Technology based capstone projects are becoming one of the commonly used teaching techniques being offered in higher education today. Capstone projects have evolved to provide students with a unique opportunity to work with actual clients and to develop real world solutions to client’s real world business problems.

When involved in a capstone project, students are grouped into teams and collaboratively apply real world and theoretical knowledge to solve problems. They are given a chance to defend their solutions and to reach a consensus on project decisions as a team. Many universities use capstone projects as a reflection of real work environments where solving complex problems cannot be achieved individually but as a team of talented individuals who can brainstorm possible solutions and achieve project milestones. Conducting real-world projects in a university setting does have its advantages for students and instructors since the opportunity exposes the classroom and the university to current IT business needs. Some additional benefits are listed below.

### Table 1: Benefits

- Projects provide students with actual hands-on work needed by a client.
- Shows students how to work with diverse group members.
- Finished projects will give students a sense of accomplishment.
- Projects may be continued from prior semesters as does happen in the real world with long term projects often having group members leave and new group members join.
- Develop technical and soft skills needed to work as group.

One difficulty with the approach to solving the business problems of real-world clients is that real-world problems frequently require more than one semester to solve. Due to this issue, some
universities have offered a capstone project as a two-semester course or have offered the course outside of the normal academic year.

At the School of Computing and Mathematics at the University of Western Sydney, they have identified several factors which contribute to the success of capstone projects. These factors are categorized as:

- Characteristics of the information system to be developed and the client perception,
- Individual student and group characteristics,
- Development methodology used,
- Support and supervision provided. [1]

There are several other characteristics of Information System capstone projects which are taken into consideration when relating to the project management issues that arise from the undertaking of such projects. Project management characteristics are categorized as:

- Complexity of the system to be developed,
- Required technology and technology available to students,
• Whether a new system is being built or an enhancement of an existing system is created. [1]

It is imperative that the selected projects are not too complex for students to comprehend or far less complex that students feel like the project is a regular assignment. While project characteristics are important factors, the characteristics of student groups cannot be overlooked. Student characteristics that should be considered are as follows:

• Mean group grade point average,
• Number of group members,
• Time devoted to the project. [1]

Researchers have previously used student grades as one method of measuring the success of a project. [1] A more straightforward approach to measuring project success is based on the final deliverables which reflects the expectations of the professional IT workplace. Grading breakdowns take the following into consideration:

• Successful implementation of the Information Systems as per client’s requirements and expectations,
• All required functions are developed,
• All implementation is in accordance with specification,
• The developed system is ready to be put into production.

Group formations can be done using several possibilities. Some professors may group students by similar grade point averages so these students are of all the same level or similar skill set. Others may use a personality, alphabetical, random or shared interest profile in a project to form groups [2]. At the UCOSP and Monash University in Australia, project group formations are done by the students themselves [3] [4]. Groups also have been chosen by professors based on discipline, specialty, and academic achievement [5]. At the Michigan Technological University different group formation
schemes have been used by faculty members to form engineering design groups. The faculty states that each of these methods has their own advantages and disadvantages however most are fatally flawed because they do not consider the strengths and weakness of the individuals involved. The identified schemes are:

- Let students choose their own groups
- Select students alphabetically
- Select students by institution’s student number code
- Select group members based on previous performance
- Select groups based on a heterogeneous mixture, i.e., sex, age, nationality, specialization
- Select the group leaders and let them pick one additional member in turn
- Select group members based on sitting or standing position
- Select group members based on astrological star sign or month of birth
- Select group members based on their Personality Type and/or Learning Style
- Issue coded labels to students who then form groups based on the codes. [6]

Table 2: Grouping Schemes

According to the Michigan Technological University, the first three schemes are used most frequently. When students are allowed to choose their own groups, they commonly pick their friends or others who think like them. [6] Heterogeneous mixtures of students are believed to perform well due to the students blending of expertise, experience and perspectives although in some instance, even well-balanced groups fail to perform to standards. [6]

It is usually a challenging task for instructors to assemble students into groups for appropriate projects. This task should be divided into two segments. In the first segment, the instructor must possess the understanding and requirements required of the project. The second segment begins with classifying the required skills for the project and identifying the students who match the skill requirement. [1] After the mapping of students to the required project skills, the project groups can be assembled. At the School of Computing and Mathematics at the University of Western Sydney, the high complexity level projects are assigned to high GPA students and low complexity projects are assigned to low GPA students. There
is an adjustment made by mixing some high GPA students with low GPA students to ensure the overall student learning experience and level of achievement is met at the end of the project. [1]

From a study of 153 University of Western Sydney students there was a very strong positive correlation between the student’s GPA and the project achievement level. This indicates that students with higher GPAs are more likely awarded with higher achievement in project outcomes. [1] There was also a strong correlation between complexity levels of the projects and the student’s final grades. It was shown that a project’s complexity level is a key driver to the final project achievement level and results in the student’s final grade. [1] At the Polytechnique Montreal, the overall grading is 20% individual and 80% group thus suggesting group oriented capstone projects significantly favor team work[6]. Students overall feeling of accomplishment is based on the performance of the team which directly resembles professional teams in the real world. Finally, correlations between a student’s GPA and final grades shows a significant decline which implies that students with higher GPAs do not necessarily receive a higher grade then students with lower GPAs when projects are of the same complexity. [1] University of Western Sydney’s observations have shown that some students with lower GPAs who were working on less complex projects have in fact performed better and completed the specified development with required standards. [1] In the end it is important to insure that the projects assigned are feasible and that they can be completed within the specified allotted time.

At the University of North Carolina Wilmington, the professors measure the success of individual capstone projects by the client’s level of use of the system. Approximately 60% of the final projects have been implemented for use by the end clients. [7] The other 40% of projects do not meet the standards of production quality and these projects are kept in the project pool for future reassignment or re-designed in future semesters.

Clients and customers have to understand that they need to adjust their approach to the working relationship with students due to the fact that a student needs coaching and close supervision. It is not a commercial business experience but a learning experience for the student. According to the University of
North Carolina Wilmington, most clients have stated that student capstone project results have saved them time in their operations and that they would welcome another student or student group. [7]

The use of project to solve real world business issues brings together the theoretical knowledge students gain from textbooks and provides them with an opportunity to demonstrate and apply that knowledge in a real world setting. In addition to their technical skills, students also gain soft skills such as communication and project management which are necessary for success in the professional workplace. It allows students to make the transition from students to IT professionals. Employers look for these qualities in future applicants and those who have capstone experience and completed a real world project can enjoy that advantage in the job market.
REFERENCES

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