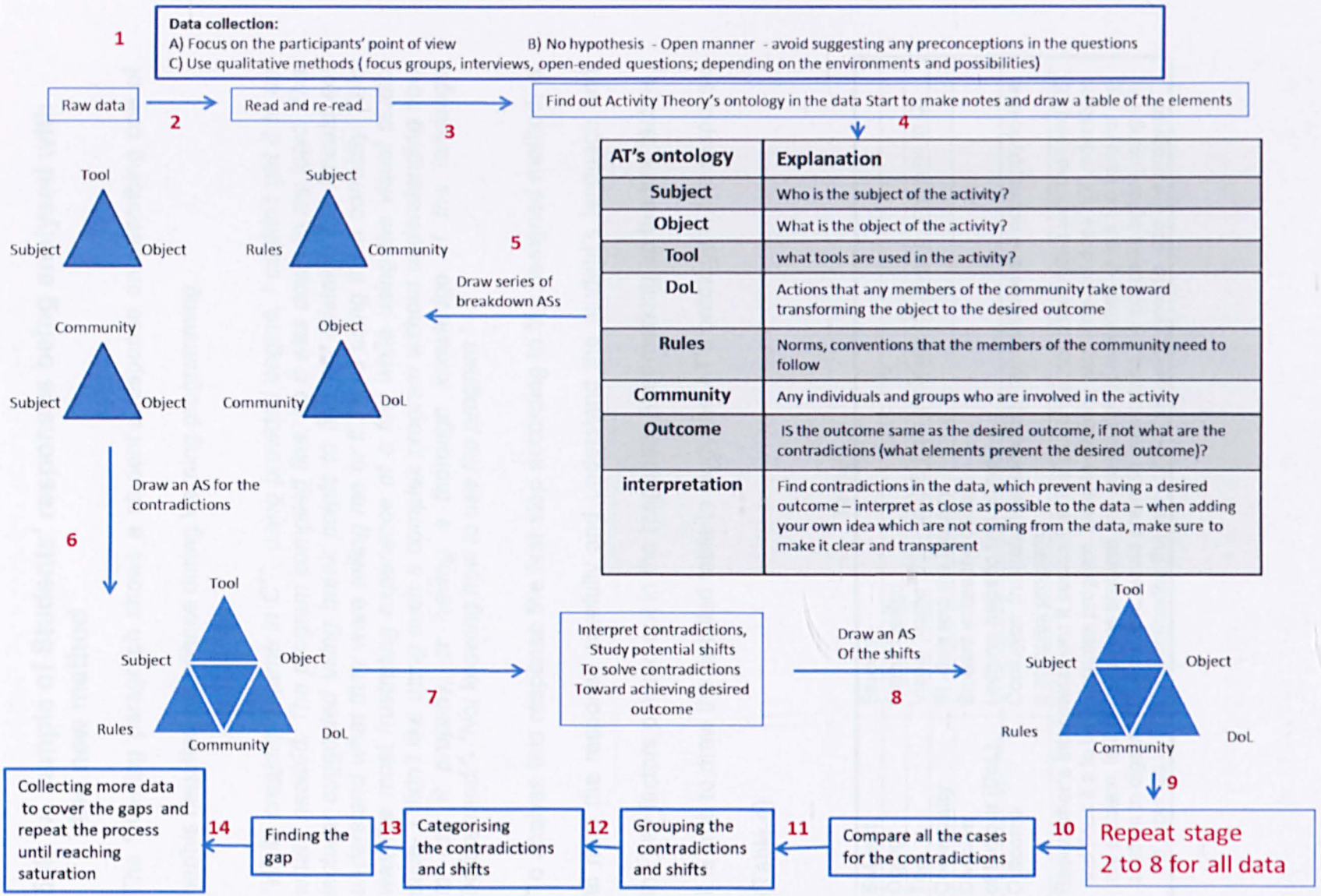
Figure 24



The second step of the designed method starts with comparing all the analysed data. Contradictions are compared, grouping and categorising contradictions takes place at this stage, matching their similarities and differences (same as the "categorising step" in GT - please refer to chapter 2 for more information). The next stage is to examine the data for any possible gaps to see if there is any information that has come from the data that cannot be answered with the existing data. If there are any gaps, the process of collecting data needs to be repeated, as well as analysing the data. When the new data has been gathered and analysed, new groups and categories might appear which could change the existing findings. However, it is possible that the new data falls into the previous groups and categories.

The cycle of finding new data and covering the gaps will be continued ("Theoretical sampling" – please refer to chapter 2 for more information) until no new concepts can be found in the data. At that time saturation has happened and the process of collecting new data can be stopped ("theoretical saturation"). At the end of the analysis, a series of contradictions categories will be formed. Then a list of appropriate potential shifts for the contradictions can be suggested to transfer the contradictions toward the desired outcome.

Figure 25 illustrated the finalised new method. It shows that almost any qualitative data can be gathered and analysed in a clear and transparent way by following its steps.



AT's ontology	Explanation
Subject	Who is the subject of the activity?
Object	What is the object of the activity?
Tool	what tools are used in the activity?
DoL	Actions that any members of the community take toward transforming the object to the desired outcome
Rules	Norms, conventions that the members of the community need to follow
Community	Any individuals and groups who are involved in the activity
Outcome	IS the outcome same as the desired outcome, if not what are the contradictions (what elements prevent the desired outcome)?
interpretation	Find contradictions in the data, which prevent having a desired outcome – interpret as close as possible to the data – when adding your own idea which are not coming from the data, make sure to make it clear and transparent

Figure 25

5.4. A sample of Students' responses being analysed with the new method

The following paragraph shows a student's response on describing one of her/his negative experience during learning programming.

"While creating a game in C++, using provided engine, I couldn't get it to do what I needed. The program compiled fine, so it was down to my logic. The lecturer suggested using break points to find my mistake- but I could not understand what they were telling me or if I was using them correctly. This was the most frustrating experience of a few while using the visual studio suite- I didn't like using such a complex program without understanding how to use it properly, or having a thorough knowledge of the language beforehand."- "Not knowing how to use the program "

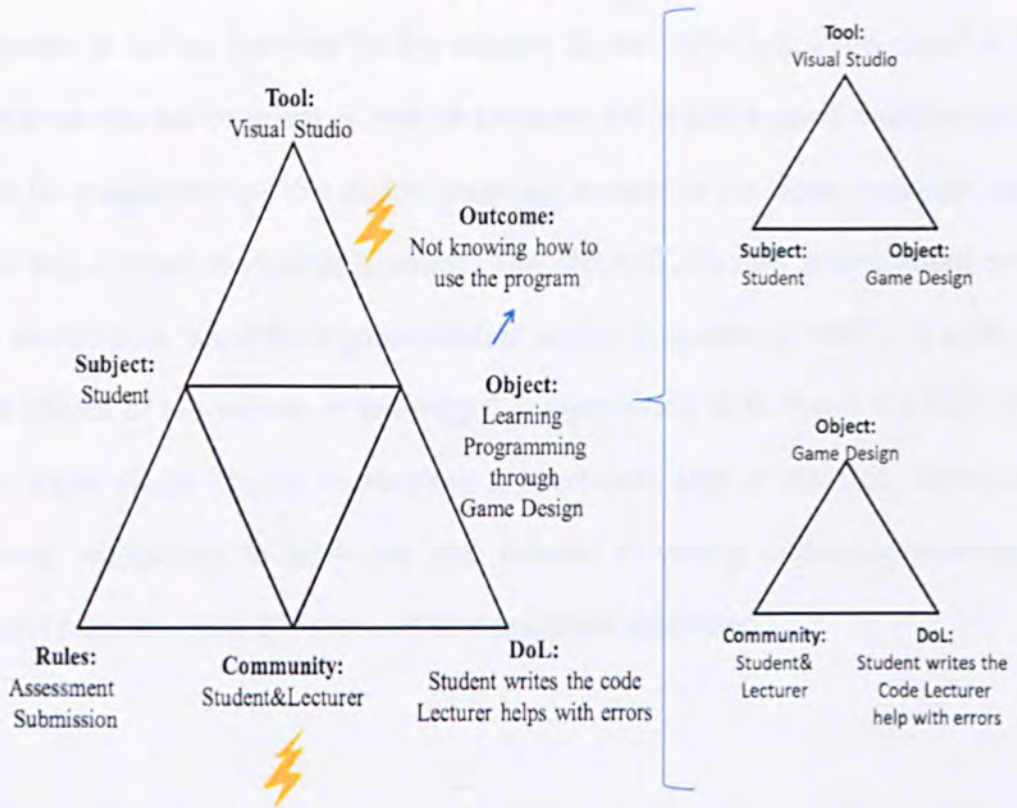
To analyse this response the first step according to the designed method, is to read the response carefully and understand the student's language and the key factors pointed out in the response. After marking up the key factors, it is time to draw the detailed table to study the AT's ontology in the response (Table 4).

Table 4

Subject	Student
Object	Game Design
Tool	Visual Studio (VS - an IDE from Microsoft to develop programs in C)
Community	Student and the lecturer
Division of Labour (DoL)	Student writes the codes Lecturer helps to find errors
Outcome	Confusion, frustration, student didn't understand and not happy to use a complex program
Researcher's interpretation: It seems that the student is not comfortable with the tool (VS). and finds it a to be a complex program. Despite seeking help s/he still does not understand the problem. Is it because the problem has not been fully explained or is it too hard for the student to digest? This student would prefer to understand the concepts before using it in the provided IDE. S/he summaries the story : ***"Not knowing how to use the program"***	

The next part is to draw the ASs to illustrate the activity, clarifying the Outcome and underlining the contradictions. (Figure 26)

Figure 26

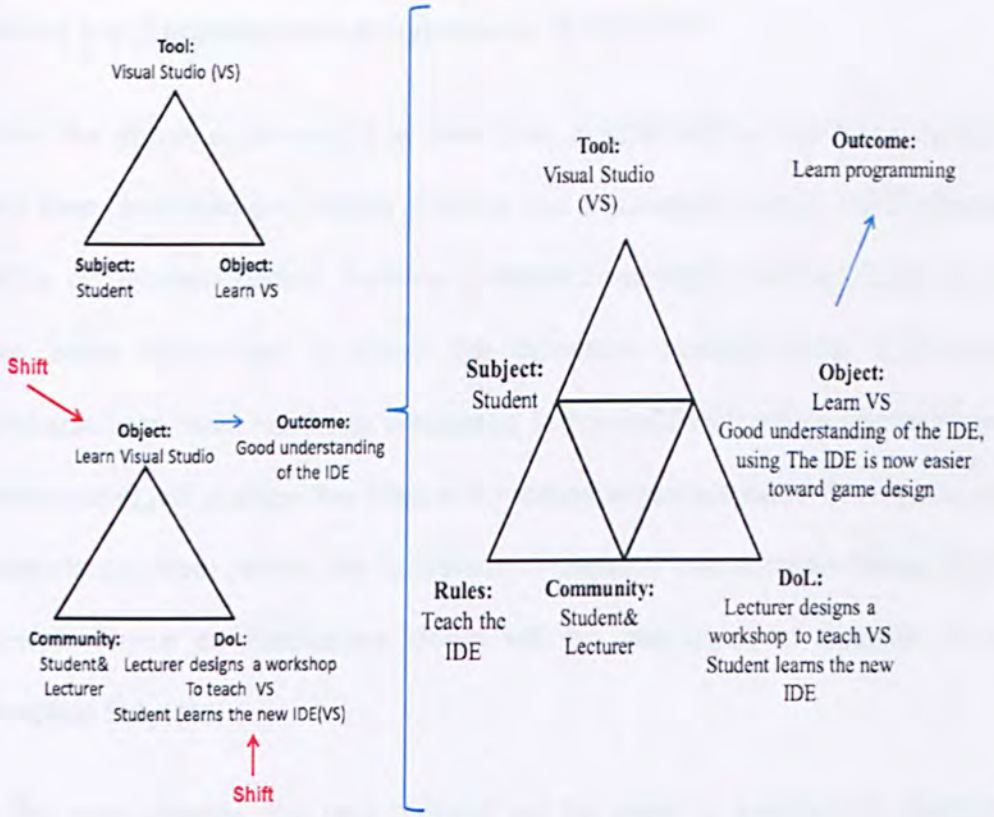


As you can see from the above ASs, a clash happened in using the Tool, Visual Studio (VS), to design the game, because the student does not know how to use the IDE (in this example VS) properly. Therefore, the Outcome is "not knowing how to use the program", instead of learning C programming. It describes that the desired Outcome (learning programming) has not been achieved in this case and therefore a secondary contradiction between Tool and Object has happened. In addition, a primary contradiction also occurred in the Community node, that the lecturer and the student might have not been able to communicate suitably to solve the secondary contradiction (of

using the Tool toward achieving the desired Outcome of learning programming).

Thus, two suggested shifts (improvements) seem to be useful. The tool appears to be too complex for the student to use. Why is this the case? Is it because the environment is new or because VS is not a good development tool for programming? We do not know the answer to the latter; however, we can argue about the former question. The problem of a new environment can be solved by a "short lived goal directed" action (Engestrom, 1987). A shift in the Object of the activity of learning C programming is to "learn the IDE", in this case Visual Studio. In addition, a short-term shift in the DoL, which is having workshops to learn the IDE instead of writing code/programming, would help. In figure 27, these shifts have been illustrated.

Figure 27



The above example demonstrates that the designed method does help to analyse collected data in a systematic step by step method which will support the aim of clarifying contradictions that are happening during learning programming.

5.5. Conclusion

In this chapter, a method has been designed and explained to collect and analyse data in a clear, transparent and systematic step-by-step approach. In addition, samples from the collected data have been tested with the new method to validate its use. The test sample analysis showed, by following all the steps of the method, that a clear systematic pathway can be followed

easily as well as finding reasonable outcomes closely from the data, without having any preconceptions or hypothesis to start with.

From the above examples, it is clear that, contradictions that have occurred and been analysed are mostly primary and secondary, which are happening within or between nodes. Tertiary contradictions might happen when a shift has been introduced to solve the pervious contradictions. Quaternary contradictions have not been discussed in this research which might happen when a shift will change the rules in a module which will need the educational systems approval (within the university or beyond that such as management levels). These contradictions levels will be discussed in chapter 6 that analyses the data.

In the next chapter, the new method will be used to analyse the collected data. The collected data is divided into three different types of responses: from the students, focus groups with the staff and workshops observations. In addition, to understand different layers of the AT's ontology, documentation of the modules has been studied as well as the collected data to clarify some of the elements of the AT, which might not be obvious from the collected data, such as rules that apply to the workshops and the modules.

Chapter 6 – Data Analysis

6.1. Introduction

In this chapter, all of the results are analysed using the method introduced in the previous chapter. As discussed previously, the method suggests reading and re-reading the collected data to get familiar with the language used in the responses and how they have described their experiences of learning programming. When the researcher is familiar with the data, s/he can start to make notes and write memos using AT's ontology to code through reading the data line by line and taking notes. These notes can be added to the table 3 introduced in chapter 5.

A series of ASs are drawn from the notes and memos to clarify the students' actions in their described stories. In the negative experiences when the desired outcome of learning programming did not happened, contradictions that prevented the desired outcome will be discovered and linked to the students actions in a whole AS to understand the total context. Since the researcher studied the whole situation, a potential shift can be suggested to solve the specific contradiction.

When all of the data is analysed using this method (see chapter 5 and figure 25) the process of comparison between the contradictions will be started (as discussed in chapter 2, most of the contradictions in this study are primary and secondary contradictions). Groups and categories will be shaped according to the emerged concepts from the analysed data. Finally, core shifts will be suggested to transform the contradictions toward achieving the desired outcome of learning programming.

To clarify the process of analysis a series of figures, ASs and categories are used to show the summary of the concepts, contradictions and shifts.

The data is grouped into three sections: individual responses from students, focus groups with staff and observations of the workshops. Each section will focus on analysing the negative experiences, finding contradictions and solving the contradictions by introducing shifts. Also by analysing the positive experiences and designing ASs, lessons to be learnt are discussed.

6.2. Individual responses from students

In order to use AT's ontology, information about the activity of learning programming was collected directly from the students to understand the problems and contradictions that get in the way of their learning. Also the context of their positive experiences were examined to understand what lessons could be learnt.

In the following sections, both negative and positive experiences are analysed according to the designed method and the results are shown in ASs.

6.2.1. Contradictions (the negative experiences)

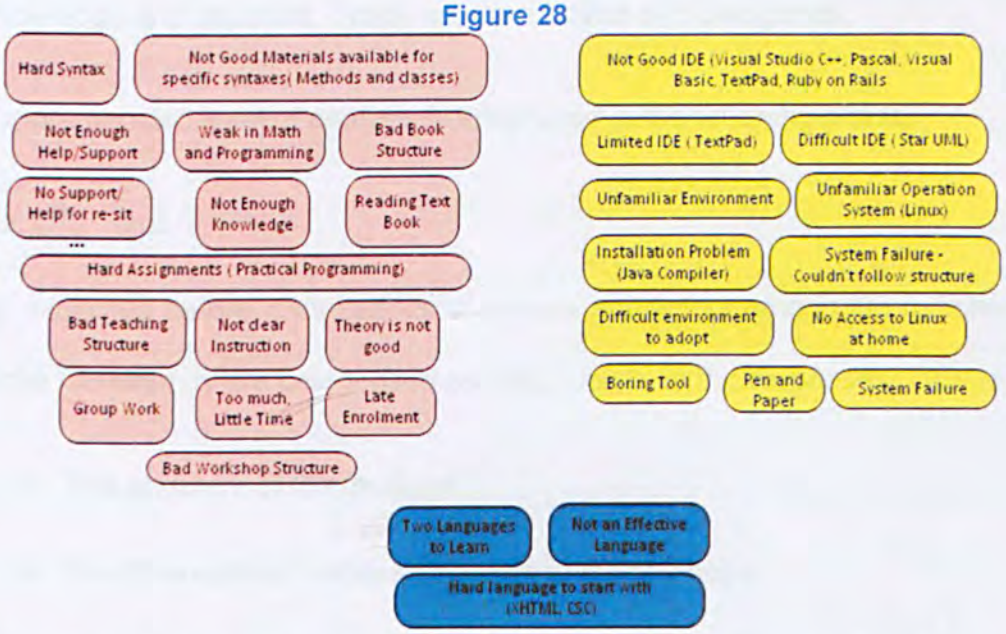
Since the students were asked to summarise their stories, those summaries guided the researcher to label each response and then classify these into groups. As already noted in previous chapters, students' responses were read and reread several times to ensure early familiarity with the data. The next step was to identify the most significant points in the answers given by participants, which, in most of the cases, were the same as the students'

summaries of their own stories. Similar topics were found among stories and these were used to classify them into groups (see figure 28). For example, some of the students found the syntaxes, taught for the specific programming language, hard to learn or too much to accommodate in a semester. Some other students pointed out that the materials available for the modules did not cover the harder assignments. Other students pointed out that the assignments were hard for their level of knowledge. The structure of lectures and workshops were criticised in some students' responses as negative experiences. These were initially grouped together because the structural aspects are related to the module's organisation and knowledge in terms of their entry understating and level of understanding required as outlined through the module's delivery (coloured peach in figure 28).

IDEs, Operating Systems (OS), software, books, and system failures made up another group. IDEs included TextPad which is a text editor for Windows used as a compiler and debugger for the Java language, Visual Studio (VS) for C, Star UML to draw diagrams, Visual Basic (VB), gedit which is an official text editor on Gnome desktop in Linux to write, compile and debug C programming codes. Some of these IDEs appear to be limited for the work that the students have to accomplish such as TextPad, which is a simple IDE, and some of the students highlighted that it does not help them in terms of solving and providing useful feedback on errors. Other IDEs such as VB and VS are more complex IDEs which some of the students found overwhelming to use for the first time. Yellow indicates this group in figure 28.

A variety of programming languages are referred to across the responses and some of the students stated that the language they were learning was not useable in term of future careers, or too hard as a first programming language to learn. Also being taught multiple programming languages in parallel during one semester was cited as another negative experience for some of the students. These were grouped together in blue in figure 28, while repeated experiences have not been shown in the figure 28, because the focus of the research is qualitative rather than quantitative. However, the frequency of the similar negative experiences will be indicated later.

Figure 28



After classifying responses into three different groups, according to each significant point coming out of each response and their similarities, it was time to compare these groups with AT's ontology, and because these categories emerged from the negative experiences, and each time a contradiction had happened, these were labelled 'contradiction' categories. According to the AT's ontology, any artefacts that can be used during the

activity by the Subject are called Tools, such as IDEs that the students have used to write their programs. Therefore, any artefacts that the students reported in their responses have been categorised as Tools. Consequently, any distributions of actions and works among the Community of the activity have been categorised as DoL. Finally, anything that can stimulate the activity and have been reported as the purpose of the activity by the students have been categorised as Object.

In addition, each category has some sub-categories that indicated more detail about the responses. For instance, DoL has two sub-categories of knowledge and structure. There are then further sub-categories.

A more detailed level of analysis is introduced in the following phase.

6.2.1.1. DoL

As explained before, distributions of actions and works among the members of the Community are categorised as DoL. These, in the responses, include:

- The structure of the modules
- The time division between lectures and workshops,
- The design of materials for both lectures and assignments for the workshops
- The method of teaching syntaxes and concepts of the programming language
- The background knowledge of students in programming and mathematics

- Time consuming : how much time students need to spend working on code

6.2.1.2. Tools

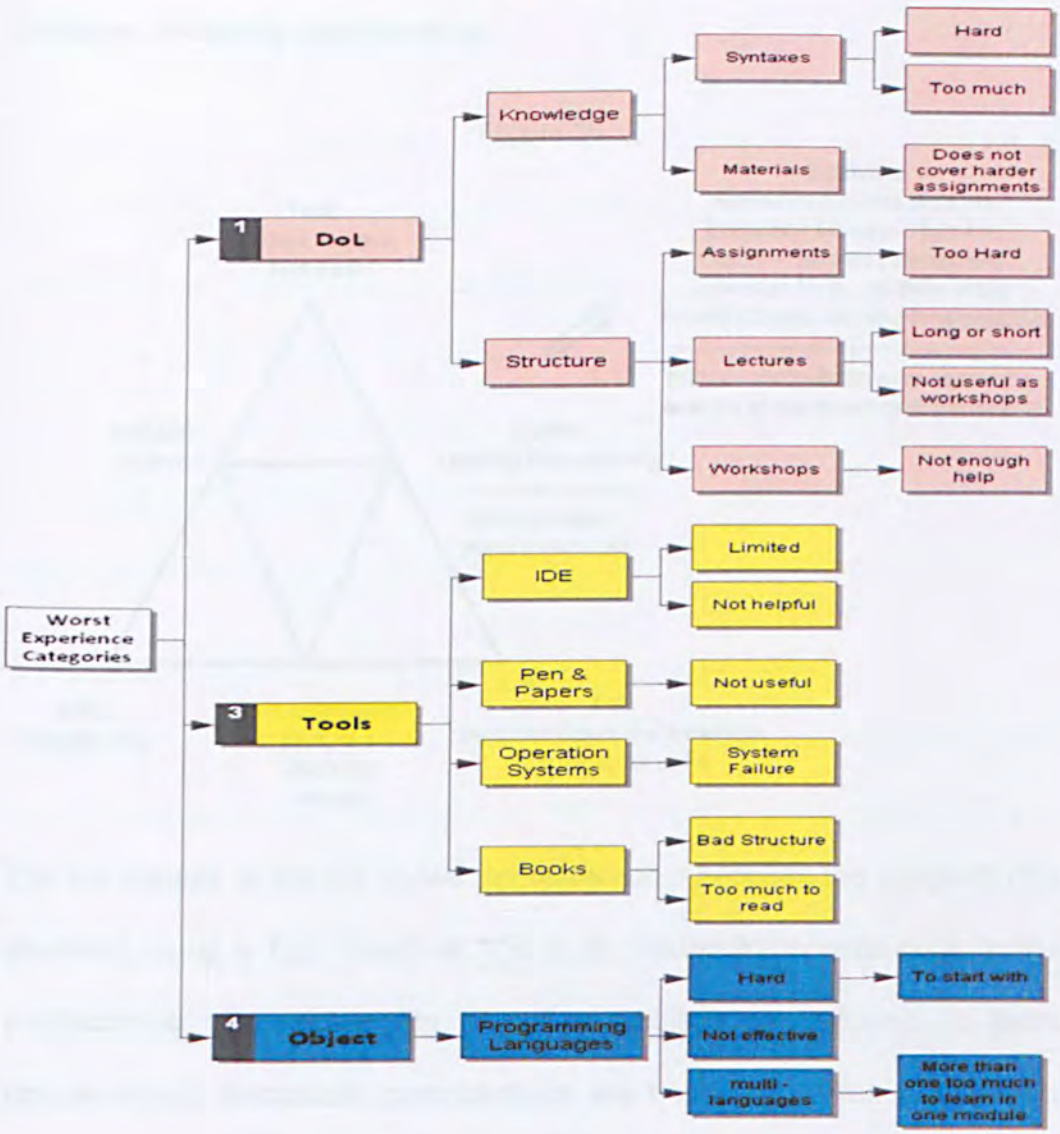
From the negative responses, all the applications, IDEs, Books, online materials and, generally, anything that can be used to learn the programming language have been categorised as tools. There are four separate sub-categories to show the different types of tools that students cited as negative experiences in the particular activity they were describing. For example, all technical tools have been categorised and named as IDEs, such as the development software that the students used to write, edit, compile and debug their code. The examples were TextPad, gedit, VB, VC and Star UML. OSs are another subcategory with a subcategory of system failure and the type of OS (e.g. Linux, Windows etc.) Tools also had a subcategory of pen and paper (which included books) instead of using an actual IDE to write and compile code. Some of the students reported that they did not find it useful to write programs on paper, because they could not see if there are any errors. They would prefer using an IDE which shows the errors when the code has been compiled.

6.2.1.3. Object

Learning programming languages, as the Object of the activity, were frequently reported in the negative experiences. The students found some of the programming languages hard to learn or hard to start the learning of programming for the first time. Another view was that the languages they are learning are not useable in the industry for their future careers. In addition,

students reported that learning more than one language in each semester decreased the effectiveness of learning. They also explained that in a limited time period they are better off concentrating on one language and learning in more depth, rather than being taught two languages and learn neither. This problem was repeatedly reported especially in the second semester (module CI1152) when two programming languages of Java and C were offered. In 2009 the students were divided into two groups for teachings, in the first 5 weeks when first group was learning java the second group was learning C and in the second 5 weeks vice-versa. However, in 2010, all students were learning Java for 9 weeks, while C was taught in only one week for 5 days. Most negative experiences, which caused the contradictions were reported about this mode of difficulty. The students felt overwhelmed with the amount of new knowledge they received in just 5 days and they did not have enough time to practice and accomplish the standard self-study time for the module. Even though the module was designed to just cover the basic concepts of C programming, still it appeared to be too complex a task for the students. Figure 29 illustrates the categories and sub-categories of the negative experiences from the students' responses, which have been explained above. The colours used are the same as used in figure 29 to make it fast to spot the different 'contradiction' categories.

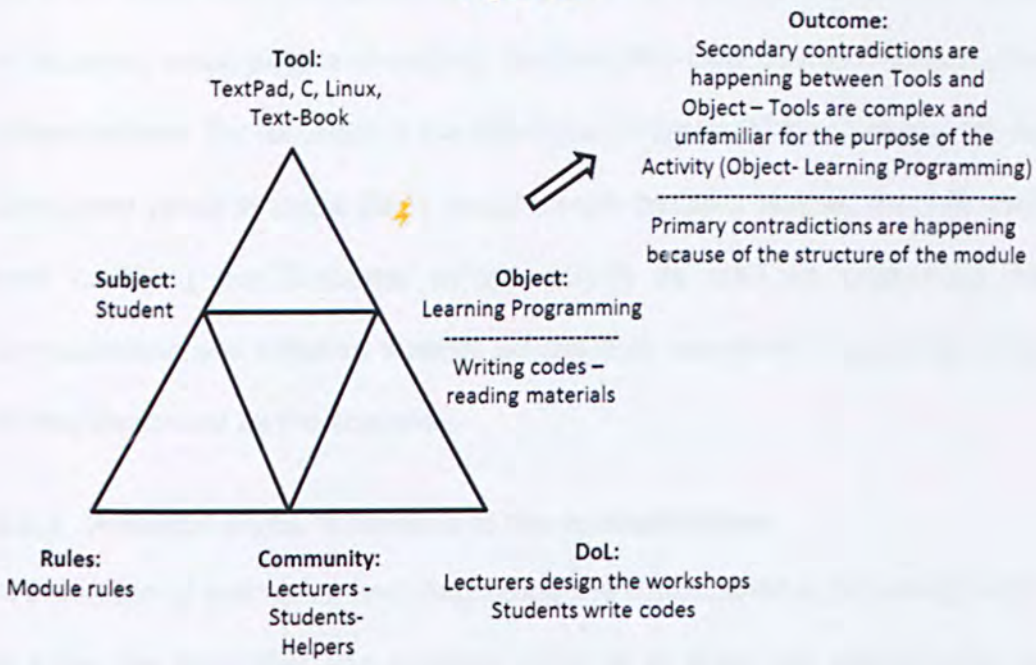
Figure 29



As explained before in the chapter 2, an Activity System (AS) shows a very clear pathway of the event within a complete picture of the event. Contradictions and shifts are easily identifiable in AS too. The AS in Figure 30 illustrates a summary of the contradiction categories that were indicated in Figure 30. A yellow highlight has been used to show the contradictions in the AS. The Outcomes that are shown in the AS, summarise the negative

categories that caused the contradictions and prevented the desired Outcome of learning programming.

Figure 30



The top triangle of the AS shows the relationship between the Subjects (the students) using a Tool (TextPad, Linux, C, Textbook) to write code in the programming modules (as the Object) to achieve an Outcome (to learn programming). Secondary contradictions are happening when the Subject has any kind of problem in using the selected Tool to write their Programs. In addition, primary contradictions happen because of the structure of the Object, when two different languages were taught in a single semester or learning the programming language was hard for the students because of difficult syntax, as noted before.

The bottom right triangle in the AS shows the connection between the Object, Community and DoL. The structure of the lectures and workshops, the

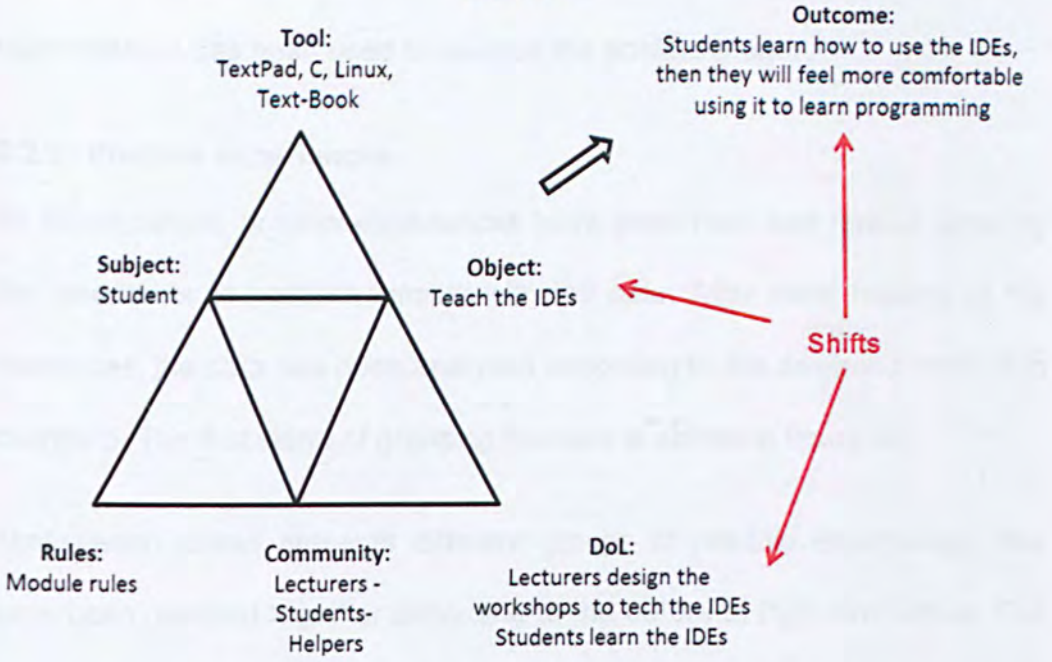
context of the materials, and instructions given for the workshops were among the contradiction categories.

As it has been discussed previously in chapter 2, ASs are useful instruments to illustrate whole picture of activity, clarifying the Outcome and showing the contradictions. For example, if the AS shown in figure 30 be compared to the categories listed in figure 29, it would clearly become visible, that AS does help clarifying the Outcome of the activity as well as presenting the contradictions and different level of actions and operations happening in the activity described by the students.

6.2.2. Potential shifts to transform the contradictions

In the action of examining and diagnosing the contradictions, one simple shift to solve the unfamiliar and complex IDEs, is to teach the related IDEs to students before starting to use those in learning programming. For example, some early workshops (before the actual semester begins or at the beginning of the semester) could be designed to teach TextPad, Linux and other IDEs that will be used in the programming modules to the students that think they need extra help. The shifts are shown in figure 31.

Figure 31



Thus, as it shown in figure 31, the focus of the Object from learning programming has changed for a short time to learning the related IDE. Instead of designing the workshops and lectures for learning programming languages (LPs), the lecturer will design a series of materials to teach the IDE. Immediately after this string of actions, as soon as the students feel comfortable using the IDE and the IDE become Operation, focus can be returned to the initial Object of LPs.

There are other contradictions, which have been pointed out in the students' responses such as having errors when writing code. However, the reasons for the contradictions have not been explained in the students' stories. Therefore a gap has appeared here, which will be explained more in the observation section. As justified earlier, observations had been undertaken to study the gaps that were investigated in the students' responses.

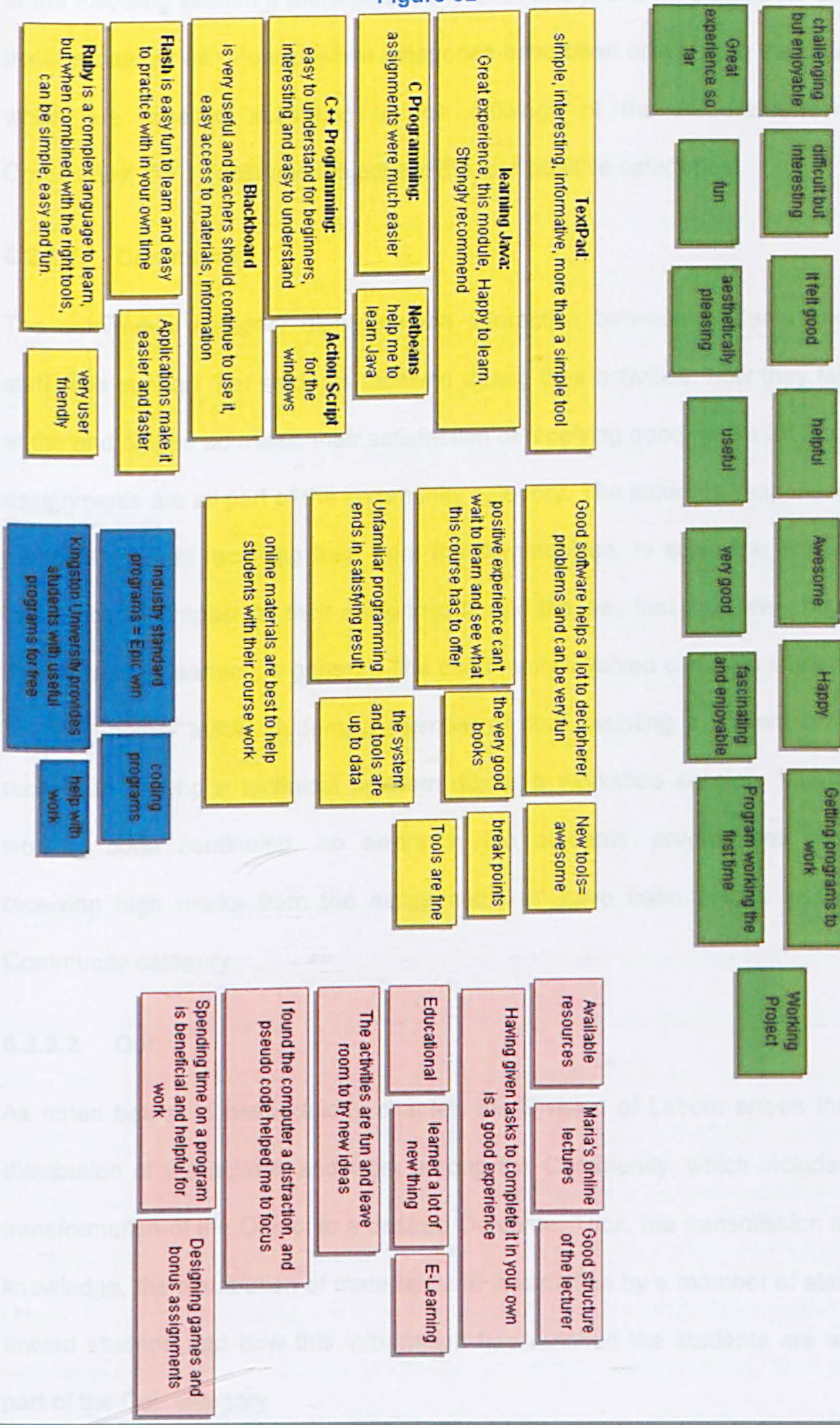
In the next phase, students' positive experiences have been analysed. The same method has been used to analyse the positive stories.

6.2.3. Positive experiences

As noted before, positive experiences have been read and reread again by the researcher to become familiar with the data. After initial reading of the responses, the data has been analysed according to the designed method in chapter 5. The first stage of grouping the data is shown in figure 32.

Again, each colour presents different groups of positive experiences that have been grouped together according to the nature of their similarities. The next step is to categorise these groups according to the ontology of AT. Community category indicates relationships between the members of the Community, who are doing the same activity toward achieving a common purpose. Therefore, the group that presents this relationships has been categorised as the Community category. The Tool category represents the artefacts that the students described. The category of DoL, symbolised a series of actions and works that each members of the Community perform during the activity. The Object category illustrates the purposes of each activity. The categories' colours are the same as the groups' colours to keep the comparison easy between two figures. Each of these groups represents a category and there are some sub-categories too. The categories and sub-categories are indicated in figure 33. These same colours are used as in figure 32.

Figure 32


TextPad: simple, interesting, informative, more than a simple tool
learning Java: Great experience, this module, Happy to learn, Strongly recommend
C Programming: assignments were much easier
Netbeans help me to learn Java
C++ Programming: easy to understand for beginners, interesting and easy to understand
Action Script for the windows
Blackboard is very useful and teachers should continue to use it, easy access to materials, information
Flash is easy fun to learn and easy to practice with in your own time
Applications make it easier and faster
Ruby is a complex language to learn, but when combined with the right tools, can be simple, easy and fun.
very user friendly
Good software helps a lot to decipherer problems and can be very fun
New tools= awesome
positive experience cant wait to learn and see what this course has to offer
the very good books
break points
Unfamiliar programming ends in satisfying result
the system and tools are up to data
Tools are fine
online materials are best to help students with their course work
industry standard programs = Epic win
coding programs
Kingston University provides students with useful programs for free
help with work
challenging but enjoyable
Great experience so far
difficult but interesting
fun
It felt good
aesthetically pleasing
helpful
useful
Awesome
very good
Happy
fascinating and enjoyable
Getting programs to work
Program working the first time
Working Project
Available resources
Maria's online lectures
Good structure of the lecturer
Having given tasks to complete it in your own is a good experience
Educational
learned a lot of new thing
E-Learning
The activities are fun and leave room to try new ideas
I found the computer a distraction, and pseudo code helped me to focus
Spending time on a program is beneficial and helpful for work
Designing games and bonus assignments

In the following section a more detailed level of analysis is introduced for the positive categories. Four positive categories have been driven from the data which are labelled according to the ontology of the AT framework. Community, DoL, Tools and Object are the four positive categories.

6.2.3.1. Community

The community category highlights the interaction between students and staff. The support that students received during their activities, how they felt at the end of their activities, their satisfaction of receiving good marks for their assignments are all part of the community category. The students' responses demonstrate that receiving help from the communities, to solve the errors, has a positive impact on their assignments and the way that they feel about the process of learning in general. The community involved can be a student helping another fellow student, a member of staff assisting a student or a technician solving a technical problem during a workshop session. Finally working code continuing, no errors in the students' programmes and receiving high marks from the assignments all have been placed in the Community category.

6.2.3.2. DoL

As noted before in methodology chapter, the Division of Labour shows the distribution of the actions and work among the Community, which includes transformation of the Object to a desired Outcome. Thus, the transmission of knowledge, the distribution of materials and information by a member of staff toward student, and how this information has reached the students are all part of the DoL category.

Students indicated in their responses that accessing teachnig materials online and in hard copy easily and quickly are among their positive experiences. Therefore, the DoL category has two subcategories of online resources and books. Access to online materials is possible via Study Space. A member of staff, normally the module leader, uploads the information in Study Space and makes it available to the students registered on the module. There are also forums and discussion boards where students can discuss their problems and pose questions. That will be answered by either another student or the lecturer. Online access itself has two subcategories of videos and written materials. Lecturer's videos received a high number of positive responces, which was a recent addition to CI111. In addition, there are hard copies of the materials available for the student to collect in the lectures if they wish. As well, access to books, journals and papers are all provided via Kingston University learning resource center.

6.2.3.3. Tools

The applications, IDEs, Books, online materials and generally anything that can be used to learn the programming language have been categorised as Tools. The quantity of tools mentioned in the positive experiences is higher than the variation in the negative experiences. For instance; Black-Board, Flash, Ruby, Action Script and Netbeans are all the tools among the stories that students mentioned in a positive event plus the previous tools mentioned in negative experiences, such as TextPad for Java programming and Visual Studio for C Programming. The students explained that they liked working with simple tools that do not get in the way of learning programming, such as

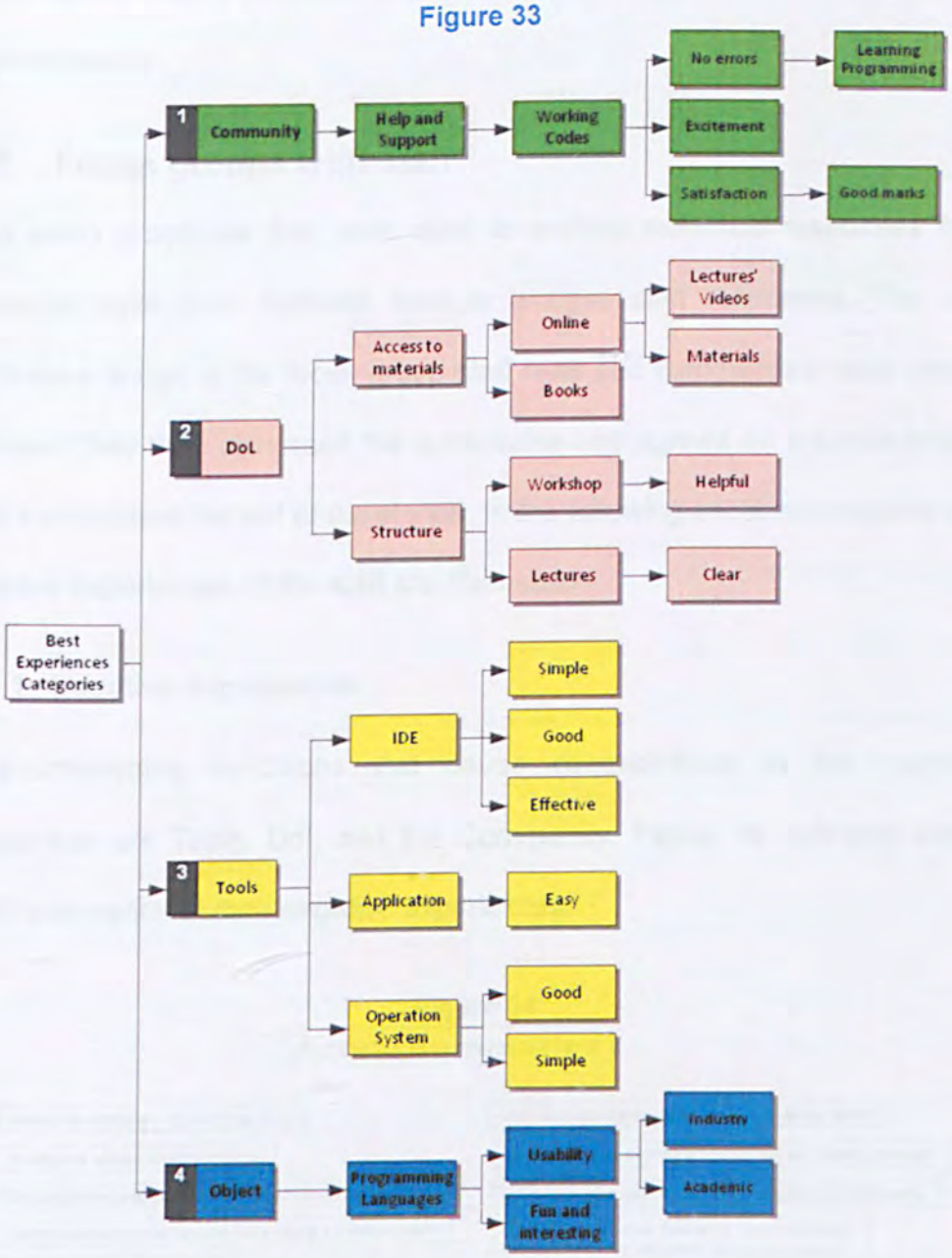
TextPad. They also liked more developed and helpful IDEs such as Netbeans and Visual Studio because they helped with learning syntaxe and offered clear explanation of the errors. Other varieties of Tools that were pointed out by the students were software applications and OS. Good and simple OS helped the students to have a smooth experience during learning programming. If the students are familiar with the OS's environment, they feel comfortable and confidence to use it. In addition, simple applications also helped the students to learn more easily.

6.2.3.4. Object

As discussed before, an Object stimulates the activity and the Object mediates between the Community and the DoL. Learning programming languages are among the positive experiences given with high frequency, which are categorised as Object. The Students' responses highlighted that they enjoy learning programming languages that are up-to-date and will be used in industry and their future careers. In addition, the clear structure of teaching and practising these languages in lectures and workshops are in their responses. The students explained that a comprehensible module structure improved understanding of new contexts and made learning the programing language more convenient.

Figure 33 displays the four categories considered above in a diagram. The colours represent different categories. Green, pink, yellow and blue indicate Community, DoL, Tool and Object respectively. Sub-categories have also been illustrated in figure 33 and more details are offered about each category.

Figure 33



The next section offers an analysis of the data from the focus groups with the staff. Same method that was introduced in chapter 5 and used in the individual students' responses is followed in this section too. The responses have been read and re-read to become familiar with the data. Open coding and axial coding have been undertaken, groups and categories were shaped,

contradictions were identified in the negative experiences, an AS of each contradiction was drawn, and finally shifts were suggested to overcome the contradictions.

6.3. Focus groups with staff

The same processes that were used to analyse individual responses from students have been followed here to analyse staff responses. The only difference is that in the focus group staff read and summarised each other's stories. They then discussed the summaries and agreed on a single phrase that summarises the set of the stories. In the following sections, negative and positive experiences of the staff are discussed.

6.3.1. Negative experiences

The intervening conditions that cause contradictions in the negative responses are Tools, DoL and the Community. Figure 34 indicates actual staff summaries of their negative experiences.

Figure 34

Actual Summaries

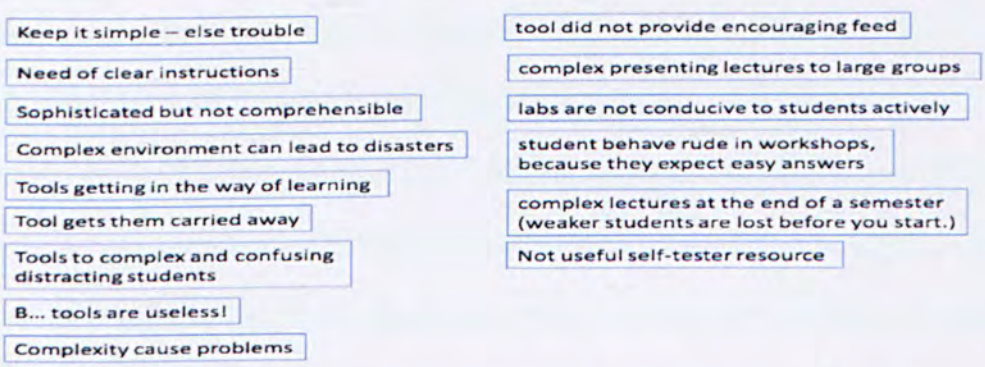
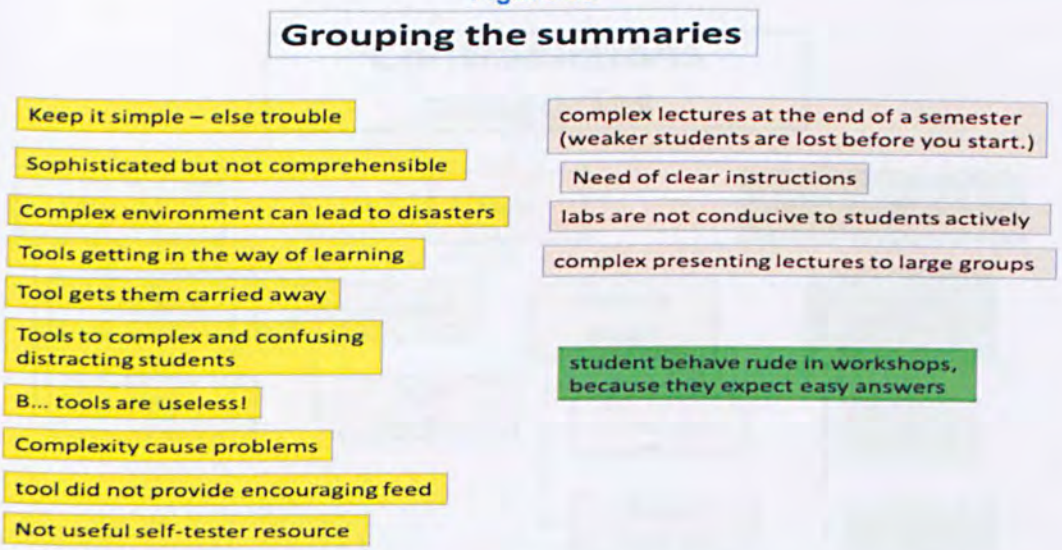


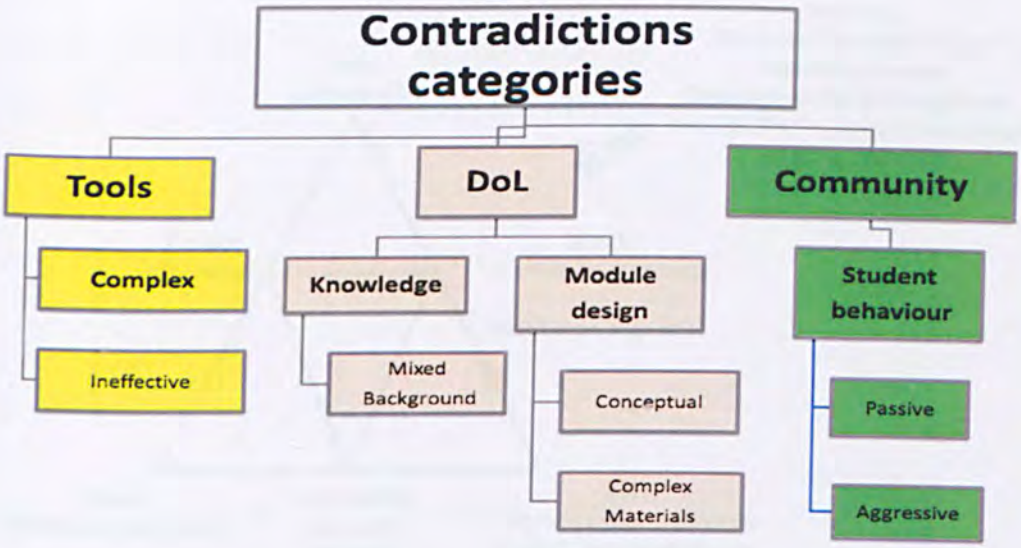
Figure 35 shows the grouping of the actual staff summaries of their negative experiences. The summaries have been compared and classified into different groups. The colours of yellow, pink and green represent the groups.

Figure 35



After grouping, the next step was to categorise and name them according to the ontology of AT. Figure 36 indicates the categories and sub-categories. The same colours have been used here too. Yellow, pink and green represent Tool, DoL and Community respectively. One more, Tool category presents students' responses about the artefacts that they used during the process of activity. The category of DoL demonstrates the distributions of the actions and works undertaken to achieved the desired Outcome. Finally, Community category shows relationships among the members of the Community.

Figure 36



The analysis indicates that tools are either too complex or ineffective in the process of teaching programming. The DoL contradictions present the module design, workshop design, and size of classes with the students having a mixed starting knowledge of programming, which makes the teaching difficult. In addition, programming modules, which are hard to teach for the current level of the students' knowledge, and, the present complex teaching materials, are other elements of this category. Finally, the Community category includes students' behaviour toward learning programming and towards the other members of the community (such as staff). For example, one of the staff pointed out that within a student asked for help to solve an errors in his/her code when the staff tried to explain the error and ask the student to think about the error, the student became angry and impatient and was only interested in the final solution. Another member of staff reported the same problem; however, the student was not aggressive, but still only interested in the final solution to the assignment from the staff and constantly kept asking different members of staff.

Figure 37

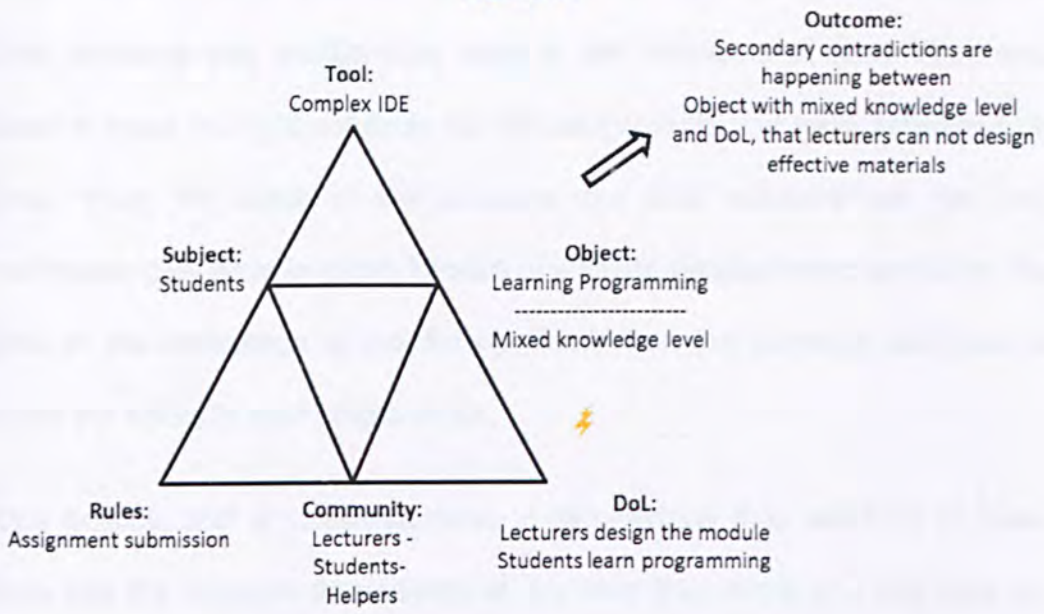


Figure 37 shows an AS of the contradictions that were indicated in figure 36. The yellow lightening shows where the secondary contradictions are happening.

Some of these contradictions, such as complex IDEs, have already been defined and explained in the student's responses. In addition, possible shifts have been discussed to solve the contradictions for the category of tools. While some other contradictions are new in the staff responses, such as students' behaviours towards other members of the community related to their assignments. The staff explained that some of the students might not be keen to learn and the students are looking for the final answers instead of learning programming, and because of this reason sometimes they act inappropriately.

To suggest a shift to solve this contradiction, one needs to understand why some of the students are behaving in this manner. One possible answer

might be, to pass. In addition, the students are not required to demonstrate their solutions and explain their code to any members of staff. They only need to have the right solutions for the assignments and have submitted on time. Thus, for some of the students, the final solutions are the only motivation they have in mind, instead of learning programming and using the time in the workshops to ask for clarification on the concepts and how to solve the errors in their programmes.

One feasible shift is to ask students to demonstrate their solutions to make sure that the students do understand the code they wrote and that they are capable of explaining the code. This will encourage the students to make sure they did understand the code before submitting it, and it might help them to learn the concepts they are working with. One might argue that demonstrations are time consuming. However, a group of staff will mark the assignments later, time will be spend to compile and run the assignments in any case. Therefore, it might be better to spend the time in demonstrations to solve the contradiction instead of marking later.

6.3.2. Positive experiences

The positive responses suggest that good effective tools help the process of programming without getting in the way of learning. Clear module instructions guide students to take the best way to learn programming. Instant feedback on errors in the workshops assists students to learn how to solve problems. Figure 38 illustrates the actual summary of positive experiences that staff reported in their focus groups.

These positive responses can shape a model to be used in future design of the programming modules. For instance, both groups of responses from students and staff suggest that simple but effective structures for the modules have enormous impact on how the students interact in the lectures and the workshops, as well as learning programming better, because of the clearer structure. In addition, a class that includes students with the same level of knowledge helps to design teaching materials that are clear and effective for that group of students.

Moreover, a choice of a transparent, easy and effective Tool for each programming language can help to learn the programming, instead of presenting the need to learn the tool first.

Figure 38

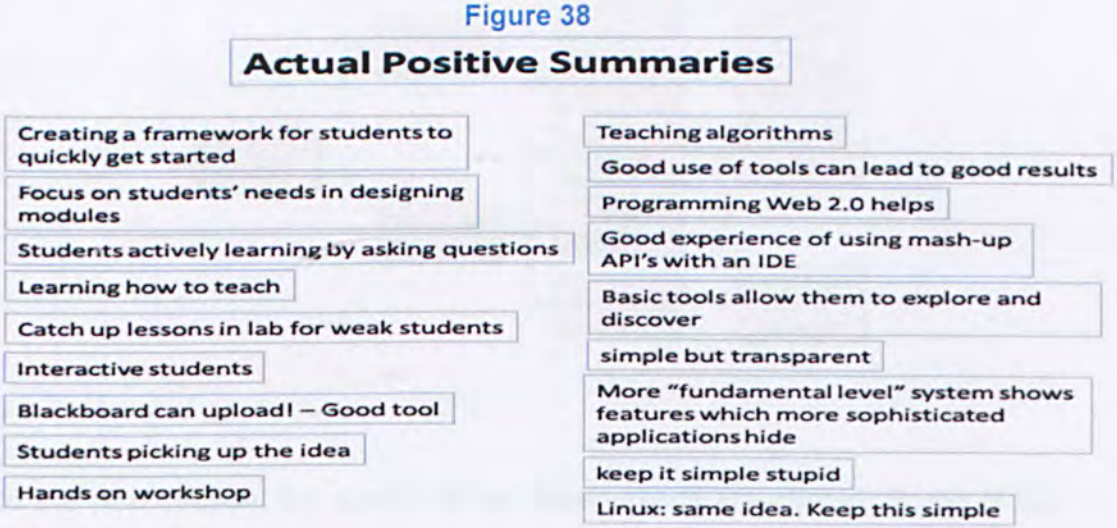
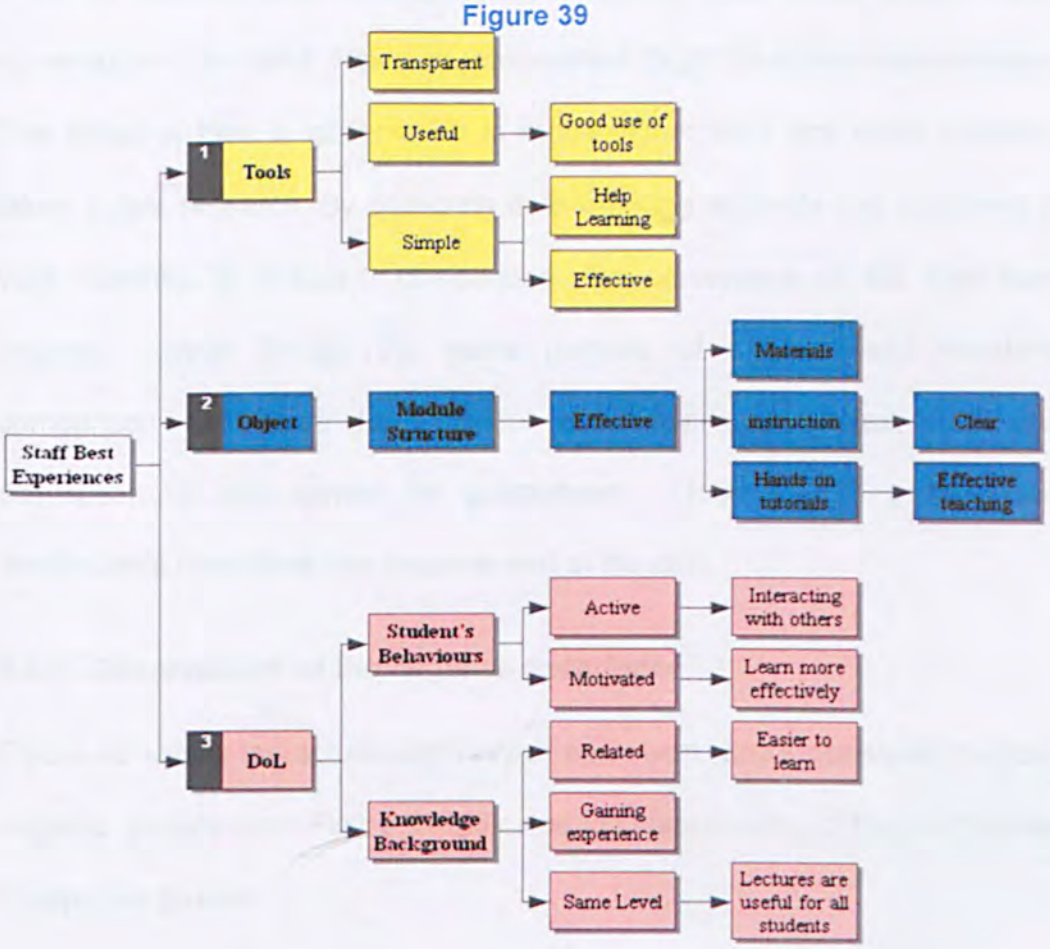


Figure 39 illustrates categories of the positive responses. It shows that there are three categories of Tools, Object and DoL. It indicates that simple and useful tools are effective in terms of helping students learn programming. In addition, a well-structured module that contains the right materials and has

been designed according to the students' needs and abilities helps students to learn more effectively. Moreover, activated and motivated interactions make the process of learning less complicated.

Figure 39



In the next section, the results of the observations are offered. Some of the contradictions that appeared in the analysis and could not have been answered from the students' responses alone have been covered here.

6.4. Workshop's observations

As it has been discussed in chapter 4, the researcher has observed the same modules of CI1111 and CI1152 for 4 semesters from 2009 to 2011. Notes

have been taken and the same analysis approach used. The notes have been read and reread again. Categories were identified and named according to the ontology of AT. As argued before, GT allows for different research methods such as interview, focus group, open-ended question and observation to be used. However, observation might have one disadvantage. The effect of bias in observation is much higher than any other methods taken in this research. By collecting data from the students and analysing it very carefully by constant comparison, the percentage of the bias was lowered. Even though the same process of analysis and constant comparison has been followed for the observation notes, complete elimination of bias cannot be guaranteed. However, GT argues that researcher's comments can become part of the data.

6.4.1. Observations of the negative experience

Figure 40 shows the actual summary of each workshop's observation about negative experiences. Figure 41 indicates the classification of the summaries in separate groups.

Form the observation; three categories of contradictions are emphasised – these are the same as students' responses categories – however, with slightly different elements. In the following sections, these contradiction categories have been explained in greater details.

Figure 40

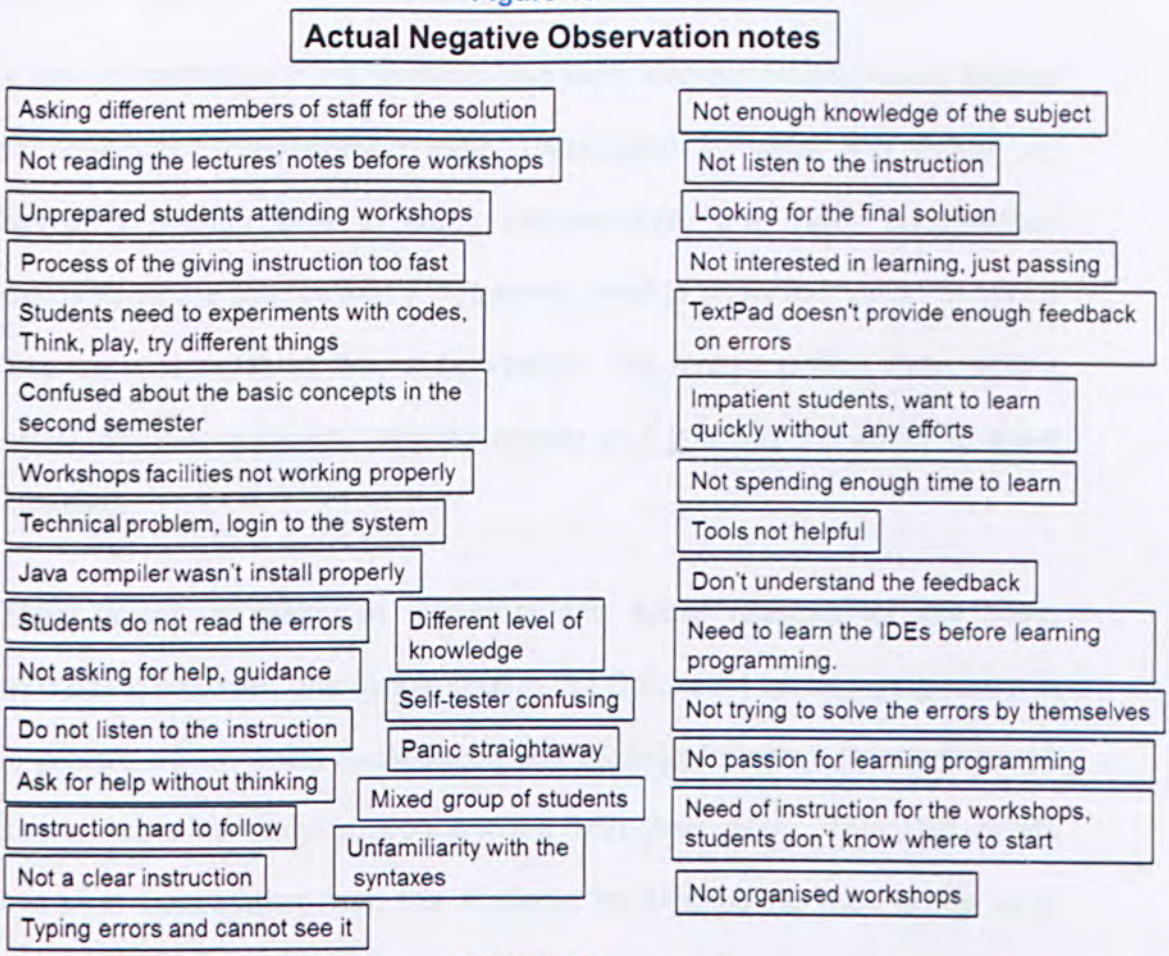
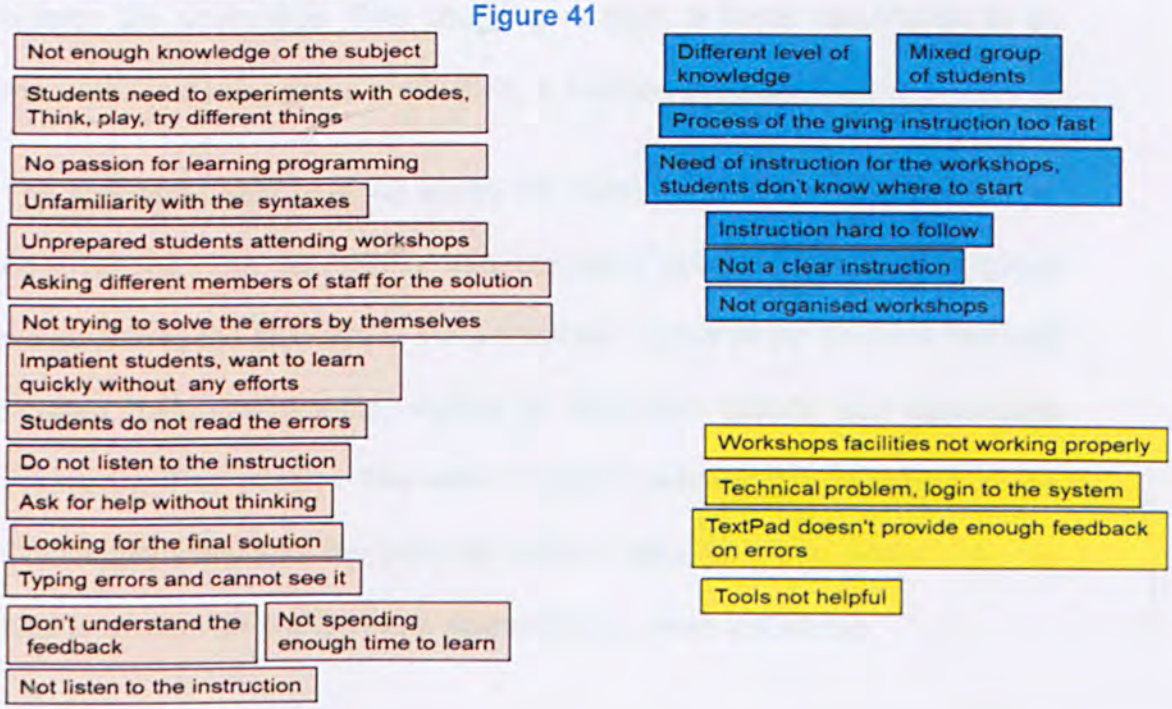


Figure 41



6.4.1.1. DoL

A lack of motivation in the students who were learning programming, looking to understand programming logic, understand syntaxes and finally not spending enough time to study independently are major contradiction elements of the DoL category. Students need to show motivation to spend time on accomplishing their assignments. This means writing code, editing errors by understanding syntaxes deeply and learning the ability to solve problems.

There might be plenty of individual and social reasons for not being motivated; however, one simple shift in the DoL could be engaging students in group's works, which could encourage students to work harder and spend longer hours in studying programming with their peers. This shift needs complete cooperation from the students by keeping up their group work outside the workshops. This should give them a better opportunity to be motivated and raise group productivity in learning programming.

The suggested shift of group works has been inspired from the workshops' observations. The researcher had observed several Spontaneous group works among the students in the workshops. Some of the students that had finished their assignments, started to help their friends and classmates voluntarily. This positive free-willed reaction between the members of the Community stimulates the potential shift of "informal group works" that can help to encourage and motivate students to do more self-study.

As discussed in chapter 2, Zone of Proximal Development (ZPD), which was introduced by Vygotsky, can be seen in the group works. Students can offer help to each others and improve their programming abilities in terms of learning.

In addition, this shift needs another change in the DoL from the staff side. The staffs need to choose groups of students that will work together productively, and explain to the students what they need to do in terms of working in a group and their responsibilities. Furthermore, changes in the community and the rules might be necessary too.

The contradiction of not understanding the programming logic means poor understanding of any kind of algorithms. 22 courses are taught in the School of Computing and Information Systems (CIS). 12 courses contain both or one of the Modules that I have observed. (Seven courses taught both Programming Essentials and Practical Programming modules and five courses taught just Programing Essentials). None of these courses requires any prerequisite skills. The programming essentials module starts with a basic introduction of different parts of a PC in the first lectures and from the second lecture the context and syntaxes of Java are introduced. No programming logic has been taught to the students; therefore, there are at a disadvantage. However, one lecturer in the school uses pseudo codes in the Fundamental Programming Concepts module in a Web Development course, which some of the students found quite useful.

Another outstanding contradiction is that students have not mastered the concepts of programming and especially the meaning of syntaxes before

starting to write their code. For example, trying to write a program for converting mileage to kilometre before having a deep understanding of the concepts of class, methods and initializing variables in Java programming will not have a successful Outcome.

6.4.1.2. Object

The mixed group of students with differing levels of background knowledge and expectations of programming languages are categorised as Object contradictions. A mixed group of students makes the design of effective instruction for any module a huge challenge, which seems to be a contradiction itself. Therefore, the current structures of the modules cause difficulty for students to understand the taught syntaxes and thus prevent learning programming.

The current structure of the modules includes an hour lecture and two to three hours' workshop each week. All students (more than 200) attend the lecture; however, students are divided into at least three different groups for their workshops. At the moment, this division is just according to their surnames. To solve the mixed group contradiction, one shift can be designing a test or a survey to examine students' knowledge of programming before the beginning of the semester. The next step could to either run optional workshops for the students without a computer background to introduce syntaxes that are more basic and algorithms, or dividing the students into different groups corresponding their knowledge levels and designing different workshops for each group that will help them to learn programming more effectively. Therefore two shifts appear necessary here, a

shift in Rules that decide how to divide students into different groups and, secondly, a shift in the structure of the modules based on the students' knowledge. These shifts are also related to DoL and Community, because both students and lecturers are affected by these shifts/changes.

Figure 42 illustrates the categories of the observation contradictions discussed above. Figure 43 shows an AS of the contradictions that are happening between Object and DoL, as secondary contradictions. While students' current knowledge of programming does not adjust the level of the knowledge that is taught in the module, the secondary contradictions will keep arising.

Figure 42

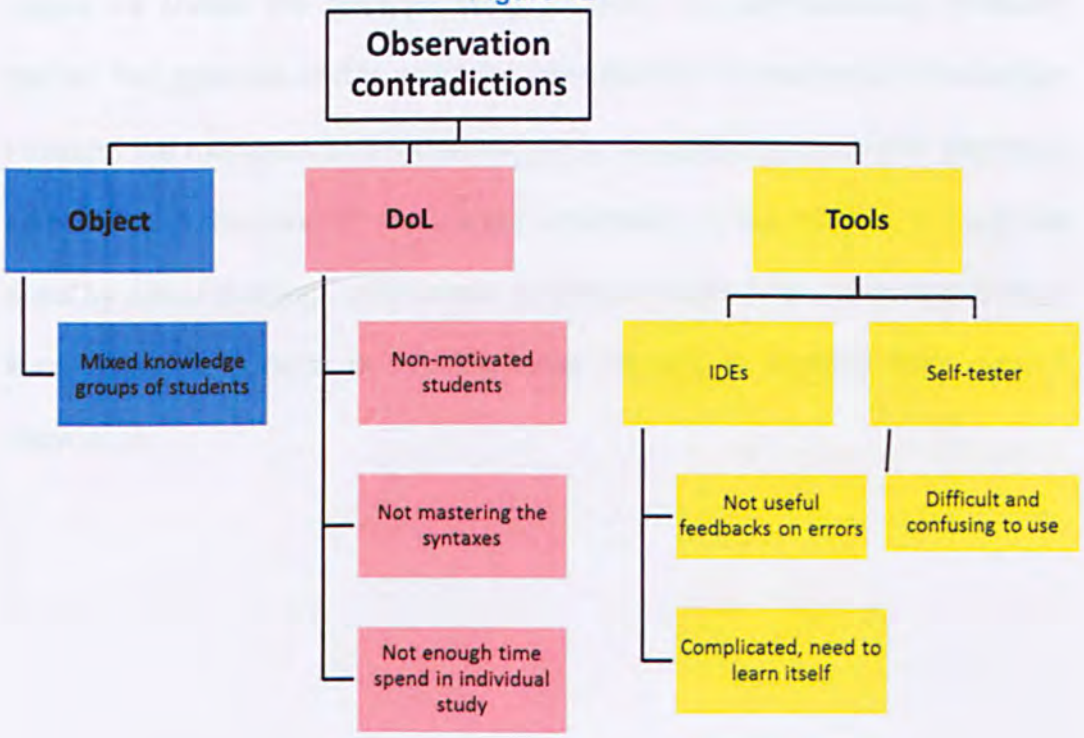


Figure 43

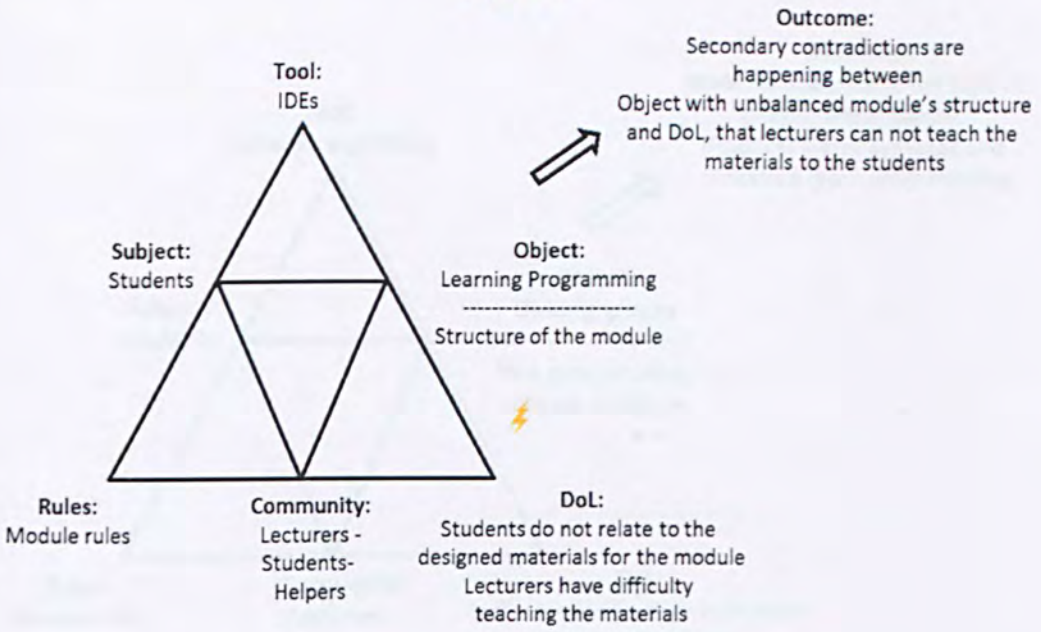
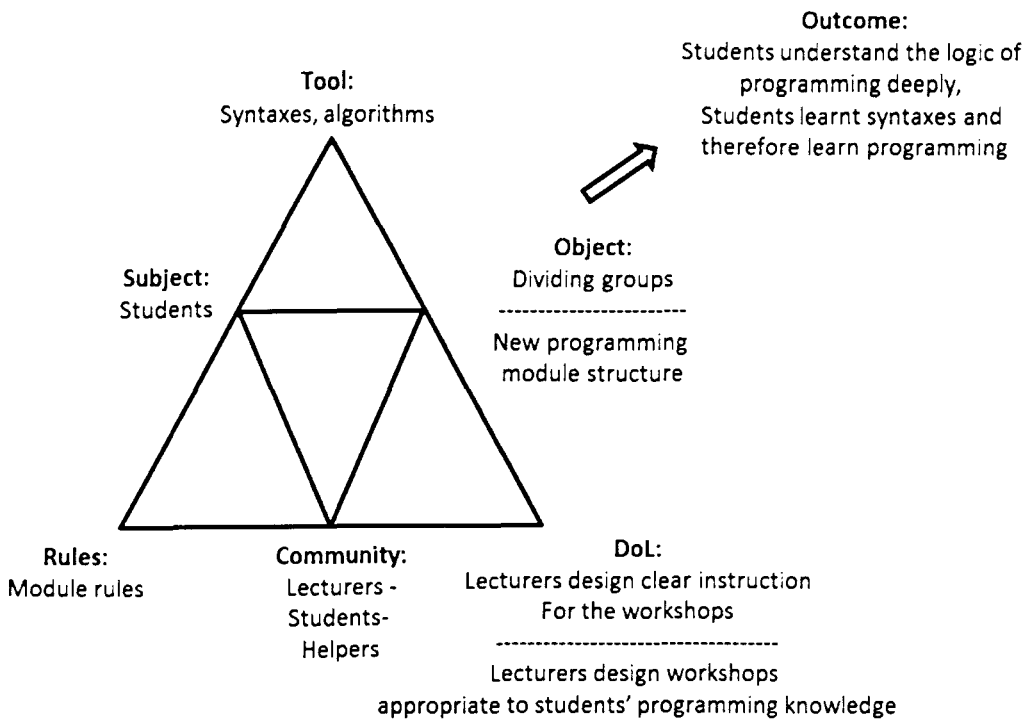


Figure 44 shows the possible shifts to solve the contradictions reviewed above. The potential shift to solve the contradiction of unbalanced knowledge between the members of the Community is, to balance the current' students' knowledge to the level of the offered knowledge in the module. It could be done by either dividing the students to different workshops according to their knowledge background or offering extra classes to improve their current knowledge.

Figure 44



6.4.1.3. Tool

Another observation of the worst educational experience in the workshops was about the Tools. The students seem to having difficulty using some of the Tools such as IDEs. Group of students had issues with simple IDEs such as TextPad, which they claimed, did not assist with errors. Others argued that complicated Tools are hard to use and need more time to learn. Another tool that caused contradictions was a "Self-Tester". The self-tester was designed to give instant feedback on students' codes, from a formative point of view. However, Students found it difficult and confusing to use. The same point was mentioned in a response from one of the staff.

From the notes that the lecturers and the helpers took from one workshop common mistakes/errors were identified. Mistakes that students make during

learning programming can identify specific problems and help to find solutions to minimise those types of errors made by novice programmers. Therefore, to minimise those errors a list of the errors were published in the Blackboard and made available to students.

The contradiction of having a mixed group of students with different background knowledge and level of motivation matches the contradiction from the Focus groups with Staff. These are snown in Figure 37. The Tool contradictions were also discussed in the individual responses from students section, and the ASs of contradictions are shown in Figure 37 too. These similarities in the contradictions emphasis vital issues, which have been repeated both in the individuals' responses and the focus group.

6.4.2. Observation on the positive experiences

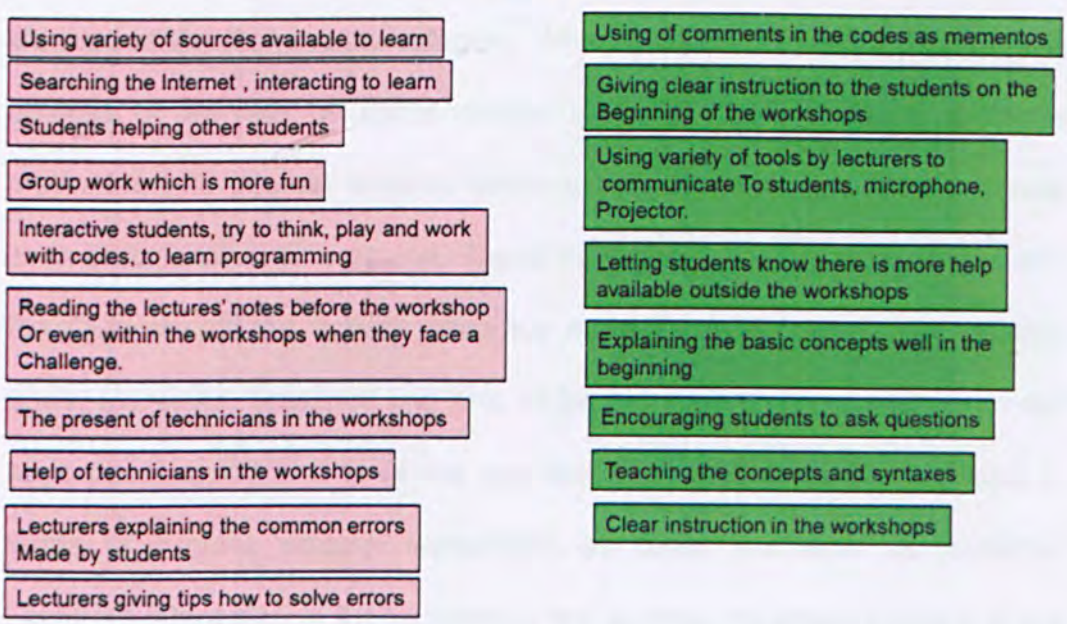
During the observation of the workshops, positive experiences have been noted. Figure 45 illustrates the actual positive summaries of the observed workshops. In addition, Figure 46 indicates the grouping of the actual positive summaries. Colours have been used to clarify the groups. DoL has been showed as pink, green shows the Community group and blue shows the Object group.

Figure 45

Actual Positive Observation notes

- Students helping other students
- Lecturers explaining the common errors Made by students
- Encouraging students to ask questions
- Workshops are the place to practice and learn
- Using variety of sources available to learn
- Lecturers giving tips how to solve errors
- Using variety of tools by lecturers to communicate To students, microphone, projectors
- The present of technicians in the workshops
- Interactive students, try to think, play and work with codes, to learn programming
- Letting students know there is more help available outside the workshops
- Clear instruction in the workshops
- Reading the lectures' notes before the workshop Or even within the workshops when they face a Challenge.
- Help of technicians in the workshops
- Using of comments in the codes as mementos
- Teaching the concepts and syntaxes
- Searching the Internet , interacting to learn
- Working in group, more fun, having support
- Explaining the basic concepts well in the beginning
- Group work which is more fun
- Giving clear instruction to the students on the Beginning of the workshops

Figure 46



As Figure 46 shows, two different groups that emerge from the positive observation notes are Community and Object.

6.4.2.1. Community

As noted before, the activity of learning is mediated by a Community. A Community also may enforce some Rules that might have impact on the activity. Therefore, the way the members of the Community interact with each other seems to be quite crucial in the process of learning. Giving the right information about the support available to the students, providing help and support when it is required and using the right Tools when interacting with the students in the workshops are all critical elements in the Community category. Encouraging students to ask questions when facing errors in their codes, or having doubt about the assignments, helps students to be active learners.

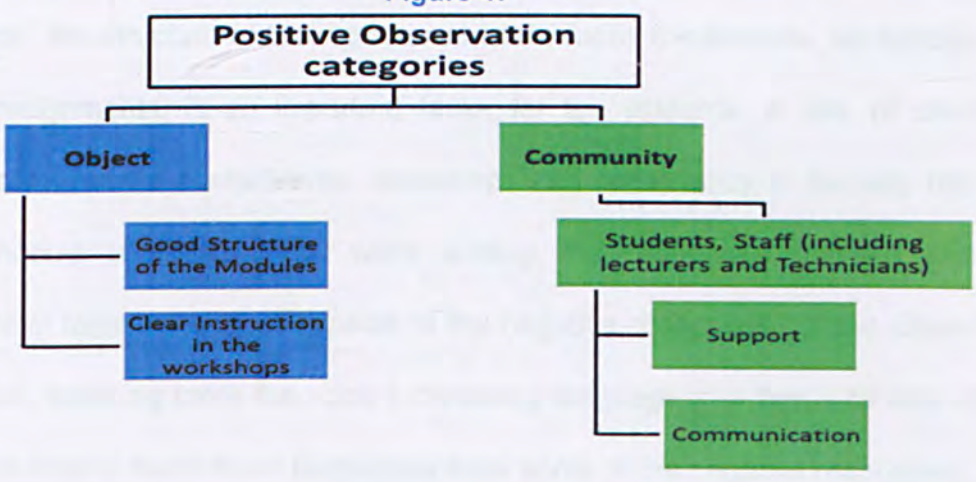
In addition, a clear balance a variety of activities between different members of the Community (students, technicians and the lecturers) are another element of the Community category. When students interact actively in the process of learning by using various types of Tools to learn, it shows motivation and interest towards learning programming, and they can help each other and work in groups. These all suggest positive experiences and the Outcome of the activity becomes more focused towards the desired goals. Moreover, presence and help of the technicians in the workshops are huge positive points. If there are any technical, their presence is critical in terms of running smooth workshops as fewer problems as possible. Lecturers interacting in the workshops are another important element in the Community category. The way that the lecturers run the workshops, the

numbers of tips and instructions given to the students all have a vital impact on how the students interact in the workshop too.

6.4.2.2. Object

As discussed before, the Object refers to the programming modules here, the materials used in the module and the structure of the module. Specifically, the structure of the workshops and the instruction given in the workshops appear to be critical in affecting the way students interact in the workshops. The first workshop appears to be equally important for the students as they get the idea of how the rest of the workshops will be. If there is a concrete structure, and the students find it helpful, they will continue to attend to the workshops regularly and interact actively. Figure 47 demonstrates the positive categories. Colours, as before, show the groups, blue for the Object category and green for the Community.

Figure 47



6.5. Conclusion

This section will offer a summary of the analysis and demonstrate the most important outcomes of the study. Firstly, a review of the analysis of the negative experiences from individuals' responses from the students is undertaken. Also, the staff focus group and the observations are presented. Secondly, a summary of the positive experiences from the same groups is offered.

6.5.1. Negative experiences

Individuals' responses from students' perspectives reveal that DoL, Tools and Object are the Negative elements that concern students. The DoL includes the programming knowledge offered in the module and also the structure of the module. If the Programming knowledge was not in harmony with their level of development (such as syntax being too difficult), then they did not have a positive experiences during the process of learning. In addition, the structure of the module, which includes the lectures, workshops and assignments, is an important factor for the students. A lack of clear instruction for the assignments, workshops and consistency in the way that the module was managed, were among the responses. Limited and unfamiliar tools were other aspects of the negative responses. In the Object element, teaching more than one programing language at a time and lack of enough time to learn those languages were some of the negative responses.

From workshops observations, it was studied that most of the students do not put enough effort and time into independent study time, which they have been advised to do so in their Module documentation (a contradiction in the

DoL). For example, for each 22 hours of Lectures and 22 hours of workshops (11 weeks of teaching period), students are advised to self-study at least 2-4 hours per week. However, those numbers of students that do independent study appear to have more success in terms of learning programming and achieve higher marks.

The analysis of staff focus group responses of negative experiences suggested that ineffective Tools get in the way of learning programming. In addition, the mixed group of students caused contradictions in the design of the module's lectures, workshops and assignments. Furthermore, passive and aggressive behaviour in the community caused contradictions too.

6.5.2. Positive experiences

Community, DoL, Tools and Object are the categories of positive experiences from students' responses. The clear structure of the module and easy access to the teaching materials are some of the positive factors in the DoL. Simple, helpful and effective IDEs are reported by students as being positive elements in the Tools category. The help and support available during the workshops helped students to solve the errors they receive during writing their programs, which have been raised by the students as positive experiences in the Community category. The useful Programming languages taught in the module are another positive experience classified in the Object category.

Analysing positive experiences from focus groups with staff suggested three categories of Tools, Object and DoL. Simple and effective tools, a well

organised and structured module; and related background knowledge are respectively pointed out from the positive categories.

The observation suggested a high level of communication between different members of the community, which include Students, Staff and the Technicians in helping students to learn programming in a more enjoyable environment. In addition, the structure of the module and the instruction given in the workshops are critical elements, which have significant impacts on the process of learning programming.

The next chapter offers a conclusion to this study by reviewing the new designed method. In addition, a review of the main contradictions and shifts is offered followed by recommendations and list of further work that will complement this study.

Chapter 7 – Conclusion

7.1. Introduction

This chapter presents a summary of the research by revisiting the main aims and objectives of this thesis. In addition, an overview of the research findings will be offered. Two final sections will indicate recommendations and future work.

7.2. Research summary

The principle aims and contributions of the research which have been studied and reported in this thesis are:

- The design and construction of a new method built on AT's framework containing a systematic step-by-step approach.

- The application of this new method to the case study to test the usability and applicability of the method, examine if the new method helps to aid the understanding the complex environment of learning programming. It also enables the study of contradictions that are happening during the activity of learning and looks to transfer these contradictions toward the desired outcome by introducing changes, which might achieve potential shifts.

The work that was carried out to attain these aims and intentions and the result of the research have been reported in the previous chapters of this thesis. In this final chapter, the achievements and conclusions that have been discussed previously are summarised.

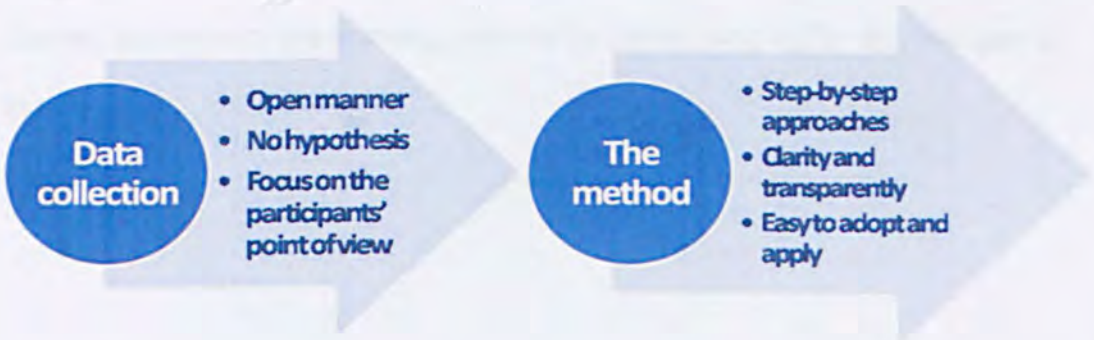
7.3. Designing a novel systematic method by combining Activity Theory and Grounded Theory

As reviewed before, AT offers a solid and concrete structure with a defined ontology, which helps to breakdown complex environments into different layers that are easier to understand and easier to describe. As Nardi (1996) highlighted, this defined ontology provides the necessary awareness that is needed to understand and describe these different layers. However, AT does not present a clear systematic step-by-step method to collect and analyse data. Therefore, combining AT with another qualitative method that can fulfil this gap appeared to be beneficial.

As discussed before, three candidates that were initially considered to be coupled with were Action Research (AR), Grounded Theory (GT) and Phenomenography (Ph). It was established that GT is most appropriate method to be combined with AT. The choice of GT above Ph and AR, found to be right considering the initial outcomes as it was experienced during this research, they are working in harmony together to produce a new method. AT helped to breakdown the complicated situations into less complex pieces, which was easier to see through the issues studying the history of the contradictions and analysing to find potential shifts. GT allowed the researcher to have a flexible and open-minded strategy toward collecting data, to decrease presumptions and hypothesises which helped to broaden the possibilities of findings. In addition, both GT and AT have the ability to study the history of an activity by following an iterative process.

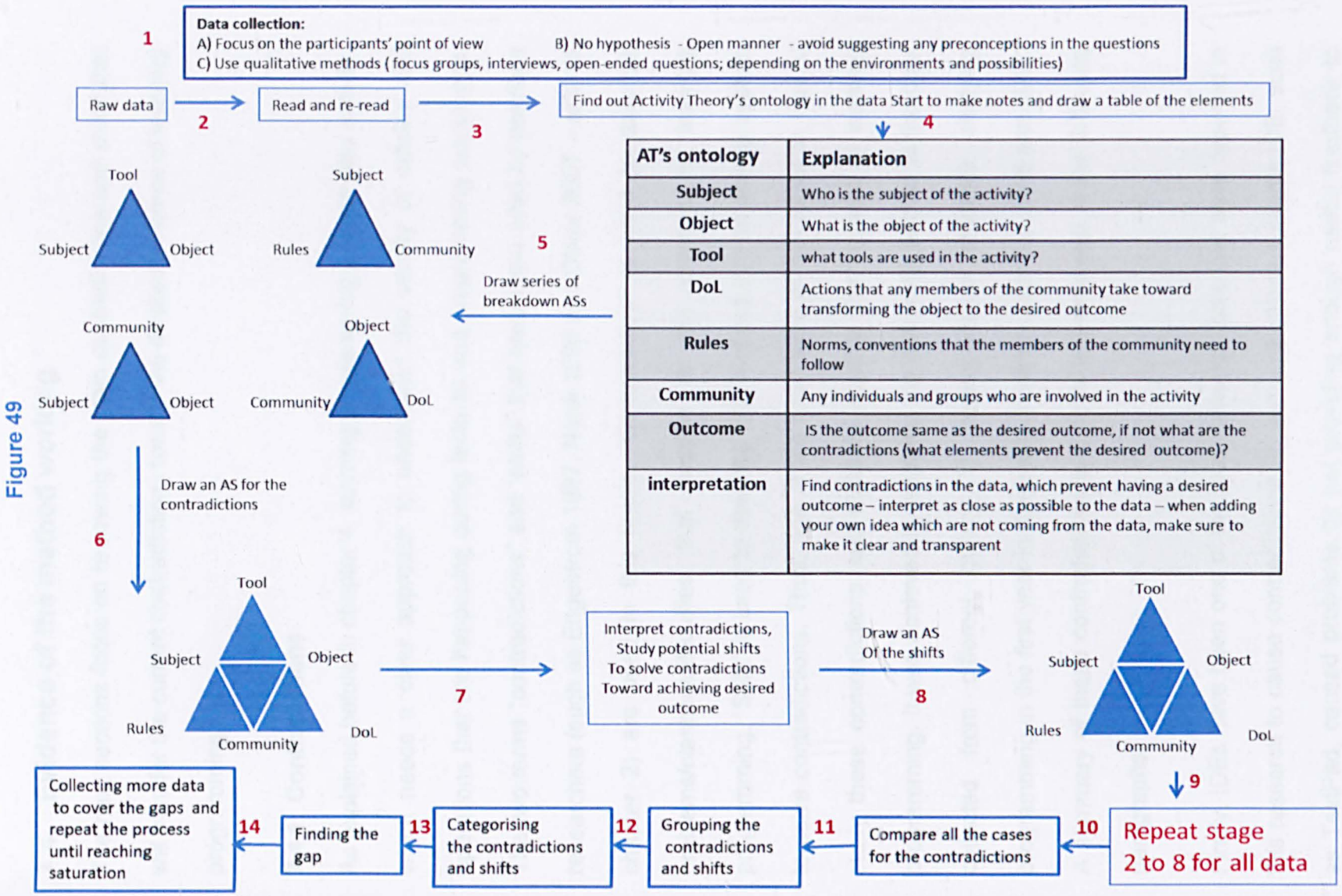
Subsequently, a systematic step-by-step method was designed to analyse the collected data by combining AT and GT. A series of stages that are clear, transparent and consistent for both collecting and analysing data were designed. For instance, AT's ontology provides a conceptual terminology that helps to interpret the data firmly throughout the research. Within the use of AT's ontology, GT's open-minded manner helped to avoid preconceptions in designing the questions and the way that the data was collected. Figure 48 indicates that there are two main aims of the new method. These are data collection in an open manner, which reduces the preconceptions of the researcher and focuses on the participants' points of view, and the use of the new designed method, that offers a systematic step-by-step approach, that can be used other researchers.

Figure 48



It is useful to discuss that even though there are stages to the new method, these stages do not have to be followed exclusively as a linear research method. This method can be adopted according to the requirements of other studies. The designed method has been influenced by GT; therefore, there are iterative steps that enable the researcher to return to the previous analysed data to revalidate the existing discovered contradictions and generate a new series of shifts to transfer the contradictions toward the desired outcome. Figure 49 shows a summarised diagram of the new method.

As it was discussed in the previous chapters, after designing the new method, it was applied and tested on the case study to study contradictions and shifts in the activity of learning programming. The method is likely to be useable in similar contexts e.g. it can be used in different learning environments to study contradictions happening during the process of learning. In addition, it can be used to transfer contradictions toward the desired outcome of the learning process by introducing shifts and changes to the activity.



AT's ontology	Explanation
Subject	Who is the subject of the activity?
Object	What is the object of the activity?
Tool	what tools are used in the activity?
DoL	Actions that any members of the community take toward transforming the object to the desired outcome
Rules	Norms, conventions that the members of the community need to follow
Community	Any individuals and groups who are involved in the activity
Outcome	IS the outcome same as the desired outcome, if not what are the contradictions (what elements prevent the desired outcome)?
interpretation	Find contradictions in the data, which prevent having a desired outcome – interpret as close as possible to the data – when adding your own idea which are not coming from the data, make sure to make it clear and transparent

Figure 49

7.4. Evidence of the method working

The next sections focus on reviewing the main contradictions and shifts that will transfer the current contradictions toward the desired outcome of learning programming.

7.4.1. Contradictions

As explained before in chapter 4, learning programming is a complex activity, which needs a clear approach to understand the variety of actions and operations that are happening during lectures and programming workshops. The two terms "contradictions" and "shifts" that have been used by previous researchers (such as Engestrom 1987, Nardi 1996 and Oliver 2007 – refer to chapter 2) are used in this thesis. "Contradiction" is used to describe problems/clashes/difficulties that happen in the process of learning programming. "Shift" is used to describe interventions into an activity system to solve contradictions. Thus, one of the main aims of this research was to study these contradictions and shifts to improve the process of learning programming. It was achieved by applying the designed method to the data collected from different groups of undergraduate students studying programming in the first year in Kingston University between 2008 and 2011. A summary of these contradictions and shifts are reviewed in the following paragraphs.

Firstly, IDEs have been one of the most common tools that were reported in this research to cause contradictions. In some situations a simple IDE, such as TextPad, caused problems by not providing enough useful feedback to solve the errors in the code, in other situations a more complex IDE such as

Netbeans and Eclipse which have more developed environments to provide more accurate and detailed feedback on errors were considered to also be causing difficulties. These complex tools - which seem to be non-familiar IDEs - caused confusion for the novice programmers and it was reported as getting in the way of learning programming and were seen to be ineffective in terms of helping the students to learn programming. In was concluded that unfamiliarity with the IDEs in use caused most of the problems and not the IDE itself.

Secondly, the structure of the module, assignments and workshops created contradictions. In addition, the mixed group of students with different background knowledge was another contradiction. The analysis pointed out that having a mixed group of students in a classroom with different background knowledge of programming made the design of effective lectures and workshops almost impossible. It was also indicated that module design that used complex teaching materials caused contradictions too. For instance, when assignments and tasks in the workshops are not in balance with the students' knowledge, it causes contradictions. Additionally, the students often complained about the speed of the instruction that they received in the workshops, especially in the first few weeks. They often fell behind when the lecturer demonstrates how to write a series of code for a specific task. These problems are sometimes related to the level of students' preparation and readiness for the workshops. For example, if the students read the lectures notes before attending the workshops, this might help to understand the code and speed up the process of following the instruction

given in the workshops. It also depends on if they have learnt the concepts and syntaxes well enough to experiment it in the workshops.

Thirdly, teaching multiple-programming languages in a single module caused contradictions. The students argued that there was not enough time to learn multiple-languages. In addition, another group of students reported that the chosen programming language was too hard for them to begin with. Another group of students argued that the taught languages were not effective for their future career.

Fourthly, the students' motivation appeared to play a vital role in having a successful activity. If the students are not well motivated, they might not concentrate on learning programming, and may not spend enough time in independent study and the chance to become a better programmer might be low. In addition, a lack of deep understanding of the concepts and syntaxes of the language will affect the level of knowledge and the students' abilities to solve problems.

7.4.2. Shifts

As discussed before, shifts are interventions, which can transfer the contradictions into solutions. This section reviews the positive experiences of the students and staff and also those observed by the researcher to indicate the lessons that can be learned to use them as potential shifts towards achieving the desired outcome of learning programming.

Firstly, it was concluded that simple and familiar IDEs and OSs assisted the students to learn. In addition, the students highlighted that an effective and

well-structured module made the process of learning easier and more enjoyable. Clear instruction in the workshops provides a relaxing environment for the students to learn more effectively. Moreover, anytime-anywhere access to the teaching materials was among the positive responses. Usability of the taught languages in their future careers was also mentioned in the positive experiences of students' responses.

Secondly, staff argued that the level of students' background knowledge on the subject is quite important in designing an effective module. In addition, they suggested active and motivated students encourage positive interactions in the community and help other students to learn more effectively. Furthermore, the simplicity of a tool and the way it effects on the students learning was among the positive experiences.

Thirdly, the analysis of the positive observations suggested that help, support and effective communication between the members of the community (students – staff including lecturers and technicians) have a vital positive impact on the level of students learning. Likewise, the structure of the module and clear instructions in the workshops reduce stress and facilitate a good environment.

In the next section, recommendations - according to the shifts that might solve some of the contradictions - have been reviewed.

7.5. Recommendations

As Alsop and Tompsett (2002) argue in any educational institutions the different conceptions of different stakeholders- which includes: "University

managers, system designers, system implementers, course lecturers, students and researchers"- are critical in future development and these needs to be an integration of these differences to satisfy all these stakeholders.

Therefore, the suggestions offered here may refer to different parts of the University. Some of the changes may need permissions from committees and others might just need to be done by the module leaders and the lecturers.

As the analysis has been divided into three parts: students' responses, staff focus groups and observations, the recommendations will follow the same structure.

The students prefer an IDE that does not get in the way of learning programming. This problem was referred to as working with unfamiliar IDEs. One simple shift is to offer one or two non-compulsory workshops to introduce the IDE before the actual module starts. The group of students that think they might need help learning the IDE could attend the workshops and get familiar with the IDE before they actually use it to develop any programs.

The staff highlighted a very common contradiction that could happen in any module, which is having a group of students with a mixed background knowledge of the subject in the same module. One possible shift to solve this contradiction is to divide students into different groups based on their experience. For example, a test before the beginning of the first semester can lead to an allocation to groups based upon ability. In addition, the

module's materials could be designed to start from the differing knowledge levels of the students.

The result of the analysis of the observation suggests that students' motivations are equally important as the structure of the module. If the structure of the module corresponds to the students' abilities and knowledge, then students will be more motivated and encouraged to learn and spend more time independently to learn programming. Also, designing assignments and projects that enable students to work as a group might motivate the students to work harder and make the process of learning more enjoyable for them.

As regards to the designed method, it is suggested that the research should not be started with a literature review to make sure that the data analysis is less biased and no hypothesis and preconceptions are added to the interpretation. In addition, since, both AT's framework and GT's methods are not straightforward to use and, therefore, any research that would like to apply the method to any other context, needs to understand the history of changes and transformation in AT and GT.

7.6. Further work

This research has focussed on the design of a new systematic method to clarify a pathway of collecting and analysing data transparently. In addition, the method was validated by using a case study of learning programming. So it is clear that the method's use in this context is acceptable. In order to test whether the method has more general application, there would be a need to validate this on other samples and case studies. However, the achieved

results suggest that such generic use will provide additional proof of the method working.

7.7. Limitations of the thesis

Although this research has been carefully planned and has reached its aims, there were some inevitable limitations.

First, because of the time limit and difficulties facing collecting data from the students, the data collection was limited to Kingston University students. While initially, it was designed to collect data from two different universities, to make sure that generalization was *feasible*.

Secondly, the observation of students in workshops could be more advanced, by video taping the sessions and analysing the videos. However, the cost and time for the recording and analysis was not realistic for this research, as it would require more than one person to cope with the amount of data collection and resulting analysis.

Finally, the sample of this research was changing from one semester to the next. It would be useful if specific groups of students could be followed from one semester to another, to observe their programming skills improvement. However, it would need each student's permission and their full collaboration, which could be quite hard to achieve.

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Appendix 1

Students' questions

Computer Graphics and Digital Imaging	☐	*Games Programming*	☐
Computer Science	☐	*Network Communications*	☐
Part time	☐	*Full time*	☐

Other (please specify): .....

Best educational experience:

Tools are used to learn programming for example: books, Applications, Online materials, etc.

Tell me about your Best experience of learning Programming using a tool.

Please specify the tools and the module in which the experience happened.

Name of the module: ☐

Name of the tool: ☐

Please write about 8-15 sentences in the space below that outlines the details of the experience.

At the end, please summarise your story of the experience in a single word or brief phrase (up to 5 words).

Your Story

Your summary

If you are happy to be contacted for more participation, please write down your name and your email address. Many Thanks for your time. Maryam Kheir Abadi, Maryam@kingston.ac.uk

Computer Graphics and Digital Imaging ☐ *Games Programming* ☐

Computer Science ☐ *Network Communications* ☐

Part time ☐ *Full time* ☐

Other (please specify): .....

Worst educational experience:

Tools are used to learn programming for example: books, Applications, Online materials, etc.

Tell me about your worst experience of learning Programming using a tool.

Please specify the tools and the module in which the experience happened.

Name of the module: ☐

Name of the tool: ☐

Please write about 8-15 sentences in the space below that outlines the details of the experience.

At the end, please summarise your story of the experience in a single word or brief phrase (up to 5 words).

Your Story

Your summary

If you are happy to be contacted for more participation, please write down your name and your email address. Many Thanks for your time. Maryam Kheir Abadi, Maryam@kingston.ac.uk

Appendix 2

Staff questions

Q1- Worst educational experience

You will have had a range of experiences in using various tools to teach programming. Some experiences will have appeared more helpful, some less helpful, some challenging or satisfying and some others less effective, confusing or even frustrating.

I would like you to concentrate on what you, personally, could identify as a single occasion which you consider as the occasion (or one of the occasions) which was the worst educational experience using one of these tools.

I would like you to tell us about this event. Please write about 8-15 sentences in the space below that outline the details of how the event occurred. Please specify the tools and the module that the event happened.

Your Story

Q2- Best educational experience

You will have had a range of experiences in using various tools to teach programming. Some experiences will have appeared more helpful, some less helpful, some challenging or satisfying and some others less effective, confusing or even frustrating.

I would like you to concentrate on what you, personally, could identify as a single occasion which you consider as the occasion (or one of the occasions) which was the best educational experience using one of these tools.

I would like you to tell us about this event. Please write about 8-15 sentences in the space below that outline the details of how the event occurred. Please specify the tools and the module that the event happened.

Your Story

Explanation for staff focus group - Working in groups:

Please list the Group Members (as letters):

1- Summarise your article on your own sheet in a single word or brief phrase on a post-it note (up to 5 words).
Write your own letter code on this post-it but do not show it to anyone else.

You are now going to review the stories for each of the others in the group. When ready, circulate your stories to the left and without comment. It is very important that you read each text without comment in order not to influence anyone else.

2- As you read each other's answers, note any ideas that come to mind on the post-it note - any ideas such as matching with your own experience, surprise at what someone else found.

3- Summarise each article as you go in a single word or brief phrase (up to 5 words), just as you did for your own story.

When you all have finished, write your individual letters on this group sheet below:

GROUP MEMBERS (letter codes please):

Then:

4- Discuss the summaries for each of the stories in turn.

When you have considered all the stories

5- Agree on a single phrase or word that could be used to summarise the set of stories (if you start with strong disagreement, note this down on the group sheet

Then, if you have time,

6- Individually, on your own page, outline the key point of each story that is most distinctive for your personally.

Then, if you have time,

7- Jot down as a key word or phrase any idea that is important to you that has not yet been mentioned in your stories so far that, if it were not covered by anyone else in the research process should be raised with you at a later stage...

Appendix3

1) Have you bought the textbook?

Yes	**45**
No	**157**

2) If the answer to question 1 is no, what were the reasons?

Too expensive	**47**
easy access to the book in the library	**86**
not useful	**69**

Write down any other comment

3) Did you use any other resources. E.g, other textbooks, websites, etc. How useful and why?

Yes	**180**
No	**2**
Don't have Personal Computer	**20**

Write down any other comment

4) Have you installed Java compiler and Textpad on your home computer?

Yes	**172**
No	**10**
Don't have Personal Computer	**20**

Write down any other comment

5) If the answer to question 4 is yes, did you have any problem in process of installing?
Did you successfully resolve any problems?

6) Did Textpad and Java compiler help? How?

7) How easy did you find the course?

Very easy	
easy	**108**
difficult	**94**
very difficult	**0**

why was it easy or difficult?

8) If the answer to the question 7 is easy or very easy, does it relate to any of theses issues?

Previous knowledge	**53**
work experience	**7**
high quality of teaching and helps	**34**
High motivation to learn	**39**

9) If you find the course difficult, please explain the reasons.

10) Did you have any previous programming exprience? Which language?

Write down any other comments.