MSC Project

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Types in Programming Languages

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Declaration

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Abstract

Type systems occupy an important role in the field of programming languages (Pierce, 2002). Because of the effect of types and the type systems on the development time, performance and tasks of the software, these types are worth studying in depth, especially regarding the different types of programming languages available as part of this trend. During the course of studying many aspects and features of different types of programming, it emerged that all learners of programming language face difficulty in choosing the appropriate language to meet their requirements in different fields (Lahtinen, Ala-Mutka, and Jarvinen 2005).

The aim of this research is to establish and create a targeted learning environment in order to share the findings related to this research, also to help learners who seek appropriate solutions to meet their requirements in terms of choosing a suitable language and gaining better control of the principles of the new language.

This project covers the following topics

1. The role of type systems in programming language concepts:-

The project introduces the fundamental principles regarding programming language, such as type of safety and polymorphism (Pierce, 2002), and provides an overview of the various types of system (Cardilli, 1996). Also, it discusses the development of new types of systems of programming language for Java, assembly language, C, Scala, and Ruby.

2. Available solutions for optimizing the safety and expressiveness of various programs:-

The project focuses on designing a method for combining the dynamic and static types of checking in programming language, in order to optimize the safety and expressiveness of the programs (Lewis, Launchbury, and Meijer, 2003). It also analyzes the trend of development in types of systems and the new class of type systems that is described in this project (Pierce, 2003).
3. Helping learners to choose a suitable language through analyzing the main features of different languages.

The common issue that has emerged during the course of the research topic is the difficulty of choosing an appropriate language (Soloway and Spohrer, 2013). This research describes and analyzes the main features of different languages and gives comprehensive instructions and examples for learners on how to identify and select the appropriate language (Mayer, 1981).

4. Differentiation between the program safety and high performance of the program

The efficiency and safety features of dynamic/static type checking and strong/weak typed programming language are construed by building various programs and executing them in different programming languages (Pratt, 1984) and (Tennenhouse and Smith, 1997). This project can also help in giving suitable advice for choosing the programming languages during designing software.

5. Questionnaire feedback illustrates the objective presence of difficulty in choosing programming languages and this also affects learners in the learning environment.

The objective presence of language choice difficulty will be illustrated in the form of questionnaire feedback at the end of the project. The project analyzed the collected questionnaires and the results from the questionnaires collected from different learning levels make an effective and realistic contribution towards helping learners in choosing and learning a programming language.
Chapter 1  Introduction and Objectives

1  Introduction

Type system is a significant research subject in programming language theory. The type system is defined as “as any property of a program we can determine without executing the program” (Cardelli, 1985). Where the programming language develops a wording type system, it achieves a more accurate rule set than the checking type. However, this comes at the price of the programmer having to pay more regard to certain computer functions. This project is structured as follows: chapter two considers and draws conclusions on the status of certain research studies in the area of types of programming languages. Chapter three focuses on analyzing the main requirements of the website that will be used as a learning platform for learners of programming languages. Chapter four discusses type systems in terms of programming languages. Also, chapter four compares and contrasts the nature of the various types, such as weak and strong types, and dynamic and static programming. In addition, it demonstrates and explains clearly the learning website environment and its basic components. Respectively, chapter five clarifies the website test environment and the results, and evaluates the website’s effects on the respondents. Next, chapter six places a number of related issues under the microscope, such as legal, social, professional and ethical issues. Finally, chapter seven will summarize the trends of types in programming language and the learning website’s aims. The main concepts to be covered in the project are:

1. Identifying the role of the type system in programming languages

Firstly, this project needs to consider many different questions, including the following: What is meant by a type system? How many type systems are there for different programming languages? What effects can the type system have on the implementation process and the development of the program? These questions could effectively be researched by identifying, examining and questioning the relevant literature sources and then summarizing this information. This project will demonstrate the role of the type systems in programming language and will focus on providing a balanced discussion and overview on selecting from the various type systems.
2. Identifying possible solutions to understanding type systems and the trends in this concept

Recently, analysis of the programming language from TIOPE has identified increased interest in the use of dynamic programming languages such as Ruby, Python and Perl (Matsumoto and Ishituka 2002). Issues relating to the type system can only be resolved when the interpreter of these languages becomes familiar with interpreting the object. This may explain why productivity and flexibility are becoming more significant issues for both learners and programmers. In addition, several tools of the languages that are used to provide the interface of the static type may demonstrate that programmers do not need to abandon a system whereby the robustness and the safety of the programming language is supported by type checking. This project will suggest many thoughts in order to determine the ultimate considerations in terms of safety, types and expressiveness in different programming languages, based on the idea of the diversity of uses of the various types in the programming languages.

3. The trade-off between type system safety and expressiveness

Firstly, checking of the type system cannot completely ensure the program’s safety. In the compiling stage, most languages cannot provide detection of errors that occur through dividing a number by zero; this leads to run-time errors, and therefore the system cannot be considered a completely safe system type. Secondly, whereas the type system may have a pleasing design, it can generate a large number of the errors, largely through reduction of the debugging time. Large classes of other such errors are excluded in order to simplify the debugging task. In addition, in order to show up the type errors, the programmer will need to develop and improve the style of any code that has caused logical errors. However, many arguments persist about which is best: a weak or strong type system and a dynamic or static type system. This project compares the many differences between weak type, strong type, dynamic type and static type and also researches the characteristics of these types by providing survey of the role of data type and system safety types for several programming languages, thereby providing advice for real programming.
1.2 Background

It has been found by administering questionnaires in the course of the research that many of the learners who wanted to learn programming languages faced difficulty in choosing them. As a result of the learners’ inefficiency, they cannot precisely choose which programming language to learn. In addition, before realizing the programming goal, many learners abandon their language learning. Thus this project demonstrates through analysis the diversity among several programming languages. It also provides examples and analysis of the advantages and disadvantages of various languages. During the course of the research, the project summarizes emergent questions and analyzed conclusions. Through the questionnaire results, a difficulty in choosing a suitable programming language on the part of the learners was observed. Therefore, this project invites them into the learning programming languages environment and helps them in choosing and learning the programming languages. The foundation of learning environments can improve the efficiency of language learners, help them to gain better understanding of programming languages and solve the problem of choosing a suitable language.

1.3 Objectives

The project has several objectives as follows:

1. To compare the differences among several programming languages

This project explains in chapter four the main types of system as exemplified by the various programming languages discussed. This explanation will enable these languages to be more easily distinguished based on their types. Assembly, Java, C language, Ruby, and Scala programming languages are demonstrated in detail by comparing and contrasting them based on displaying the basic concepts of each. Therefore, even those who have little relevant experience will then be able to distinguish among them accurately.
2. To help users in choosing the right programming language

This project demonstrates in chapter four the different sets of requirements relating to different languages when achieving the same objective, in order, through comparing and contrasting the different types of programming language, to build a helping environment where learners can select a programming language that is compatible with their personal aims.

3. To enable learners to learn programming languages effectively

This project aims to interpret the required precautions in order to avoid misconstructions that can easily arise via a learning course. These are identified in various aspects of the languages through analyzing the main features of the different languages as is explained in chapters two and three. The learning environment includes a platform for learners who have some experience, in order to enable them to communicate with others and thereby enhance the quality of their programming. The learning environment also helps to provide mutually interactive platforms such as Discussion area activity that is used to discuss knowledge about programming languages and to improve programming levels among the learners; therefore, they will be able to communicate and acquire additional information in this field.

4. To demonstrate the process of solving, analyzing, validating questions

In fact, the course of the research included in the project is a complete technique that includes question solving, question analysis and question validation. During acquisition of programming language knowledge, it is found that most learners encounter difficulty in choosing a suitable language, as is explained in chapter five. However, it is also found that the problem of choosing a language can be solved by analyzing the individual course of language learning and practical procedures that are used to solve the problem when using a learning language environment. Also, as the questionnaire results demonstrate, the project can offer an effective solution, a suitable environment to learn the language, and environmental communication with other learners, to thereby enhance the learners’ efficiency in learning these languages.
Chapter 2  Literature Review

2.1  What is meant by type and type system?

No human beings can avoid the diversity of types. One of the most important aspects of human nature is the ability to make classifications of various elements in different fields, which enables abstraction of our world and improvement in the efficiency of people’s thinking and subsequently their language proficiency to communicate with other people. Hence, the main concept of type in programming language can reasonably be introduced and considered in similar terms to the diverse nature of things.

The current project justifies the introduction of the type system to programming language through complementing and referring to the following reasons provided by H Jiang (Mitchell, 1991) in his article “Type System in Programming Language”:-

1. Using the type system can help programmers to express their aims, and improve the reading of the code as procedure.
2. The use of system type allows modularization and polymorphism and simplifies the maintenance and development of complex systems.
3. Via using system type, improper operations among data belonging to the different types can be excluded, such as the integer type that is used as a pointer address to access memory.
4. Through the diversity of data type, such as the float and integer types, as well as the various modes of internal storage, using different types can improve the efficiency of computing through their optimization in the computing stage.

Function can be developed during construction by means of continuous application of type systems in the programming language, so that type system definitions are developed simultaneously. Discussion of the type system can be described both as self introduction and introduction of contents, reflecting the potential value of the types and the modes via which they interact with other types. Through such an introduction, it is possible to avoid many apparently unimportant errors, for example, telling the native English speaker that it is not necessary to learn a different language to write in this language. The type of systems used in different languages is a good definition of different types and a good way to describe relations among types. The following section provides introduction to some of the main concepts relating to the type system.
2.2 The Main Concepts of Type Theory

2.2.1 Type safety

With regard to program errors in the run-time, Luca Cardelli relied on the time difference from the generation of errors to the program’s failure to make the following classification: trapped errors are defined as those that cause the computation to stop straightaway, while un-trapped errors are those that go unnoticed but then cause arbitrary behavior. Strict adherence to type safety requirements not only avoids trapped errors but also un-trapped errors. As Robin Milner explains, “Well-typed expressions do not go wrong”; through using the perfect type system, type safety can be realized (Milner, 1978). On the basis of checking safety time and potentiality for satisfying type safety, programming languages can be classified into dynamic and static types as well as weak and strong types.

2.2.2 The Dynamic and Static Typologies

To be exact, the dynamic and static types of language should be called “dynamic checking” and “static checking” respectively (Pierce, 2002). In the compiling stage, those languages that have a data type that can be demonstrated directly are referred to as statically typed programming languages.

The use of typed languages can ensure the program’s type safety through the tools of the static system type (Ortin, Zapico, and Perez, 2010). Categorically, type systems can help to ensure the avoidance of certain poor programming behaviors (Aiken and Murphy). On the other hand, they cannot help to prove their presence and thus they must also occasionally refuse programs (Ortin, Zapico, and Perez, 2010). For example, the following Java code needs to be taken into account.

```java
ArrayList<object>  arrayList= new ArrayList();
for( int counter =0; counter< 9; counter ++);
arrayOfList.add(" short strings");
int number = arrayOfList[counter].lenght;
```

This leads to production of errors at compile time: “the type of the expression must be an array type but it resolves to ArrayList<object>”, although the part of the code does not occur as errors
in the run-time. Even though checking of the static type system can provide chances via exploiting either the user infers or specifying the type of information statically to make the optimizations, occasionally, the value type is not defined until run-time (Van Noort, Achten, and Plasmijer, 2010). The tags of the run-time type used to distinguish several types of structures in the heap are called “dynamically typed programming language”. Occasionally, for ensuring the safety of type, checking of dynamic type must be used by the programming languages in order to specify the operation of type that cannot be checked during the time of the static check. For example, when conversions among two types can only occur in cases where there are inheritance relationships among them, in the program run-time it can only be checked whether one type is a sub-type of the other or not.

2.2.3 Weakly and Strongly typed systems

According to Peter Wenger, if the language is classified as strongly typed the compiler can guarantee that the accepted program will be executed without any type errors. This clarifies that the use of strong language ensures the program’s language safety, as the compiler will receive warnings after the static checks if the dynamic checks throw up any exceptions. The use of strongly typed language will ensure the program is free from any un-trapped errors. In contrast, those languages that do not ensure such safety are called “weakly typed systems”.

However, in terms of the strength of the typed system, a static system is not always considered a typed system; hence several static typed languages are of no use in ensuring that un-trapped errors will be deleted during the compiling stage. For example, the Pascal programming language does not ensure program safety in the case of using function parameters (Wirth, 1971). Also, the C language can cause many problems, particularly in relation to pointer arithmetic. Therefore, the C and Pascal languages are considered weakly typed languages.

When trying to write a program in C language, in order to ensure the program’s safety, programmers must focus on the programming habits (Spencer). However, C language’s safety has been enhanced largely in Java and C++ languages, to improve the performance in terms of safety. It should be noted that to ensure the program’s safety, the garbage collection mechanisms within Java have been improved to reduce the development time and the code size. This can be considered a good example of program safety that works by improving the speed of development.
reversely. Dynamic typed languages can also be strongly typed languages and the most commonly used in this framework are Ruby and Python.

### 2.2.4 Typed and Un-typed languages

More of the main concepts must be discussed here before introducing the type systems in different languages, in terms of how to distinguish between un-typed language and typed languages. Luca Cardelli and Peter Wenger refer to four universes in their article: “On understanding types, data abstraction, and polymorphism”

1. “Bit strings in the computer memory”.
2. “S-expression in the pure lisp”.
3. “λ-expressions in the λ–calculus”.
4. “The sets in set theory”.

According to analysis of the four universes, the properties of un-typed systems can be defined as follows: all programming languages that have the same elements are considered as the same type of system, whilst otherwise there is no clear definition of type systems. In another article Luca Cardelli defines un-typed language from a different angle by describing it as a language that does not restrict the range of variables. Furthermore, Luca Cardelli demonstrates that type systems can be considered as components of the typed language that ensure that it keeps track of the variable types. Although occasionally types can be affected by grammatical neglect, when the types play this role in the confirmed language, the language should be regarded as typed language. Where the type appears in the language’s wording this is called an explicitly typed language, but where expression of type is not included in the language, such language is referred to as implicitly typed language. In order to make a comparison between the advantages and disadvantages of the two forms of language, Reynolds said that “one side claims that the un-typed languages preclude compile-time error checking and are succinct to the point of unintelligibility, while the other side claims that typed languages preclude a variety of powerful programming techniques and are verbose to the point of unintelligibility” (Reynolds, 1985). He later concluded his argument with the comment: “From the view of the theories, both sides are right, and their arguments are the motivation for seeking types systems that are more flexible and succinct than those of existing typed languages”.

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2.2.5 Type inference

In some types of programming languages, the term type inference is used to refer to the direct deduction of expressions. It checks each of the function calls and inserts them in the type declarations, to ensure correct computing of the expressions. Though this process reflects a kind of obvious declaration, type inference must refer to restructuring of the types (Palsberg and Schwartzbach, 1991). There is a reverse operation to type inference that is called type erasure. Several statically and strongly typed languages can be found to have typed inference characteristics. In addition, type inference is considered a distinctive characteristic of functional and efficient language, in that it reflects the way of thinking instead of using tacit machines (Goldberg, 1996). Good examples of type reference languages include C, C++ and Java. Type reference helps programmers to develop their programs quickly, without needing to consider type declaration tags, and guarantees automatically the safety of the type.

2.2.6 Polymorphism

Polymorphism is an important technical aspect that represents object oriented features and it is a generalization of the type systems in expansion (Milner, 1978). Luca Cardelli provides four types of polymorphism that depend on the classification by Strachey.

1. Parametric Polymorphism
2. Inclusion Polymorphism
3. Overloading Polymorphism
4. Coercion Polymorphism

According to Luca Cardelli, the types of polymorphism can be shown more precisely in tree form as follows:
The generalization called “parametric polymorphism” is used when the functions that can be received in different types depend on the template or common features such as parameters (Reynolds, 1983). For example, in Java language various types may use the same interface and they can be regarded as the contained parameter when calling the method that is checked by a template in C++ language. Inclusion polymorphism is an individual concept of object oriented programming languages that is called sub-typing. Inclusion polymorphism can be obtained when the type is inherited from another type or it can be contained in another, hence there is inclusion.

The above two types of polymorphism make up what is called “universal polymorphism”; universally polymorphic methods can handle an infinite number of types that conform to certain behaviors (Ducournau, 2002). In the case of superficial polymorphism, overloading and coercion of polymorphism lead to so-called “ad-hoc” polymorphism. In reality, the overloading of polymorphism constitutes a group of the same name in terms of the various definition methods. A specifiable definition is given to each member of the group and although they are unrelated, each one of them handles the type (Smith, 1993). Based on the type that the function handles, the compiler labels the method according to the same specific name of the function in the real situation.

Coercion, meanwhile, can be used to convert one particular type to another one based on the method or the type of process required. For example, if the compiler can convert an integer number to a floating-point number when adding the integer and floating-point number, the type conversions code will be written in the programs automatically, and this is called “coercion polymorphism”. Compared with universal polymorphism, ad-hoc polymorphism can process
2.3 Types in different programming languages

It can be noted that in Fortran language the floating and integer types are distinguished to enhance the program’s running efficiency, which marked the start of classification of various programming languages (Veldman, 1967). The first language to have clear differential signs was ALGOL 60 (Backus and Bauer and Green, 1963). There are many different basic types of ALGOL 68, including most types of modern languages, such as char, int, and string. Meanwhile, the ALGOL contents reflect the basic trend of polymorphism. Simula can be considered the first object oriented language because it introduced the concepts of type and inheritance in programming. The use of subtypes has helped in terms of inheritance of the attributes of a super type and its contents. However, Simula ignores the hiding of information (Mailloux and Peck and Koster, 1969). This topic leads in to a discussion of type programming languages and their attributes in relation to the trend of traditional and modern languages.

2.3.1 Assembly language

Assembly language is tacit programming language. It is specified especially for the environment of the computer and its certainty is only clear in relation to particular computer architecture. In comparison with advanced languages, it cannot be described as portable language; it is executed without interpretation or compilation. The first appearance of assembly language dates back to the first appearance of the EDSAC computer in 1949 (Dandamudi, Gries, and Schnieder, 1998). It enhanced programming efficiency and helped to reduce the probability of errors occurring because it liberated programmers from calculating the address and saving the digital code.
2.3.1.1 Types in Assembly Language

In spite of specification of assembly language for particular computer architecture, this represents a huge mass of language. In general, three types of instruction statements are used to determine the behavior of programs, namely the directives of assembly language and data parts. In comparison with C language, assembly language has almost no type systems and undoubtedly it does not guarantee safety of type. The type system in assembly language is considered an unsophisticated classification that serves only to develop the efficiency of programmers in programming, but it did liberate them from repeated machine codes and supported the main concepts of data abstractions for the programming language evolution.

2.3.2 Types in C Language

C language is a complicated language but an accomplished one (Burgess, 1987). In the field of engineering applications, it is considered one of the lengthiest languages. It was not designed for a particular object, but also as a general language, for example, the applications and core of Linux were programmed in C. The first version of C language was generated between 1969 and 1973, at the AT and Bell lab (Ritchie, 1993). Later, C has been developed through many versions, including the “C” published in 1999 by ISO, whilst the most recent version was “C11”, produced in 2011. It is very important to explain the C type system according to its position in the history of programming. C language is classified as a weak and statically typed language. While C language is usually applied for programming series of underlying programs, type checking is neglected in the diversity of trends. For example, type casting enables conversion into other pointers that are used to point at any type of data. There are some types of data particular to C language.

1. Array
2. Types of pointer
3. Structure
4. Basic types
5. Fixed-with integer types
6. Additional floating-point types

2.3.2.1 Pointers in C Language

The C language pointers are used in the program in order to allow manipulation of addresses and gain access to the memory (Kelly and Pohl, 1997). These pointers must be used in the case of dynamic distribution of memory. In addition, the pointers enable management of memory resources and improve the program’s efficiency. Furthermore, the pointers may provide flexibility and extra power in programming with C language. Pointers are used to store the pointed variable addresses and have different types of pointed variable as array pointers and function pointers. In addition, the function pointers are used to enable C language to release parametric polymorphisms via inputting the directed pointers as a parameter into the function at various functions and making direct calls into the functions. The pointer function can be used to help C language to realize the parametric polymorphism by input of directed pointers at the different functions as parameters to the functions and calling them for directing at the different functions. For example, the following code can be taken:

```c
#include <stdio.h>
Int triple(int a){
    return 2 * a;}
Int squire(int a){
    return a * a;}
Void transform(int array[], size_t  len, int (*fun)(int)){
    size_t  i=0;
    for(; i<len; ++1)
        array[i] = fun(array[i]);}
Int main(){
    int array[2] = {1,2};
```
transform(array, 2,&triple);
transform(array, 2,&square);

size_t i=0;
for (;i < 2; ++i)
    printf("%d ", array[i]);
Return 0;
}

In this code, the function pointer can be used to call various parameters including the same parameters in the transform function in order to achieve reusing the codes of transform function. The void pointer can be used to point to the arbitrary and unspecified data type. Because of type safety and irresolute specified type considerations, the void pointer points to an inability to be supported for pointer operation and indirect referencing. However, the C language allows the pointer type to be transformed with other pointers and such transformation can be included generally (Kelly, 1997). In C language the null pointer points to the area that is not fit to be used. If the program calls for a null pointer, a segmentation fault can occur. Furthermore, null pointers can be function error flags for the pointer type, requiring a return to perfect conditions. Generally, while all the other pointer types are compatible with true, the null pointer is compatible with false (Burgess, 1987). To improve pointer safety, the C compiler was introduced to provide many checks that can enable conversion and calculation of the pointer. When compared with other languages, the C reference type is highly characteristic of this language.

2.3.2.2 Arrays in C Language

In C language, new features that included variable-length arrays were introduced when the C99 came into existence. Meanwhile, the elements of the arrays must be of the same type when arrays are required in C language (Kelly and Pohl, 1997). In addition, if the (Malloc) function is used, the programmer can allocate the space of a specific memory and deal with it as the array. Each of the pointers and arrays in C is closely related to the others and, in reality, the abovementioned
features contribute to application of the arrays and arrays with limited lengths that are almost equivalent, because they can be considered as fixed pointers, whilst the pointers can call the elements via the subscript. It could be noticed that the array and pointer are related closely. When visiting the arrays, the stepping problem that crosses the boundary of an array must be considered, usually as soon as the compilers can provide a setting for examination of boundary [13]. As a result, the arrays subscript occurs frequently beyond the boundary when running the codes that can bring about different problems such as false reference to data, invalid memory access, run-time errors and memory overflow. In order to ensure array boundary safety, only the manual inspection must be worked.

The multi-dimensional arrays in C language cannot be supported explicitly, for example in declaring the multi-dimensional arrays. The arrays can however save elements of types, and can within the type system declare arrays of arrays. In such cases, the C language perfectly provides the multi-dimensional array. Thus, for passing a call for Thus, for passing the call for the multi-dimensional array Thus, for passing a call for the multi-dimensional array, a call is implemented for each line in the array. In terms of the mathematical operations involved, multi-dimensional arrays in C language are used to operate and save the matrixes. Also, C language helps to support such mathematical operations. Although the arrays are similar to pointers, the arrays have either constant boundaries or a sub-program with a dynamic limit for additional transmission. Through the many subscripts, the multi-dimensional arrays are not called unless the pointer of the column vectors can be defined to implement the tasks.

### 2.3.2.3 The relationship between pointers and arrays

The pointer and array are closely similar because memory is accessed in the same way in array and pointer. However, there are many differences among them as the pointer can update the contents of its memory and points to various values whilst the array usually saves the certain pointer or the fixed stating addresses.

For accessing the same element in C language the array[i] and *(array +1) can be used as the two expressions. The array[i] can be used to access the ith element in the array. However, the expression of *(array +1) is the pointer operation that can be used to take array as the pointer and access the ith of pointer value. Similarly, in the pointer, point[i] and *poin(point+1) point to the
same results. The array initial address can be passed to function instead of entire array, therefore
the pass is applied by references instead of passing by value, and lastly, the changes cannot be
kept after finishing the function process to parametric variable.

The number of the elements in the array can be obtained by using sizeof function, also it could
help to know the size of the other types of element in the memory. However, the function sizeof
works to declare the name of array and does not provide the information about array element size
of the pointer that points to the array or is applied to the array dynamically, because the compiler
observes the sizeof function as a pointer that itself searches for its particular size in the memory.
When transforming the pointer name to pointer type is not possible, the sizeof function can be
used to obtain its value size. In addition, while applying the array dynamically the compiler
considers it as the pointer type and then in such a case, the sizeof function must not be used to
help the programmer to obtain the number of array elements. The other difference between
pointer and array is that the name of array transforms to pointer that will not be saved. In the
array, the renamed array is invalid and also the new start address cannot be assigned for the
array, for example

\[
\text{a = p ++a a+=3 &a}
\]

In C language, this way could not be used, because the compiler is unable to change the
constant pointers of the array’s name. Also, the contents of the array can be duplicated through
its elements.

### 2.3.2.4 Pros and cons of C Language

Firstly, C language has a weakly and statically typed programming language. In C language,
the weakly typed programming language achieves highly efficient operation because of its ability
to write and read the hardware environment (memory). In addition, the type of variables
guarantees protection of the different programming functions in various platforms.

In the C language type systems, all the types can be considered as the numbers approximately,
the characters can be changed into ACII code, and also the value of Boolean is 0 or 1 actually. In
considering the following code:

\[
\text{char c = ‘o’;}
\]
This code in C language generates various results according to the data of the same character type and then the different outputs that are specified by the programmer when typing the codes. This means that C language is weakly typed programming language because it cannot know the values type that it has saved.

Also, in C language the object can clearly be defined, for example the structures. However, it does not provide safety protection to the types. Also, this feature was not fully developed in C++ language. Transformations are available among different types of pointers by using the (void *), therefore the transformation operation is supported from the specific type to other types and achieved by destroying the safety of types in C language. Generally, C language does not provide safety of types and it has a sophisticated type system; hence the type system can cause many problems in maintenance of operations and it reduces the power of expression (Ritchi, 1993).

2.3.3 Types in Java

According to Eckel (2003), Java is considered as the first language to incorporate object oriented programming language successfully. Java is not only object oriented programming language, however; it also provides synchronous behaviors and maximum thought has been put into improving the compatibility of running. “Writing at a time, running everywhere” is the well known banner of Java language based on the “JVM (Java Virtual Machine); it means that the application program can be executed and interprets on the JVM when compiling the code (Tyma, 1998). “The Java code file with extension of .java” can be compiled to bytecode for running on JVM to support various implementation codes that are targeted at various platforms. Over many years Java has become one of the most common languages, and has also been used in the development of a huge number of applications, particularly in the field of business applications. James Gosling identified a need to reduce the underlying operation characters in programming the language and he embraced the idea of object orientation in programming language; hence, Java language was developed. Firstly, Alan Kay identified the following five elements of object
oriented language as basic norms to determine whether the programming language refers to the object or not:-

1. Everything in the programming language must be an object (Goldberg, 1996). In programming languages, every unresolved issue and element is considered as the object. The object can be used to save the numerical values and then it could be requested.

2. Objects communicate with other objects by means of messages. When needing to pass the information to the object, the message can be used to inform about what must be known. This can be considered very similar to the conventional method of function references.

3. Each of the objects is related to the same class. Every object in object oriented languages must relate to the class. In fact, that is other expression of the type.

4. The objects share the same paradigmatic behavior and composition. In its definition, the object can indicate to other objects, and then several sophisticated relationships can be written among objects. The code can be very simple when including these objects in the other objects.

5. The objects that are constructed in the same class have the same method. As has been defined above, the type can refer to the data range and also its operations. As well, in the case of class, all the objects in the same class can receive the same message and have the same method.

Java was developed according to the above criteria, therefore it is considered object oriented and its object oriented character is reflected in the type of type systems. The object oriented style reduces potential problems for the programmer when writing and interpreting the code, and also it decreases language complexities. Java language ensures type safety as well as decreasing writing problems, thus Java is strongly and statically typed. In comparing with C++ language, in Java the time spent on development is reduced by more than 50% and it has accelerated development speed (Stark, 2001). In addition, Java language supports many functions and methods for applications of web programming and for multi-threading. In comparison with C language, in Java language, there is no union, structure or pointer as the object is used instead of these concepts. As a consequence, in terms of the running activity, Java increases the
effectiveness of the programming through reducing the period of developing codes. Each value in Java language can be a value of many types, the most important types are mentioned below:

1. The basic types: those types mainly contained in Java have emerged since ALGOL 68, such as Boolean, Double, char and int, etc.

2. The Array types: the type of storing arrays that are formed by including all types of type elements.

3. The class type: the basic type of object oriented is mostly defined by users.

4. The null type: the type of indicating to the concept of “null”.

2.3.3.1 Class and Objects

In general, objects were constructed to contain the behaviors and states. The object state is saved via the fields and the behaviors are materialized by the methods. In Java language, the state of objects can be changed via accessing the objects and performing the behaviors of objects through operations that change the state. If, for instance, a mobile phone is defined as the object, its width and length will make up the state and the behaviors will be the activities that it can implement, for example sending a message or making a call.

The class is the object abstract of comparable behaviors and attributes, and it can be considered as a schema to create the object types or individual objects. The type can be distinguished in two main parts, methods and field. The methods are determined by the object type of the message received and the messages returned after receiving it, and by methods processing. Fields can be constructed by creating objects belonging to any type, such as Int, Boolean, double, etc. When creating objects, the creation types are declared, and lastly the constructor is specified by the type passing the parameter to be initialized.
2.3.3.2 The polymorphism

All the types of polymorphism have been supported in the latest versions of Java language. A subclass in Java can inherit the methods and also the attributes of the subclass. When declaring the Superclass, it can save the subclass that is contained in it. This could be a very important concept in object oriented programming language. Also, the Interfere can be used and the class can be assigned to interfere the object when realizing; therefore, the object types are updated when running dynamically.

Overloading is also supported in Java. Through the class, several methods can be written with the same name and they then can be distinguished by using different parameter types. However, Java can dynamically check which t method of object type is called in running time. In addition, overloading is not allowed to define the operator of the user, which is completely different from C++ language. In Java, overriding can also be realized; all the methods can be written and covered and, as a result, the subclass provides the same method name as that of the Superclass but with a different realization.

The final keyword is used to support particular control over overriding. Overriding cannot be used for method declaring at the final keyword. In Java, for defining the abstract class the abstract keyword can be used. Also, as is the case with other classes, the abstract class may not be used to provide a specific realization but it only indicates the methods for realizing the other classes. When declaring the methods, it can provide a form in which to realize other classes. When calling the object method, the compiler searches the method for calling it dynamically based on the inheritance tree of the objects.

2.3.3.3 Generic type

Generics were not supported in early versions of Java language that were included in J2SE5.0 in 2004. The following information gives the introduction to the generic characters. The Java code of J2SE5.0 (Cia xuepu, 2005) is considered as follows:
List v = new ArrayList();
v.add(“test”);
Integer i= (Integer)v.get(0);                // run time error

Even though no errors were made during compiling this code, run-time error will happen in the real running. This could be explained by the fact that the type safety of Java language is not ensured under such conditions. Thus, for ensuring the type safety, Java language provides support to the generics as follows.

List v = new ArrayList();
v.add(“test”);
Integer i= (Integer)v.get(0); compile time error

The compiler can check if the type information displays the behavior demonstrated in the code during compiling and therefore the type safety of the code can be ensured because the type of elements such as those contained in the above list has been specified. The classification and hierarchy of the generics are clearly demonstrated within Java language specifications (Gosling, 2005). The type variable is the absolute tag that can appear in the definition of method, class, interfere, and also constructors. It must be noticed that the type of variable is not supported in one of the primitive types. When defining one or more than one of the type variables by class, the class requires the generic criteria. These variables are the parameters of type in this class. After they have been defined, all the object operations in the class can be replaced by the specified type variables. The defined objects are expressed in concrete syntax of the class name as <T1, T2, …., Tn>. The method to realize the constructor, method and interfere is similar to that used for class.
2.3.3.4 Pros and Cons of Java

Java language developed many features in C language. For example, object oriented programming language is one of the important characteristics of Java and definitions of its structure, pointers and unions cannot be found in Java. However, Java executes examinations of the static type, and type safety has been strengthened more significantly than in C. The static type and type system in Java support type safety and clarify the properties of program expressions. Nevertheless, Java has preserved multiple types transmitted from C, and inheritance among the types causes Java to become more complicated occasionally. However, Java does not allow the methods to be separated from the class. The rich applications of Java and its strong type have had a significant effect on programming language development. There is a view that the character of Java has been developed in comparison with C++; however, for those who need to implement multiple requirements, the Java language appears sufficiently strong and coherent to fulfill their tasks.

2.3.4 Types in Ruby Language

Ruby is a programming language that was designed to make programming pleasurable (Flanagan and Mastumotom, 2008), but it is also taken seriously as a language (Cooper, 2007). In addition, Ruby is a strong and dynamic type of language. Ruby was intended to reduce the time and effort required to develop the program, and it also improved the programming expressions. It is different from Python and Java in keeping to the basic types. All the elements in Ruby language are object-oriented, the behavior and state can be determined. The class hierarchy is illustrated as follows (Mastumoto and Ishituka, 2002).
2.3.1 Hash

Hash is one of the most used packages in Ruby language. Hash in other languages is called “dictionary” or “HashMap”. Hash can use characters and other data types for saving the objects. The Hash key is comparable to the arrays in other languages and can be used through reading the hash to get the object corresponding to the value of the key.
The hash key as the arrays in other programming language can be used through reading from the Hash to certain objects based on the values of key. However, the hash is different from the arrays when hash key values are not only limited to number, and it could be objects instead of numerical value such as regular expression or character string. When saving the values in the hash, it can be any object. In addition, the hash is very beneficial for some algorithm processors.

In Ruby language, the seeking for values of key is very efficient, because Ruby only calculates the integral key value for every item in the Hash and it allows this value to divide the number of bins for getting the number and the rest of modules that are bin indexes of items. When the program searches for the value of key, the Ruby language uses the same method for making calculations operations for the value and getting the modules number, for quickly determining in which bin a certain object must be sought. Ruby will dynamically add the values of key based on the items number in the hash.

### 2.3.2 The Duck type

The duck type in programming language means that the program must be determined if the calculation operation is the type safety for the object based on certain methods instead of defining the object type. The duck type helps to realize the polymorphism result other than by inheritance.

When a bird walks and swims and quacks like a duck, I call that bird a duck (Hiem, 2007). The duck type in programming language specifies that type safety depends on an object’s methods and characteristics rather than on defining the type collectively. In the duck type, the programmer may be concerned with an object behaving in a particular way, but not concerned with the object type. However, the Java language does not provide or support the duck type, thus the objects in the method parameter are constructed to receive the duck type, and then its quack and swim method are called. This method within the Duck type can call the quack and swim methods and it can also receive objects that belong to any type.
Class Duck
Def quack
  Puts “Quaaak”
End
Def feathers
  Puts “The big duck has gray and white feathers.”
End
End
Class Person
Def quack
  Puts “the person imitates a duck.”
End
Def feathers
  Puts “The person takes a feather from the ground and shows it.”
End
End
Def in_the_forest(duck)
  Duck.quack
  Duck.feathers
End
Def game
  Donald = Duck.new
  Michael = Person.new
  In_the_forest Donald
  In_the_forest Michael
End
game

This code examines if the Person class has the feathers and quack methods at the dynamic running time. Thus, for judging whether the current operation is the type safety or not, instead of
denying the feasibility of the Michael object as the parameter for introducing the in_the_forest method via static examination. The result in static type may be required by depending on the keyword of the dynamic examination. However, in Java language the reflection can be developed to realize the duck type.

2.3.2 Pros and Cons of Ruby

Ruby language is considered clearly to be an object oriented language of a strong dynamic type. Ruby language enhances expression and flexibility in programming and decreases the time and effort required to develop the program. However, dynamic languages make greater demands on the experience of the programmers. The availability of duck typing allows the program to make changes to behaviors and states of an object through the implementation process.

2.3.5 Types in Scala language

The Scala language is one of the scripting languages and it is also object functional language. It was developed in 2001 by Pollak and David and the first version was launched in 2003. The version 2.0 of Scala was released in 2006 (Pollak, 2009). When a program is written in Scala, it can directly run on the JVM. The Scala language combines strong type language, object oriented and procedures languages. Its type has very rich expression of functions; the following figure shows the main types of Scala.
The type system in Scala can take the Any as the root and it has two sub systems: AnyVal and AnyRef. The Null is a special type that can be taken as the sub-type of all AnyRef for compatibility with Java language. The Nothing type can be taken as the sub-type of all AnyVal and AnyRef types.

### 2.3.5.1 The type inference

Most of the people who criticize traditional languages such as Scala do so because of the use of burdensome syntax. In Scala, this syntax has been developed through using type inference. Scala develops flow based and local type inference that is very different from the “global Hindley-Milner type inference” that is developed by other languages such as Haskell and ML (Pollak, 2009). The “flow-based” type inference has limitations, while the processes of object-oriented branch typing are more stylish in Scala than in Hindley-Milner. The limitation of
Scala’s flow-based typed inference is that it does not infer the type of parameters. The following “partially applied function declaration” can be inferred naturally by “the Hindley-Milner type inference (global)”, while errors occur in Scala:

```
Scala def foo(a: Int, b: String) = a + b

Scala> val f = f00(200, _)
<console>:8 error: missing parameter type for expand function ((x$1) => foo(200, x$1))
   Val f = foo(200, )
```

In the above, the type is missing in the marker of the second parameter and clear declaration of type of the variable (f) or clear declaration of type of the marker parameters is required. The type inference will therefore pay attention to the generic parameter.

### 2.3.5.2 The higher-kindled type in Scala language

The figure below shows a comparison of Scala with Java and demonstrates the definition of the basic generics.

In the above generic figure, the Java language cannot support the function for setting the type parameter. Scala, however, can support the type parameter of generic type; therefore, in comparison with Java, Scala can have a stronger, more robust type system. If the type system is
the data abstract type, for example, one, two and three can be abstracted to the Int type and then, the “world” and “hello” can be abstracted to String type. “The proper type” in Scala refers to Int, String, List[Int], List2[List], etc and the generic type refers to type used to constitute the “proper type” as List, List2, etc. The proper type abstracts to the same type, the generic type, such as Set and List, forms the proper types when passing them on. In the case of type parameters, when passing on the “generic type (type constructor)” for constituting the proper type, the type parameter will be the generic type also. This is called the higher-kinded type.

The higher-kinded type application is “the proper type of the generic type parameter” that could be specified; unlike in Java language where “the parent type of the specified type” can be taken as the processing object.

### 2.3.5.3 The pros and cons

In comparison with Java, Scala obviously reduces the number of codes and in large projects the effects will be more visible. Scala is used to develop the procedures for orientation style; therefore, Scala has more robust and meaningful power and it produces fewer errors in comparison with object oriented programming language. In addition, Scala language introduces many different concepts that are lost in the other languages; as a result, the programmer may spend a long time adapting to the new syntax. Because of these unique features, Scala language demands significant requirements in terms of the habits of the programmers when programming. However, it is not easy for most programmers to understand the Scala syntax.
Chapter 3  Website Design Requirements

3.1  Introduction

The project is divided into three stages. The first stage deals with learning about the important and basic key concepts of types in programming language and making comparisons of the main programming languages based on their types, such as typed and un-typed languages, type safety, static, strong and weakly typed systems. It also provides a clear and detailed demonstration of each one. The second stage deals with website design aspects, involving familiarization of the researcher with basic design concepts. In addition, a very important aspect of this stage is collection of the basic tools for designing a website, such as PHP language books, building a database system in MYSQL platform, and using Apache server. The final stage consists of build a learning website to help users in learning about the basic features of the different programming languages. This website is published for learning purposes by http://learningwebsiteosa34.co.uk. Also, it will provide some board discussion between the students and teachers, so they can develop mutual interaction for learning the fundamental features of each language.

This project can achieve major success by meeting as many as possible of the existing requirements for learning programming languages. In this instance, the website will require the information and functionality that are important to fulfilling its objectives, such as PHP language, Apache server and MYSQL.

3.2  The website’s aims and objectives

Many programming language resources are aimed at teaching learners a unique language at various levels. A large number of books have been written about programming language in order to provide practical guidance in the field. On most occasions, learners spend a great amount of time improving their skills before developing any software. Each language has a performance goal that is targeted by the learners. However, the languages may offer various methods to achieve the same purpose and differ in terms of the time and difficulty entailed. Because of incursion by languages, it can be noticed that each language tends to have a particular field, but
they may implement various methods in investigating the same objective and differ in the time and complexity involved. Presently, most of the relevant books demonstrate the targeted languages through instructing learners about the particular field that is being developed, but they rarely deliver the information during a suitable period. It often happens that learners only succeed in understanding the language after expending a great deal of time.

The proposed website could be a good way for learners to acquire a comprehensive understanding of each language without spending too much time, and to identify which language can perform the required functions. Even professional software developers have proposed the creation of such a website. As learners are often compelled by certain software to add a function, they search for an environment that will enable them to select the appropriate language from among several languages that could implement the same task.

This system aims to generate a new environment that will help learners to quickly understand the essence of the various languages and will summarize the differences among the programming languages introduced, such as assembly, C and Java language. This website will enable them to choose a suitable language to fit in with their tasks and conditions in an easy and rapid manner.

3.2.1 Website requirements

One of the project requirements is to develop a website learning system that will help learners to understand the differences among several programming languages. The learning system is designed to demonstrate the educational materials in a website environment and to address the difficulty of finding suitable learning course materials. This system uses PHP language to design and create a dynamic form of website; many system functions use the MySQL database system, PHP processor operations and webpage interfaces.

In order for the website to be as useful as possible the data and information displayed will need to be tested and researched to the highest standards so that every element that is read is reliable and trustworthy. Clearly the website must include a section to introduce each programming language, including C, Java and Assembly language. This section must also contain the most important information about each language, so that learners can gain maximum benefit in an easy and fast manner.
Many materials and tools will be delivered to the learners through front-end webpage activities that will cover programming languages such as assembly, C and Java languages. Also, integration of the basic functions will employ tools such as Password and Account. The website will, furthermore, encapsulate two types of user permissions, as admin and learner, and multiple functional permissions will be introduced in the certain system. The register is defined as a high level of permission; thus it would enable use and modification of any function in the system. The website aims to facilitate user login, add account and other functions. The website was produced and designed based on the specific requirements of programming self learning and the necessary tools.

The basic goal of background operation integration is to support the following operations: Forum login, open register, Main programming languages and their basic concepts, lost password, Articles that include (add articles and upload files), Forum home page, teachers and students list, recent topics, Teaching Materials and discussion groups (Discussion area). The website also supports two types of user authorization: student and teacher. In addition, many functional authorizations and demands are set in the environment system. The basic authorization is represented by the register, which enables use and modification by the user of any module function. The designed authorizations for teachers are determined as Register, Teaching Materials, Discussion area, courseware uploading files, assignment distribution, and specifying the specialist activities with the student through the discussion group area (Discussion area). The designed authorizations for students are determined by the Register password management part, thus they can use teaching materials, answer questions added by the teachers and interact with the discussion group (Discussion area). In the case of forgetting the password, the user can retype the new details in the Lost Password. Also, the students can download a complete assignment of their courseware and issues causing confusion could be discussed in the discussion group (Discussion area).

This website is designed, in as eye catching and attractive a style as possible, as a window for explaining the questions and frontiers of knowledge. In order to improve the interaction of learning between students and teacher, the discussion group area (Discussion area) is operated by updating and raising questions. In general, it is easy to understand the instructions on the background for operating purposes and also it is easy to modify and add to the contents of the website because code is not required for that purpose.
3.3 The website environment design

3.3.1 The website front end design

The webpage front end has been designed in a striking and attractive style with ease of transiting to any other page to learn the particular programming language. The homepage could be used to search for desirable language and specialist materials and for the user to enroll personal information; therefore, it will be easy to log in to the Background operations for additional learning purposes as below.

![Picture 1: The website front end design](image-url)

3.2.2 Enroll and Login design

The user enrolling tasks are designed for the users to upload their personal information completely independently and this information will be processed and verified simultaneously in other links. The users can require the corresponding personal information to update such as an incompatible username with related requirements when verifying it. Through the enrolling process, the users are supported with learned requirements to be used for final achievement.

The system checks the accuracy of personal information that is submitted and then saved in the database system. The legal user can pass the checking, and can then access the background functions for additional learning. Also, the illegal user will be refused permission to continue with the login through required instructions as in the picture below. Users can also indicate
whether they are teachers or students by selecting these options in the Register fields and their details can then be inserted in the teachers and students list. This list contains all the relevant details, such as Display name, Status, Article title, Article, and uploads.

**REGISTER FOR FORUM**

Your answers must be unique, and cannot be changed later. We use your email address to send you a secure password and verify your account.

- **Username**: [ ]
- **First name**: [ ]
- **Last name**: [ ]

Please specify whether you are a teacher or a student

- **Teacher**: [ ]
- **Student**: [ ]

![Enroll and Login design](image)

Picture 2: Enroll and Login design

### 3.3.3 Programming language tutorials

The main concepts of the following languages are supported in the website front end; therefore access for each concept will be easy for both professionals and beginner learners of programming languages. In each concept, the additional detail and more information are added, including explaining, coding, detailing of concepts and also some basic examples.
3.4 The background interface design

3.4.1 The main background interface design

The main background interface design provides the permission account on the webpage. Firstly, the users can register and enter all their personal information in the register part and then those details will be the permission key for using the forum contents when the user name and personal password are typed in.

![Permission Account](image)

Picture 3: permission account

3.4.3 The main background operations

The background operation contains the following functions:

1. The function of Admin uses the Access teaching Materials, List of teachers and students, Account Management, Articles (add article and upload files), Recent topics, and Discussion area.

2. The function of Teacher or Student account registration uses The Register, Articles, Recent topics, and Discussion area functions.
LIST OF STUDENTS & TEACHERS

<table>
<thead>
<tr>
<th>DISPLAY NAME</th>
<th>STATUS</th>
<th>ARTICLE TITLE</th>
<th>ARTICLE</th>
<th>UPLOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairouz</td>
<td>Teacher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mnn</td>
<td>Student</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omar Aljareh</td>
<td>Student</td>
<td>new article</td>
<td>Is Java driving you loopy? Loops and iteration can be tricky to master for beginners. In our no-nonsense guide, we take the complexity out of looping, so you won’t go pesci loco.</td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>Student</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Picture 4: Teachers and Students list

3. The function of Edit my profile provides access to the overview of general information for the teachers and students, deletion of student or teacher accounts and addition of a teacher or student account.

Picture 5: Edit profile

4. The function of Articles is a visual function platform. It can allow the user to insert graphic and textual contents to the front end page by clicking on the Add Article. Also, users can delete and modify the related article by clicking on the Add Article. The use of Add Article allows
content to be added, removed and modified, and also it does not require users to have further experience to deal with website operations because it is suitable for use by anyone.

5. The function of Upload files provides two basic operations to upload the Homework and Courseware or articles in any format as (PDF, WORD or JPG). They can be uploaded by clicking on Upload files. Courseware can be downloaded and deleted in the file format by the Upload Article. Then, it can be evaluated in the circulated subject and distributed by clicking on Upload in the View list of Teachers and Students. Also, the updated contents will display in the specified Discussion area and can be deleted when using the Discussion area.

6. The function of Recent Topic has been added for displaying the learning environment activities when the teachers type a question in this feature. Many features are included to make the asking operations easier, such as Edit, Close, Spam, Reply, and other features. In turn, the student can answer the question by clicking on Reply, and then they can type their answers. Also, some features have been inserted, such as Img, Ul, li, code and others, to provide some animation and language tags when typing a code as an essential requirement for answering.

7. The function of Discussion area is used to build the learning environment. The student in this area is allowed to participate in debates and complete assignments distributed by the teacher. The Discussion Area supports accessible activities of student and teacher accounts. Thus, subjects
that are posted randomly could be debated by students through asking and answering questions. Teachers can access students’ answers and then can delete, reply, move, merge, and split them as desired.

![Picture 7: Discussion area](image)

As has been mentioned in Recent Topics, the following operation can be used to determine such answers as Edit, Close, Spam, Reply, and other features. Also, some features were inserted as Img, Ul, li, code and others to provide some animation and language tags when typing a code as an essential requirement for answering.

8. Profile Function is added to provide additional information about users’ activities as their Profile, Topic started includes the user’s topics, Replies created includes the user’s replies, Favorites includes the user’s favorite topics, Subscriptions includes the user’s subscriptions, and Edit includes the user’s personal information.

![Picture 8: Profile](image)
9. Finally, after finishing all the previous operations, teachers or students can log out and finish their tasks through using the Log out function.

### 3.4.2 Using (MOSCOW) Requirements

In order to analyze the requirements of the project clearly, (MOSCOW) requirements analysis will be applied to split the requirements into different levels based on the importance of their inclusion in the final design of the website. These requirements can be defined as follows:

1. **Must:** The website must provide certain information about each language, including assembly, C and Java languages.
2. **Should:** The website should allow the user to interact with it through a series of permissions, such as Register and Login.
3. **Could:** The website could allow for the user to access the information on the website and modify other user edit permissions.
4. **Would:** It would be desirable to include private information that is only available to submitted users.

### 3.5 Practical evaluation of the website

The objective of using the website environment is to enable learners to choose a programming language that will suit their aims and to enable effective learning about programming languages through instruction on languages features via the website. The objectives of the website will be achieved through the following three aspects:

Firstly, the website platform will help learners in choosing a certain language based on their requirements. Before investigating this aspect, bilateral exchanges on the problems will be conducted in the first stage of language learning. Comparisons of the different languages will then be conducted according to the experience of the individual learners in order to help them to select the appropriate language.
Secondly, the website can facilitate effective learning about the basic concepts of different languages and provide comparative analysis of various languages. Whilst various books are usually used as guidance in learning about and differentiating among new programming languages, from fundamental to advanced level, many learners may finish reading such programming language books without achieving their basic learning aims.

Thirdly, the website will provide good opportunities for beginners to communicate with other beginners and with those who have more experience as developers. Although all the components contained in the website will be developed through personal effort, several specially designed functions, including multi administrator management and information posting, will support information swapping between experienced developers and beginners. The website characteristics will have competence expansion and there will be capability to connect with other websites, which will help learners to increase their efficiency in the long run.

It is suggested that there is a need to increase type system strength in order to ensure system safety and improve the experience based on the programmer’s requirements. Most programmers consider quality and safety to be the most crucial components of a system. However, for most programmers, it is also important to concentrate on assessing the strength of specific language.

### 3.6 Details of optional and mandatory requirements

The learning website was built on the basis of providing an eye catching style and attractive window for the learners, and basic requirements listed in it include such as forum login, register of teachers and students, and fundamental concepts of Java, Assembly, Ruby, Scala and C language. On clicking on any of these languages the basic concept appears for the learners, so they can benefit from its content. In order to provide crucial sharing between the teachers and students, the register part allows for them to insert their basic details as a type of privacy, such as name, E-mail, password, and username, thus they can get permission to access their personal forum and start using learning materials by adding, uploading, and answering the teachers’ questions.

In addition, the forum part is a most important function in the website because it contains the basic learning materials such as teachers and students list, upload courseware files, add article, recent topics and Discussion area. The learners can easily log in to this part through typing their
password and username and then clicking on log in to gain access; therefore, the students can communicate and share their tasks through the forum part. After finishing their tasks, students can finish their mutual interaction by logging out.

However, due to time limitations, some other optional features could not be added to the learning website, such as correcting a code when the students send codes to the teachers based on the teacher’s questions and the teacher then checks it to see whether it is correctly typed. Also, the score list feature could not be added, to enable the students to find out their current level and develop it. It was also planned to insert an interactive exam feature that would enable teachers to ask the students within a certain period of time about coding for a certain subject.

If additional time had been available, it may have been possible to add some other basic features for each of the programming languages that is explained in the website. This could possibly require some other main aims to be set for learning purposes and certain support methods. Similarly, more findings and comments from learners or even users might have had a chance of making it into the actual website system. In addition, the suggestions provided by the learners that were put to use in this website were of extremely high value.

However, not being able to include some of these features may not have a direct effect on the learning website, as provision of the main functions will ensure its success to some extent. Also, the features that have been provided could make an important contribution to the users’ learning of the basic concepts.

### 3.7 Challenges in designing the website

While designing the learning website, several problems emerged. It is not easy to design a website that can cover most of the required aims and objectives in learning programming languages within a short period and deliver the information to the learners in an acceptable method. Such challenges are related to collect the programming resources, time factor, selection and coordination of educational interfaces, and how to make it easy to navigate. Therefore, these factors of success in achieving the project’s goals had to be considered throughout the design and construction process.

Because of lack of familiarity with designing such a website, it was very important to make use of programming resources such as PHP language, website books and video clips, to achieve
enough knowledge to design the website. In addition, differentiating among prestigious and useful resources was another problem faced, particularly with the time constraints. It was necessary to learn the PHP language, website programming, and to design the website within a short period. Thus, it was very important to make a clear plan to overcome this problem.

Also, in order to achieve the overall aim of designing a website for learning by students, it was important to select an accessible homepage and design its front end in an educational and passable way. Building educational interfaces in an attractive style was another challenge faced because of lack of expertise in the educational field and designing learning pages. However, through accessing educational websites, the intended target of designing a website that was easy to access and navigate for all learner levels was achieved.
Chapte4  Methodology

4.1  Compare and contrast the common properties of type

The main concepts and terms in relation to type in programming language have now been explained. Also, various types of programming language have been discussed. This section will use different methods to compare and contrast the types of programming language that have been discussed earlier.

4.1.1  Compare and contrast data methods of type checking conversion in various languages

This table summarizes methods of type checking used in various programming languages.

<table>
<thead>
<tr>
<th>Type checking</th>
<th>Programming language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong and Dynamic</td>
<td>Ruby and Python are both object-oriented languages. All languages classified as dynamic type need a strong system at the run time.</td>
</tr>
<tr>
<td>Strong and static</td>
<td>Java, it is essential to declare the types in Java language.</td>
</tr>
<tr>
<td>Statically typed</td>
<td>The parameter sets to generic programming; thus, the abstraction type level becomes stronger and has higher flexibility.</td>
</tr>
<tr>
<td>Weak-typed</td>
<td>Assembly language does not determine type checking.</td>
</tr>
<tr>
<td>Weak and static</td>
<td>C language, it is very important to declare the type objects as the structures.</td>
</tr>
</tbody>
</table>

Table 1:  Comparison of programming languages
It can be noticed from the above table that Java language has a static and strong checking type, whilst also the assembly language is un-typed and weak. However, Ruby and Python are dynamic, strong languages. The strong and dynamic types may represent the future of programming languages. It is important for the programmer to focus on the code rather than on the details of the program language.

### 4.1.2 Compare and contrast data types in various languages

The table below summarizes the pros and cons of the data types used in assembly language, C language, Java, and Ruby.

<table>
<thead>
<tr>
<th>Language</th>
<th>Data types</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td>Just numbers</td>
<td>Simple to manipulate with certain registers.</td>
<td>Difficult to maintain, write and read.</td>
</tr>
<tr>
<td>C</td>
<td>Arrays, pointers, Structures, float-point</td>
<td>It can integrate manipulation of hardware and writing a code</td>
<td>Difficult to maintain in huge systems, and to write and read.</td>
</tr>
<tr>
<td>Java</td>
<td>Class, array, null.</td>
<td>It supports object oriented features and type safety is supported by elimination of pointers.</td>
<td>Difficult to maintain in huge systems, and to write and read the code.</td>
</tr>
<tr>
<td>Scala</td>
<td>Generic type</td>
<td>the abstraction type level becomes stronger and has higher flexibility</td>
<td>For learning purposes, it takes additional time to understand</td>
</tr>
<tr>
<td>Ruby</td>
<td>All the data types are objects</td>
<td>It supports the object oriented features clearly.</td>
<td>Experience and testing of units is needed to complete Object Oriented Program successfully</td>
</tr>
</tbody>
</table>

Table 2: Summary of data type pros and cons
As shown above, data types in assembly language are easy to use and unsophisticated. C language supports many data types that appear very complicated and of a low level. Java language clearly supports object-related features; however it still lacks the C language features that allow separation of the types.

4.1.3 Compare and contrast the type system of expressiveness in various programming languages

It is difficult to measure language expressiveness, but it can be supposed that the dynamic code has considerably less expressiveness than static code because the former has less requirement for explicit description in the programming. There are two points to remember when measuring expressiveness in relation to a particular language:

1. In the same language expression, the rate of code size in another language with that in C.
2. Using the running impact of complex code under various languages conditions on different hardware parts as demonstrated in “http://benchmarksgame.alioth.debian.org”

This table summarizes the expressiveness of various languages

<table>
<thead>
<tr>
<th>Language</th>
<th>Statement rate</th>
<th>Line rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Python</td>
<td>6</td>
<td>6.5</td>
</tr>
<tr>
<td>Fortran</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Java</td>
<td>2.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 3: Expressiveness of various languages

The statement rate column in the above table illustrates the rate of statements in different languages in relation to the equivalent rate in C language. The higher rates among the other languages reflect that each line in the language is more expressive than each code line in C. It
can be demonstrated from the table above that, according to expressiveness aspects, Python and Java languages have greater expressiveness than C language.

4.2 Survey of the role of data type

Firstly, I chose the following languages through which to research the role of data type.

1. Assembly language:
   To enable the program in the register to run easily, assembly language does not have data types, also it is classified as weak-typed. Even though assembly language is better than in the machine code expressions, it still creates major problems in terms of maintaining and understanding the code.

2. The C language:
   There are many data types in C languages, such as pointers and arrays, also these are classified as weak and static types. C language can access the resources of the hardware; however, the code that is typed by C language is occasionally more complicated, particularly in the case of huge projects.

3. Java Language:
   This is a strong static type language. The common use of data types is to use class methods. The pointers in C language are removed in Java language, which ensures the safety of types, and object orientation is supported. Code written in Java is very complicated because large projects in Java require duplicated writing of much of the content.

4. Ruby language:
   This is a perspicuous, object oriented language, all the data being objects. It is considered as a dynamic and strong type. In Ruby language, because no extravagant or unusual types occur during program running, it is able more easily to meet the programmer’s requirements.
4.3 **Survey of system safety types**

As has been described in the literature review of different types of programming languages that are still in use, the following are possible variations in structure:

1. The weak static type. C language is a good example of the weak static type. Although C language contains different types, safety types were not illustrated.
2. Weak but no typing found: assembly language, for example, does not have data types.
3. Dynamic and strong typing: such as most of the common languages, Ruby. Dynamic languages should be of the strong type; moreover, the program cannot determine the type of data types. Thus, it is not necessary for the programmer to check safety of type at the run-time.
4. The strong and static type: to ensure type safety in Java language, static code checking is performed.
5. Weak and dynamic typing: Typed weak language may not use typed dynamic checking. On the contrary, it is unable to evaluate any data type.

It can be noticed from the above that the assembly languages are un-typed and weak language. Also, C language is a static and weak type language and Java derives many different features from C language and is a strong and static type language. Ruby, JavaScript, and Python are dynamic strong languages.

4.4 **Designing the learning website**

4.4.1 **Website contents**

The entire design of the learning website system was subjected to techniques utilized in software engineering methods. Its technological viability has led to development of PHP scripting technology as a general purpose programming language. The website environment depends for the most important part on the SQL scripting and PHP technologies. Design of a learning website can include the use of PHP, HTML, CSS, and DIV web interface, front-end and background programming tools, and also MYSQL technology. The website developed in this project was built using PHP scripting technology and its dynamic style was based on B/S
structure. The stored data is called by an MYSQL system that is modularized and structured to meet the needs of an integrated learning website and to simulate every required function. This website was constructed using the following modules: platform user interface management, registration and login, platform teachers list, basic information on membership, platform articles management, platform addition teacher information, platform assignment requirements, platform uploaded courseware, and platform discussion and other components. The registered users can learn the related information and acquire the knowledge in this website by managing the mutual interaction immediately between learners and teachers, for example, when assignments are distributed among them. Lastly, the main components of this website will be introduced as process operations of the website structure, learning website design, and the function of the database.

4.4.2 Feasibility considerations

Based on the analysis of results on website requirements and aims, in terms of technological feasibility it was found unnecessary to purchase learning software. A scripting technique such as PHP scripting language is all that is required to solve related problems in developing the learning environment and ensuring realization of the website functions. In terms of the utility of the whole system, displaying and IE browsing are used for the interface. This will help to attract learners and increase the website’s popularity. As far as possible, the user is supported with a general capsule of detailed knowledge that explains the navigating basics of the website in an easily understandable manner. Throughout the website the interfaces are as user-friendly and interactive as possible. Meanwhile, operation of the website is concise, simple and calls only for explicit knowledge on the part of users.

In regard to the economic impact, development of the learning website does not need to incur significant cost, because all the main components of the website are available free through PHP, MYSQL and the Apache server; only the website host needed to be purchased, from the Siteground website. This website was therefore developed at low cost and is now running in an economically effective manner.
The performance requirements include developing website management functions such as introducing discussion board questions, completing uploaded homework, interactive activity for learner-teacher interface, and validating the information and documents that are downloaded by learners. By fulfilling these requirements, the website has now reached full maturity and is full of information.

4.4.3 Developing the website environment

In order to design a successful website, basic tools such as hardware, server, database, and MYSQL environment were required. Each one of these tools contributed to construction of the learning website as follows.

1. Hardware environment: The hardware environment required by the Central Processing Unit (CPU) is any version of Pentium processor or better, internal storage memory of more than 1Gbyte, operating system such as Windows XP or Windows 7 and hard disk storage memory with capacity of more than 100Gbyte.

2. Server environment: The environment used for running the application software is one that accepts requests from clients and gives responses accordingly. The basic server used is Apache, obtained from the World Wide Web.

3. Database environment: The database system uses MYSQL technology for storing, accessing, and retrieving the information stored within it.

4. Operating environment and development tools: The software tools used were PHP and MYSQL and the software platform for designing the webpage was WordPress 4.2.2. The operating environment is developed by the server using the Linux operating system. In general, this website is applied by three components: web client, web server and the database service.
5. The technical field: The technical field uses B/S technical structure framework and was developed within the website.

4.4.4 Website programming details

The details of the website programming are classified into three main parts. The first part relates to designing the website style, the second part explains the public application design, and the third and final part demonstrates the database basic mode.

1. Website design

Generally, as has been shown in the above, this website uses the Model–View–Controller (MVC), which provides the architectural software patterns required for user interfaces. Predominantly, it divides the learning website application into three correlated parts to separate the information representation from the ways that the introduced information is accepted or presented by users. Therefore, the MVC architectural pattern of the website makes it more attractive and eye catching for users.
2. Public application design

Even a website with well-proportioned structure can still be improved. Seeking out factors that share common features and including them in the right place could be a necessity for designing an effective learning website.

3. Basic model of the database

The separation of a connection linked database system into the general document for processing in PHP scripting is typically performed using the wp-config.php. When requiring database system connection via the webpage contents, calling of the general document by PHP’s `<?require_once(ABSPATH . 'wp-config.php')` will not only help to avoid having to compile the database connection for every webpage, but also it helps to avoid the problem of updating each one as database system connection modifications. The separation of the general functions from the background control functions can save time and execution of programming to a great degree and be of significant benefit to the maintenance phase.

4.4.5 Stages of developing the learning website

The fundamental stages of developing the learning website demonstrate each of its functions separately. In this part some basic code is provided to demonstrate how each basic function has been added and executed. Pictures have been added as follows to demonstrate the targeted operations for developing the website.

1. In order to use the website, the user must first use the Register function. Users must enter their personal details by using user-new.php, including such as Username, Email, First and Last name, Password, and then all these details can be added into the database as below:
Messages may appear when such errors occur as repeating the username more than once; these are alarm messages that will prevent the user from adding other details. The input data must be legally checked with database contents. When typing the username and Email, the two cannot be used on another occasion for two different users. For example, if the username is (learni91) and Email is omar.taheer@gmail.com in the user profile, these cannot be used on another occasion with a different user and the alarm message will appear based on the following code.

```html
<meta name='robots' content='noindex,follow' />

<body class="login login-action-register wp-core-ui locale-en-gb">
<form id="login">

<h1><a href="https://wordpress.org/" title="Powered by WordPress" tabindex="-1">Learning Website</a></h1>

<p class="message register">Register For This Site</p>

<div id="login_error" class="error"><strong>ERROR</strong>: This username is already registered. Please choose another one.<br />
  <strong>ERROR</strong>: This email is already registered, please choose another one.<br />
  <strong>ERROR</strong>: Password confirmation does not match.<br />
  <strong>ERROR</strong>: Password confirmation couldn't be empty.<br />
</div>

Then any following attempt at inserting details will fail when the Username or Email have previously been added based on the ajax test, because of the fact that both Username and Email must be unique. The input data must be compared with the database contents that are stored in MYSQL. The error message is shown below:
If the username, Email, and other data are added successfully, the registration phase will be completed and then the user, student or teacher, can use the website functions based on their unique Username and Email:

![Registration Complete](image)

Picture 10: Error message

![Forum Login](image)

Picture 11: Confirmation of registration

2. The user can log in to the website to explore contents by using the wp-login.php page as shown in the following picture:

![Forum Login](image)

Picture 12: Forum Login
On this page, it can be noted that the Username is submitted in the form of POST to the homepage of wp-login.php. This helps to specify whether the Username is stored in the database via this code <form name="loginform" id="loginform" action="<?php echo esc_url( site_url( 'wp-login.php', 'login_post' ) ); ?>" method="post">. When the Username and password are entered correctly, the login is successfully completed. The structure tag of <form> functions details can be submitted for any page contents whenever the user desires. The password must be typed and then the function retrieve_password() will check whether the password is entered or not. If it is found in the database system, this function directly retrieves the password as the shown code; else ware means that the password is not registered and then another one must be typed

```php
function retrieve_password() {
    global $wpdb, $wp_hasher;
    $errors = new WP_Error();

    if ( empty( $POST['user_login'] ) ) {
        $errors->add('empty_username', '<strong>ERROR</strong>: Enter a username or e-mail address.');?></strong>
    } elseif ( strpos( $POST['user_login'], '@' ) ) {
        $user_data = get_user_by( "email", trim( $POST['user_login'] ) );
        if ( empty( $user_data ) )
            $errors->add('invalid_email', '<strong>ERROR</strong>: There is no user registered with that email address.');
    } else {
        $login = trim($POST['user_login']);
        $user_data = get_user_by('login', $login);
    }
}
```

In order to log out, all the posted data must be removed. The session technique can be used to adopt the contents from the server and then the data can be removed by using the session mechanism with this code:

```php
/*
 * Remove all stored post data on logging out.
 * This could be added by add_action( 'login_head', 'wp_login_post_loginout' )
 * but maybe better if it's not removable by plugins
 */
if ( 'loggedout' == $wp_error->get_error_code() ) {
    <script>
    if("sessionStorage" in window){try{for (var key in sessionStorage){if(key.indexOf("wp-autosave-")!=-1){sessionStorage.removeItem(key)}}}catch(e){}
    </script>
    ...
}
```

Also, cookies are used to store passwords in the user’s website. When using the website, the browser has the cookie sent back to the server to notify the website of the user’s preceding
activities. Then, the life span of the post password cookie can be filtered. By default, the cookie will be expired ten days after creation. To turn this into a session cookie, return 0 is used. This is done by using this code:

```
   $expire = apply_filters( 'post_password_expires', time() + 10 * DAY_IN_SECONDS );
   $secure = ( 'https' == parse_url( home_url(), PHP_URL_SCHEME ) );
   setcookie('wp-postpass_' . COOKIEHASH, Shasher->HashPassword( wp_untrash($_POST['post_password']) ), $expire, COOKIEPATH, COOKIE_DOMAIN, $secure );
   wp_safe_redirect( wp_get_referer() );
   exit();
```

Also the login will fail if there are too many failed login attempts; in this case, the user must wait for twenty minutes before making another attempt.

![Picture 13: Waiting message](image)

### 4.4.6 Updating personal information module and the password

1. The `wp_long.php` code that is accessed by the personal information page must be used in order for logging in to be successfully completed. Here, the operation includes judging whether the ‘username’ is stored in the SESSION. When there is a positive response the below message appears after completing the updating of personal information. Otherwise the attempt to log fails. In such a case, the code will display the user register form automatically and then the user will need to enter the ‘username’ correctly, because unless logged in the user cannot have access to the Forum learning functions.
2. Resetting or changing the password can be done based on the function of `retrieve_password()` that is included in `wp_login.php`. When changing the password in the user profile part, the new password must first be checked and confirmed by inputting it again in the ‘Repeat new password’. If the two match, the following message appears: ‘Your password has been reset’, otherwise the message ‘The passwords do not match’ will appear. Through the POST, the new data will be stored once the process of resetting the password has been completed correctly.

```php
$errors = new WP_Error();

if (isset($_POST['pass1']) && $_POST['pass1'] != $_POST['pass2'])
    $errors->add( 'password_reset_mismatch', __( 'The passwords do not match.' ) );

//
//  * Fires before the password reset procedure is validated.
//  * @param object $errors WP Error object.
//  * @param WP_User $user WP_User object if the login and reset key match. WP_Error object otherwise.
//  */
do_action( 'validate_password_reset', $errors, $user );

if ( !isset( $_POST['pass1'] ) || empty( $_POST['pass1'] ) )
    reset_password($user, $_POST['pass1']);
    setcookie( $rcp_cookie, '', time() - YEAR_IN_SECONDS, $rcp_path, COOKIE_DOMAIN, is_ssl(), true );
    login_header( __( 'Password Reset' ), '<p class="message reset-pass">' . __( 'Your password has been reset.' ) . '</p>' . esc_url( wp_login_url() )
    login_footer();
    exit;
```}

3. Updates to users’ personal information can be made by using `user_edit.php`. Firstly, the update function must be called and then the old data can be replaced with the new. An array can be used to add this as long as it isn’t duplicated elsewhere. Finally the new information will be stored and the user will be informed by Email.
4.4.7  Background of the Forum menu mode

After completing the log in successfully in the homepage, the contents of the Forum menu will display automatically. Essentially, this Forum includes the various elements of the learning website environment, such as Teachers and students list, Articles, Recent Topics, and Forums. These functions were designed in WordPress software platform and each function can retrieve the data on teachers and students from the MYSQL system. Displaying of the various contents can be activated by clicking on the appropriate function.

Picture 15: Forum menu

4.4.7.1  List of Students and Teachers

List of Students & Teachers was created as a function by installing a plug-in in the WordPress platform. Firstly, the name of the list had to be determined and then each field name that would be displayed in the list. This is shown below in the design page.
Picture 16: Design page for Teachers and Students list

After creating this list, the contents of each field will display when they are called from the WordPress designing platform by this link http://learningwebsiteosa34.co.uk/list/. As the following:

**LIST OF STUDENTS & TEACHERS**

<table>
<thead>
<tr>
<th>DISPLAY NAME</th>
<th>STATUS</th>
<th>ARTICLE TITLE</th>
<th>ARTICLE</th>
<th>UPLOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980044nn</td>
<td>Student</td>
<td>new article about java</td>
<td>Is java driving you loopy? Loops and iteration can be tricky to master for beginners. In our no-nonsense guide, we take the complexity out of looping, so you won't go pazzo loco.</td>
<td><a href="http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/1948044nn/file/java-coda.txt">http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/1948044nn/file/java-coda.txt</a></td>
</tr>
<tr>
<td>nn</td>
<td>Student</td>
<td></td>
<td></td>
<td><a href="http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/fn/file/java-coda.txt">http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/fn/file/java-coda.txt</a></td>
</tr>
<tr>
<td>Omar Aljaseh</td>
<td>Student</td>
<td></td>
<td></td>
<td><a href="http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/Omar/file/java-coda.txt">http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/Omar/file/java-coda.txt</a></td>
</tr>
<tr>
<td>s</td>
<td>Student</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Picture 17: List of students and teachers

4.4.7.2 Article list in the background model

The Article list contains two basic types of function: Add Articles and Upload Files. These functions were designed in WordPress, and can be called based on profile.php. Both teachers and
students can submit articles and they can modify them by clicking on the Visual button; also, if they so wish, they can build a simple code by using the Text button. If they have a PDF, Image or text file, they can upload it by using upload courseware and also they can delete it from their profile. After completing these operations, the users must update the profile and then the updated text or inserted file will be displayed on the screen.

![Picture 18: Add article and Upload Courseware](image)

4.4.7.3 **Recent Topics and Discussion area model**

1. Recent Topics was designed in WordPress in order to display the latest questions, answers and topic details based on the newest topics. In the recent topic list, only the last three topics can be listed so that teachers and students can access them easily. Also, they can view a proposed topic with the account that it is created in and the time of modification.

In addition, users who wish to further develop their learning in programming languages can use
mutually interactive resources that are provided in Recent Topics.

2. The Discussion area is the most crucial area in terms of learning programming language. It uses several tools that make the learning of programming language concepts easier and these are presented via a systematic approach; thus, Teachers and Students can achieve considerable benefit from such electronic interaction. In the Discussion area, most of the learning tools are made available in an educational format to some extent; for example, teachers can type and edit questions and students can participate in various topic and interact with more than one teacher and student at a time. This could make their association more streamlined.

In order to close the topics to make changes and to open it, the Close and Open features have been added. In addition, any comments, questions, answers, and other replies can be merged when using the Merge activity. Meanwhile, teachers can delete answers by using Trash. In such cases, the teachers can Restore the reply or Delete it permanently. Also, the comment can be identified as Spam or Un-spam, so that the users can ask for replay when necessary. Finally, with the Replay feature, users can replay any question or answer and the new window form will appear for them to type in and submit the details.
These operations for editing a topic are executed by post.php. First, the user must log in to the learning website, then the login (id) can be used as permission to put in $post_id for deleting. $post = get_post( $_REQUEST['post_ID'] ) makes the request to use the editing function with $post_type based on checking of whether the post is equivalent to $post_type. The editing operation can then be completed.

```
$post_type = $post->post_type;
if ( 'post' == $post_type ) {
    $parent_file = "edit.php";
    $submenu_file = "edit.php";
    $post_new_file = "post-new.php";
}
```

When not logged in, the users cannot trash the topic, as only users who are logged in can trash,

```
if ( ! wp_trash_post( $post_id ) )
    wp_die(__( 'Error in moving to Trash.' ) );
wp_redirect( add_query_arg( array('trashed' => 1, 'ids' => $post_id), $sendback ) );
exit();
```

In the Un-trash, there are two probabilities, either Restore or Delete. For restoring, if the users have not logged in, they cannot Restore the topic.

```
if ( ! wp_untrash_post( $post_id ) )
    wp_die(__( 'Error in restoring from Trash.' ) );
wp_redirect( add_query_arg( 'untrashed', 1, $sendback ) );
exit();
```
The following code is used for deleting purposes once the user has logged in.

```php
if ( ! current_user_can( 'delete_post', $post_id ) )
    wp_die( __('You are not allowed to delete this item.'));
```

Through post-new.php, the new replay will be created. The post_type must be valid and is invoked by $_GET['post_type'].

```php
global $post_type, $post_type_object, $post;
if ( ! isset( $_GET['post_type'] ) ) {
    $post_type = 'post';
} elseif ( in_array( $_GET['post_type'], get_post_types( array('show_ui' => true) ) ) ) {
    $post_type = $_GET['post_type'];
} else {
    wp_die( __('Invalid post type') );
}
```
Chapter 5    Evaluation of the testing results

5.1    Website system testing

This sophisticated website function is constructed according to a set of testing requirements. Based on the findings that emerged from the testing practices, the testing plan and results are described below.

5.1.1    Testing plan

The testing plan function is provided in order to verify whether the website environment fulfills the requirements of the design. Before use, each function and feature that is required in the website must be verified according to a testing plan. Also, the testing plan can test procedures of the webpage contents when displaying basic features of the content of each language and forum, such as teacher list, student list, upload courseware, and add article; in this way, it can be ensured that the website tools are fit for the purpose of successful learning.

5.1.2    Testing tools

Testing determines whether the features of the website are fulfilling their functions. In this case, the aim is to obtain detailed information on the following aspects of the system:

- Memory: 4 Gbyte
- CPU: Intel(R) Core ( TM ) i3 CPU M 350 @ 2.27 GHz 2.27 GHz
- Hard Disk: 250Gbyte
- Operating system: Microsoft Windows 8.1
- Explorer system: Google chrome
5.1.3 Testing method plan

Testing of the system entails manual implementation of the following steps.

1. Complete the assessment of the incorporated data after testing the website system functions and draw conclusions on providing additional tests.
2. The technicians specify the website functions to be tested, such as verification of the website, file editing and accounts administration.
3. The test practices must comply with the particular requirements of the website system testing process.
4. Operation of the system’s functions must be verified and simulations of the different user habits must be devised and tested.
5. The website system must be compliant with the requirements of system design in relation to display functions and effects on the various WebPages and testing for amending the system must be applied continuously.

5.1.4 Results and effects

1. Home page: This thesis focuses on testing those aspects that were designed according to the website system requirements. The following table lists each function in the system along with the relevant test results, effects, and any special testing cases. These special testing cases such as display a main home webpage, verify the login, account administration, verification of website, and document user editing, are then considered in detail in the next table.
<table>
<thead>
<tr>
<th>Special testing cases</th>
<th>Result</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Display a main home webpage</td>
<td>Using Google Chrome</td>
<td>Similar display effect for every page</td>
</tr>
<tr>
<td>(2) Verify the login</td>
<td>Authenticated user By username and password</td>
<td>When logging into the system, the current page calls the user name and authentication webpage</td>
</tr>
<tr>
<td></td>
<td>Unauthenticated user By wrong username and password</td>
<td>Alarm message appears when login is unauthorized</td>
</tr>
<tr>
<td>(3) Verification of website</td>
<td>Test the contents of page</td>
<td>Correctly displays the information when responding to users commands</td>
</tr>
<tr>
<td>(4) Account administration</td>
<td>Register and open a new account by entering a password and user name</td>
<td>Successful login and registration</td>
</tr>
<tr>
<td></td>
<td>Register and open a new account when an error occurs in length of password and user name</td>
<td>Unsuccessful login and registration</td>
</tr>
</tbody>
</table>

Table 4- A: Testing of special cases (Home page)

2. Forum contents: the testing of Forum contents includes View list of teachers and students, Articles (Add Article and upload Files), Recent Topics, and Forums (discussion area). The following table shows the test details.
### Table 4- B: Special testing cases (Forum contents)

This special case testing assesses whether the basic design requirements of the website are met. It also allows the user to know which website functions the learner needs when learning a language.

#### 5.2 Test effect

In order to develop the basic functions, some learners will be invited to visit and use the website. The questionnaire delivery tools will be evaluated to give an overview of the influence of the website on the users’ programming language learning and will be used to specify the website basic functions as design aspects.
5.2.1 Plan of testing

The plan of testing includes participation in activities by volunteers who can contribute to the success of the website system, such as competent volunteers interested in independent learning using online materials, and who can identify what they expect to learn about a programming language. It also includes development of general knowledge on how the website system is used to help learners through administering the questionnaires, and finally, the questionnaires will provide feedback from the learners after learning.

5.2.2 Selecting the respondents

Messages were posted in different online communities to recruit the test volunteers and eleven persons expressed a desire to participate in the test operation and fill in the questionnaires. As a result of lack of time, one volunteer could not complete the programming language learning. The other volunteers who are ten volunteers completed the proposed within ten to fifteen days and they also filled in the questionnaires, which was useful for monitoring the effects of using the website.

5.2.3 Verification of the fundamental questions

The questionnaire contained fourteen questions to evaluate this method of learning programming language. It included several questions about programming experiences and seven fundamental questions (Q8 to Q14) exploring the respondent’s capabilities and learning of the foundations after using the website. These questions would be used to evaluate whether the final website has achieved the study’s aims and objectives. Essentially, the respondents were working towards different academic degrees and had sufficient free time available to engage in this learning. Most of the respondents had a programming languages base and the others desired to learn some programming languages concepts. The period of self learning ranged from ten to fifteen days.
5.2.4 Analysis of effect

1. Can you select an appropriate programming language?

The first question determines whether the user has selected and determined an appropriate programming language. The collected data on 7A and 3B as shown in the figure below indicates that most of the respondents clearly had selected the appropriate language.

![Pie chart showing 70% agree and 30% very agree.]

2. Did you read the contents of the selected language carefully?

This question aims to specify whether the respondent has conducted the self-learning in a committed way. The collected data from 10A as shown in the figure below demonstrates that every respondent browsed the website contents related to programming language.

![Pie chart showing 100% agree.]
3. **Did you experience confusion before accessing this website?**

This question determines that the complexity of choosing a suitable language is a widespread problem. The collected data from 6A, 2B, and 2C as shown in the figure below indicates that this is a common problem among learners.

![Confusion Pie Chart](image)

4. **Can you build software and do you have experience in the programming field?**

This question assesses the importance of this website. The collected data from 1B, 1C, 5D, and 3E as shown in the figure below indicate that most of the respondents lack the necessary experience in programming.

![Experience Pie Chart](image)
5. **Did you use another website to learn from as well as this website?**

This question was asked to determine whether the volunteers had limited the range of their learning. The collected data from 5A, 3B, and 2C as shown in the figure below indicate that most of the learners searched for materials from other websites.

![Pie chart showing data for 5A, 3B, and 2C](chart1.png)

6. **How much did this website help you to learn programming language?**

This question assesses the effect of the website. The collected data from 3A, 5B, and 2C as shown in the figure below are mainly similar to the former replies, even though the questioning form varied, in indicating that this website’s functions had a confirmed effect.

![Pie chart showing data for 3A, 5B, and 2C](chart2.png)
7. Can you write a code to create a solution with the language that you learned?

This question assesses the learners’ latest learning qualifications in a programming language. The collected data from 2A, 5B, and 3C as shown in the figure below demonstrates that most of the learners could complete the desired procedure successfully, but three failed. It may be a crucial indicator that they do not have enough skills in programming.

8. Will you reuse the website another time when facing problems in programming?

This question assesses the website’s effect. The answer yes means the website is influential to some extent. The collected data from 3A, 6B, and 1C as shown below in the figure suggest that most of the participants will use the website again and it illustrates the website’s uniqueness in addressing certain significant problems in comparison with other websites.
9. Was your learning efficiency enhanced?

This question attempts to validate the effect of learning by using a website learning environment. The collected data on 3A, 5B, and 1C as shown in the figure below suggests that most learners believe that their efficiency of learning has been enhanced.

![Pie chart showing responses to question 9]

10. Did you increase your programming foundations and functional skills through learning?

This question is looking at learning achievement. The collected data from 5A, 3B, and 2C as shown in the figure below indicate that most of the learners achieved considerable improvement in their programming skills. However, other learners did not achieve success through implementing the practices and consider no significant improvement has been achieved.

![Pie chart showing responses to question 10]
11. Did you perfect learning a new programming language?

This question assesses the latest learning qualifications in terms of a new language. The collected data from 1B, 6C, and 3D as shown in the figure below indicate that three learners do not believe that they have perfected learning a new language.

![Pie chart showing learning outcomes](image1)

12. Did it fail to increase your programming efficiency?

The collected data from 1C, 6D, and 3E as shown in the figure below demonstrate that the learners do not think that it failed to increase their programming efficiency.

![Pie chart showing efficiency](image2)
13. **Did you learn several programming languages by using this website?**

This question attempts to determine the significance of the website. The collected data from 1A, 3B, 5C, and 1D as shown in the figure below suggest that this website was useful for enhancing the efficiency of learning several languages among these learners.

14. **Did you understand the functions of the website?**

This question assesses whether respondents obtained enough learning through the website contents and whether they applied all the functions and displayed the website functions. The collected data from 5A, 4B, and 1C as shown in the figure below demonstrate that the respondents, overall, came to completely understand the website.
5.3 Summary

The testing of website functions illustrates that the website met the basic functional requirements. The questionnaires indicate that this website will solve some of the confusion over choosing a programming language and other basic features based on the procedure methods. Also, it could be helpful in increasing users’ efficiency in learning a programming language, and finally, it illustrates that use of the website was successful and effective for most of them.
Chapter 6   Professional, Legal, Ethical, and Social Issues

In designing or developing any system that involves human interaction, such as developing a website for learning the basic concepts of types in programming languages, issues regarding professionalism, legality, ethics, and sociability will emerge. These issues may have negative impact on the use of such a website; therefore it is crucial to the success of the website that these issues are identified.

It can be seen that the inexperienced website designer faces a number of major issues in developing and designing such a learning website environment. Additional time may be needed to collect the basis tools for building it, such as learning a PHP language and its basic technologies, creating a database system and filling it with data, and finally, designing the main WebPages to be displayed on the website. To overcome this problem, it was very important to refer to books such as PHP 6 and MYSQL, and also Head First PHP and MYSQL in order to develop this website accurately.

Many learners may become discouraged if they fail in quickly identifying an appropriate language. In order to address this issue the project suggests that the website summarizes the programming language features and the type analysis. In addition, the website aimed to introduce several languages and thereby to help learners to choose an appropriate programming language.

An additional issue involves unauthorized entry to the website to access and manipulate the information. Safety is an important aspect of any website. To prevent access by the unauthorized user, many procedures have been investigated in the development of the website, such as designing register and login functions that will allow only authorized users to access the information on the website.

Ethics relates to the moral standards according to which the website needs to be developed, taking diversity into consideration. Diversity among learners will be reflected in a range of users from beginners to experienced developers and professionals. When designing the website, it will be very important to achieve a balance among these various levels, to avoid features that may cause offence to others, and to respect users’ feelings and requirements. Also, while investigating, developing and building the learning website it will at all times be vital to apply an ethical and moral perspective.
The abovementioned professional, legal, ethical, and social issues could cause problems for those seeking to learn about programming languages. However, the strategies that have been specified, such as providing a summary of important aspects of programming languages, supporting secure procedures and evaluating the levels of learners, will be effective precautions in avoiding such issues and thereby fulfilling the learners’ aims.
Chapter 7  Conclusion

7.1  Summary and conclusion

As has been shown in the literature review there are many different aspects of programming languages, such as data type, type safety and type checking. The most important limitation lies in the fact that the newly developed and modern languages are more beneficial than the older languages. Even though the Java and C languages are still the most commonly used languages, assessment measures have confirmed the greater expressiveness of newly developed languages and they are attracting large numbers of users with various requirements. However, the exchange between type safety and expressiveness cannot be deduced immediately by measurement. It also includes aspects such as the experience and habits of programmers.

Firstly, it must be understood that type checking cannot ensure complete program safety because only a small part of code can be excluded by type checking. For example, most languages cannot detect the error of dividing a number by zero in the compiling phase, thus such languages cannot be regarded as entirely type safe. Secondly, when the type of system has a good design, it can also detect a high ratio of errors and considerably reduce the time of debugging. The errors that occur are simpler to detect because many other types of errors are excluded. In addition, the programmer can develop a style of coding that can clarify the type of error. There is a debate about the relative merits of the dynamic and static types, weak and strong types; however, defenders of dynamic types claim that large size of program is not in reality connected to type error. The number of errors can be reduced if the programmer is experienced and adopts appropriate habits.

Realization of the appropriate learning website environment is a requirement for learning of programming languages. During the course of compiling this thesis, the learning environment was designed appropriately for analysis of the research and fulfilling the project’s aims. This website is expected to be targeted at programming language beginners to help them to choose and learn programming language. This website is published for learning purposes by (http://learningwebsiteosa34.co.uk/). Basic instructions are provided for five languages: C language, Scala, Ruby, Assembly and Java, with a learning platform determined by the Discussion area structure for discussion among the users and for mutual learning.
7.2 Contributions

This project may contribute to learning about different programming languages among learners who may have failed to find or learn a suitable language in a short time period. This project provides a schema for resolving this problem by developing and performing model analysis of the basic language features. It displays several languages and it is expected to be useful in helping learners to choose a language, as indicated by the feedback from the questionnaires. Also, the project may contribute to the analysis and discovery of language learning problems. It has discovered and addressed issues that are commonly faced but rarely identified. Moreover, the way in which information is presented by the website may help learners to improve their learning efficiency regarding programming languages. The process of learning is not only important in the software field, however; the skills can be transferred to other areas. This process of identifying analyzing and addressing the problem can also be of great benefit in other fields of learning. Finally, it can be noted that the financial cost of this learning website is low, and little expense is required except for the server that is a combination of PHP, MYSQL, and the Apache server. Therefore, this website was developed at low cost and is now running cost effectively on the server.

7.3 Evaluation

This project has identified and presented comparative analysis of the many differences and similarities among various programming languages. This process could be useful in helping programmers to understand the basic concepts of these languages through identifying their distinguishing characteristics and could thereby enhance their understanding of properties of programming language. Evaluation of the project, based on the questionnaires, identified that a large number of learners have faced difficulties in choosing a suitable language. The additional specifications provided in the website are expected to enable learners to succeed in this task. If they can change their traditional learning style, they will have a great opportunity to identify the appropriate language, via a method that will sharply decrease the complexity of learning these languages and allow them to learn more efficiently.
This project is oriented towards the types found in many programming languages. A summary of the comparative analysis can provide some helpful conclusions for programmers. The Java language has a static and strong checking type, whilst the assembly language is un-typed and weak. However, Ruby is a dynamic, strong language. The strong and dynamic types could represent the future of programming languages. It is important for the programmer to focus on the code rather than on the details of the programming language. These main issues were identified by abstracting, concluding and analyzing the phenomena that emerged through the process of reviewing previous studies. Also, the project defines the integrated clues and processes that play important roles in identifying and explaining other common issues.

7.4 Future work

In this project, the future work will significantly focus on constructing the learning environment. Firstly, the environment learning structure will be improved further by adding other features. The current system environment focuses on the display of knowledge; however, it could be enhanced by adding features such as learner posts, replies and evaluation of answers by teachers, and provide tables of scores given by teachers to the learners. Optimizing the website functions and structure to provide additional information and to create bilateral exchanges among users will attract more learners to the website.

Secondly, further models will be displayed based on the acquired knowledge and other information derived from the learners’ exchanges to compare the effectiveness of various languages in achieving the same purpose. The website will be updated to allow for bilateral exchanges and will be designed to be available for professional learners who are willing to share their experiences with others and to join the population of the learning environment.

Finally, when the functions in the learning environment are fully developed and the contents updated constantly, this website will become more widely used. Additional learners will be accessed and attracted to this website by the opportunity for sharing information via website activities and exchanging knowledge for language learning purposes. The environment of the website will come under the shared administration of the learner group through sharing of dedication, interest and time in this website, developing profiles, contributing to the updating of mutual knowledge, attraction of new learners, information accumulation and exchange of experiences.
References


Appendices

Appendix A: Questionnaire form sample

Name:
Email:
Age:
Educational attainment:
Professional level:
Programming experiences:

Questions:
1. Can you select an appropriate programming language?
   A - Very agree   B - agree   C - neutral   D - disagreed   E - Totally disagree

2. Did you read the contents of the selected language carefully?
   A - Very agree   B - agree   C - neutral   D - disagreed   E - Totally disagree

3. Did you experience confusion before accessing this website?
   A - Very agree   B - agree   C - neutral   D - disagreed   E - Totally disagree

4. Can you build software and do you have experience in the programming field?
   A - Very agree   B - agree   C - neutral   D - disagreed   E - Totally disagree

5. Did you use another website to learn from as well as this website?
   A - Very agree   B - agree   C - neutral   D - disagreed   E - Totally disagree

6. How much did this website help you to learn programming language?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

7. Can you write a code to create a solution with the language that you learned?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

8. Will you reuse the website another time when facing problems in programming?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

9. Was your learning efficiency enhanced?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

10. Did you increase your programming foundations and functional skills through learning?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

11. Did you perfect learning a new programming language?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

12. Did it fail to increase your programming efficiency?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree

13. Did you learn several programming languages by using this website?
A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree
14. Did you understand the functions of the website?

A - Very agree  B - agree  C - neutral  D - disagreed  E - Totally disagree
APPENDIX B: Learner’s Guide

1. How to register into the website

Step 1: Enter your personal Username.
Step 2: Enter your Email.
Step 3: Enter your Password.
Step 4: Confirm your password.
Step 5: Enter First name.
Step 6: Enter Last name.
Step 7: Specify whether you are a teacher or a student.
Step 8: Insert the code and the register.

REGISTER FOR FORUM

Your username must be unique, and cannot be changed later.
We use your email address to email you a secure password and verify your account.

Username: 

Email: 

Password: 

Password confirmation: 

First name: 

Last name: 

Please specify whether you are a teacher or a student

Student: 

Insert the code: 

Register
2. How to Log in the website

Step 1: Go to Forum Login.
Step 2: Type your Username.
Step 3: Type your Password.
Step 4: Click simply on Log in to open your account.

3. How to use the website

Step 1: Select one of programming languages as Java, there are many important Java concept.
Step 2: Select one of the Java concepts.
Step 3: Displaying the concept’s contents. For example, on selecting the Basic Data Types this page will be displayed.

**BASIC DATA TYPES**

Variables are nothing but reserved memory locations to store values. This means that when you create a variable you reserve some space in memory.

Based on the data type of a variable, the operating system allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different data types to variables, you can store integers, decimals, or characters in these variables.

There are two data types available in Java:

- **Primitive Data Types**
- **Reference/Object Data Types**

**Primitive Data Types:**

There are eight primitive data types supported by Java. Primitive data types are predefined by the language and named by a keyword. Let us now look into detail about the eight primitive data types.

---

**4. How to use Forum Part**

Step 1: Go to the Forum part in the Homepage.

Step 2: Displaying the Forum menu.

Step 3: Select one of the Menu contents as Teachers/Students List, Articles, Recent Topics, and Forums (Discussion area).

---

Step 4: Press on the View List of Teachers/Students list to display the contents.
# LIST OF STUDENTS & TEACHERS

<table>
<thead>
<tr>
<th>DISPLAY NAME</th>
<th>STATUS</th>
<th>ARTICLE TITLE</th>
<th>ARTICLE</th>
<th>UPLOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>omnnd</td>
<td>Student</td>
<td>Java</td>
<td>1. Java Language: &lt;br&gt;It is strong static type. The common used of data types is using the class. The pointes in C language is removed in java language. it makes to ensure the safety of types and finally is supported the object oriented. The code has been written in Java is very complicated because the large projects of Java are needed to writemany of duplicated contents.</td>
<td><a href="http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/osa35/file/Project-dissertation.docx">http://learningwebsiteosa34.co.uk/wp-content/Cimy_User_Extra_Fields/osa35/file/Project-dissertation.docx</a></td>
</tr>
<tr>
<td>osa35</td>
<td>Student</td>
<td>Java</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Step 5: Press on Add Article to insert your personal article.

![Article Title](java)

Step 6: Press on Upload files to download the files as (PDF, WORD and other file forms).

![Upload Courseware](Project-dissertation.docx)

Date of registration: 20 July 2015 @ 10:17 Date of registration

Update Profile
Step 7: After completing the Add Files and Upload Files operations, Click on the Update Profile for downloading them.

6. How to use Recent topics and Discussion area

Step 1: Press one of the last topics that are displayed under the RECENT TOPICS.

Step 2: The contents of next page will be displayed that include Discussion area environment.

Step 3: Click on Edit for editing the topics

Step 4: Click on Close to close the topics and then you open it by clicking on Open.
The relationship between pointers and arrays

The pointer and array are closely similar because of accessing to memory in the same way in array and pointer. However, there are many differences among them as the pointer can update the contents of its memory and points to various values whilst the array saves the certain pointer or the fixed stating addresses usually.

Step 5: Click on Merge to merge two topics together.
Step 6: Click on Trash to Delete the topics or Restore them.

Step 7: Click on Spam to indicate the topic as the spam topic.
Step 8: Click on Reply to provide a reply topic for the main topic.
Step 9: Click on Discussion area to access the main topics, to create a new topics and reply them.
Step 10: Click on one of the topics in the discussion area, the follow page will be displayed.

Step 11: Click on the Favorite on the previous page to add the topics to your favorite topics, or click on the Subscribe.

Step 12: Click on Username on the left of the screen as (laerni91) to display the following page that contents user Profile, Topics Started, Replies Created and favorites.

Step 13: Click on Topics Started to display them.
Step 14: Click on Replies Created to display the replies topics.

FORUM REPLIES CREATED

This user has not replied to any topics.

Step 15: Click on Favorits to display the Favorite list of the topics.

FAVORITE FORUM TOPICS
APPENDIX C: The Gantt Diagram

The main project procedures are shown in the diagram below by means of a Gantts diagram. During each stage there will be dissertation writing and tests.
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