

2 CLASSES, 2 LANGUAGES, 2 METHODOLOGIES AND 1 ASSIGNMENT

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ABSTRACT

In 2002 two different programming classes at Christchurch Polytechnic Institute of Technology were given the same application to build as part of an assignment, with one class working in JADE and the other in PHP.

The purpose of this paper is to identify the tasks that were the most difficult to complete, and what were seen as being the most important skills and competencies needed to complete the assignment, based on the language used.

The students were enrolled in either NDPR215, which was a second year JADE programming paper for the Diploma in Business Computing, or BCPR342 which is a PHP programming paper completed by students in the Bachelor of Information and Communication Technologies and the Graduate Diploma in eCommerce.

The application that the students were required to complete was a simple eProcurement system as described by writers such as Zsidisin (2002) and Essig and Arnold (2001) that enabled employees in an organisation to send out tenders for products they needed to procure to a range of potential suppliers, and to allow those suppliers to put in their best price for the requested products.

The students enrolled in both courses were asked to complete a questionnaire in which they were firstly asked to rate the relative level of

difficulty of a range of tasks from 1 to 5 on a likert scale, and to also identify which three tasks were seen as being the most difficult. Secondly the students were asked to rate the relative level of importance of a list of skills and competencies needed from 1 to 5 on a likert scale, and to also identify which skills and competencies were seen as being the most important.

The results of this survey are compared with what are seen as being the typical advantages of languages like JADE, as described by writers such as Clarke (1998) and PHP, as described by writers such as Schwendiman (2001) to see if the experiences of the students in the two classes are consistent with them.

1. INTRODUCTION

In 2002 two different programming classes at Christchurch Polytechnic Institute of Technology were given the same application to build as part of an assignment, with one group working in JADE and the other in PHP.

The purpose of this paper is to identify the tasks that were the most difficult to complete, and what were seen as being the most important skills and competencies needed to complete the assignment, based on the development environment used.

The students were enrolled in either NDPR215, which is a second year JADE programming paper for the Diploma in Business Computing (DipBC), or BCPR342 which is a PHP programming paper completed by students in the Bachelor of Information

Table 1 – Tasks That Were Rated By Relative Level Of Difficulty

Generic task descriptions
Developing an understanding of the requirements of the assignment
Designing the data model (Entity Relationship Diagram or Class Diagram)
Building the data structure
Populating the data structure with sample data
Creating the logging in function for suppliers and employees
Enabling employees to create a new tender
Generating the tender requests to be sent to each potential supplier of the component
Enabling a supplier to view the tender requests they have been sent
Enabling a supplier to submit a price for a tender
Enabling an employee to see the prices that have been submitted for a tender
Enabling an employee to convert a submitted tender into a purchase order
Linking the data on different pages and forms together
Testing

and Communication Technologies (BICT) and the Graduate Diploma in eCommerce (Grad Dip eCom).

As one of the assessments for both NDPR215, and BCPR342 students were required to build an application that was a simple eProcurement system as described by writers such as Zsidisin (2002) and Essig and Arnold (2001).

The students were asked to complete a questionnaire to enable data to be gathered about the relative difficulty of tasks that needed to be completed, and the relative importance of skills and competencies that were needed to build the application.

The results of the questionnaire were analysed to identify not only the most difficult tasks and most important skills and competencies, but also to identify

Table 2 – Skills and Competencies That Were Rated By Relative Level Of Importance By PHP Students

Skills and competencies rated by PHP students
Entity Relationship Diagram Modeling
SQL
HTML
General Programming Knowledge and Expertise
Planning Skills
Testing and Debugging Skills
Understanding of Session Variables
Understanding of Apache
Understanding of Business Processes in General

Table 3 – Skills and Competencies That Were Rated By Relative Level Of Importance By JADE Students

Skills and competencies rated by JADE students
Object Oriented Data Modeling
General Programming Knowledge and Expertise
Planning Skills
Testing and Debugging Skills
Understanding the Underlying Operating System
Understanding of Business Processes in General

similarities and differences that may exist across the two development environments.

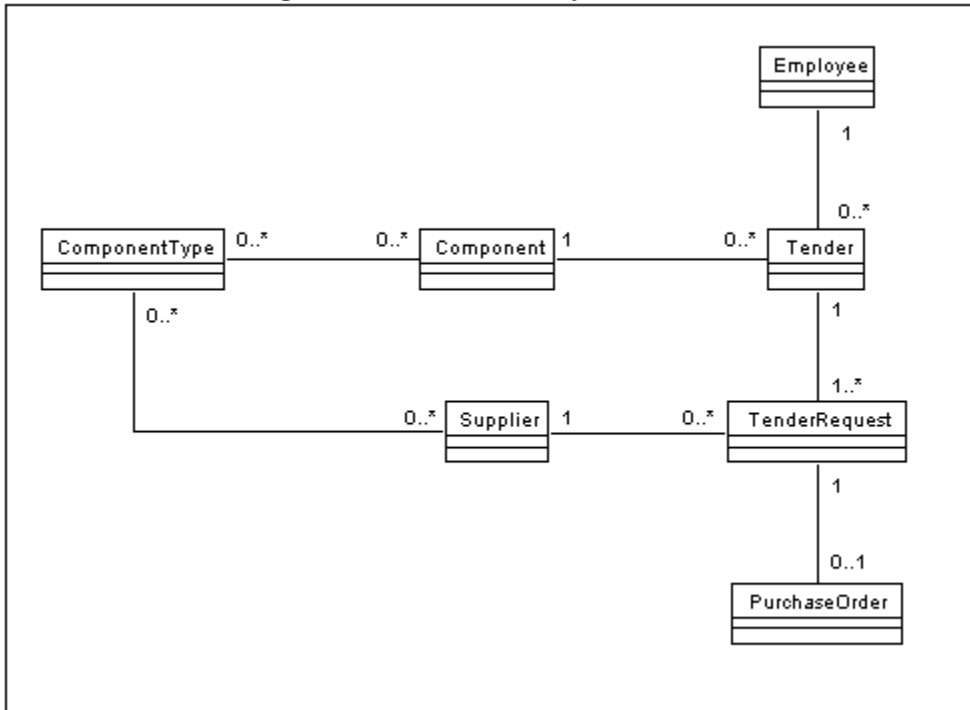
While no generalisations were able to be made due to the small sample size, some trends were identified and some future directions for this research were identified.

2. METHODOLOGY

2.1 Participants

The participants in the research were the students who were enrolled in NDPR215 and BCPR342 in semester two of 2002 at CPIT. Of the 17 students who worked in PHP 10 completed the questionnaire, and of the 11 students who worked in JADE 7 completed the questionnaire.

Figure 1: eProcurement system



With these numbers enrolling in the courses and completing the questionnaires, it was not possible to make generalisations about how the entire population of students would perceive different aspects of the assignment.

2.2 Questionnaire

The questionnaire was designed to gain information about the perceived level of difficulty of a number of tasks, and about the perceived level of importance of a number of skills and competencies needed.

In the first part of the questionnaire the students were asked to rate the relative level of difficulty (on a likert scale where 1 is very difficult and 5 is elementary) of 13 tasks that were part of the assignment, and to indicate which of these tasks were the three most difficult. With the two groups of students building the same application, the tasks were worded generically so that they were the same for both groups of students. These tasks are shown in Table 1.

In the second part of the questionnaire the students were asked to rate the relative importance (on a likert scale where 1 is very important and 5 is not important at all) of a number of skills and competencies that were needed, and to identify which of these were the three most important. With the two groups of students working in different development environments a different list of skills and competencies were constructed for each group. The list that were rated

by the students working in PHP is shown in Table 2, with the list that were rated by the students working in JADE being shown in Table 3.

2.3 Analysis

The data collected relating to the relative difficulty of tasks was initially analysed by looking at the frequency with which each task had been identified as one of the three most difficult tasks. The tasks were sorted into order on this frequency based on three different groups of responses:

- ◆ All of the students irrespective of the development environment used
- ◆ Students working in PHP
- ◆ Students working in JADE

If tasks were rated as being one of the three most difficult in greatly varying frequencies across the two groups of students, those tasks were examined to determine if there is any basis for this relating to the different development environments.

The data was examined to see if there were any patterns in which tasks were perceived as being more difficult. Where there appeared to be a pattern, a Mann-Whitney test as described by Zikmund (2000) was conducted using the WINKS Statistical Analysis Package to determine the significance of the pattern.

The data collected relating to the relative importance of skills and competencies was analysed by looking at the frequency with which each was identified as being one of the three most important. The skills and competencies were sorted into order based on these frequencies within each group of students. The sorted groups were then examined to see if there was a pattern across the two groups that related to the nature of the skills and competencies, and if there appeared to be a relationship between the tasks that were seen as being difficult and the skills needed to carry them out.

3. BACKGROUND OF THE ASSIGNMENT

3.1 Requirements of the Assignment

The students were provided with a basic description of the system, and were given opportunities to clarify the requirements of the system with the lecturer playing the role of the owner/manager of the organisation.

The students were required to create a data model for the system (a Class Diagram in the case of the JADE students, and an Entity Relationship Diagram in the case of the PHP students). The data model was checked off prior to the students commencing development of the application.

The students were required to document what their planning process was, and the relative proportions of time spent on different aspects of the assignment. The actual planning processes used were to a large extent left up to the student.

The purpose of the eProcurement system was to enable employees in an organisation to create tenders and send out tender requests for components they need to procure to a range of potential suppliers, and to allow those suppliers to put in their best price for the requested components. The components are grouped into "component types" with each "component type" able to be supplied by a number of suppliers.

A skeleton Static Class Diagram that could be used for the JADE version of the assignment is shown in Figure 1, and indicates the many-many relationships that exist between "Component" and "ComponentType" and between "ComponentType" and "Supplier".

3.2 The Benefits of eProcurement Systems

Turban, King, Lee, Warkentin and Chung (2002) describe the benefits of eProcurement systems or

procurement management tools as being reduced purchase prices and reduced purchase cycle time. They go on to describe the GE Trade Process Network, which has resulted in significant cost savings and positive impacts on their profit as a consequence of this.

A scenario that was described to students in both of the courses was of an organisation that spends 60% of its income on purchasing components and materials, 37% on other costs, leaving a profit margin of 3%. If the introduction of an eProcurement system were to reduce the purchase price of components and materials by 10%, the profit of the organisation would triple as shown below:

Income	100	100		
Less Purchases	60	54	10% Saving	
	40	46		
Less Other Costs	37	37		
Profit	3	9	Profit Tripled	

3.3 JADE and PHP

Clarke (1998, page 31) described JADE as being a "completely integrated development single source environment for the development of object oriented client server systems for distributed processing", and goes on to explain how JADE implements an object oriented database, a programming language and the graphical forms (screens) generator.

Examining this description, the key components of JADE could be described as being that it is an integrated development environment, that it is object oriented, that it can be used for the development of distributed systems, that it has a programming language and can generate user interfaces.

Schwendiman (2001) describes PHP as being "a programming language created to enable web developers to quickly create dynamic web applications". In describing why PHP should or could be used, Schwendiman (2001) goes on to explain that PHP provides support for a wide range of databases from commercial products through to open source products. As a consequence of these factors, PHP could be described as being a tool for dynamically generating HTML, based on data that is residing in a range of databases, the vast majority of which are relational.

In looking at the above descriptions of JADE and PHP by Clarke (1998) and Schwendiman (2001) respectively, it is clear that there are a number of similarities and a number of differences. The similarities include (a) that both can be used for the development of distributed applications as web applications by nature are distributed and (b) that both

Table 4 – Frequency with which tasks were rated as one of the three most difficult by all students

Task	Frequency
Designing the data model (Entity Relationship Diagram or Class Diagram)	15
Developing an understanding of the requirements of the assignment	8
Building the data structure	6
Generating the tender requests to be sent to each potential supplier of the component	5
Testing	4
Creating the logging in function for suppliers and employees	3
Enabling an employee to convert a submitted tender into a purchase order	3
Enabling employees to create a new tender	3
Linking the data on different pages and forms together	2
Populating the data structure with sample data	1
Enabling an employee to see the prices that have been submitted for a tender	1

Table 5 – Frequency With Which Tasks Were Rated As One Of The Three Most Difficult By PHP Students

Task	Frequency
Designing the data model (Entity Relationship Diagram or Class Diagram)	10
Developing an understanding of the requirements of the assignment	5
Testing	4
Building the data structure	3
Enabling employees to create a new tender	3
Creating the logging in function for suppliers and employees	2
Linking the data on different pages and forms together	2
Enabling an employee to convert a submitted tender into a purchase order	1

Table 6 – Frequency with which tasks were rated as one of the three most difficult by JADE Students

Task	Frequency
Designing the data model (Entity Relationship Diagram or Class Diagram)	5
Generating the tender requests to be sent to each potential supplier of the component	5
Developing an understanding of the requirements of the assignment	3
Building the data structure	3
Enabling an employee to convert a submitted tender into a purchase order	2
Populating the data structure with sample data	1
Creating the logging in function for suppliers and employees	1
Enabling an employee to see the prices that have been submitted for a tender	1

provide facilities and tools for interaction with databases.

The differences include:

- ◆ The nature of the development environments with JADE being an integrated development environment and PHP development tending to be more fragmentary
- ◆ That the underlying data model of a JADE application is objected oriented with the vast majority of underlying data models in a PHP application being relational and therefore having SQL as part of the tool set
- ◆ That JADE is proprietary and PHP is open source.

4. RESULTS

The tasks that had been rated according to their relative level of difficulties were sorted into order by the number of times they were identified as being one

Table 7 – Frequency with which skills/competencies were rated as one of the three most important by PHP students

Skill/Competency	Frequency
Entity Relationship Diagram Modeling	8
SQL	7
General Programming Knowledge and Expertise	6
Planning Skills	3
Testing and Debugging Skills	3
Understanding of Session Variables	2
Understanding of Business Processes in General	1

Table 8 – Frequency with which skills/competencies were rated as one of the three most important by JADE students

Skill/Competency	Frequency
Object Oriented Data Modeling	6
General Programming Knowledge and Expertise	5
Understanding of Business Processes in General	4
Testing and Debugging Skills	3
Planning Skills	2
Understanding the Underlying Operating System	1

of the three most difficult tasks. The results of this are shown in Table 4.

This data was then broken down by which development environment the students completed the assignment in. Table 5 shows the frequency by which the PHP students rated the task as being the one of the three most difficult tasks, with Table 6 showing the frequency by which the JADE students rated the task as being one of the three most difficult.

The skills and competencies that had been rated according to their relative importance were sorted into order by the number of times they were identified as being one of the three most important skills or

competencies. The results of this for the PHP students are shown in Table 7, with the results for the JADE students being shown in Table 8.

5. ANALYSIS AND DISCUSSION

5.1 Perceived Difficulty of Tasks

When it comes to looking at the tasks that were found to be the most difficult, one task was identified as being one of the three most difficult tasks by 15 of the 17 students irrespective of the development environment used. This task was “Designing the data model” as shown in Table 4. This was followed by “Developing an understanding of the requirements of the assignment” which was seen as being one of the three most difficult tasks by 8 of the 17 students irrespective of the development environment.

When these two tasks are looked at in comparison with the other 11 tasks that the students were asked to rate the relative difficulty of, it is apparent that these two particular tasks are the only ones that relate to the analysis and design phases of the systems development life cycle. This suggests that, among this group of students, tasks that are part of the analysis and design phases are perceived as being more difficult than tasks that are part of phases later in the cycle.

If the students who completed the assignment in PHP are looked at in isolation, “Designing the data model” was seen as being one of the three most difficult tasks by all of the students. For this group of students, this task was followed by “Developing an understanding of the requirements of the assignment” which was identified by 5 of the 10 students as being one of the three most difficult tasks. This appears consistent with analysis and design tasks being perceived as the most difficult.

If the students who completed the assignment in JADE are looked at in isolation, “Designing the data model” was seen as being one of the three most difficult tasks by 5 of the 7 students. However, the task of “Generating the tender requests to be sent to each potential supplier of the component” was also seen by 5 of the 7 students as being one of the three most difficult tasks, with only 3 out of 7 of the students seeing “Developing an understanding of the requirements of the assignment” as being one of the three most difficult tasks.

Curiously the task “Generating the tender requests to be sent to each potential supplier of the component” was not seen as being one of the three most difficult

tasks by any of the students who completed the assignment in PHP. That this task figured as one of the most difficult tasks for the students working in JADE would appear to be due to the lack of an SQL-like query-tool in JADE as the following discussion describes

Referring to the Static Class Diagram in figure 1 it can be seen that for a particular component there can be more than one component type, and that for each component type there can be more than one potential supplier. The consequence of this is that there might be more than one link from a particular component to a particular supplier, and one of the requirements was that such suppliers should not get duplicate tender requests sent to them.

To find all of the potential suppliers when working in PHP, an SQL command needed to be issued to the database that was a generic SELECT statement that pulled data from a number of tables and joined the tables together. The result of this particular SQL command would be all of the suppliers that could potentially supply the component. The SQL statement would be similar to the following:

```
SELECT field1, field2, field3
from table1, table2 where
table1.fieldX = table2.fieldY ;
```

The only alteration to this to remove the duplicate suppliers was to insert the SQL keyword "DISTINCT" after SELECT:

```
SELECT DISTINCT field1, field2,
field3
from table1, table2 where
table1.fieldX = table2.fieldY ;
```

However, this was a bit more complicated in JADE. Most of the students as an initial step wrote a method that included two nested loops to find all of the potential suppliers, and as each one was found, generated tender request for it. The pseudo code for this might look as follows:

```
foreach ComponentType this Component
belongs to
  foreach Supplier of this
  ComponentType
    generatePurchaseOrder
  endforeach
endforeach
```

Unfortunately this approach resulted in duplicate suppliers being found.

One solution to this was to create a temporary collection of suppliers, and as each supplier is found, check to see if the supplier is already in the collection – if it isn't, then add the supplier to the collection. Once all of the potential suppliers have been looked

at, this temporary collection would have a collection of distinct potential suppliers of the component in it. A tender request could then be generated for each of these suppliers.

The pseudo code for this might look as follows:

```
Create an empty temporary supplier
collection
foreach ComponentType this Component
belongs to
  foreach Supplier of this
  ComponentType
    if this supplier is not in
    the temporary supplier collection
      add the supplier to the
      temporary supplier collection
    endif
  endforeach
endforeach
foreach supplier in the temporary
supplier collection
  generate PurchaseOrder
endforeach
```

This particular task aside, the trend of analysis and design tasks being perceived as more difficult appears likely for students completing the assignment in JADE.

While this trend of the analysis and design tasks being perceived to be more difficult appears to exist, it is only based on a small sample, with the measure being the number of times that students rated the task as being one of the three most difficult.

To test the significance of the differences, for this group of students, between the analysis and design tasks and the other tasks, which were more of a development nature, the Winks Statistical Analysis

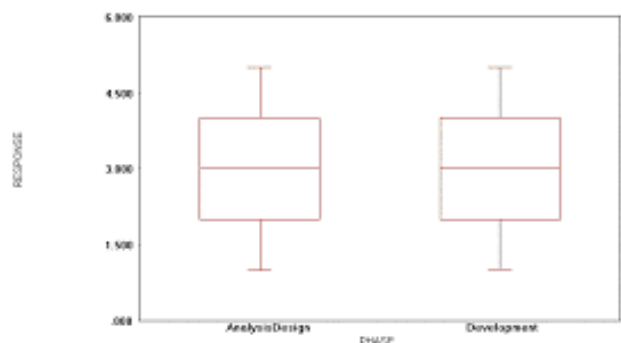


Figure 2 – Box and Whisker Plot – All Students

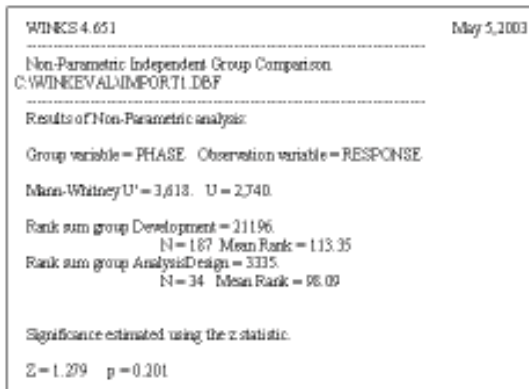


Figure 3 – Mann Whitney Test – All Students

Package was used to create a Box and Whisker Plot and to perform a Mann-Whitney Test.

The Box and Whisker Plot (shown in Figure 2) indicates that there is unlikely to be a difference between the tasks relating to analysis and design and the other tasks.

The Mann-Whitney Test (see Figure 3) shows a Z-statistic of 1.279, with $p = 0.201$ which indicates that the difference between the two groups of tasks is only significant at a 20.1% level, with this needing to be 5% or lower for the difference to be statistically significant (Zikmund, 2000). This suggests that there is not a significant difference between the two groups of tasks across all of the students.

5.2 Perceived Importance of Skills and Competencies

Of the 10 students working in PHP, 8 indicated that they perceived “ERD modeling” to be one of the three most important skills and competencies needed, with 7 of the 10 students indicating that “SQL” and 6 of the 10 indicating that “General Programming Knowledge and Expertise” were among the three most important skills and competencies needed.

When it came to the 7 students working in JADE, 6 rated “Object Oriented Data Modeling” as being one of the three most important skills needed, with 5 rating “General Programming Knowledge and Expertise” as being one of the three most important skills and competencies needed.

This suggests that for this group of students, the most important skills needed appear to be database related (data modeling and SQL) as well as general programming knowledge and skills.

The fact that data modeling skills figure highly in perceived importance by this group of students, as well as the design of the data model being one of the most difficult tasks involved, suggests that while the

modeling of data may be seen as being difficult, these students are aware of the importance of getting it right.

6. CONCLUSIONS

With the small sample size involved in the research it is not possible to make generalisations about how all students would perceive different aspects relating to building an application similar to the one built in this assignment.

Trends that emerged from the group of students surveyed included:

- ◆ That designing a data model is seen as being both a difficult task and an important skill to have by this group of students.
- ◆ That the most important skills needed appear to be database related.
- ◆ That the lack of an SQL-like object query language in JADE will make some tasks in JADE more difficult than they are in PHP.

7. FUTURE DIRECTIONS

Future directions that this research could be taken in include:

- ◆ Surveying future groups of students enrolled in these courses so that the sample size is increased, with the possibility of being able to make statistically sound generalisations.
- ◆ Surveying practitioners about their perceptions of difficult tasks and comparing the results with the perceptions of students enrolled in these courses.

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