Building a Taxonomy of Learning Outcomes from Module Descriptions for the Computer Science Degree

Interim Report

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Learning Outcomes are an important and necessary part of setting course material within educational programs. The report explains the background research into Learning Outcomes; what they are, their development, importance and how they relate to the Computer Science Degree. It then goes on to detail the progress made in the project and the different aspects that have been researched, developed and carried out to retrieve data for analysis next semester. The overall aim of the project is to provide recommendations for both the course syllabus and module descriptions in the Final Report.

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1. Introduction

The School of Computer Science & Informatics recently underwent a redesign of all its degree schemes, changing the content of what was being taught and how this was going to be taught to the students to better reflect their needs, keep up-to-date with the latest developments within the industry and to more appropriately follow the outcome-centred learning. As a result of this redesign 3 years ago, many new and improved modules have been introduced. However, while a lot of feedback has been gathered from running these modules, this is only on an individual basis i.e. each specific module; it does not relate to how all the modules in a year interact or how they build upon each other year on year. Certain issues such as were the overlap between modules lies and whether students are properly building upon their knowledge base year on year need to be better understood and clarified to ensure that learning is occurring in the way the school intended.

One of the key ways that lectures communicate the main aims and objectives of a module to their students is through Learning Outcomes. Learning Outcomes are statements describing what a student should know, understand and be able to do at the end of a module (Moon 2002, p. 42). The focus of this project is to examine both the overall programme Learning Outcomes and also the Learning Outcomes for each of the modules on the Computer Science degree scheme. A Taxonomy will then be built to formally structure the acquired knowledge and use as a framework to reason about LOs and their relationships in order to discover where potential dependencies and gaps lie. Along with this, research will be carried out into students' perception of the actual learning outcomes as they are delivered in teaching practice and how they match the pre-defined Learning Outcomes. Overall, such analysis will be used to provide recommendations for improvements of both the course syllabus (i.e. how the content is distributed across modules) and the module descriptions in order to better reflect the outcomes of the taught content.

2. The Development of Learning Outcomes

Bloom et al. (1971) discussed in detail the purpose of education as producing change within a student; that whatever course, program or unit of education that a student undertakes that the purpose of this is to bring about some significant change within them. In whole, education is meant to provide some new perspective, ideas or knowledge that can then be taken forward with the student to inform them in ways that they would not have had without this learning. Each interaction that occurs between a lecturer and a student is based on some implicit convention for both the lecturer and students about the possibility and desirability for change i.e. that they both wish for the change to occur (Bloom et al. 1971, p. 8).

However, if the role of education is to change the students then decisions have to made into what changes are possible and what are desirable (Bloom et al. 1971, p. 8). Goals have to be created to state these possible and desired changes. In creating these goals though, it does not ensure that implicit goals are in-line with explicit goals, nor does it state that explicit goals can actually be realised (Bloom et al. 1971, p. 8). Evaluation therefore needs to take place to help realise the goals that can occur and redefine the ones that cannot.

Bloom et al. (1971, p. 8-9) also stated that students had to be involved within this process of setting educational goals and objectives; they must both accept and understand these if learning is to occur as

wished. It is recognized however, that not all learners will want to take part in this process or that all will be able to grasp the long term goals that are set; it is desired though that these students at the very least accept the goals and objectives (Bloom 1971, p. 9).

Overall though, the main responsibility for setting these learning goals lies with the lecturer (Bloom et al. 1971, p. 9). It is through the lecturer setting these objectives that they can explicitly state the intended learning for the course at the beginning to the students; they can then also consciously base their chosen teaching material, teaching procedures and strategies around these (Bloom et al. 1971, p. 9).

The lecturer is not alone in setting the goals however; other material available such as syllabi, textbooks and governing bodies have always had a major effect on the objectives set (Bloom et al. 1971, p. 9). They must remember though, that they cannot just borrow word for word objectives, that these need to be adapted and applied to the current local environment in order to go above and beyond what these specifications set, and aim to advance what others have stated before them (Bloom et al. 1971, p. 9).

Another consideration when setting objectives is that one lecturer is very limited in the objectives they can set; only certain objectives can be realised in context with the subject matter, others move beyond these boundaries into other domains and areas (Bloom et al. 1971, p. 10). It is therefore possible that a number of courses can help to support and reinforce learning; by setting objectives that relate to each other over several courses can have a far more powerful effect cumulatively than each single one on its own (Bloom et al. 1971, p. 10).

The overall learning then, that takes place due to the cumulative effect of all the courses, needs to involve all the lecturers at one stage or another in order to effectively decide the changes that are expected to take place in the student due to cumulative learning over a number of years (Bloom et al. 1971, p. 10). As well as stating the expected cumulative change there needs to be an overall vision or view of the learning and these needs to be constructed in relation to some purpose (Bloom et al. 1971, p.10).

One of the main reasons students decide to study at university is to receive an advanced education; to learn new things and gain new skills. Below outlines the polices that the School of Computer Science & Informatics employ in relation to the above theory; the information provided in this was supplied from Prof Steve Hurley the Deputy Head of Teaching for the school (Appendix 1).

The School of Computer Science & Informatics provided module learning outcomes for each module that are set by the lead lecturer for each module. These are designed to indicate to students what they can except to gain from the module they are studying. There are no formal procedures or guidelines in place that help lecturers set these learning outcomes, however as the School is accredited by the “Chartered Institute for IT” (BCS) they provide a list of numerous learning outcomes that can be included within the modules were appropriate.

Once modules learning outcomes have been set, these get assessed against how they relate to any coursework and exams set and are also reviewed by fellow lecturers to check that they are being covered. As well as this they can be reviewed annually alongside the module descriptions depending on whether the lead lecturer decides to do this.

Overarching all of these, is the program learning outcomes for the Computer Science degree program there is again no formal procedure for setting these however the BCS provides learning outcomes for the degree programme that can be used.

While there are procedures in place for evaluating and reviewing these learning outcomes, there are still gaps that need to be addressed. Bloom et al. (1971) identified that the best way that learning outcomes could be set were ones that produced a cumulative effect across multiple modules and years; they also emphasized the importance of involving students within this process to ensure that they both understood and accepted the learning outcomes set.

This project aims to look at whether the current learning outcomes do adhere to this cumulative learning or whether there are gaps or in some cases unnecessary among them; as well as looking at the overall cumulative learning that takes place across the full 3 years.

The project will also look at the students opinions on the learning outcomes for modules and assess whether these match up with the set purposes of that module.

Learning outcomes are described using natural language, but when stated independently across modules text information cannot be easily processed by either human brain or a computer. In order to better grasp the picture of this complex domain, a structured framework is needed to represent this information in a format that can be queried and explored effectively and efficiently both manually and automatically. For this purpose, a taxonomy of learning will be constructed from the readily available text information and will be used to support reasoning about the learning outcomes and their relationships.

A more general taxonomy has been developed by Benjamin Bloom called “Blooms Taxonomy of Learning Objectives”. This is a taxonomy designed to provide a framework for educational bodies to aid communication and exchange of ideas and materials (Bloom et al. 1956, p. 4). It was decided that the framework would work best if it centred around the objectives set for educational purposes since these objectives represented the starting point for designing and developing curriculum (Bloom et al. 1956, p. 4). However, it does not include details about LOs in specific disciplines such as computer science. In other words, it provides predicates, but not their objects, i.e. it does not describe the actual subject matter taught. Our aim is to extend the general framework with the specific details of the subject area. For example: “Implement fundamental data structures and algorithms.” In this context “Implement” is the verb specified within Blooms Taxonomy and “data structures, algorithms” are the objects describing the content of the module.

“Blooms Taxonomy of Learning Objectives” falls into one of three areas they were developing to build a complete taxonomy; it falls into the cognitive domain. This includes all those objectives which deal with recall, recognition or knowledge and the development of intellectual abilities and skills (Bloom et al. 1956, p. 7).

The taxonomy could be used to aid development precision over definitions for learning as well as enable educational institutions to discover similarities and differences among their objectives, therefore allowing

them to more completely understand the various learning experience that were taking place on the different courses and the changes that were taking place in their students (Bloom et al. 1956, p.7).

Figure 1 below shows the full Taxonomy; the different stages that occur, definitions as to what each of these stages describes and how it relates to learning and then the key verbs that are typically associated with each of these stages when describing learning objectives.

This taxonomy will be used to analyse the learning outcomes set for each module and categorise them into one of the learning stages. Through this analysis can then take place against the criteria outlined above, alongside this student feedback with be collected and this will also be analysed along the developing taxonomy. It is the aim that at the end a complete picture can be discovered of the learning that is taking place on the Computer Science degree program and were further suggestions can then be made to improve this and the process of setting learning outcomes.

Definitions	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Bloom's Definition	Remember previously learned information.	Demonstrate an understanding of the facts.	Apply knowledge to actual situations.	Break down objects or ideas into simpler parts and find evidence to support generalizations.	Compile component ideas into a new whole or propose alternative solutions.	Make and defend judgments based on internal evidence or external criteria.
Verbs	• Arrange • Define • Describe • Duplicate • Identify • Label • List • Match • Memorize • Name • Order • Outline • Recognize • Relate • Recall • Repeat • Reproduce • Select • State	• Classify • Convert • Defend • Describe • Discuss • Distinguish • Estimate • Explain • Express • Extend • Generalized • Give example(s) • Identify • Indicate • Infer • Locate • Paraphrase • Predict • Recognize • Rewrite • Review • Select • Summarize • Translate	• Apply • Change • Choose • Compute • Demonstrate • Discover • Dramatize • Employ • Illustrate • Interpret • Manipulate • Modify • Operate • Practice • Predict • Prepare • Produce • Relate • Schedule • Show • Sketch • Solve • Use • Write	• Analyze • Appraise • Breakdown • Calculate • Categorize • Compare • Contrast • Criticize • Diagram • Differentiate • Discriminate • Distinguish • Examine • Experiment • Identify • Illustrate • Infer • Model • Outline • Point out • Question • Relate • Select • Separate • Subdivide • Test	• Arrange • Assemble • Categorize • Collect • Combine • Comply • Compose • Construct • Create • Design • Develop • Devise • Explain • Formulate • Generate • Plan • Prepare • Rearrange • Reconstruct • Relate • Reorganize • Revise • Rewrite • Set up • Summarize • Synthesize • Tell • Write	• Appraise • Argue • Assess • Attach • Choose • Compare • Conclude • Contrast • Defend • Describe • Discriminate • Estimate • Evaluate • Explain • Judge • Justify • Interpret • Relate • Predict • Rate • Select • Summarize • Support • Value

Figure 1: Blooms Taxonomy (King 2012)

The following sections will detail the tools and processes that have currently been carried out to start collecting the data i.e. the learning outcomes for each module set by the university and student feedback.

3. Database Construction – For Storing Learning Outcomes

The main tool for the project is the database. This is where all the data that has and will be collected is stored, queried, analysed and changed into a taxonomy; it is through the functionality of the database that in-depth analysis can take place to help form the end result. It is vital therefore that the type, platform and design of the database is carefully considered and the best fit is picked for storing and querying the data.

In this section details about the background research conducted into selecting the appropriate database will be discussed as well as the design process that occurred and then a look at the database as it currently stands.

3.1. Background Research

The Relational Database Management System (RDBMS) – which is based on the relational model, represents the second generation of DBMSs and has become the most widely used data-processing software in use today (Connolly and Begg 2010, p.91).This is the database system of choice for the project due to it being the most commonly used and distributed model.

Within the relational model data is logically structured into relations (tables) where each relational has a name associated with it and is made up of attributes (columns) of data; each row within the relation is called a tuple and contains only one value at most per attribute (Connolly and Begg 2010, p.91). The biggest strength of the relational model is its simple logical structure (Connolly and Begg 2010, p.91).

The main objectives of the relational model were to: allow for a high degree of data independence, provide an environment for dealing with data semantics, consistency and redundancy problems, and to also enable the development of set-oriented data manipulation languages (Connolly and Begg 2010, p.91).

The relational model uses SQL as the standard database language used to manipulate the database structure and data within it. It is the first and only standard database language which has been widely accepted and it is therefore integrated within many database products (Connolly and Begg 2010, p. 137). The language is also fairly easy to learn; it is a nonprocedural language, meaning you define what is being searched for but not how to get it, it is free-format and the language used is standard English words easy to understand (Connolly and Begg 2010, p. 135).

Figure 2 – Advantages and Disadvantages of RDBMS (Connolly and Begg 2010, p. 808)

Relational Database Management System	
Advantages	**Disadvantages**
Avoids Data Duplication	Semantic Overloading
Avoids Inconsistent Records	Limited Operations
Easy to manipulate data	Difficulty handling recursive queries
Easy to maintain security	Poor representation of “real-world” entities

After deciding on the model, the platform that will be used for the database also needs to be considered. There are two main options for this MySQL using phpmyadmin as the Graphical User Interface (GUI) or SQLite using SQLite Manger. These are the two options available due to being able to have access to them (MySQL through university license, SQLite due to being open source); oracles and PostgreSQL are not available due to licensing and admin, and while Microsoft Access is another option it is not portable between operating systems. The advantages and disadvantages of both are outlined on the next page in Figure 3.

While MySQL is the better known and more commonly used platform for the focus of this project SQLite using the SQLite Manager is perfectly suitable. The only major issue with this database is that SQLite does not support regular expressions i.e. for advanced text processing, however this will not be a problem for this project, simple querying should be all that needs to occur. Due to its ease of use and being suitable for small, temporary databases like the one being developed in this project this is the platform of choice; also previous experience of working with both of these platforms has helped inform the decision that this would be more suitable.

Figure 3 – Comparing MySQL and SQLite (Oracle 2012; SQLite 2012)

MySQL		**SQLite**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Good for both temporary and large scale databases	Difficult to set up	Easy to set	Lacks performance measurement features
Suitable for managing users and permissions	Not good for Ad-hoc file storage	Good for temporary databases	Not good for large scale databases
Good for rapid development		Suitable for using in embedded applications	Not readily scalable
Highly scalable		Great for rapid development	Not suitable were stored procedures are needed

3.2. Design

Once the database model and platform had been picked a design for the database needed to be constructed before creating it to ensure that all data requirements were met and that querying could take place efficiently and easily.

The first method used to communicate the nature and requirements of the data was an Entity Relationship Diagram (ER). The ER Diagram is a top-down approach to the design process that identifies the key entities and relationships between the data, as well as information that will be stored about the entities and relationships which is called attributes (Connolly and Begg 2010, p. 321).

The ER Diagram designed for the database is shown below in Figure 4 It highlights the key components as being the overall program, the modules within that then and then the learning outcomes that can

be associated with each of these. The learning outcomes are then linked to an entity called Blooms Taxonomy which represents the classification scheme that will be used (as outlined in Section 2) to help analyse the data and build the taxonomy.

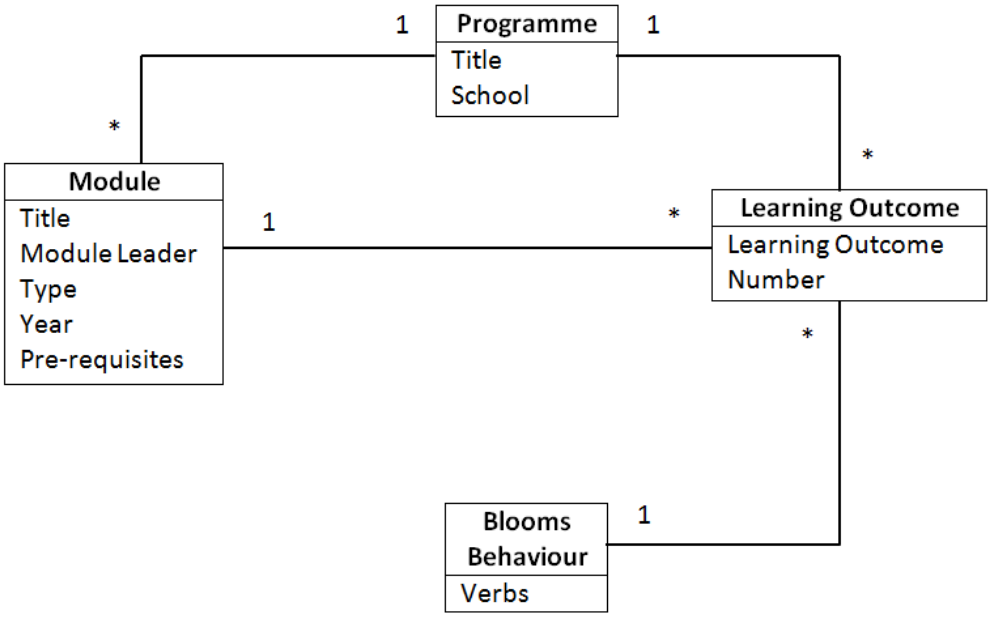


Figure 4 – ER Diagram for proposed Database

After the ER Diagram had then be designed and the general vision for the database thought about a normalisation process took place in which the relationships (functional dependencies) between the entities and their attributes are looked at and the tables that will be part of the database are developed (Connolly and Begg 2010, p. 365). The purpose of the normalisation process is to highlight suitable sets of relations that support the data requirements. That is that there is as small a number of attributes as possible to support the data requirements, that the attributes which have a "close logical relationship" are within the same relation and that there is minimal redundancy (Connolly and Begg 2010, p. 366).

The normalisation process itself follows several stages in order to reduce data redundancy and update anomalies. It goes from 1st normal form were the data is in a basic table format, to 2nd normal form were partial dependencies have been removed; then to 3rd normal form were all dependences expect for the ones associated with primary keys have been removed and then can continue on to Boyce-Codd, 4th and 5th normal forms (Connolly and Begg 2010, p. 379). However, for the purposes of this database the process need only be carried out to 3rd normal form. Figure 5 shows this normalisation process. This process went through several stages to reach the one shown below the other versions of the database normalisation can be seen in (Appendix 2 & 3).

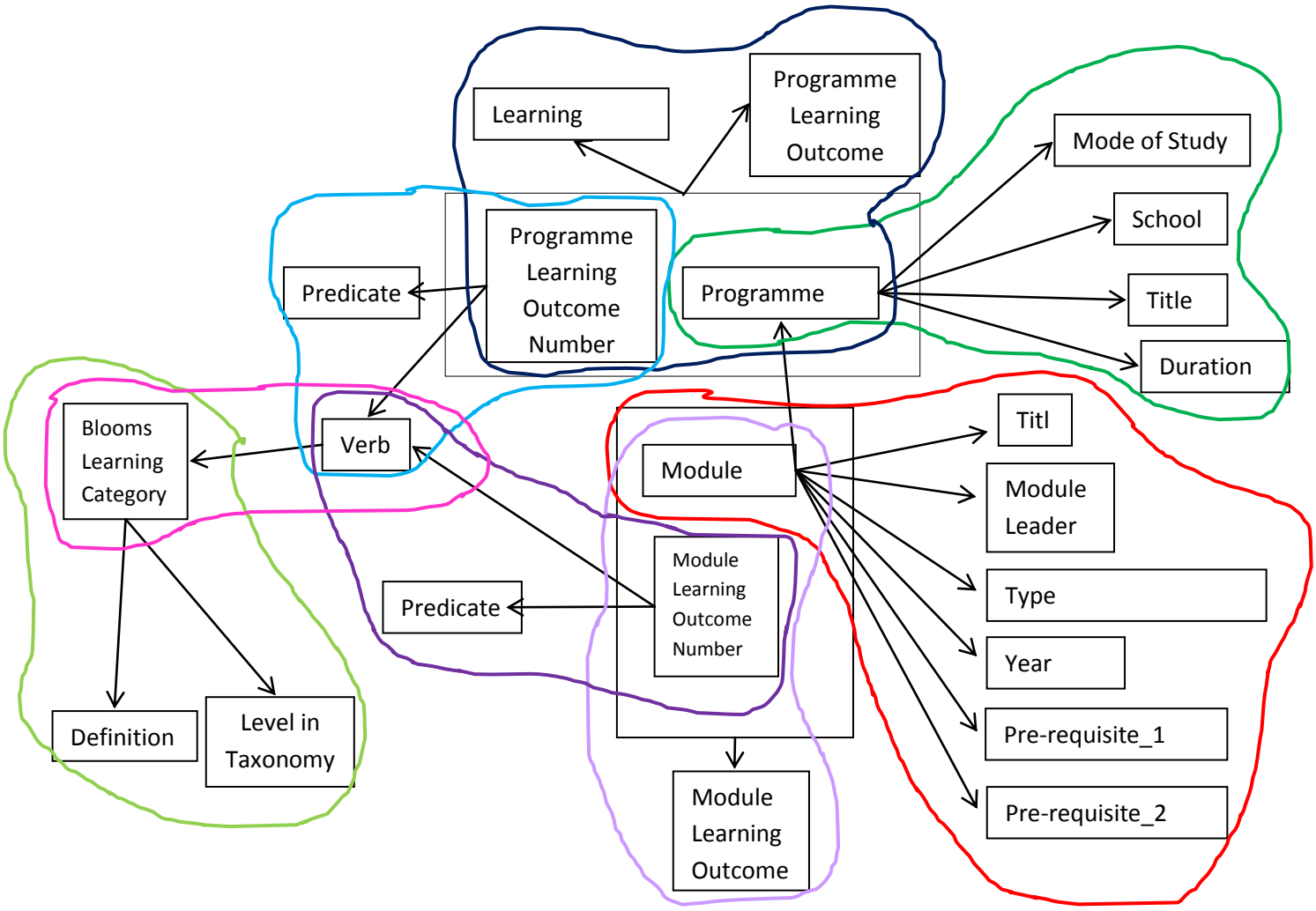


Table 1 {Module_Code, Programme_Code, Title, Module_Leader, Type, Year, Pre-requiste_1, Pre-requiste_2}
Table 2 {Programme_Code, Title, School, Duration, Mode_of_Study}
Table 3 {Programme_Code, Programme_Learning_Outcome_Number, Learning_Category, Programme_Learning_Outcome}
Table 4 {Programme_Learning_Outcome_Number, Predicate, Verb}
Table 5 {Module_Code, Module_Learning_Outcome_Number, Module_Learning_Outcome}
Table 6 {Module_Learning_Outcome_Number, Predicate, Verb}
Table 7 {Verb, Blooms_Learning_Category}
Table 8 {Blooms_Learning_Category, Definition, Level_in_Taxonomy}

Figure 5 – Normalisation of Proposed Database

Some assumptions were made when designing this and these have been stated below:

- A Module can only occur on one degree programme
    - While this is not the case for many modules within the School Of Computer Science, since my project is focusing on the Computer Science Degree programme for the instance of this database this assumption can stand
- A Module can only have 2 pre-requisite modules
    - Again this might not always be the case for all modules on all degree programmes; however in the case of the Computer Science degree programme no modules ever state more than 2 pre-requisite modules.
- All Learning Outcomes identified for a specific module are unique

- All Learning Outcomes identified for a specific programme are unique
- Module Learning Outcome Numbers and Programme Learning Outcome Numbers are unique
- The Pre-requisite columns will hold Module Code values.
    - These can then be used for querying to find out what previous modules learning outcomes where and compare these to the current modules ones.
- Predicate columns state what is being classified by Blooms Verbs.
- The Learning Category column states what the programme learning outcomes fall under from four categories of learning outlined by the school
    - Knowledge & Understanding, Intellectual Skills, Discipline Specific including practical skills, Transferable Skills
- The Verb table will list all the verbs that Blooms Taxonomy identified for learning and then each verb links to one of the 6 learning categories that Bloom identified in his Taxonomy.
- Blooms Learning Category table will give information relating to Blooms Taxonomy which can be used when querying to help bring clarification
- Type under the Module table refers to whether a module is compulsory or optional
    - This will be useful for looking at the different paths that can be taken dependant on a student's modules choices.

The database will contain several foreign keys to help with ensuring data integrity and assisted when querying the database.

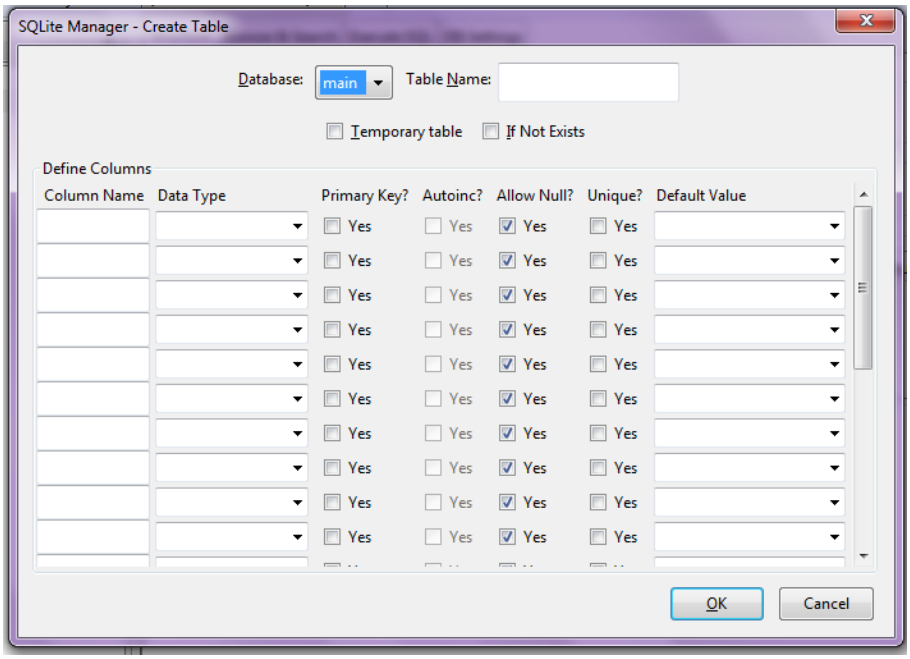
- **Modules Table** – Modules will contain the foreign key Program_Code referencing the program table
- **Module_Learning_Outcomes Table** – Module Learning Outcomes will contain the foreign key Module_code referencing the module table
- **Module_Analysis Table** – Module Analysis will contain the foreign key Module_Learning_Outcome_Number referencing the Module_Learning_Outcomes table
- **Program_Learning_Outcomes Table** – Program Learning Outcomes will contain the foreign key Program_Code referencing the program table
- **Program_Analysis Table** – Program Analysis will contain the foreign key Program_Learning_Outcome_Number referencing Program_Learning _outcomes table
- **Verbs_Taxonomy Table** - Verb Taxonomy will contain the foreign key Blooms_Learning_Category referencing Blooms_Taxonomy table

3.3. <u>The Developed Database in Current Use</u>

Once the database design had been successfully planned, the SQLite database could be set up through the Mozilla Extension – SQLite Manager.

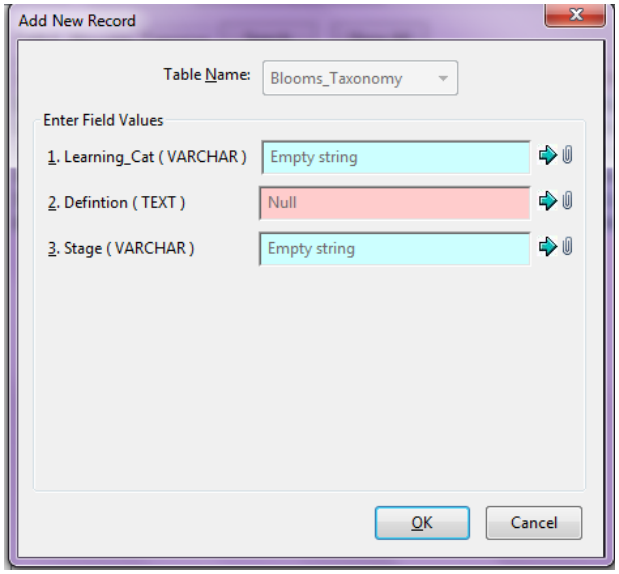
The tables were created using the graphical user interface (GUI) (Figure 6) which allowed easy set-up as it did not require sql code to be written. All you needed to do was enter in the attribute title, select a data type for it and then if the attribute was part of or the primary key the box was ticked. The interface also allowed you to state when a particular attribute for a relation could be null or unique.

Figure 6 – SQLite Manager GUI: Creating a Table



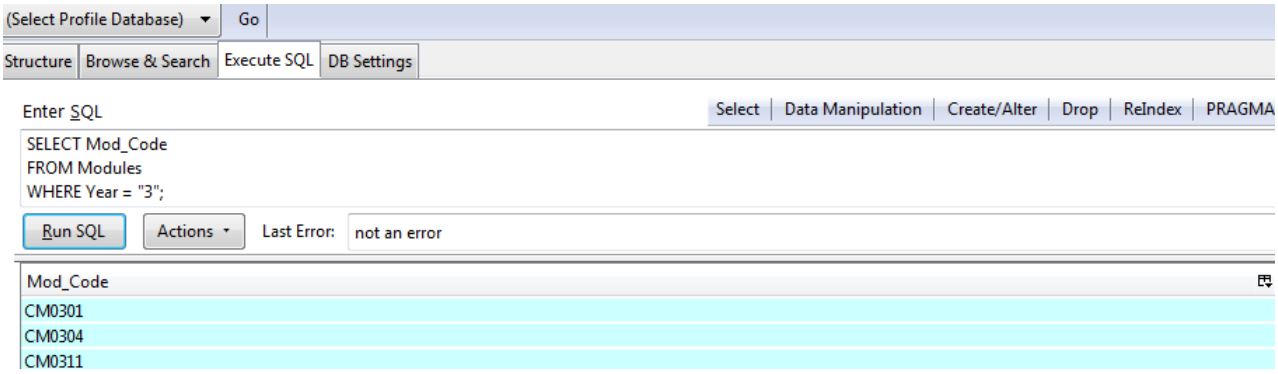
Once the tables had been created data could be entered into them again using the graphical interface (Figure 7). The GUI allowed the data for each attribute in the tuple to be entered and highlighted in different colours the ones that were null and not null.

Figure 7 - SQLite Manager GUI: Inserting Data



Once all the data had been entered into the database, querying using SQLite could begin to start analysing the data and building a taxonomy. Again the GUI provides a section where querying can take place and the results are displayed below (Figure 8).

Figure 8 – SQLite Manager GUI: Querying Datas



However, while it had initially stated in the initial plan that some form of a taxonomy would have been produced by now, due to time restrictions and workload this part of the project has not progressed as far as other aspects (Refer to Section 5 for more information). Therefore the analysis side of the project is a little behind however, as all of next semester is set out for just analysis I do not feel that this slip in time management will have a big impact on the overall results of the project.

Moving forward the main part of next semester as mentioned is the analysis of the data, therefore the database will be queried to help produced the taxonomy. As this taxonomy is constructed the database will evolve as new tables are created to reflect this taxonomy and foreign keys between these new tables and the old ones will be formed.

While the database will grow it is unlikely that the changes will have too dramatic effect on the structure and design as outlined in section 3.2; any changes that do occur will be recorded and reported upon in the final report.

4. Student Data Collection

Alongside analysing the data collected from the program and module learning outcomes it was decided that gathering and analysing students' opinions and feedback on these learning outcomes would also be both useful and insightful as they provide a different perspective on the data.

As previously mentioned in section 2, the purpose of the learning outcomes for each module and the programme is to inform students of what they can expect to be taught and learn on the module, it also provides a way of the university assessing whether the module is adhering to requirements as set out by The Chartered Institute for IT. However, these provide only one view of the modules and learning occurring on the course, the other side is the students; therefore to gather comments and opinions from students on what they think of the modules and whether this matches what has been defined in the learning outcomes can provide detailed and informative data.

This next section details the different ways in which data can be collected from students and then the strategies employed within these; it then goes in to detail about the two strategies chosen – focus groups and questionnaires. The design, limitations and future use of the data is discussed in detail in both of these providing a complete picture of the whole process.

4.1. Research Methodologies

Research can be carried in a number of different ways and can occur in many forms and situations, however the different methods and strategies can usually fall into either one of two categories - Quantitative and Qualitative.

Quantitative research consists of studies in which the data concerned can be analysed in terms of numbers; it is more directly based on its original plans and its results are more easily analysed and interpreted (Best and Khan 1989, p. 89 - 90). However, qualitative research can describe events, persons, concepts scientifically without the use of numerical data; it more open and responsive to its subject (Best and Khan 1989, p. 89 - 90). The strengths and weaknesses for both of the two methods are outlined below in Figures 9 and 10.

Figure 9 (Hughes 2006) – Strengths and Weaknesses of Quantitative Research

Quantitative	
Strengths	**Weaknesses**
Precision through reliable measurement	Cannot control all variables
Control through sampling and design	People do not respond in the same ways
Statistical techniques allow for sophisticated analysis	Quantification can become an end in itself
Replicable	Leads to the assumption that facts are true for all people all of the time
Can produce causality statements through the use of control experiments	Can produce trivial results due to the restrictions on controlling the variables

Figure 10 (Hughes 2006) – Strengths and Weaknesses of Qualitative Research

Qualitative	
Strengths	**Weaknesses**
Due to close involvement between researcher and participants, researcher gains an insider view	Problem of adequate validity and reliability
Descriptions can play an important part in suggesting relationships, causes, effects and dynamic processes	Takes a lot of time to conduct
Adds flesh and blood to social analysis	Issues of anonymity and confidentiality
	Viewpoints of researcher and participants have to highlighted due to issues of bias

While research can be carried out using just one of the methods they are not mutually exclusive and it is possible for a single research strategy to use both methods (Best and Khan 1989, p. 89 - 90). Both methods have strengths and weaknesses and while these can prove problematic no one method is better than the other, therefore an approach was chosen that incorporated an element of both methods with the hope that it would yield better results.

4.2. Data Collection Strategies

Both quantitative and qualitative methods can be carried out using a number of different strategies from interviews and observations to questionnaires and experiments each one with its one merits and flaws. However for the purpose of this research one strategy from each method was chosen to collected data. In order to gain the most from the data collected the two strategies had to complement each other so the data collected from each could be analysed alongside each other and comparisons made.

Questionnaires was an obvious choice for the quantitative research method as these are easy to create, distribute and could be designed so as not to take up too much of the students time.

The qualitative strategy therefore had to complement this; interviews and focus groups were the two options that would allow for this. Both of them could use and ask similar questions as in the questionnaire but gain more insight and detail from the responses; they would also both be easy to set using resources and facilities that the university provides. In the end focus groups were chosen, simply because they involve more than one person and so foster a better environment for communication than interviews which can be intimidating and uncomfortable for the students.

4.3. Focus Groups

Focus groups were one of the two methods chosen to gather data from students. This next section details the design, planning, organisation and limitations of the focus groups as well as a look forward as to what the data collected will be used for.

4.3.1. Design

The structure and design of the focus groups was one of the most important aspects; ensuring that the participants were fully informed of the process as well as asking questions that would produce relevant and useful information while being understandable was vitally important.

There are several steps that were carried out in the designing of the focus groups; choosing the participants and target audience, developing questions, structuring the session and picking recording methods (Krueger 2002).

In deciding upon the participants for the focus groups this was straightforward as the research is specifically targeted to the Computer Science degree program, therefore the target audience was students currently on the course.

Developing the questions and structuring the session was more complex, as the questions needed to be designed so that the comments and opinions were in-depth and detailed providing valuable information; however they also needed to be understandable to the student. Studies into developing questions suggested that ones such as opened ended, “think back”, focused or “all things considered” are better for getting more information out of participants; while dichotomous or why questions should be avoided (Krueger 2002). It is also

important that different styles of questions are asked to get participants to really think about the topic and to help them with answering them. Structuring these questions is also important, starting off with questions that introduce the topic and general idea, moving then into the key questions that are pivotal to the focus group and lastly moving into the summary questions (Krueger 2002).

Taking this all into consideration five questions were developed that could be used for any module studied. The first two were used to introduce the topic, using a mixture of open ended, rating and choice questions, the third and fourth were then the key questions asking participants to analyse material and provide feedback, and the last one was a summary question finishing the session off (Appendix 4).

The overall structure of the session was then developed based on the simple format of introduction, asking questions and conclusion. In the introduction a brief summary of who I was, what the research was for and the session was going to be conducted was explained, this then moved on to the actual questioning and then concluded with a roundup of what had occurred, what was now going to happen to the data that had been recorded and finishing off with thanking them for attending (Appendix 4).

As well as developing the questions and structuring the session, general material that would aid the focus groups needed to be considered too, as some of the questions that were developed involved concepts that participants might not be familiar with. A PowerPoint presentation was therefore developed that provided additional information that the participants could refer to when answering any questions (Appendix 5).

4.3.2. Data Protection

When designing the focus groups an important consideration was data protection and keeping any comments that were recorded from students confidential. Cardiff Universities guidelines (2010, p. 10) set out that any research that takes place must keep in line with any legal requirements and guidance produced by appropriate bodies which include both Cardiff University and the Data Protection Act 1998. Any data that has been gathered through research has to be kept strictly confidential and secure (Cardiff University 2010, p. 10).

As the data that was being collected from the focus groups was not personal information the Data Protection Act 1998 did not apply; however due to the nature of the information being collected (recorded personal comments from students on modules) a consent form was needed so that students were fully informed of the research, what it was being gathered for and how it would be used.

In producing this form, contact was made with both Dr John Evans (School Manager) and Prof Nick Avis (School's Ethics Representative) with regards to what needed to be included (Appendix 6 & 7) and from this the form for consent was produced (Appendix 8). This form was given to each student at the beginning of the session for them to read, ask any questions and then sign.

4.3.3. Planning and Organisation

The focus groups were reliant on being able to get students across all three years of the Computer Science degree to participate. Issues such as providing times that were convenient to students and incentivising them to actual take part were major factors in the success of them.

Initially an email was sent round to all years in week 5 detailing what the focus groups were for and asking them to get involved; it mentioned that free food would be provided (as an incentive) and that the session would be planned around when they were free (Appendix 9). This did not prove to be very successful however, only getting 2 responses.

After this lack of response a different approach was adopted. Emails were sent out again but also posts were left in Facebook groups and shouts outs were made in lectures for all 3 years. The email and Facebook posts also focussed more on the incentives available to students (i.e. free food and also freebies) and that they were flexible around their timetable; rather than providing in-depth details on the point and objectives of the focus groups (Appendix 10 & 11). This method proved more effective with a total of 21 students across the 3 years agreeing to participate.

The modules that were being discussed then had to be ones that Computer Science students either had studied or were currently studying. All of 1st and 2nd years modules could be discussed as any that took place within the 2nd semester could be talked over by the year above; for the 3rd year modules that are studied in spring semester this was not possible. Altogether then there were 24 modules.

Originally the idea was to pick 2-3 modules from each year and get extensive feedback on each of these and then try to apply any common themes across all the other modules. However, on revision of this method it was decided to try and get feedback from a few students on all the modules; this was due to realising that each module has different learning outcomes set and is unique in what it wants the students to learn and achieve therefore trying to applying feedback from module to another would not work.

The 24 modules were therefore split across each focus group, with each set of students talking about two modules; these could be two modules they were currently studying, two modules they had previously studied or half and half.

Finally, the only other aspect to organise for the focus groups was where they would be held, how long each session would last and placing students into groups.

The most convenient and accessible place to hold the focus groups was in the library study rooms; they are private closed off areas were the sessions could occur without any interruption, students know about these so can easily find them without having to travel too far, they provide a circular table which meant everyone could sit round and see each other aiding communication and lastly they provided a TV screen which could be used to run the

PowerPoint presentation off. Booking of these rooms was allowed for 2 hours each day which was restrictive but workable.

The focus groups needed to be long enough that relevant information and data was gathered but not too long that students did not have the time to give or got bored half way through. It was decided that as there were only 5 questions being asked that around 20-25 minutes would be plenty of time for students to talk in detail around these; add in 10 minutes at the beginning to introduce the focus groups and get students to sign the consent form and then 5 more at the end to round everything up, it seemed appropriate that each focus group would last no longer than an hour.

Lastly, students were spilt into groups based on the availability that they provided, which year they were in and what modules they studied. The majority of the groups contained 2-3 people within in them, though one or two had to be conducted with only 1 student in them due to availability restrictions.

4.3.4. Limitations

The main objective with collecting data from students was the hope that it would provide insight into how the university learning outcomes were viewed by students and whether what the university set was actually taking place (in the students eyes). In setting up the focus groups therefore, the aim here was to gain additional insight through in-depth comments and discussions that cannot be gained through questionnaire or surveys. However, as with any data collection method quantity in the responses is needed in order to gain real insight and to be able to draw accurate and reliable conclusions.

The number of students who volunteered for the focus groups was rather small; only 21 students across 3 years each of which contain 70-90 Computer Science students is not representative. While the lack of students' participating means that comments and observations made cannot be representative of the majority of students opinions these can still prove useful as the medium provides much more insight and detailed comments than would usually be given; analysis of these will prove whether they are useful.

In conducting the focus groups it also helped with the design of the questionnaire questions as, these could then be set around what did and did not work within the focus groups and which questions provided the most insight. It is also hoped that the questionnaires will provided a higher response rate and improve the data set collected from students.

The only other concern with the focus groups then is that data analysis may prove to be time consuming and difficult to conduct. Originally it was planned that the transcripts would be analysed, data extracted from these and then placed in a database. The use of scripts and programming tools could aid in this, however that may prove to be too advanced a task for me to successful carry out while also being time consuming. Another way is to manually analyse the transcripts and extract out data; again however this will take a lot of time. Further research

needs to be carried out into how these transcripts can be successfully analysed in as quick and efficient way therefore.

4.3.5. Future Use of Data

Looking forward then, as mentioned the purpose of the focus groups is to collect in-depth comments and opinions from students to provide a different perspective and view of the learning outcomes that are set for modules on the Computer Science degree programme.

The focus groups were conducted in week 8 and the recordings for each one then transcribed making each participant anonymous. Next semester these transcripts along with data collected from the questionnaires will be analysed and used alongside the data being analysed from the modules learning outcomes database to help shape and form the final taxonomy that will be produced. The taxonomy will then be used to provide suggestions and recommendations as to where module learning outcomes have been successful and useful and were perhaps there are gaps or overlaps between modules. It is expected that the data provided from students will prove to be informative and useful within this process.

4.4. Questionnaire

The second of the two data collection methods chosen was questionnaires. This sections details the chosen means of distributing the questionnaires, the design, limitations and future work still to do.

4.4.1. Background

The first factor to consider when choosing to send out questionnaires was whether these would be conducted as face-face conversations were students would be sought out and their responses recorded on the spot; or whether to send out a web-based questionnaire that could be filled in by the students. The advantages and disadvantages of both methods are outlined on the next page in Figure 11. In considering both options it was decided that the questionnaire would be distributed as a Web Survey due to the potential faster response rate and as it would be less time consuming.

The next decision to make was which distributor to use to create and send out the questionnaires. Google Form and SurveyMonkey are the most familiar providers for this service; both of these provided a medium in which the questionnaire could be uniquely and purposefully designed and easily distributed through social media sites and email.

SurveyMonkey is a provider which allows you to sign up for a free account and easily create questions using either templates or from scratch; it also provides analytical tools to analyse the data collected (SurveyMonkey 2012). However, the free account limits the number of questions you can ask, as well as saves certain features such as logical movement within questionnaires based on respondents answer for the premium account (SurveyMonkey 2012). The analytical tools would not be needed either, as the data collected will be transferred and stored in a database for analysis.

Figure 11 (Phellas 2011, p. 182 - 190) – Comparing Face-to-Face Surveys and Web Surveys

Face – Face		Web Surveys	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Can ask complex questions as they can be easily explained	Interviewers can introduce bias	Fast	People can quit half way through
Participants are less likely to give up half way through	More time consuming as have to seek out participants and fill it in for them	Can use formatting options to emphasis content and questions	No control over who replies and how often they reply
Visual aids can be used	Participants might feel uncomfortable answering questions	Participants give more honest opinions	
More scope to ask open questions	Would need to know target audience to be able to pick them out	Less time consuming as you don't have to fill it out with them	
		More convenient for students as they are on the internet anyway	

Google Forms is part of the Google Drive package that allows you to create a survey (form) which is automatically connected to a spreadsheet with the same name. When the surveys are sent out the data that is entered into these is saved to the spreadsheet (Google 2012). The spreadsheet can then be downloaded in excel form which can later be used to upload to the database which saves on inputting time. The other advantage of Google Forms is that there is no limit on the questions that can be asked, it provides logical features and the questionnaire can be uniquely created and styled.

Comparing both the two distribution providers Google Form was decided on as being the best option due to the greater flexibility when creating the form and being able to save the data to spreadsheet that can be then used to upload the data straight to the database saving time.

The last point to consider before designing the questionnaires is data protection and complying as with the focus group to legal requirements and guidance set out by both the university and data protection act 1998.

Again however, no personal data will be collected when filling in the questionnaire and all response will be completely anonymous so that nothing can be traced back to the participant; therefore the data protection act and university guidelines are being followed and no further action needs to be taken.

4.4.2. Design

Originally the two methods were going to be run side by side with the questionnaires sent out at the same time the focus groups were being held. However, on further consideration it was decided that the questionnaires would be sent out after the focus groups as the focus groups could be used to help inform the questions and structure of the questionnaire (Morgan 1997).

In conducting the focus groups two key things were gained; one that students responded better to the questions when they had completed the module and were looking back retrospectively, and two certain key questions were highlighted as being useful and informative for gaining information.

Both of these points were taken into consideration when beginning to design the questionnaire; therefore the questionnaire will be sent out at the beginning of next semester as all first semester modules will be completed, they will also have a filter question at the beginning asking them to select which year they are in. This question will then filter the modules that they are able to provide feedback on, to only ones that they have completed fully (Appendix 12: Figure a & b). Also the questions that are to be included within the questionnaire are based around ones that had a good response reaction when asked in the focus groups.

The main design point when creating the questions for the questionnaire is that the overall data collected needs to be measurable and analysed in a quantitative manner. Unlike the focus groups, the questionnaire is meant to provide a way of generalising the results and picking out key trends quickly and easily; therefore the majority of questions created will be ones were the student simply has to rate them or tick boxes, rather than provide long complex answers that have to be semantically analysed (Appendix 12: Figure c & d).

The next important factor considered when creating the questionnaires is the wording within them; they need to be simple and concise so that participants can quickly and easily read and understand them. This has proven to be challenging as a lot of the questions centre around the learning outcomes produced by the university; these can be long and verbose at times and cannot be reworded or edited as they need to remain in their original form (Appendix X: Figure d). Moving forward this is a problem that is being worked on by looking at ways within Google Form were colour and emphasis can be added to certain words or phrases to make them stand out as well as wording questions and choices in different ways were possible.

As well as creating easy to read questions, the number of questions asked and how long the questionnaire would take to complete needed to be considered too. The most important principle when creating a questionnaire is to keep it short; participants will not want to spend a long time answering questions with no incentive (Phellas 2011, p. 192). In order to ensure there will not be a high dropout rate of students half way through filling in the questionnaire it was decided that it should take no longer than 10 minutes for them to complete; this way helping to improve over all response rates. Questionnaires were tested to check how long they took by getting fellow colleagues to take them and give feedback.

Overall, the design of the questionnaire is progressing steadily. A first version of the questionnaire has been developed (Appendix 13) and fellow colleagues have tried this out and reviewed it, providing comments and feedback on what they liked and disliked. Work will continue on the questionnaire design over the next few weeks ready for it to be sent out in beginning of next semester.

4.4.3. Limitations

The biggest problem to contend with is the response rate for the questionnaire; typically response rates for online surveys vary from as low as 20% to 47% (Nulty 2008). This is low and given the response rate from the focus groups it is important that as many responses are got from students as possible.

In order to combat this low average therefore, emphasizing how quickly it can take to fill in and regular emails and posts in social media will need to occur. Also utilising contacts within the years and asking them to fill it in and get friends to will need to be employed too.

The number of responses will need to reviewed on a regular basis to keep an eye on the numbers and if they appear low further action will need to be taken either through adding incentives or doing shout outs in lectures and labs to generate enough interest and increase the response rate.

4.4.4. Future Work

Moving forward then, over the next few weeks the questionnaire will be revised and refined through testing by colleagues i.e. on Understandability and completion time etc., ready to be sent out first week of the second semester. From that point on copies of the link will be emailed out to students, posted in social media sites and connections will be targeted for filling in the questionnaire. One problem will be quality control, and identifying random or malicious responses; further research will have to be conducted into how this can be controlled.

After this all the data stored in the Google spreadsheet will be downloaded in an excel spreadsheet, edited to make it compatible with SQLite and then uploaded into a database. It will then be analysed along with the focus group data with the intention that it can help shape the taxonomy being built and provide feedback and suggestions in the final report.

5. Project Management

The main aims of the project for the autumn semester where to:

- Build and populate with data the database for analysing the module outcomes
- Start to Analysis these learning outcomes
- Gather data from students through focus groups and a questionnaire

For the most part these objectives have been successfully completed. The database as was outlined in Section 3 was researched, designed and then implemented. The design for the database changed as the

project progressed and certain aspects of the database will continue to evolve throughout the project as the taxonomy beings to take shape and change. This is expected though and any alternations will be minor so the overall structure of the database will not be affected to a huge extent.

Analysis has started to take place on the data stored within the database; however this has not progressed as much as originally outlined in the interim report. This is mainly due to time management issues; other modules' coursework commitments took up more time than expected and the database took longer to set-up and populate with data. However, while this aspect of the project is behind, the next semester is solely dedicated to analysing the data therefore this delay should not affect the overall outcome of the project.

The focus groups as outline in section 4.3 were carried out successfully. All the data from this has now been collected and analysis of it will take place next semester. It was originally planned that the focus group data would be stored in a database, however due to the nature and complexity of the data that was collected this may not be the best process. Research will therefore be carried out over the next few weeks into the best way possible to analyse this data.

The questionnaire has been designed (as outline in section 4.4) and is ready to send out to students. This is also behind schedule as it was originally planned to be sent out in week 9 and it is again due to time management issues and not been able to design the questionnaire till later on. However, while this is behind schedule it does not affect the project too much, as time was outlined in the plan for sending it out again at the beginning of next semester.

In terms of the quality of the data that will be received then, this is a better time to send it out as students will have completed the modules. It was found in the focus groups that better feedback was received when students had completed a module than when they were currently studying it. Also, to send them out at the beginning of next semester when students won't have as many time commitments will hopefully improve the response rate.

Google Drive and documents was employed for ensuring that my supervisor was kept informed of all progression throughout the project. An initial document was created where a weekly update of what had been completed as well as outlining the next weeks plan (Appendix 13: Figure a).

Along with the weekly plan a folder was set up in the drive and shared with my supervisor (Appendix 13: Figures b & C). This was used to upload all documents that were relevant to the project. It allowed my supervisor to review these, check that progress was occurring and to then edit and add any comments to each section as it was being uploaded. It proved to be a very efficient tool that aided communication and meant that feedback could be received almost instantly for each bit of the work as it was completed and uploaded.

Due to the use of Google drive, this meant that weekly meetings were not needed as feedback was being constantly given through the use of comments on the weekly plan and within specific documents. However, a specific slot was set aside each week on Wednesdays for Final Year Project students to meet with our supervisor. This meant that if more of a discussion was needed in relation to a particular aspect of the project there was a time set aside to go and address this.

Overall progression with the project has been steady and everything is more or less on track. Next semester will be focussing specifically on analysing the data and producing the taxonomy of learning

outcomes. The most important aspect to focus on with this is time management; due to slight time mismanagement this semester, in order to stay on track and cover everything that's needed, better planning and more time will need to be dedicated to ensure everything stays on track.

6. Conclusion

Overall, the purpose of the project is clear and defined at this point and progress is continuing steadily. There have been a few time management issues however, as discussed; these can be easily managed next semester.

Moving forward, the focus of next semester will be on the analysis of all the data and development of the taxonomy and visual representations. The Final Report will then contain suggestions and recommendations for improvement of the course syllabus and module descriptions.

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