Assisting the International University of Rabat in Attaining ABET Accreditation

An Interactive Qualifying Project
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Abstract

The International University of Rabat (UIR) is seeking ABET accreditation, an international standard for universities, to be more globally competitive. We assisted the Director of Information and Digital Sciences at UIR in preparing the Computer Science program for the application process. We used surveys and interviews to gain an outlook from students, faculty, and alumni; curriculum mapping to assess course outcomes; and consistency tables to assess the alignment between course and lab content. We found that many courses lacked structure in their course descriptions and syllabi, making it difficult to evaluate the quality of the program. We recommend providing more structural tools for faculty to assess their courses and educating the UIR community about the value of ABET accreditation.

Figure 1: UIR Campus (Université Internationale de Rabat [UIR], n.d.)

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Executive Summary

Universities around the world aim to prepare their students for more competitive opportunities in the global workforce. One way to do this is by improving recognition of academic programs at universities. To help improve global recognition of university science, technology, engineering, and mathematics (STEM) programs, faculty and administration from universities may seek out ABET accreditation. ABET accreditation is a set of standards that programs have to meet in order to achieve a certain level of quality assurance. ABET pushes universities to improve STEM programs through criteria revolving around students, program educational objectives, student outcomes, curricula, faculty, facilities, institutional support, and continuous improvement of the program as a whole.

The specific problem our team addressed in this project was UIR's preparation for the accreditation process. Our sponsor, Professor Mohammed Boulmalf, is the Director of Information and Digital Sciences at the International University of Rabat (UIR). In 2011, Professor Boulmalf assisted Al Akhawayn University (AUI) in obtaining ABET accreditation for the Computer Science program. Now, he has been helping UIR obtain ABET accreditation for four of the university's programs. Currently, AUI is the only university in Morocco that has obtained ABET accreditation for a program, which is why Professor Boulmalf is qualified to help UIRs' programs obtain accreditation. UIR is located in Rabat, the political capital of Morocco, and was founded in 2010 (Université Internationale de Rabat [UIR], n.d.). The reason that UIR wants to obtain accreditation is to improve their programs while providing students with the opportunity to be more competitive in the global workforce, even if they choose to work locally. UIR also wants to obtain accreditation to improve the stature and reputation of its faculty and the university. The goal of our project was to assist Professor Boulmalf and UIR in obtaining ABET accreditation for the Computer Science program. To help achieve this goal, we established three objectives.

Objective 1

Our first objective was to analyze the program curriculum from the perspectives of students, faculty, and alumni in order to understand the relationship between postgraduate

experiences and student outcomes. In this context, postgraduate experiences are based on the skills students gain during their graduate or undergraduate studies which may impact their encounters in the workforce. The methods we used to complete this objective included conducting surveys with students, faculty, and alumni from UIR. With these surveys, we assessed the alignment of the program with the student outcomes set by ABET and the program educational objectives set by UIR. We also conducted interviews with students from UIR. With these interviews, we assessed the alignment of the program with the ABET criteria. To analyze the data collected through the surveys, we utilized statistical analysis techniques. To analyze the data collected through interviews, we utilized various types of inductive coding.

Objective 2

For our second objective, we utilized Bloom's Taxonomy to map the alignment of course and student outcomes. The methods we used to complete this objective included the organization, formation, and assessment of course outcome maps for each course in the Computer Science program. Using these maps, we compared the course outcomes created by professors and student outcomes set by ABET. We analyzed if and to what extent the course outcomes aligned to the student outcomes using Bloom's Taxonomy and the IRE system. The IRE system is a framework formed from Bloom's Taxonomy in which "I" stands for introduce the student outcome, "R" stands for reinforce the student outcome, and "E" stands for emphasize the student outcome (University of Rhode Island [URI], n.d.). Professors that are teaching introductory courses should use active verbs that reflect the cognitive level "I" such as "understand" or "identify". On the other hand, professors that are teaching a higher-level course that requires a student to apply their knowledge need to use active verbs that reflect the cognitive level "E". This includes verbs such as "design" or "appraise". For each course analyzed, we created abbreviated course outcome maps showing if and to what extent the overall course addressed each student outcome. UIR can address where the program's curriculum may have gaps through this master sheet.

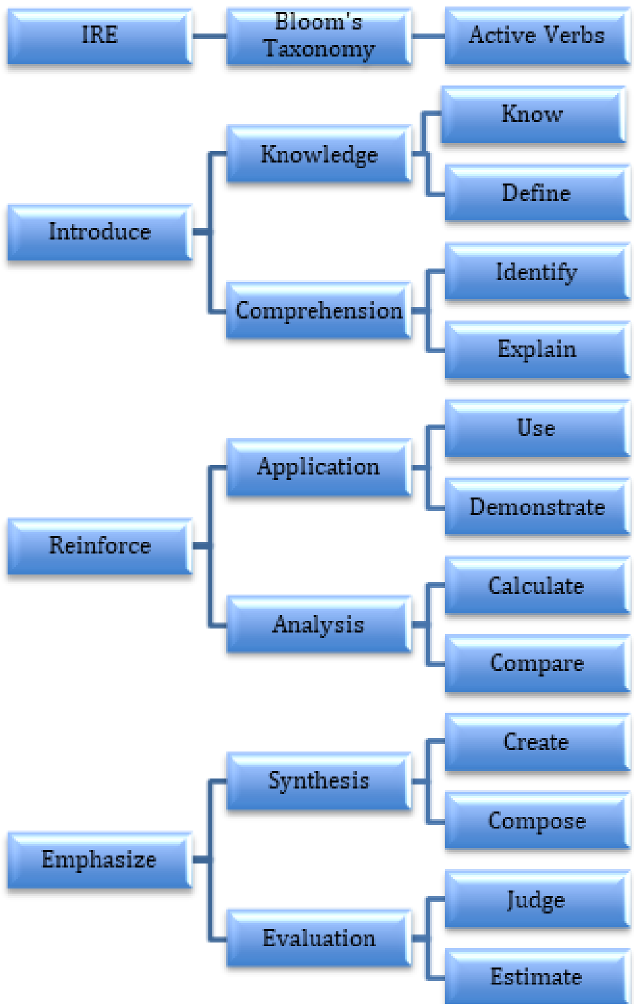

Figure 2: The relationship between IRE, Bloom's Taxonomy, and Active Verbs

Objective 3

Our third objective was to assess the alignment of lecture and laboratory course content. To do so, we created consistency tables, which allowed us to compare the lecture and lab descriptions side by side. We also included a column where teachers list tools they use in their lectures or labs. Our team was able to identify overlapping or missing content between the two parts of a course. Additionally, we noted if professors mentioned any tools in either description.

Findings

Objective 1

For Objective 1, our primary findings included the following:

1. Overall, students, alumni, and faculty are content with the alignment between ABET criteria and the Computer Science program.
2. Students felt that they may not be provided with adequate opportunities to get hands-on technical experience related to industry practices.

Objective 2

For Objective 2, our primary findings included the following:

1. Student outcomes related to teamwork, communication, and ethics were under-addressed.
2. Faculty do not seem to have a uniform use of active verbs that are related to the IRE system.
3. The number of course outcomes between each course varied from 2-10. In order to communicate the goals of a course effectively, each course should only have between four and five course outcomes. This number is based on a recommendation from our sponsor who believes this number of course outcomes will be most beneficial for students to understand what they will gain from each course.

Objective 3

For Objective 3, our primary findings included the following:

1. Faculty do not seem to be following a standardized outline for the course and laboratory descriptions in syllabi.
2. In multiple syllabi, professors did not include course lab descriptions and tools from their syllabi.

Conclusions and Recommendations

Objective 1

From these findings, our team concluded that some students believe that the courses in the Computer Science program lack opportunities to gain adequate technical experience.

Technical opportunities that relate to real-world problems help to offer experience in practical and industrial applications.

Figure 3: Laboratory at UIR (Université Internationale de Rabat [UIR], n.d.)

This experience assists students when they join the global workforce. Based on these conclusions, we have come up with multiple recommendations for our sponsor to consider.

Recommendation 1: We recommend that the Computer Science program provide more opportunities for students like group projects that involve real-world problems. These experiences would allow students to practice skills they may use in the workforce.

Recommendation 2: We recommend that the Computer Science program seek advice from members of industry to structure lab activities.

Objective 2

From these findings, our team concluded that if professors give students adequate opportunities to practice communication, teamwork, and ethics in the classroom, they should communicate these skills more in their course outcomes.

Figure 4: Students at UIR (Université Internationale de Rabat [UIR], n.d.)

Our team has also concluded that professors should have a uniform understanding of the IRE system and student outcomes to create effective course outcomes using active verbs. Based on these conclusions, we have come up with multiple recommendations and a deliverable for our sponsor to consider.

Recommendation 1: We recommend that professors alter their course outcomes to cover not only technical skills, but also soft skills like communication and teamwork. Professors should keep the ABET student outcomes in mind when creating their course outcomes.

Recommendation 2: We recommend that faculty narrow down the number of course outcomes to either four or five per course.

Recommendation 3: We recommend that professors standardize their use of active verbs in course outcomes. To address this recommendation, we created an educational infographic that illustrates the relationship between course outcomes, active verbs, Bloom's Taxonomy, and the IRE system.

Objective 3

While comparing the course and lab descriptions, we observed a lack of consistency in the structure of course and lab descriptions. For many courses, the format of the lab and lecture descriptions varied. When evaluators consider a program for ABET accreditation, course materials must be clear and demonstrate consistency. Based on these conclusions, we have come up with a recommendation and deliverable for our sponsor to consider.

Recommendation 1: We recommend that faculty standardize these lecture, lab, and tools descriptions. To address this recommendation, we created a standardized outline for course descriptions and lab descriptions. We made this tool to simplify the comparison process between lecture and lab content for faculty and ABET evaluators.

Limitations

The biggest limitation our team faced was a lack of compliance from faculty to provide materials. We had difficulty receiving survey responses from faculty in a timely manner. Our sponsor also explained to our team how it has been difficult to collect the information needed for faculty portfolios, such as syllabi and course assessments. One potential reason for this resistance is a lack of understanding about the benefits of ABET accreditation for faculty as individuals; essentially, professors do not want to put in extra work if they do not see the benefits of this accreditation for themselves. Due to this push back, our team had to wait for syllabi from multiple professors, which impacted the timeline of our second and third objectives. Originally, our sponsor asked us to evaluate four UIR programs, but because of the delay, we were only able to complete the Computer Science program. To help UIR complete the audit of the other three programs, we formulated a recommendation and a deliverable that our sponsor can use to educate and motivate faculty about ABET. We recommend that our sponsor and the UIR administration bring in ABET professionals to hold informative seminars to educate the faculty about the value of this accreditation. To address this recommendation, our team helped create a brief, pre-recorded ABET seminar from Professor John Orr, former Chair of the ABET Engineering Accreditation Commission. The seminar addressed the fundamentals of ABET accreditation, its value, and what professors can do to help contribute to the process.

Authorship

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2.2 Background Section 2: Obtaining ABET accreditation for STEM programs	Anthony, Rachael, Johvanni	Tarik, Rachael
2.3 Background Section 3: Evaluating curricula and syllabi Bloom's Taxonomy in higher education	Tarik, Genavieve, Johvanni	Tarik, Rachael
2.4 Background Summary	Rachael, Tarik	Genavieve, Johvanni
3. Methodology	Genavieve, Tarik	Rachael, Johvanni, Anthony
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Glossary

ABET Commission: Entities within ABET that conduct the accreditation of educational programs; established by the Board of Directors.

ABET Program Evaluator: Experts in ABET who evaluate program materials, visit campuses and participate in accreditation decisions.

Accreditation: An assurance that a program or institution meets established quality standards. In the United States, it is a non-governmental, voluntary peer-review process.

Bloom's Taxonomy: A tool for determining educational goals and helps educators determine the alignment of educational objectives, assessments, and activities. This tool is used by educators to structure cognitive skills into six themes: knowledge, comprehension, application, analysis, synthesis, and evaluation.

Computing Accreditation Commission (CAC): The commission that accredits programs leading to professional practice across the broad spectrum of computing, computational, information, and informatics disciplines. CAC accredits a program at the bachelor's degree level only.

Course Outcomes: Statements that describe the specific type and level of new learning students will have achieved and demonstrate by the end of a course.

Course Outcome Mapping: An assessment protocol that assesses an entire program based on its student outcomes and the courses that make up the program.

Curriculum: A set of courses constituting an area of specialization offered by an educational institution.

General ABET Criteria: A list of eight criteria that must be satisfied by Baccalaureate Level programs seeking accreditation from their respective commission of ABET.

Global Workforce: The international labor pool of workers, including those employed by multinational companies and connected through a global network.

UIR-ABET

Higher Education Institutions: A higher learning organization that delivers one or more educational programs leading to degrees.

IRE System: A framework based on Bloom's Taxonomy in which "I" stands for introduce the student outcome, "R" stands for reinforce the student outcome, and "E" stands for emphasize the student outcome.

Laboratory Content: Refers to the information presented about a particular course subject through the form of conducting scientific experiments, tests, and investigations.

Lecture Content: Refers to the information presented about a particular course subject through the form of an oral presentation.

Postgraduate Success: In the context of this project, postgraduate success refers to the technical and soft skills students gained from their graduate or undergraduate studies. These skills have helped qualify and prepare them for opportunities in higher education or employment.

Program Educational Objectives: Broad statements that describe what graduates are expected to attain within a few years after graduation. These are based on the needs of the program's constituencies.

Soft Skills: Interpersonal skills that enable someone to interact effectively with others. Examples of soft skills include communication, time management, cooperation, and teamwork.

Standards: A set of requirements that proves quality is met. In the context of this project it refers to universities, programs, skillsets, and the industry.

Student Outcomes: Statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program.

Syllabus: A document that communicates an outline of subjects about a specific course and defines expectations and responsibilities.

Technical Skills: Set of abilities and knowledge to perform practical task.

1. Introduction

Universities around the world aim to prepare their students for more competitive opportunities in the global workforce. One way to do this is by improving recognition of academic programs at universities. Seven engineering societies designed the Accreditation Board for Engineering and Technology (ABET) specifically for STEM programs to ensure that they provide quality education (ABET, n.d.). To help improve global recognition of university STEM programs, faculty and administration may seek out ABET accreditation.

The purpose of ABET accreditation is to improve the quality of STEM programs at universities, which could lead to more competitive opportunities in the global workforce for graduates. Before ABET evaluators will consider programs for ABET accreditation, must meet several criteria. When these criteria are met, the accreditation process can begin. The specific problem our team addressed in this project was the International University of Rabat's (UIR) preparation for the accreditation process. Professor Mohammed Boulmalf, the Director of Information and Digital Sciences at UIR, has been helping prepare UIR for the ABET accreditation process for three of the university's programs: Automotive/Aerospace Engineering, Renewable Energy Engineering, and Computer Science. Our sponsor asked our team of five STEM students from Worcester Polytechnic Institute to gather perspectives from constituencies at UIR and to analyze information from faculty. This approach will help Professor Boulmalf evaluate the three programs to ensure that they are able to meet the ABET criteria. However, our group focused on only the Computer Science program due to the time constraints regarding our project.

Our project goal was to assist UIR in preparing for the ABET accreditation process for the Computer Science program. We started by analyzing the program curriculum and the relationship between the postgraduate experience and student outcomes by surveying and interviewing students, faculty, and alumni. While gaining those three perspectives, we utilized Bloom's Taxonomy to map the alignment of course and student outcomes. We also assessed the alignment of lecture and laboratory course content using consistency tables to address content gaps. We used this information to identify any gaps between the program and ABET's criteria.

2. Background

In this chapter, we begin with a brief overview of accreditation in higher education institutions and, more specifically, accreditation of STEM programs. We will be focusing on a STEM accreditation called the Accreditation Board for Engineering and Technology, also known as ABET. Al Akhawayn University (AUI) located in Ifrane, Morocco, received ABET accreditation for one of their programs in 2011. Our sponsor, who was the chair of the Quality Assurance Committee at AUI in 2011, would now like to pursue ABET accreditation for four STEM programs at the International University of Rabat (UIR) (M. Boulmalf, personal communication, December 11, 2020). Our sponsor's experience in helping AUI get ABET accreditation for their Computer Science program will be beneficial to UIR. This is because he understands the improvements and assessments that the program needs to do in order for a program to successfully obtain accreditation. While the case of AUI's accreditation process is useful, UIR is applying its own methods to prepare for their program evaluation. To obtain this accreditation for the Computer Science program, UIR must first meet the criteria set by the program's respective commission, the Computing Accreditation Commission (CAC) (ABET, n.d.). Our sponsor also plans to obtain ABET accreditation for three other engineering programs, which would need to meet the criteria of the Engineering Accreditation Commission (EAC). For UIR, part of this process includes aligning course outcomes and student outcomes using the cognitive assessment tool, Bloom's Taxonomy. In this section, we will introduce Bloom's Taxonomy in detail and describe its relationship to course outcomes.

2.1 Accreditation for STEM Programs

This section addresses the importance of higher education accreditation for programs and accreditations specific to STEM programs. We also discuss ABET accreditation specifically.

2.1.1 Accreditation in Higher Education Institutions

The problem that we are addressing in this project is accreditation and how to obtain it. Accreditation is a form of quality review that a higher education institution can go through to prove the value of their educational programs (Eaton, 2018). Accreditation proves that the institution has met the level of standards set by the accreditation agency for a specific amount of time (Chaatit, 2007). Undergoing accreditation shows that an institution is striving to meet industry standards and sees potential for internal accountability and growth (Casazza, 2018). Accreditation may be valuable in the context we are working in because employers often seek students who come from a certified program or university (Eaton, 2018). Many professional licenses and accreditations also require graduation from an accredited program (Eaton, 2018). This is because accreditation ensures students have the knowledge, technical skills, and soft skills, to help them be successful when entering the workforce. Examples of technical and soft skills include programming and communicating with teammates, respectively. For this reason, accredited institutions may provide students with more job opportunities and possibilities for pursuing further education (Best Schools, 2020). There are organizations that only accredit specific programs of study. For instance, the Accrediting Bureau of Health Education Schools (ABHES) accredits medical related programs (ABHES, n.d.). The National Accrediting Commission of Career Arts and Sciences, Inc. accredits programs for the cosmetology arts and sciences (NACCAS) (NACCAS, n.d.).

Figure 5: National Accrediting Commission of Career Arts and Science (NACCAS, n.d.)

The Accreditation Council for Business Schools and Programs gives accreditation to business programs (ACBSP) (ACBSP, n.d.). There are also various accreditations for STEM institutions.

2.1.2 Accreditation in STEM Programs

Around the world, institutions offer a wide variety of STEM programs. STEM stands for Science, Technology, Engineering, and Mathematics. Many fields of study in STEM, such as computer science, biomedical technology, and civil engineering, are in high demand for employment opportunities (Value Colleges, n.d.). STEM accreditations are integral in assuring that programs keep up with the advancements of technology (Value Colleges, n.d.). There are national and international STEM accreditations that strive to ensure students in STEM fields will be successful post-graduation (Best Schools, 2020). While these benefits are different from each other, they are all advantages universities can obtain through STEM accreditations. An example of a national STEM accreditation is the National Institute for STEM Education in the United States. This agency accredits educators and schools based on classroom portfolios (National Institute for STEM Education [NISE], 2020). An example of an international STEM accreditation is the Accreditation Board of Engineering and Technology (ABET).

2.1.3 ABET

ABET advertises that it has accredited "4,307 programs at 846 colleges and universities in 41 different countries" (ABET, n.d.). The organization also advertises that it has obtained ISO 9001, which is a quality management accreditation that organizations and businesses can obtain (ISO, n.d.). There are more than 2,200 experts from industries, educational institutions, and government institutions that serve as program evaluators, commissioners, board members, and adversity, n.d.). The goal of ABET accreditation is to provide quality assurance to a STEM program that meets the standards of industry (ABET, n.d.). While this accreditation is sought after worldwide, some institutions have criticized the expectation to become certified and the process itself.

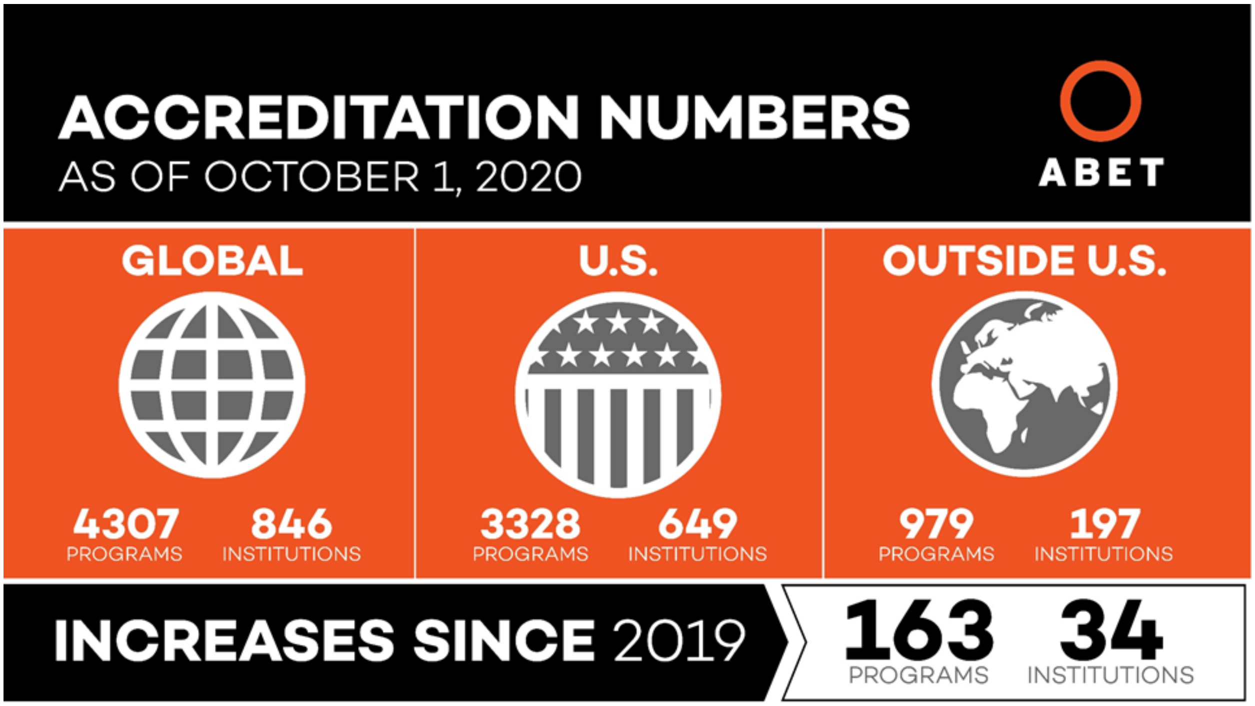

Figure 6: ABET Accreditation data (ABET, n.d.)

Professor Gene Lee Fisher (2017) from California Polytechnic Institute State University argues that the ABET process is time consuming. The process itself takes approximately 18 months, but only if every part of the process is seamless. Fisher also claims that the results of the process are not always productive for university programs and that there is an oversaturation of participating universities that obtained ABET (Fisher, 2017). Other educators at universities around the United States argue that the ABET criteria are inflexible and often lead to roadblocks in educational advancements (Arnaud, 2017; Heilman and Abdallah, 2019). This may be true for universities that already have a status, such as California Polytechnic Institute State University, but for universities without this pre-existing status, ABET accreditation is valuable because it offers credibility to a university's STEM programs.

Despite criticism of ABET being time consuming, oversaturated, and potentially inflexible, ABET accreditation helps universities around the world create a standard for quality assurance (Al-Yahya, 2013). ABET accredited universities expect programs to prepare students to understand the needs of the STEM industry for jobs in their field (Walden University, n.d.). However, it is important to clarify that ABET accreditation does not guarantee students employment or education opportunities, as this is dependent on both the students and the regional and global job market. ABET can only enhance opportunities for graduates by improving the program of study through the criteria it addresses. ABET accreditation allows the faculty to address gaps or weaknesses in their courses, which in turn allows for continuous improvement in the quality of education at the institution (Al-Yahya, 2013). Continuous improvement is just one of the criteria a university program must follow in order to obtain ABET accreditation.

The ABET criteria consist of eight key components: students, program educational objectives, student outcomes, continuous improvement, curriculum, faculty, facilities, and institutional support (ABET, n.d.). Each institution defines these criteria differently for their specific needs. For the International University of Rabat (UIR), we break down these criteria in Appendix A. To meet the criteria set by ABET, UIR needs to evaluate the curriculum for each program being considered for accreditation. To do so, they must relate course outcomes, student outcomes, and program educational objectives in order to contribute to student success in the global workforce. UIR must also assess the perspectives of related constituencies, such as faculty, students, and alumni, to evaluate program curricula and facilities. These actions will contribute to the continuous improvement of UIR's programs, which will help the university to meet ABET's criteria. We prepared for our project by researching, gathering, and organizing information related to ABET, UIR, and educational assessment protocols. We used this research to establish the goal and objectives for this project.

In addition to the ABET criteria, seven basic guidelines describe the standards a university program must meet before consideration for ABET accreditation. A regional ABET accrediting body must accredit universities within the United States. Universities outside the United States must also be accredited by a national accrediting body. The program must also meet ABET's definition of a college program focused on STEM and fall under one of ABET's commissions. Within ABET accreditation, there are four types of commissions that provide accreditation for programs. These commissions include the Engineering Accreditation Commission (EAC), the Engineering Technology Accreditation Commission (ETA), the Computing Accreditation Commission (CAC), and the Applied Science Accreditation Commission (ABET, n.d.). STEM programs being considered for ABET accreditation must fulfill the general criteria and fall under one of the commission types. Once the ABET reviewers have determined these requirements fulfilled, the program may begin the ABET accreditation process. The first step in the ABET Accreditation process is a readiness review if the university does not already have ABET accredited programs. (ABET, n.d.).

2.2 Obtaining ABET Accreditation for STEM Programs

In this section, we discuss how a STEM program can obtain SBET accreditation along with the steps and guidelines for the process. A university must assess and align the student course outcomes set by ABET to the course outcomes set by the professors. We also compare AUI, the only university in Morocco that has obtained ABET accreditation for a program, and UIR. Finally, we examine UIR in the context of the ABET accreditation process.

2.2.1 Obtaining ABET Accreditation

To obtain ABET accreditation, there is a specific timeline that programs must follow. Figure 8 displays a timeline of this process as described by ABET.

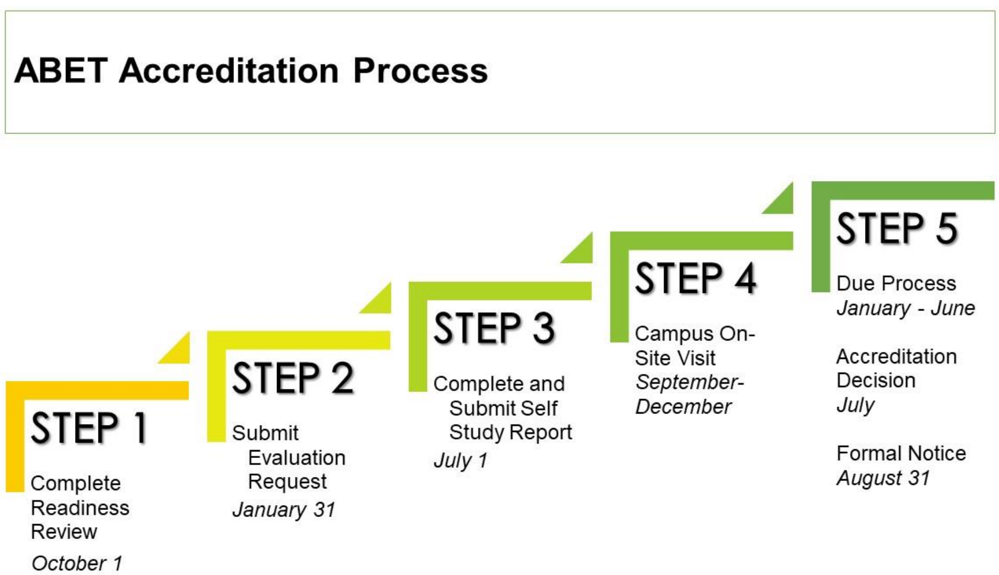

Figure 7: The ABET accreditation process (extracted from ABET, n.d.)

First, the university must complete a readiness review, which includes a readiness review report, one year before the on-site visit. UIR is still preparing for their readiness review, so they are currently at the beginning stages of the accreditation process. To submit a readiness review, UIR must have three semesters of complete portfolio collection, which may consist of syllabi for all courses and whatever outcome are supposed to be in those syllabi, from all faculty in the programs being considered. UIR has not yet gathered all of this information.. After the evaluators approve the readiness review, the university may submit a request for evaluation and the self-study report may begin. This report evaluates if the program meets the ABET criteria for accreditation. Once this is complete, evaluators conduct an on-site visit, which includes one ABET team chair member and two program evaluators if a single program sought out evaluation. A multi-program visit is scheduled if UIR gets to the on-site visit stage for all four programs. A multi-program visit would include a team chair and a program evaluator from each of the four programs being considered for accreditation. The visit will include verification of their self-study reports, evaluation of the facilities, as well as student and faculty interviews. After the visit, the evaluators and ABET commissions meet to discuss accreditation for the programs. If the evaluators and commissions have enough evidence to prove that the program meets the ABET criteria, then ABET will formally notify the institution about the accreditation action (ABET, n.d.). ABET accreditation is a complex process and takes time. We will discuss in the following section Al Akhawayn University ABET accreditation and how it compares to the context of UIR's efforts to obtain ABET accreditation.

2.2.2 Comparing AUI and UIR’s accreditation

Al Akhawayn University (AUI) in Morocco has already undergone this ABET accreditation process for three of its STEM programs (Al Akhawayn University [AUI], 2017). AUI is a public, science-based university in Ifrane, Morocco (AUI, n.d.; Agnaou, n.d.). In 1993, royal decree established the university, with a current school body consisting of just over 2,000 undergraduate and graduate students (Agnaou, n.d.). In 2011, AUI obtained accreditation for its Computer Science program (Al Akhawayn University [AUI], 2017). In 2017, AUI was able to simultaneously accredit the General Engineering program and the Engineering and Management Science program. In the same year, they also renewed the ABET accreditation for their Computer Science program (Al Akhawayn University [AUI], 2017).

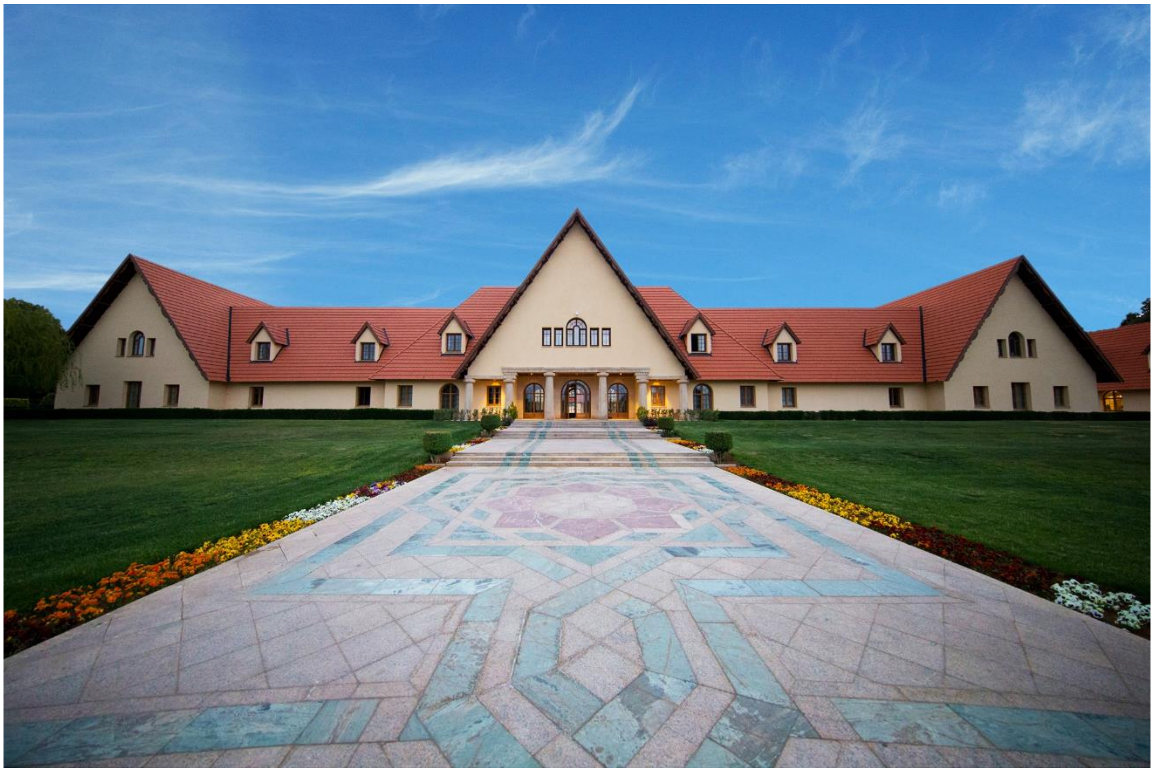

Figure 8: Al Akhawayn University's campus (Al Akhawayn University [AUI], n.d.)

UIR and AUI are both universities in Morocco but differ in many aspects. This means UIR's accreditation process is not going to be identical to AUI's process. UIR is located in Rabat, the political capital of Morocco, and has a student body population of 4,600 (Université Internationale de Rabat [UIR], n.d.). The recently established university was founded in 2010 (Université Internationale de Rabat [UIR], n.d.). Rabat has a population of 580,000 while Ifrane has a population of 74,000 (World Population Review, 2021). Rabat also borders the Atlantic Ocean and Ifrane is in the Middle Atlas Mountain range, meaning Rabat is more accessible to Europe and other foreign nations (World Population Review, 2021). The population of UIR's student body is more than double the size of AUI's and UIR is much newer. We are pointing out these differences to emphasize that while AUI's accreditation process may influence UIR in some ways, these universities cannot be directly compared. Therefore, UIR will have a unique ABET accreditation process.

2.2.3 ABET Accreditation Process at UIR

To obtain this accreditation, UIR needs to assess which parts of their programs lack alignment with ABET standards. Six colleges comprise UIR, which are in turn composed of fourteen schools, also referred to here as programs (Université Internationale de Rabat, [UIR], n.d.). To assess where these programs may improve as measured by ABET standards, UIR will need to understand the personal experiences of students, faculty, employers, and alumni through interviews and surveys. UIR will also need to assess course outcomes (COs), student outcomes (SOs), and program educational objectives (PEOs) and the relationships between them.

ABET has defined COs, SOs, and PEOs. Course outcomes (COs) are statements about what the course expects students to achieve at the completion of the course (ABET, n.d.). Student outcomes (SOs) are statements that describe what skills the program expects students to have by the time of graduation (ABET, n.d.). UIR has listed the SOs for each program based on the commission accrediting the program. For instance, the same student outcomes apply to all three engineering programs (aerospace, energy engineering, and automotive) being considered for accreditation by the EAC. The student outcomes created by the EAC can be found in Appendix B.1. The CAC accredits Computer Science program. The student outcomes created by the CAC are listed in Appendix B.2.

Figure 9: ABET logo for the Computer Accreditation Commission (ABET, n.d.)

Program educational objectives (PEOs) are broad statements that describe the career and professional accomplishments the program is preparing its graduates to achieve in 3-5 years after graduation (ABET, n.d.) PEOs are developed by the university to ensure students have the essential skills needed to be competitive in the global workforce (Benderly, 2016). These three types of outcomes (COs, SOs, and PEOs) are all related to one another. Course outcomes contribute to student outcomes. Furthermore, student outcomes are met by the program as a whole and the course outcomes should contribute to at least one student outcome. Student outcomes contribute to program educational objectives. Student outcomes from a single program should contribute to at least one program educational objective, which relates to what the program expects graduates to accomplish in the workforce. To attain ABET for a program, the university needs to assess and align all these outcomes. One tool the university is planning to use for this is Bloom's Taxonomy.

2.3 Evaluating Curricula and Syllabi

In this section, we address what Bloom's Taxonomy is and how it used to evaluate curricula and syllabi at educational institutions. Similarly, we establish what the IRE system is and its relationship to Bloom's Taxonomy. For the context of our project, we explain how program evaluators can use Bloom's taxonomy and the IRE system to assess UIR's programs.

2.3.1 Bloom's Taxonomy in Higher Education

The term taxonomy relates to organizing classifications of information (University College Dublin, n.d.). In an educational context, taxonomies are also used by faculty and administration to classify many types of learning objectives (University of Alaska Fairbanks [UAF], n.d.). Learning taxonomies range in complexity from understanding simple math concepts to gaining an understanding of how the brain processes knowledge (University of Alaska Fairbanks [UAF], n.d.). One of the most well-known learning taxonomies is Bloom's Taxonomy.

Benjamin Bloom and a group of education specialists from around the United States created Bloom's Taxonomy (Krathwohl, 2002). Bloom had a vision to produce a tool that acted as a generalized form of communication about learning goals across all levels of education (Bloom et al, 1956). This tool acts as a basis for determining educational goals and helps educators determine the alignment of educational objectives, assessments, and activities (Anderson, 2009). Educators use this measuring tool to structure cognitive skills into six themes: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al, 1956). By incorporating these aspects, Bloom's Taxonomy aims to help faculty visualize the depth and range of understanding curricular objectives (Bloom et al, 1956).

Furthermore, active verbs relate to one of the six cognitive skills given by Bloom's Taxonomy. Here, Goel explains these six cognitive abilities as described by the taxonomy:

> **Knowledge** exhibits learned material by referring to previous facts, terms, subjects, and answers.
>
> **Comprehension** refers to the understanding of the material using translating, interpreting, comparing, organizing, and stating main ideas.
>
> **Application** refers to students using previous information to solve problems.
>
> **Analysis** explains the act of observing and evaluating information by identifying key themes and making interpretations based on evidence.
>
> **Synthesis** relates to the combining of elements in methods that are the most appropriate to the context.
>
> **Evaluation** is about presenting and explaining the interpretations and statements from the information gained based on evidence. (2004)

Educators can use action verbs from these curricular objectives, which can further be categorized by their respective levels (cognitive, affective, and psychomotor) (Bloom et al, 1956). By structuring objectives or outcomes with an active verb, instructors can clearly state the cognitive abilities and learning skills they would like students to obtain during the course (Krathwohl, 2002). There are many ways in which an institution can outline how the active verbs are categorized; we have provided one example of this relationship in Table 1 below.

Knowledge	***Comprehension***	***Application***	***Analysis***	***Synthesis***	***Evaluation***
Know	Identify	Apply	Analyze	Create	Evaluate
Define	Report	Use	Calculate	Compose	Judge
Memorize	Explain	Demonstrate	Compare	Design	Estimate

Table 1: Simplified example of the relationship between Bloom's Taxonomy and active verbs (extracted from Questioning Based Upon Bloom's Taxonomy, n.d.).

2.3.2 Bloom’s Taxonomy at UIR

Mapping Bloom’s Taxonomy to IRE is a widespread practice used by program evaluators during curriculum evaluations at universities (Brown University [BU], n.d.). The IRE systems can assist educators in aligning the skills of a graduate to the course’s content. Dr. Heidi Hayes Jacobs, a professor at Columbia University’s Teachers College, created the IRE system first used in curriculum mapping (Professional Learning & Community for Educators [ASCD], n.d.) which is based on Bloom’s Taxonomy. In order to use Bloom’s for this mapping, the taxonomy must be further organized. Table 2 illustrates this relationship.

Introduce		***Reinforce***		***Emphasize***	
Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation

Table 2: Showing the relationship between the IRE system and Bloom’s Taxonomy (M. Boulmalf, personal communication, December 11, 2020).

The acronym IRE stands for Introduce, Reinforce, and Emphasize (University of Rhode Island [URI], n.d.), where each cognitive ability in Bloom’s Taxonomy correlates to a level in IRE. According to URI, the first level, “I,” involves introducing a concept that relates to one or more student outcomes. “I” also provides basic knowledge and skills to introduce the student outcome. The second level, “R,” supports and reinforces the growth of the knowledge and skills necessary for the achievement of student outcomes. The third level, “E,” emphasizes a student's ability to apply their knowledge or skills to achieve proficiency in student outcomes (University of Rhode Island [URI], n.d.). Different institutions may use different acronyms such as IRM, which stands for Introduce, Reinforce, and Master (Brown University [BU], n.d.).

Curriculum mapping helps faculty identify where outcomes are and are not being met in the curriculum as well as opportunities for assessment (University of Rhode Island [URI], n.d.). This is important to help programs continuously improve their courses by assessing how professors convey the course outcomes and the cognitive abilities. Doing so, professors will have the opportunity to determine if their course outcomes effectively convey the cognitive abilities a student should gain. For example, in higher level courses students’ professors should be using active verbs that relate to level E of the IRE system, while introductory courses should address level I of the IRE system. Overall, this will ensure professors of a fundamental course trying to introduce student outcome(s) only use active verbs related to level I of the IRE system. Table 2 shows active verbs related to introduce and they are listed under knowledge and comprehension. In other words, higher level courses should not be introducing or covering fundamental knowledge and introductory courses should not be covering advanced knowledge. Professors that ensure their courses are effectively covering the IRE levels will allow for courses to build upon each other and provide structure to the overall program.

2.4 Summary

Learning accreditation is important to provide students more job opportunities, greater financial aid opportunities, and more possibilities for pursuing further education. There are many types of accreditation for institutions of higher education, including ABET accreditation. ABET accreditation focuses on helping universities create a standard so that students are prepared to enter the global workforce. Programs with ABET accreditation are prepare students with technical and soft skills that make them competitive members of the job market. UIR wants to obtain ABET accreditation for four programs. To assess where the programs may be lacking, UIR will gain perspectives from stakeholders and assess COs, SOs, and PEOs and the relationship among these outcomes. To assess COs and SOs, UIR plans to use Bloom's Taxonomy. To refine Bloom’s Taxonomy, UIR plans to use the IRE system which analyzes if course outcomes are introducing, reinforcing, or emphasizing knowledge and skills that contribute to student outcomes. UIR will also need to address the alignment of content within the courses themselves. Our sponsor asked us to assist in this accreditation process, which we detail in the Methodology section below.

3. Methodology

The goal of our project was to assist UIR in obtaining ABET accreditation for the Computer Science program. To assess the Computer Science program at UIR, we used our methods in this chapter to collect, organize, and assess qualitative information about this program. Our first objective was to analyze program curricula from the perspective of students, faculty, and alumni. In our second objective, we utilized Bloom's Taxonomy to map the alignment of course and student outcomes. In this objective, we focused on improving the content and consistency of course outcomes as they contribute to the program and its student outcomes. For our third objective, we assessed the alignment between lecture and laboratory content. With these objectives, we gathered information to inform our recommendations to UIR in their pursuit of ABET accreditation.

3.1 Analyze program curriculum from the perspective of students, faculty, and alumni.

Our purpose with this objective was to gather and analyze qualitative information about the program's student outcomes from the perspective of the students and faculty. We obtained input and perspectives from students and faculty, benefiting our sponsor by highlighting which student outcomes the program is meeting and which student outcomes need to be addressed. By analyzing the experience of students and faculty in relation to student outcomes, we were able to make recommendations to faculty and administration. We intended these recommendations to assist faculty in making changes to the curriculum that align with ABET student outcomes.

Our purpose with this objective was also to gather and analyze qualitative information about the program educational objectives (PEOs) from the perspective of alumni. The information we gathered from alumni helped our team understand what skills and knowledge alumni should have to be competitive in the global workforce. We compared the common themes from all three of these constituencies and used them to suggest improvements for the Computer Science program curriculum in order to satisfy the ABET criteria.

3.1.1 Data Collection

Method 1: Surveys for Students, Faculty, and Alumni

We created surveys for students, faculty, and alumni via Qualtrics, a program which allowed our group to distribute surveys through a link and to automatically collect survey data. To structure the surveys, our sponsor provided us with questionnaires that he had used for the ABET accreditation process at Al Akhawayn University (AUI). We used them to tailor the style and structure of our own surveys. We chose to do this because our sponsor felt that this structure was successful for AUI during their program's accreditation process. Even though AUI is a different university than UIR, as we discussed in the background, our sponsor and our team knew this survey style would be effective at UIR because it allowed constituencies to complete the survey quickly while providing us with meaningful data. The format of the survey, which consisted of 11-14 statements, was a table with five bubbles next to each statement. The bubbles numbered 1-5 represented the answers "strongly disagree with the statement" as 1 and "strongly agree with the statement" as 5. To make the faculty and student surveys, we started by creating 2 to 3 statements to address each student outcome, as set by the ABET Computing Accreditation Commission. For the alumni surveys, we created statements about the project educational objectives which were formulated by faculty and administration in the Computer Science program at UIR. Our sponsor's assistant distributed these surveys links to the three constituencies.

The survey questions for all three constituencies can be found in Appendix C. We prepared and attached a consent form with these surveys (see Appendix D). The purpose of the consent form was to obtain permission from participants so that our team could use the information they provided anonymously. In addition to receiving consent, we also ensured that there was no identifying information on any survey responses before sending the survey data to our sponsor.

Method 2: Interviews for Students and Alumni

Our sponsor compiled a list of UIR students and alumni that would be willing to take part in an interview with our team. In these interviews, we followed a semi-structured format where our team developed both a predetermined set of questions and a guide for more open-ended questions. This helped our team receive answers to specific questions and allowed interviewees to offer their own insight (Pollock, 2019). Through these surveys, we learned to what extent the Computer Science program prepares students for the global workforce from the perspective of both constituencies. These interviews helped our team understand where the ABET criteria are not being addressed in specific courses or the overall program. We wanted to understand what skills alumni wish they had learned at UIR and what skills students believe they are lacking. We conducted these interviews over Zoom. Our project was remote due to the global pandemic, so we had to conduct our interviews online. We chose to use Zoom for our interviews because we are most familiar with this platform and all of our interviewees had access to Zoom. The interview questions for all three stakeholders are in Appendix E. We needed verbal or written consent before moving forward with the interviews. The consent form (see Appendix D) was sent out through Qualtrics and we received the form back from each participant.

3.1.2 Data Analysis

Method 1: Statistical Analysis

Our team used a variety of statistical techniques in order to analyze our survey data for students, faculty, and alumni. First, we found the mean (average), mode (most frequent answer), and standard deviation (dispersion of data set) for each question for each constituency formulated on the answers which were given as 1-5. If we found that a question had a low mean (less than 3.5) or high standard deviation (greater than 1), that indicated to our team that the related student outcome may be under addressed by the program since there might be multiple answers with a 1, 2, or 3. We also counted the number of participants who answered each question with a 1 (strongly disagree) or a 2 (disagree), since those answers indicated that specific student outcomes needed improvement within the program. If one question had any answers of 1, we noted that the related student outcome should be addressed by the faculty. If one question had multiple answers of 1 or 2, we assessed why the program may need to improve the related student outcome within the program. Our group focused on the questions with the lowest means, the greatest standard deviations, and most frequent answers 1 and 2, and qualitatively assessed why the related student outcomes may be lacking in the program and how to improve the presence of those student outcomes.

Method 2: Inductive Coding

Our team used inductive coding, used most often in “grounded theory” approaches, to analyze the interviews (Glaser & Strauss, 1967). Inductive coding is a type of coding in which there is no pre-existing codebook for the data collected. There is no prior understanding of how the data may turn out, and therefore the coding is done hinging off the data itself (Yi, 2018). To analyze the interview data, we used three steps of inductive coding to find “main themes" that emerged from student and alumni interviews. We used these steps to compare the main themes from the student and alumni interviews to assess whether these two perspectives aligned in terms of the ABET criteria.

In the process of inductive coding, open coding is the first step. Open coding is the most basic type of inductive coding in which the data collector tentatively labels chunks of data with summary statements to find significant themes in the data (Gallicano, 2013). Based on the responses we received from interviews, we found themes separately for each group. We utilized open coding to analyze both surveys and interviews. An example of our open coding methods can be seen in Figure 10.

Open Coding							
Theme 1: Internship/Job	No internships because of COVID	Experience but not in the industrial practice	Mentor Internships for 3rd Year students	Provided intetrnships/projects by university with PhD professors/students	Have them at the school to work on projects	Career fair in janurary	More international opportunities would be great
Theme 2: Practice/Theory	More technical experience	Theoretical is good but practice is most important	More visual based and theoretical (referring to completing lab assignments in lab)	Memorization	No homework	Practice is self motivated	Some classes are purely theoretical
Theme 3: Resources	More counseling and advice about branches of concentrations	Peer counseling: Not official	Attempted to make tutoring for CS club	Labs, Libraries are open	Wish there were side projects	no organized student advising	must go to professor's office to get more instruction
	PCs didn't have programs installed	Given different tools based for different topics/sides/concentrations of CS	Teachers would just teach what they wanted to teach with whatever tools they had to teach the class	Access to computers and powerful computing machines as PHD students	Need more program experience	More choice with courses	Problems with computers working

Figure 10: Open Coding from Interview Codebook

Next, we used axial coding, which identifies relationships between the major themes from open coding. This further organizes the large chunks of information into more specific themes (Gallicano, 2013). From the interview data we collected, we found relationships among common themes we saw for both groups of students and alumni. Lastly, we used selective coding by finding the key ideas in the specific themes produced by axial coding (Gallicano, 2013). For us, this involved finding similarities and differences in the major themes present in both student and alumni responses. This resulted in a small number of key comparisons between students' and alumni's main themes created from the interview data. These coding methods for students and alumni interviews (see Table 3) helped us make recommendations. We made suggestions in areas where faculty and administration may need to alter the resources and opportunities offered in courses so that students are able to learn the knowledge and skills determined by each program.

3.2 Utilize Bloom's Taxonomy to map the alignment of course and student outcomes.

Our purpose for this objective was to utilize Bloom's Taxonomy to assess the alignment of course outcomes in syllabi and the student outcomes in each program. To address this objective, we used a data collection tool that organized and mapped course outcomes from syllabi to assess their alignment with ABET's required student outcomes. The course outcomes must address at least one student outcome to ensure that each student has gained some of the expected skills by the end of the course and all of the expects skills by the end of the program. The course outcomes must also address parts of the IRE system as explained in the background section. The IRE system is based on the cognitive levels defined by Bloom's Taxonomy and the associated active verbs. The methods we used for this objective contributed to our goal by emphasizing course outcomes that the program could improve, which contributed to the improvement of the curriculum overall. We made recommendations based on this assessment of the gaps in the course outcomes as compared to student outcomes and the IRE criteria. With the recommendations we made, we intended to assist faculty in improving their course outcomes and the program overall. These improvements would help provide students with the expected skills they need to have upon finishing their program of study under ABET criteria.

3.2.1 Data Organization

Method 1: Extract Course Outcomes from Syllabi

Our sponsor collected a portfolio which contained most of the syllabi from the Computer Science program. The syllabi portfolio included details about the program and individual courses, such as the programs' student outcomes and course outcomes. The syllabi also included the course name, the number of hours required in each part of the course, and a topical outline. For Method 1, we extracted the course outcomes of each syllabus in the portfolio and put them in a separate document. We organized the course outcomes by the course they belonged to and the semester they were taken. Using Google PDF Translator, we translated course outcomes that were in French to English. Additionally, we extracted the student outcomes for the Computer Science program and put them in the separate document. We worked on Method 1first to directly assist our protocol for Method 2. To begin creating the course outcome mapping charts for the Computer Science program, we used the extracted course and student outcomes.

Method 2: Develop Course Outcome Mapping Charts for Each Program

We used course outcome mapping charts to assess the alignment between student and course outcomes in terms of the IRE system for the Computer Science program. A course outcome mapping chart is an assessment protocol that assesses an entire program based on its student outcomes and the courses that make up the program (Brown University [BU], n.d.). By incorporating the course outcomes for each course and the student outcomes for the program, along with our use of the IRE system previously mentioned, we assessed which courses correlate to which student outcomes and how. This approach demonstrates which courses are focused on introducing, reinforcing, and emphasizing program material (Brown University [BU], n.d.). This assessment protocol has been used in many different universities, including AUI. Our sponsor helped implement this type of assessment protocol at AUI, which contributed to AUI obtaining ABET accreditation. While our sponsor provided us with examples of how AUI used this tool, we developed our own mapping charts (see Appendix F) to fit the needs of UIR and its Computer Science program.

3.2.2 Data Analysis

To use the course outcome mapping charts as an assessment tool, we considered the following criteria to populate the chart:

- Does the course outcome/course overall contribute to any of the student outcomes?
- If so, does the course outcome/course overall introduce the student outcome, reinforce the student outcome, or emphasize the student outcome?

We considered these questions for each course outcome in relation to each student outcome. We also made this consideration based on the active verbs that professors used to formulate their course outcomes. For example, if a course outcome included the active verb “create,” then the outcome would correlate to the synthesis level of Bloom’s Taxonomy which correlates to the emphasis level of the IRE system (See Tables 1 and 2 in Background). Therefore, this course outcome would emphasize the student outcomes it relates to. This is important for faculty to consider when they are creating course outcomes as well. If a professor taught an intermediate level course and wanted to create a course outcome about students critically thinking to solve problems, they could say, “apply critical thinking skills to solve problems”. Because of the active verb used (apply), this course outcome would correspond to the cognitive level “reinforce”. If the professor used the active verb “recognize” or “evaluate”, then the cognitive level of the course outcome would be different.

We used this thought process and criteria to fill out the course outcome mapping chart. Once we filled out the chart, we examined the distribution of I, R, and E within the chart. The distribution of I, R, and E across the chart should be relatively even to ensure that student outcomes are being introduced, reinforced, and emphasized well. If there was an uneven distribution of I, R, or E, or if some student outcomes were not being properly addressed, our sponsor and the UIR faculty would know where course outcomes could be added or amended.

3.3 Assess the alignment of lecture and laboratory course content.

Our purpose with this objective was to assess the alignment between lecture and laboratory course content. For the purposes of this objective, we have defined course content as course descriptions, lab descriptions, topical outline, and tools used in the lab. The data collection and assessment tool we used to address this objective were consistency tables. For students to gain a full understanding of the material in a course, the lecture (theoretical) content must directly apply to the laboratory (practical) content and vice versa. If the content does not align, then students would not gain a full understanding of the knowledge and skills that professors determined they should gain. By directly comparing the lecture and laboratory content of courses using consistency tables, we were able to assess any content gaps that should be addressed by the faculty. We provided these consistency tables along with recommendations to our sponsor. This will assist in the accreditation process by giving faculty a tool to continuously assess and improve their courses, which is a key criterion of ABET accreditation.

3.3.1 Data Organization

Along with the syllabi portfolio used in Objective 2, our sponsor created an excel sheet that included information about lab content and tools for each relevant course. First, we had to match each course description to each lab description. For this objective, we organized the course descriptions, lab descriptions, and lab tools into a separate spreadsheet. In the spreadsheet, we organized courses by semester and module. There were multiple modules in each semester, which acted as a general theme for multiple courses (between 1-4) to be classified by. By organizing a course's content into two separate parts (what is covered in lecture and what is covered in the lab), we were able to organize and analyze this information using our consistency tables.

3.3.2 Data Analysis

We used qualitative data and consistency tables to assess the alignment of lecture and laboratory content described in each part of a course. Consistency tables helped our team make a side-by-side comparison of the lecture and laboratory. We were able to see which topics might not have been covered by either lecture, laboratory, or both. These tables (See Appendix G) helped our team assess how professors at UIR introduce material in lecture and how UIR students apply their knowledge in the laboratory.

Figure 11: A lecture a UIR (Université Internationale de Rabat [UIR], n.d.)

After assessing the respective course and lab descriptions, we used the consistency tables to identify inconsistencies among course content within the program. We assessed the differences between courses, primarily in the structure of the descriptions, and noticed where courses were missing information such as tools used. As a result of this objective, we created a series of consistency tables in which we compared the content of each course our sponsor wanted us to evaluate. Faculty will also be able to re-assess their course content on a regular basis with this tool, if they choose to, which leads to the possibility for continuous improvement of courses.

3.4 Acknowledgement of Research Limits

As with all scholarly research projects, our team faced challenges and limitations during this project which are important for us to acknowledge. In our first objective, our team did not receive contact information for interviews until the last two weeks of the project. Our surveys were also not sent out until the final week of data collection. We did not receive responses for the majority of the requests we sent for interviews and surveys. For this reason, we were not able to interview faculty or employers, and could not survey employers. Also, our group only conducted one alumni survey and received less than ten alumni survey responses. We did not conduct our interviews in-person, as we may have preferred, since the project was conducted during the COVID-19 pandemic. Due to the pandemic and safety concerns for everyone involved, we had to do our entire project remotely and our team stayed in Worcester. Our team had to adapt our ability to research and communicate using virtual methods.

For our second objective, we received over twenty new syllabi in the last week of data collection as well due to faculty resistance to providing course materials. Faculty resistance is a common issue at the beginning of the ABET accreditation process, but it was difficult for our team to manage this issue since we were constrained by time during this project. Lastly, our initial goal of this project was to assist UIR in the ABET accreditation process for the Computer Science program, the Renewable Energy program, the Automotive Engineering program, and the Aerospace Engineering program. Due to time constraints and faculty resistance, we were only able to complete our objectives for the Computer Science program.

3.5 Ethical Considerations

Before we initiated our project, our team had to obtain approval for exemption category two, focusing on survey and interview procedures from the Institutional Review Board (IRB). Our project has been professionally reviewed by the WPI IRB and obtained IRB approval effective February 2, 2021 under protocol number IRB-21-0314.

Our team also considered the power dynamics between ourselves and the constituencies we were collecting data from in our first objective. Before we executed any of our methods for collecting data from students, faculty, and alumni, it was critical that we informed them about consenting to serve as participants. We distributed consent forms that informed our participants about the scope and purpose of our project and that we would handle their responses with discretion and anonymity. When we chose to share our findings and recommendations with our sponsor and other personnel, it was critical that we avoided sharing any identifiers of our participants. If we disclosed identifiers, such as names or courses taken by a student or taught by a professor, to our sponsor or any member of the UIR community, it could put our research participants in positions of facing retaliation. Since we asked our participants to answer questions regarding their experiences at UIR, any responses that a stakeholder could interpret as controversial or damaging to UIR's image or members could have led to dissent between parties. For example, if a student spoke ill about a professor that contributed to them having a bad experience with a UIR, it is essential that we conceal the name of the student. If the name of the student were ever to get out along with their response to the public UIR community, the professor could retaliate and use their authority to harass or attack the student in other ways.

Similarly, if we disclosed a faculty's identity along with a controversial response, they could risk losing their job if their bosses were to find their responses displeasing.

Since we used semi-structured interviews, we often deviated from the predetermined questions that we had prepared beforehand. When asking spontaneous questions, we had to ensure that the questions we were asking would not cause harm to our participant or put them under psychological distress. While we expressed through our consent forms and at the start of the interviews that we would handle all responses anonymously, we reassured our participants that they could opt out of answering any particular question. It is also important to keep in mind that we worked directly with our sponsor, the Director of Information and Digital Sciences at UIR, who holds a certain degree of authority at the institution. Because he assisted us in finding participants for us to research, our research subjects could have seen us as authority figures. For this reason, we wanted to ensure that our participants were in control of their responses as opposed to feeling that we were pressuring or coercing them to take part in these interviews.

Another ethical consideration our team had to be mindful of during this project was the fact that we were entering a culture that we were unfamiliar with. While we had the opportunity to learn basic information about Morocco and personal experiences from our cultural partners, we did not fully understand the hierarchical relationships between students, faculty, and alumni. When conducting interviews, we had to avoid making assumptions about how students and faculty interact based on our own experiences. This was important to reduce bias in our project but also to learn about the experience of college students in other parts of the world.

Lastly, our sponsor shared with us numerous documents regarding the Computer Science program at UIR. It was imperative that we handled the documents with confidentiality. This meant that we had to ensure that we did not exchange the documents with individuals unauthorized to have them. Failing to keep those confidential documents safe could have compromised any secure information about the Computer Science program and any personnel related to the program. Additionally, our sponsor could have been subject to negative consequences at UIR. For this purpose, we ensured to keep the confidential documents on our personal devices, and we plan to delete any document shared with us from UIR at the end of our research project.

4. Findings and Analysis

The goal of our project was to assist UIR in obtaining ABET accreditation for the Computer Science program. To reach the standards required by ABET and their criteria, we collected, organized, and analyzed the quantitative and qualitative information. We gathered this information using our methodology which addressed our three objectives.

1. Our first objective was to analyze program curricula from the perspective of students, faculty, and alumni. This objective aimed to compare the experiences of these relevant constituencies to understand if student outcomes were being met.
2. Our second objective utilized Bloom's taxonomy to map the alignment of course and student outcomes. This objective focused on identifying specific courses and assessing how their course outcomes contribute to the program's student outcomes.
3. Our third objective was to assess the alignment between the content in lecture and laboratory descriptions. This objective aimed to assess the structure of course and lab descriptions, tools listed, and course topical outlines. This objective also aimed to assess the consistency between lecture and laboratory content.

In this chapter, we describe our findings and our interpretation of these findings. For Objective 1, we found that students and alumni felt that there should be more opportunities for hands-on and technical learning experiences. Some students also felt that the program did not provide adequate opportunities to get these experiences to prepare for industry. For Objective 2, we found that administration needed to refine course outcomes and focus more on the ABET student outcomes for the Computer Science program. Faculty did not address the student outcomes that related to teamwork, communication, and ethics as much as the other outcomes. We found that faculty needed to refine course outcomes because there often were too many of them and faculty were not using active verbs effectively in those outcomes. For Objective 3, our primary findings were less about the content of the course and more about the structure of the materials we used to assess the content. We found that there was no standardized outline for lab and course descriptions and there were some course descriptions and tools missing from the table that our sponsor provided our team. In the following section, we will go into detail about all of these findings and the evidence for them.

4.1 Constituency Survey and Interview Findings

4.1.1 Students, alumni, and faculty confirm alignment with student outcomes

Our team surveyed students, faculty, and alumni from UIR. Appendix C contains these survey statements. Students responded to statements by recording a value of 1-5 with one being “strongly disagreed” and five being “strongly agreed”. The majority of students answered most statements with “agree” or “strongly agree”, but we examined statements that had one or more “strongly disagree” responses. Our group examined these responses because the survey lacked few negative responses, which further emphasized what aspects to focus on. For statement three, four, six, seven, nine, and eleven, there was only one response that strongly disagreed. After more analysis, we concluded that the only statement with a significant number of “disagree” and “strongly disagree” responses was Statement eleven. Six students strongly disagreed and seven students disagreed with Statement 11. Statement 11 focused on providing students with the opportunities to get hands-on technical experience to prepare for industry. Figure 10 shows the frequency of ratings for Statement 11 compared to Statement 5. We chose Statement 5, which focused on communicating effectively with people from other professions or disciplines, because it was the question with the most positive responses.

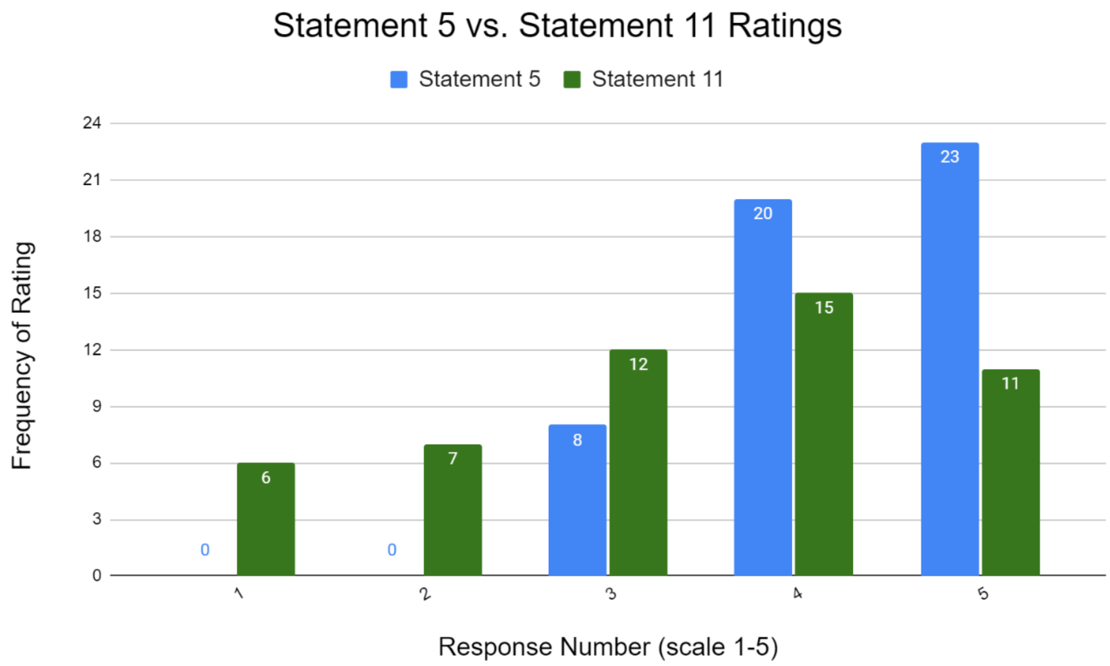

Figure 12: Frequency of ratings, Statement 5 versus Statement 11

This is significant because more students answered Statement 11 with a score of one or two in comparison to the other questions. This means that students feel that administration is not providing them with adequate opportunities to help them develop their technical skills for industrial practice. Another reason students may have responded negatively to Statement 11 could be because they did not understand what the question was asking. Statement 11 uses the phrase "industrial practices" which students may not have understood. If this survey is used in the future, this statement may need to be revised to use language students are more familiar with.

Our team utilized the same survey format for faculty but with statements respective to their role as professors. The faculty format differed in one key aspect by offering a "not applicable" choice to the survey. This allowed professors to communicate that they neither agree nor disagree. Multiple professors recorded that Statements 2-13 were not applicable to themselves. The only statement that every professor was able to answer was Statement 1, which revolved around applying computer science principles to analyze problems. Two or more professors responded to Statements 7-13 with "not applicable", which focused on communication, teamwork, and other soft skills. We also found that two professors strongly disagreed with Statements 6 and 9. These statements focused on soft skills such as communication, leadership, and informed judgements surrounding ethical principles. Figure 11 shows this relationship.

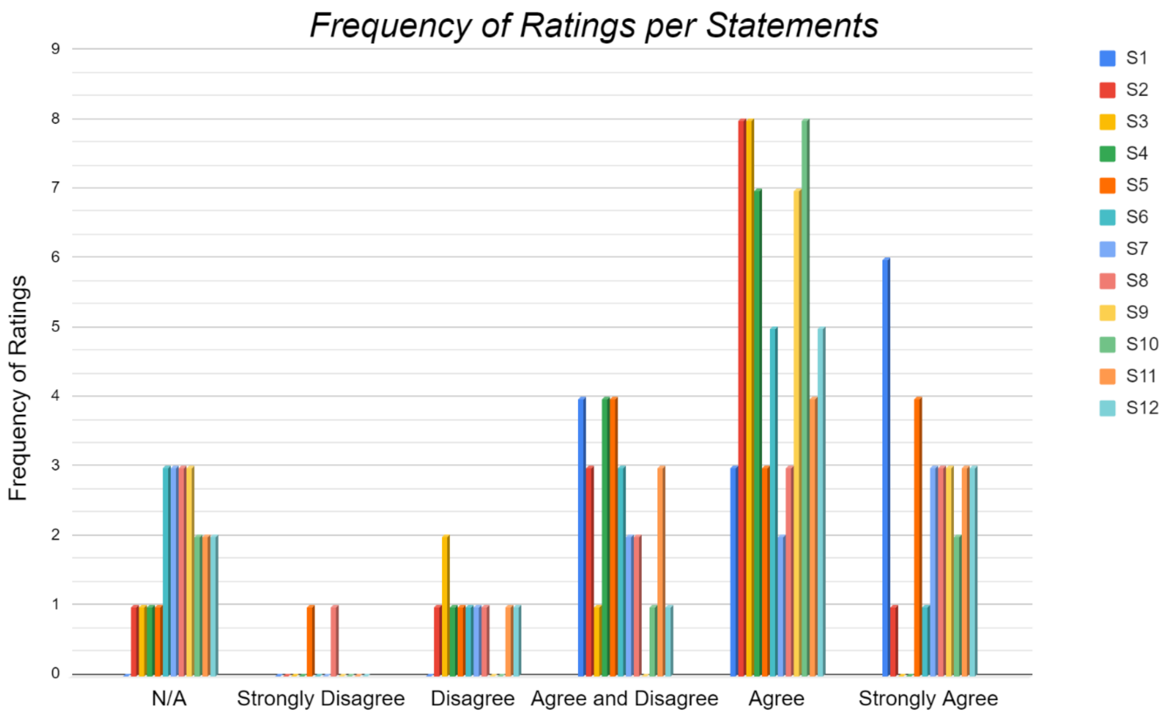

Figure 13: Faculty survey responses

This is significant because if professors could not respond to a statement, that may mean that they were unsure if their course met the student outcomes or that their course did not meet the student outcomes. Since professors also responded to the statements with low scores, this may mean that faculty are uncertain whether or not their students are gaining communication and teamwork skills in their courses.

As for the alumni surveys, nine people attempted to complete the survey but only five alumni filled it out completely. Out of the answers that we received, the majority of responses were positive. We found that alumni tended to agree or strongly agree with the statements included in the surveys. Figure 12 shows this relationship.

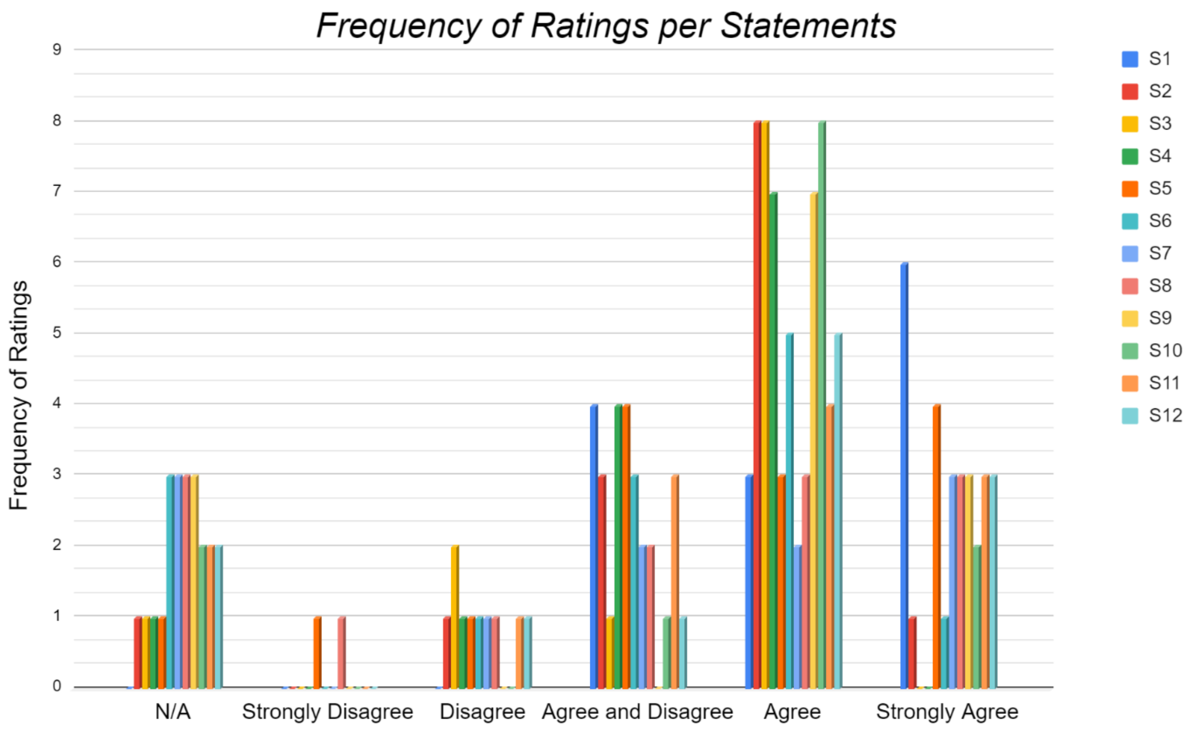

Figure 14: Alumni survey responses

As mentioned previously, almost half of the alumni that opened the survey did not complete it. Due to this, we concluded that the data was not appropriate for analysis. This is significant because it may show flaws within our survey. A possible reason for the alumni not answering is because they did not understand what we were asking. Our statements may have been confusing or the platform was not something alumni have had experience within the past. Another possibility for the low response rate we received was the lack of access our team and our sponsor had to alumni. UIR's Computer Science department does not have a list of contact information for alumni, so our team had to search for each alumnus on LinkedIn. The survey was sent by our sponsor's assistant through LinkedIn, which alumni may not check regularly or may not feel as inclined to answer if it is not sent through email. If this survey is used to assess this program in the future, we recommend revising the alumni survey to simplify the questions and sending it out primarily through email to see if the responses increase. This would also mean that UIR should start collecting current alumni information immediately. By collecting more complete alumni surveys, the program will be able to receive more feedback from members of industry about the skills students should have before entering the workforce. This will help improve the program overall.

4.1.2 Students are seeking real-world, hands-on opportunities

Our team interviewed current students to gain their perspective of the Computer Science program. Students mentioned many important themes and topics that revolved around technical applications such as opportunities in labs, projects, and places of employment. Students also mentioned other relevant themes regarding the resources they have and how professors have been supporting them. Overall, students expressed their satisfaction with the program but emphasized an important theme regarding technical skills. Various students stated that the program could improve the number of opportunities to engage in hands-on learning applications. Table 3 shows the major themes from all the constituency interviews, which illustrates our inductive coding process as well as how themes relate to one another.

<table>
<tr><th>Open Coding</th><th>Axial Coding</th><th>Selective Coding</th></tr>
<tr><th>Students</th><th>Students</th><th>Students and Alumni</th></tr>
<tr><td>Theme 1: Internship/Job</td><td rowspan="2">Major Theme: Want more opportunities to apply skills
Combines: Technical skills/soft skills, Practice/Theory, Project/Hands-on</td><td rowspan="6">Major Theme: Want more opportunities to apply skills
● Alumni interview supported student interviews in wanting more opportunities to apply and practice skills
● UIR has improved because students said they had help from UIR finding jobs but alumni said there was no help</td></tr>
<tr><td>Theme 2: Practice/Theory</td></tr>
<tr><td>Theme 3: Resources</td><td rowspan="2">Major Theme: Great experiences with faculty and university
Combines: Professors, Resources</td></tr>
<tr><td>Theme 4: Lab</td></tr>
<tr><td>Theme 5: Projects/Hands-on</td><td rowspan="2">Major Theme: Want more resources to find job opportunities
Combines: Resources, Internship/Job</td></tr>
<tr><td>Theme 6: Professors</td></tr>
</table>

<table>
<tr><td>Theme 7: Technical skills/Soft skills</td><td>Major Theme: Want lab to have more real-world applications and projects
Combines: Lab, Technical skills/Soft skills, Resources</td><td rowspan="6">Major Theme: Want lab to have more real-world applications
Alumni interview supported student interviews about wanting to partner with companies and have real world applicable project
This leads us to think that it would be helpful to have partnerships with companies, or at least allow students to do projects based on real world situations</td></tr>
<tr><td>Alumni</td><td>Alumni</td></tr>
<tr><td>Theme 1: Internship/Job</td><td rowspan="2">Major Theme: Want more opportunities to apply skills
Combines: Practice/Theory, Internship/Job</td></tr>
<tr><td>Theme 2: Practice/Theory</td></tr>
<tr><td>Theme 3: Resources</td><td rowspan="2">Major Theme: Want lab to have more real-world applications.
Combines: Resources, Practice/Theory, Lab</td></tr>
<tr><td>Theme 4: Lab</td></tr>
</table>

Table 3: Interview Inductive Coding table

Overall, we found that students desired activities such as lab experiments, projects, assignments, and other practical applications to help develop technical and soft skills. Students viewed technical skills as very important both for applying their knowledge as well as being able to complete the tasks required by employers. Students also recognized the importance of soft skills, such as teamwork, since these skills are important for success in the global workforce. The results of the one alumnus interview we conducted also emphasized the need for students to have hands-on opportunities that relate to industry. The interviewee also suggested that employers should give feedback to the Computer Science program based on what skills they are looking for. This would help the Computer Science program shape their courses around the needs and standards of industry, which would help students prepare for the competitive job market. One recent improvement in the program we made note of was that the current students said faculty assisted them in finding jobs and internships, whereas the alumnus said faculty did not give them any assistance. This indicates that the program has improved its student assistance in finding job opportunities in recent years and is evidence that this program is continuously improving.

Overall, we found that students and alumni believed that UIR offers a valuable education. However, both students and alumni suggested that the program could prepare students for the workforce better if it provided them with opportunities to apply real-world skills.

4.1.3 Overall analysis of findings

Based on data collected by both interviews and surveys, we found that students are seeking more opportunities to apply their technical and soft skills in the classroom and lab. This was because students expressed that they learned more by actively participating in their learning. Students also want more opportunities to apply their skills to real-world projects so that they can be better prepared for the global workforce and to learn more about the industry. Based on feedback from alumni, our team found that the Computer Science program may not be providing the resources to obtain these opportunities. We found that alumni and student data had more significant negative responses to statements about the industrial practices and hands-on experiences. This indicates that faculty may not be aware that students feel they are missing opportunities. It is important to note however that students and alumni may not have understood the phrases used in Statement 11, which would reflect more on the survey itself than the program. Overall, our team concluded that students expressed satisfaction in the Computer Science program but felt that the administration and faculty could improve industry and hands-on related experiences.

4.2 Course Outcome Map Findings

4.2.1 Observing course outcome inconsistencies

Our team found that course outcomes throughout all courses in the Computer Science program were not consistently structured. First, we observed that faculty did not have a uniform use of active verbs that related to the IRE system. For example, given two of the same course outcomes, one professor would use “create” while another professor would use “analyze”. Appendix H displays that “create” and “analyze” are categorized under different levels of the IRE system which would mean the same course outcome would address student outcomes differently. This creates inconsistency within the program. In Appendix I, we provided examples of course outcomes that used active verbs ineffectively or did not use them at all, along with an analysis of how to improve these course outcomes and suggested active verbs. Based on the varying use of active verbs in course outcomes, there may not be an understanding of the IRE system and how it applies to active verbs. Our team noticed that the department offered no structure or guidance to help professors create their course outcomes in their syllabi. Professors may not be seeking out information about active verbs and the IRE system as well if they are not informed about ABET and its value for their courses, their students, and themselves. This could indicate that professor involvement has an impact on the use and understanding of active verbs in course outcomes. We also noticed that professors tended to have course outcomes that all addressed a single student outcome. Often, course outcomes were all on the same level of I, R, or E as well. For example, a course could have had six different course outcomes, but all the course outcomes were on the "R" level of the IRE system and the outcomes only applied to student outcomes 1 and 6.

The second inconsistency we observed was that the number of course outcomes in each course varied from 2-10. Figure 5 shows that there are eight courses with 2-3 course outcomes, 31 courses with 4-5 course outcomes (the target amount), and 47 courses with over 5 course outcomes.

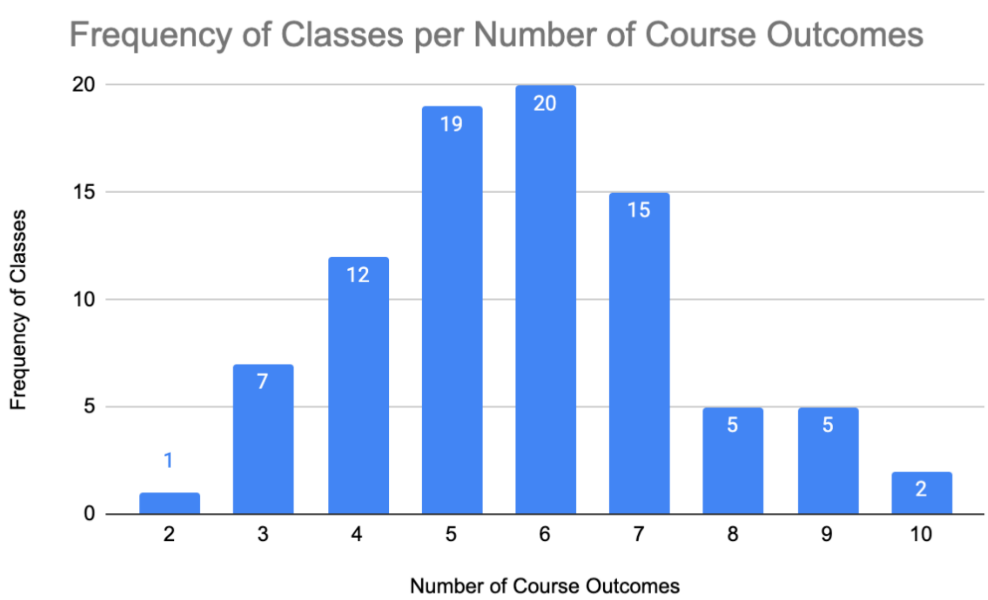

Figure 15: Number of course outcomes per course

This is significant because students may also struggle to understand what is expected of them in a course if there are too many course outcomes. Our sponsor expressed to our team that a professor should not have more than five course outcomes per course, which is why we have emphasized this finding. Including less than three course outcomes does not provide adequate information and having more than five makes the course too complicated (Boston University [BU], n.d.). The purpose of course outcomes is to provide students with a broad understanding of the skills that they will gain from a course, but those skills may become unclear if there are too many listed by the professor. Narrowing down the course outcomes will also encourage faculty to address multiple student outcomes in one course outcome. For instance, since student outcomes 3-5 relate, it is possible to address more than one in a course outcome. Almost 50% of the faculty did address more than one of student outcomes 3-5 and a little over half of the professors that addressed at least one of student outcomes 3-5 included all three student outcomes. This tells us that faculty are able to address more than one student outcome per course outcome. Overall, we found that there was not a standardized form for faculty to structure their course outcomes to appropriately address all the student outcomes. While the course outcomes seemed to be a good technical representation of courses, there was a lack of understanding about the need to correlate course outcomes to ABET's student outcomes.

4.2.2 Addressing courses that do not align with student outcomes 3-5

Student outcomes 3-5, which relate to teamwork, communication, and ethics, were under-addressed by the program overall. We found that approximately half of the courses currently listed did not cover student outcomes 3-5 at all. Table 4 shows this data.

How Courses Address SOs 3-5	Number of courses	*Percentage out of 90 courses*
Courses addressed by AT LEAST one SO 3-5	43	47.78%
Courses that address ALL three SO 3-5	22	24.44%
Number of courses that addressed NO SO 3-5	47	52.22%
Total Number of Courses we analyzed:	90	

Table 4: Courses addressing student outcomes 3-5

Many of the course outcomes focused heavily on technical skills. Overall, the evidence indicates that the focus of the CS program is primarily on technical skills and not on “soft skills”. Skills such as communication and teamwork are important for students to practice in order for the program to qualify for ABET accreditation. To prepare students for the global workforce, soft skills and technical skills should have equal importance. This program should have an even distribution of course outcomes related to student outcomes, and our team has found that it does not.

4.2.3 Overall analysis of findings

The primary issue with these findings is that the program must follow the ABET criteria and student outcomes in order to even begin the ABET accreditation process. If the program cannot prove they are addressing these criteria, they will not receive ABET accreditation. Additionally, not understanding the use of active verbs in relation to the IRE system limits a course's ability to properly communicate what students should achieve. While the course may allow students to practice skills like teamwork and communication in the classroom, they are not communicating these skills in their course outcomes. If course outcomes do not communicate these skills, then ABET program evaluators will not be able to assess the program properly. Part of the reason that professors may lack an understanding of the relationship between course outcomes and ABET criteria is because this program is still at the very beginning stages of the accreditation process. This means professors may not have been told or may not be aware that course outcomes should address these criteria. Overall, a program seeking ABET accreditation must address and meet the standards for all ABET criteria.

4.3 Consistency Table Findings

4.3.1 Observing the inconsistent structure of course and lab descriptions

When our team compared course and lab descriptions, we struggled to consistently assess the alignment of course and lab content. Professors use syllabi to state course descriptions and topical outlines. The lab description as well as the necessary tools for the lab are not included in syllabi. This may have been one reason why there were multiple courses missing lab descriptions and tools in the course and lab spreadsheet we received from our sponsor. For example, in semesters 6-9, course syllabi contained no description of tools used. Another reason tools may not have been listed in this spreadsheet is because professors may have already added their tools in the lab description. Our team assessed the lecture and lab content by utilizing a consistency table. We want to emphasize to our sponsor and the UIR faculty that the comparisons our team made are suggestions based solely on the course and lab descriptions, not on the course itself. In other words, the course and lab content may align but we cannot confirm this based on what was provided to our team. Additionally, our group has not taken these courses and cannot speak for how the course itself compares to both descriptions.

Another reason that our team could not make the claim that the content aligned was because the structure of the course and lab descriptions varied. Professors used multiple formats to communicate the purpose, topics, and skills students should acquire in their courses and labs. For example, many course descriptions consisted of a bulleted list of topics that would be applicable to lecture. In other instances, some course descriptions were in the format of a paragraph that solely described the purpose of the course. While comparing the content of the lecture and lab descriptions was possible, our team found it difficult to standardize the process in which we addressed each course. We had to take different approaches to assess each type of description format, which meant our comparisons were inconsistent. Without a standardized outline for each course, it was unclear how the lecture and lab portion related and if faculty implemented tools in the lab. While the purpose of this objective was not to assess the structure of course and lab descriptions, our team felt that this was a valuable finding for our sponsor and other faculty. In order to assess the alignment of lecture and lab content, an ABET evaluator needs to have a clear understanding of what the content is. Faculty also may not know that it is important to have a clear description of tools to aid and continuously improve the alignment of the course and lab content. To begin the ABET accreditation process, the information presented in these descriptions needs to be easy to understand and in the correct format. Overall, we found that to meet the ABET criteria, UIR administration must address the lack of alignment between the lecture portion and the lab portion of a course.

4.4 Conclusion of Findings

This chapter presented an analysis of the data organized and gathered through our interviews, surveys, curriculum maps, and consistency tables. One primary theme in our findings was that the students and alumni felt they did not have enough hands-on and technical experience. Another primary theme in our findings was that there is a lack of structure in the materials that the program used to describe courses. Based on our findings, our team was able to formulate a series of recommendations which was intended to assist the Computer Science program to align more with the ABET criteria. In the next chapter, our team will describe these recommendations, as well as conclusions, deliverables, and limitations.

Figure 16: UIR students at graduation

5. Conclusions and Recommendations

This chapter will discuss our teams' conclusions and recommendations for our sponsor, Professor Boulmalf, and the Computer Science program at UIR based on our findings from the Findings and Analysis chapter. The recommendations our team has formulated include providing more industry-related hands-on experiences, improving the alignment of course outcomes to meet ABET criteria and student outcomes, and standardizing the structures of course and lab descriptions.

5.1 Providing More Industry-Related, Hands-On Experiences

5.1.1 Providing students opportunities to apply both technical and soft skills

Based on our analysis of the surveys sent out to students, we found that students seek more opportunities to develop technical skills in practical applications. To address this, we recommend that professors offer more experiences and lab activities for students to help develop their technical skills. These experiences could be team projects, research, collaborations with companies, employment opportunities, or activities that give students the chance to practice what they learned in the classroom. Our team made this recommendation because students expressed that technical skills are very important to have after graduation. Student felt that employers preferred interns or graduates with technical experiences.

Based on the surveys sent out to faculty**,** we found that they agreed with most of the questions about the student outcomes in the survey. However, some faculty expressed that their courses did not reinforce skills regarding communication, teamwork, and leadership. Our team recommends that faculty implement more activities such as group projects where students can work on developing communication and teamwork skills. This recommendation further emphasizes the recommendation we made previously from student input about including more practical applications.

5.1.2 Preparing students more for the global workforce

From our findings, which we analyzed using inductive coding techniques (see Table 3), we have concluded that students want to learn less theoretical knowledge and practice more skills that pertain to industry. The students and alumni believed this was important to ensure that students are meeting the industry standards and actively preparing for the workforce.

Our group drew on these conclusions and we recommend that professors try to assess students with projects more frequently. We also recommend that projects should relate to real-world problems so that students not only practice but apply their knowledge. To determine what these real-world problems might be, we suggest that faculty and administration work closely with industry professionals who may also offer advice about the program curriculum. If the administration is up to date with industrial professors, they will have a better understanding of current industrial practices and needs. Part of the ABET accreditation goal is to help programs prepare graduates to be successful in the global workforce. By having more hands-on learning experiences and working directly with industry professionals, the program will be following ABET criteria.

5.2 Improving the Alignment of Course Outcomes to Meet ABET Criteria

5.2.1 Standardizing active verb usage

Based on our findings, we have concluded that faculty may not be equally informed, or willing to seek out information, about active verb usage in course outcomes and how these verbs relate to Bloom's Taxonomy and the IRE system. Faculty may not be actively seeking out information about active verbs, the IRE system, and Bloom's Taxonomy because they may not understand the value of the ABET accreditation process for the program and themselves. Our recommendation is for the Computer Science program to educate faculty about active verbs and the IRE system to ensure that all professors use active verbs appropriately in their course outcomes. Education could include seminars for faculty about the IRE system and Bloom's

Taxonomy, or online educational models that would calibrate faculty's use of active verbs in relation to Bloom's Taxonomy.

To address this recommendation, we created an educational tool that illustrates the relationship between course outcomes, active verbs, Bloom's Taxonomy, and the IRE system. Refer to Appendix H. This educational tool is an infographic we made in Canva that defines the terms active verb, Bloom's Taxonomy, and the IRE system. We also included a section that shows the funneled relationship between active verbs. These active verbs can be categorized by the six levels of Bloom's Taxonomy. The levels of Bloom's Taxonomy can also be categorized by the IRE system. The infographic also gives some instruction on the relationship between the Bloom's Taxonomy levels that active verbs fit into and the intended level of a course outcome. At the bottom of the infographic, we provided examples of how to use active verbs in course outcomes at the bottom of the infographic.

We recommend use of this infographic because it is important for faculty to have a uniform understanding of active verbs and the IRE system so that their course outcomes effectively communicate what skills professors are teaching in the classroom. This uniform understanding is also important when comparing courses. Comparing courses, specifically when using the IRE system, that have a different use and understanding of active verbs cannot be effectively compared. This is an issue because the courses should all connect since they make up the curriculum of the Computer Science program. This curriculum is what ABET will assess.

5.2.2 Improving the distribution of course outcome alignment with student outcomes 3-5

To provide evidence of the Computer Science program meeting the ABET criteria, the student outcomes for this commission need to be well aligned with the course outcomes in the entire program. As our group discussed in our Findings and Analysis section, student outcomes 3-5, which focus on teamwork, communication, and professional ethical skills were under-addressed by course outcomes in the program overall. Course outcome mapping charts are a common and key piece of evidence used in self-study reports for programs that are going through the ABET accreditation process (ABET). From our findings, we recommend that professors incorporate soft skills into their courses to address student outcomes 3-5, to further improve the distribution of alignment between course outcomes and student outcomes. This is particularly important for introduction courses, as we found that many introductory level courses did not align with student outcomes 3-5. For a student outcome to be properly introduced, reinforced, and emphasized, professors need to incorporate course outcomes that address all six student outcomes into each semester.

Some suggestions we have for this recommendation include providing faculty with tools to better understand the IRE system and how it applies to course outcomes. To address this recommendation, we created course outcome mapping charts for each course in the Computer Science program and assessed each alignment to student outcomes based on the IRE system. Faculty can look at the course outcome map for their course and reflect on the assessment that our team provided to better understand the relationship between student outcomes and the IRE system to course outcomes. In addition, we recommend that professors incorporate more learning opportunities, such as group projects, that would allow students to learn and practice the skills emphasized in student outcomes 3-5. By creating more technical group projects or opportunities for students contact companies, students have opportunities to practice communication, teamwork, and ethical skills. Another way for faculty to improve their distribution of course alignment is to narrow down the number of course outcomes each course had. We recommend that faculty narrow down the number of course outcomes to four or five per course.

5.3 Standardizing the Structures Used to Assess Course and Lab Content

5.3.1 Assessing the alignment of lab and lecture content by faculty

According to the materials our sponsor provided us about lecture and lab content, we have concluded that the content of most courses and labs align well, but that our analysis of this alignment is incomplete. This is because we were given limited information about each lecture and lab and could not accurately compare them. Our team recommends that professors assess their own courses utilizing consistency tables. Professors have a first-hand experience in both of these portions of a course, so they can more accurately compare the lecture and lab content. We recommend that faculty use our comparisons as a starting point to begin their own assessment but that it should not influence their assessment greatly as we are providing our perspective as a third-party viewer of a course, we did not participate in. Further, continuous faculty assessment of lecture and lab content will be valuable in the ABET accreditation process to provide evidence that the program is continuously improving.

5.3.2 Outlining the course descriptive materials

To assess the alignment between lecture and lab content, we used consistency tables that consisted of course descriptions, lab descriptions, and tools used for each course in the Computer Science program. Our findings from these consistency tables led us to recommend that the Computer Science program follows a standardized outline for faculty to use when comparing their lecture and lab components. This standardized outline would allow professors to have a clear understanding of where to put course information and to assess their own lecture and lab content and compare this with content from other courses. To address these recommendations, we have created a standardized outline for the course description, lab description, topical outline, and tools used. See Appendix J for this outline. We created these outlines which derived from examples of courses that we found to be the most effective for content comparisons. This is based on our experience analyzing each course and lab description.

While the topical outline can help compare lecture and laboratory content, it is important to differentiate the course topical outline and the course description, as they have different purposes. The purpose of the topical outline is to give a list of the topics that faculty will cover throughout the lecture while the course description is about the purpose of the course and the skills that students should gain at the end of the course. We found that the most effective comparison occurred when the course description was similar to a course topical outline and when the lab description was also structured as an outline of the activities or concepts applied in the lab. For this reason, we recommend that professors compare course and lab content using topical outlines, not descriptions. In the outline we created, we added a course topical outline and lab topical outline for faculty to use for the purpose of comparing the content of these two components of a course. We also provided outlines for course and lab descriptions. If faculty choose to use this outline, or an alternative outline agreed upon by the program, they should be able to communicate the alignment of lecture and lab content more easily, especially when assessing the program overall. Doing this will help improve clarity for the ABET review when they are looking at course and lecture alignment.

5.4 Summary of Project Deliverables

From our results of the surveys we created for students, alumni, and faculty, we produced a series of recommendations based on the themes we found while using statistical techniques and analysis techniques to analyze our data. We intended for our recommendations to help the Computer Science program at UIR better align their course outcomes with ABET's student outcomes and program educational objectives. We also produced a template survey to help our sponsor survey employers about the Computer Science program. Other deliverables include surveys for students, faculty, alumni, and employers from the Automotive and Aerospace program and the Renewable Energy Program.

Our findings from the interviews conducted with students and alumni led us to produce a series of recommendations based on the themes we found while using inductive coding to analyze our data. We also produced interview questions for faculty and employers for our sponsor to use later in the ABET accreditation process. These interview questions are not program specific since they are based on the general ABET criteria, so other programs could use these questions as well for future constituency interviews.

Based on the results of the course outcome mapping charts, we have produced three deliverables. The first deliverable is the document which contains the course outcome mapping chart with course outcomes and student outcomes for each individual course. This will allow professors to understand how we assessed their courses using the IRE system and course outcomes. We have also created a master course outcome mapping sheet which only includes the course name to summarize the course outcome mapping charts for the entire program. This is in the form of a spreadsheet and allows our sponsor to see where there may be gaps in the student outcomes or in the IRE system. The third deliverable we produced is an educational infographic for faculty about active verbs. This deliverable relates course outcomes, active verbs, Bloom's Taxonomy, and the IRE system to help faculty easily understand how to use active verbs properly in their course outcomes.

In light of the results of our constituency tables, we produced two deliverables. The first deliverable is the spreadsheet of the consistency tables and our own comparisons of course content for each course. This spreadsheet is organized by semester and module. The second deliverable we produced is a standardized outline that we recommend for faculty to use when comparing lecture and lab content in the future. This standardized outline includes outlines for course descriptions, course topical outlines, lab descriptions, lab topical outlines, and tools used in the lab.

5.5 Limitations

Completing this project remotely was a major limitation that our team faced. Having a remote project limited our methods in many ways. Another limitation was that we did not have the necessary contact info of individuals to set up interviews on our own. We were at the discretion of our sponsor to help us reach out to students, alumni, and faculty; Unfortunately, faculty did not respond to our emails, so we did not have faculty interviews. This may have changed our recommendations as well because if we had been able to hear about the perspective of more faculty and alumni, we may have had different and/or more findings. We were also in a different time zone which made scheduling a time to meet more complex than if we were able to interview in person.

Another limitation our team faced was that faculty were resistant to do the extra work of gathering material from their courses. Due to this we were only able to help our sponsor complete the preliminary work for one program instead of the initial goal of four programs. Our sponsor was not able to gather information about the other three engineering programs we aimed to analyze. Our sponsor ran into obstacles in obtaining the syllabi from faculty in the Aerospace/Automotive and Renewable Energy programs. Faculty are reluctant in gathering and sending the forms and information. The self-study reports required by ABET are time consuming, and faculty could see them as tedious and extra work. For this reason, if our sponsor does not convince faculty of the process's benefits, faculty will be reluctant to do the necessary work.

Similarly, the recommendations we made that suggest professors modifying their way of teaching or the structure of their course(s) may be unknown due to Morocco's education system.

We gained a better understanding of this when interviewing and surveying the constituencies at UIR. We learned that the majority of the professors at UIR used the French pedagogical model that revolves around memorization and theory (M. Boulmalf, personal communication, March 4, 2021). While our team offered suggestions about UIR professors deviating from this model, they have the agency on how they choose to teach. In other words, professors might be reluctant to even consider the recommendations we conveyed to our sponsor about implementing more practical experiences for their students. It is also important to address the political aspect of the Moroccan education systems as an obstacle for our project. We learned that the Ministry of Education in Morocco determines how and what educational institutions like UIR can teach (M. Boulmalf, personal communication, March 4, 2021). While we have tried to be mindful of the cultural challenges that may arise at UIR, there are bigger, moving parts such as the Ministry of Education in Morocco that could hinder our suggestions.

Figure 17: UIR's beautiful campus

Since we completed our project remotely and virtually, we had to utilize virtual methods and tools to gather and collect data. We had to perform our interviews and meetings over Zoom. At times, internet connectivity proved to be a challenge for us to communicate with our project's stakeholders in Morocco. For example, when we would meet with our sponsor to discuss the details and progress of our project, there were moments during meetings where participants would disconnect from the call due to internet problems. Technical difficulties would also arise for us as a group and our sponsor as well. There were moments where our sponsor could not communicate with us at the start of our meetings because his microphone or camera were not functioning properly. While these were minor obstacles, it is important to understand we lost valuable time when these problems arose. Similar situations would also happen when we conducted interviews with students at UIR. Internet connectivity was a main issue we encountered when conducting these interviews. There were times where the interviewee would disconnect from the call or encounter poor internet connection that would cause their audio to sound choppy. When their audio sounded incomprehensible due to the poor connection, it made it difficult for us to accurately understand and record their responses.

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Appendix A

ABET Criterion (ABET, n.d.)

General Criteria:	Components

Students	• Admission
	• Advisement
	    ○ Academic
	    ○ Career
	• Transfers
	• Graduation Requirements

PEOs	• Describe what graduates can do several years out of program: • consistent with university mission, constituency needs, ABET • Established with process and systematic review
SOs	• Student outcomes describe what students are expected to know
Continuous Improvement	• Regularly use appropriate, documented processes to assess and evaluate the extent to which the student outcomes are being attained • Systematically use these results as input to continuously improve the program

	• May use other available information to assist in the continuous improvement of the program.
Curriculum	• Program requirements must be consistent with PEO's and designed to student outcomes are attained • Technical and professional requirements, general education requirements electives to prepare for professional career, further study in the discipline and function in modern society. • At least one year of fundamental and advanced topics • Mathematics appropriate beyond pre-calculus. • Publish all course and program requirements and expectations.
Faculty	• Expertise and experience • Breadth and depth to cover program • Sufficient to cover the program • Have responsibility and authority over the program.

Facilities	• Classrooms, offices, labs
	    ○ Equipment, software
	    ○ Library
	    ○ Information services
	• Systematic acquisition, maintenance, upgrading, replacement

Institutional Support	• Institutional services • Financial support • Staff • Faculty attraction, retention • Space • Infrastructure

Appendix B

Appendix B.1: Engineering Program Educational Objectives and Student Outcomes

(ABET, n.d.).

(M. Boulmalf, personal communication, December 11, 2020).

Program Educational Objectives (set by UIR's Engineering Programs)
1. Apply fundamental engineering knowledge, industry perspectives and research skills to become experts or leaders within a chosen engineering career path.
2. Exhibit life-long learning and develop personal and teamwork skills in order to effectively solve real-life problems and clearly communicate their results.
3. Practice ethical responsibility and accountability in professional activities and actively participate in professional development.
Student Outcomes (set by ABET Engineering Accreditation Commission)
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgement to draw conclusions.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Appendix B.2: Computing Program Educational Objectives and Student Outcomes

(ABET, n.d.).
(M. Boulmalf, personal communication, December 11, 2020).

Program Educational Objectives (set by UIR's Computer Science Program)
1. Graduates will apply principles and practices of computing grounded in mathematics and science to successfully complete software-related projects to meet customer business objectives and/or productively engage in research. Have the ability to adopt new technology, tools, paradigms, and design methodologies.
2. Understand and deploy principles from theory of computing, mathematics, statistics, and theories of programming languages, in appropriate contexts, when needed.
3. Graduates will creatively solve problems, communicate effectively, and successfully function in multi-disciplinary teams.
Student Outcomes (set by ABET Computing Accreditation Commission)
1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgements in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

Appendix C

Appendix C.1: Survey Questions for Students

Student Survey Questions
Program: Computer Science

	Based on the courses you have taken, with 5 = strongly agree, 1 = strongly disagree, rate how you agree with these statements.				
	5	4	3	2	1
1. I am very confident in my ability to apply my knowledge of computing, mathematics, and science to identify solutions in software and/or hardware problems	○	○	○	○	○
2. I am able to analyze collected data that verifies or contradicts a form hypothesis.	○	○	○	○	○
3. I am able to evaluate various solutions to a problem and, if possible, innovate solutions before choosing the best case solution.	○	○	○	○	○
4. I am able to design, implement, and evaluate a computing-based solution in order to meet a given set of computing requirements.	○	○	○	○	○
5. I am able to communicate effectively with persons from other professions or disciplines.	○	○	○	○	○
6. I was provided with adequate opportunities to help me recognize professional responsibilities in a computing practice.	○	○	○	○	○
7. I was provided with adequate educational opportunities to help me understand the importance and impact of computer science on a societal level.	○	○	○	○	○
8. I was provided with adequate opportunities to help me improve my skills to function effectively in a group or team as a leader or productive team member .	○	○	○	○	○
9. I was provided with adequate opportunities to help me achieve a deeper level of theoretical knowledge in at least one area of focus of computer science.	○	○	○	○	○
10. I was provided with adequate opportunities to use fundamental techniques, skills, and tools to practice with software development.	○	○	○	○	○
11. I was provided with adequate opportunities to help me develop my technical skills for industrial practice.	○	○	○	○	○

Appendix C.2: Survey Questions for Faculty

	Based on the UIR students you supervise, with 5 = strongly agree, 1 = strongly disagree, rate how you agree with these statements. N/A (Not applicant to me)					
	5	4	3	2	1	N/A
1. My students were provided with adequate opportunities to practice applying computing principles to analyze basic computing problems.	○	○	○	○	○	○
2. My students were provided with adequate opportunities to practice applying computing principles to analyze complex computing problems.	○	○	○	○	○	○
3. My students were given the opportunity to design a solution to a set of computing-based requirements.	○	○	○	○	○	○
4. My students were given the opportunity to implement a computing-based design that meets a set of computing-based requirements.	○	○	○	○	○	○
5. My students were given the opportunity to evaluate a design which was implemented to meet a set of computing-based requirements.	○	○	○	○	○	○
6. My students were provided adequate opportunities to practice communicating professionally both in person and online.	○	○	○	○	○	○
7. My students were given feedback or resources to better communicate professionally for in person and online interactions.	○	○	○	○	○	○
8. My students were given adequate opportunities to recognize their professional responsibilities in computing based situations.	○	○	○	○	○	○
9. My students were given adequate opportunities to make informed judgements in computing practices based on legal and ethical principles.	○	○	○	○	○	○
10. My students were provided adequate opportunities to work with peers during computing related tasks.	○	○	○	○	○	○
11. My students were provided with adequate opportunities to practice leadership skills in teamwork settings.	○	○	○	○	○	○
12. My students were provided with adequate opportunities to practice their understanding of computer science theory and software fundamentals.	○	○	○	○	○	○
13. My students were given adequate opportunities to practice solving computing based problems using their knowledge of computer science theory and software fundamentals.	○	○	○	○	○	○

Appendix C.3: Survey Questions for Alumni

Alumni Survey
Program: Computer Science

	Rate your ability based on how well the CS program at UIR prepared you in each statement based on PEOS. 5= Strongly agree, 1= Strongly disagree				
	5	4	3	2	1
1. I apply principles and practices of computing to successfully complete soft-ware related projects.	○	○	○	○	○
2. I complete soft-ware related projects to meet customer business objectives.	○	○	○	○	○
3. I adopt new technologies, tools, and design methodologies.	○	○	○	○	○
4. I understand and can apply principles from the theory of computing in context.	○	○	○	○	○
5. I understand and can apply principles from the theory of mathematics/statistics in context.	○	○	○	○	○
6. I understand and can apply principles from the theory of programming languages in context.	○	○	○	○	○
7. I solve problems and communicate effectively in multi-disciplinary teams.	○	○	○	○	○
8. I am a productive member of society through my area of discipline.	○	○	○	○	○
9. I have high ethical and professional standards that I make technical decisions with.	○	○	○	○	○
10. I am able to be a leader in a range of technical contexts.	○	○	○	○	○
11. I seek new learning opportunities everyday.	○	○	○	○	○

Appendix D

Consent Form

We are asking you to participate in a research study titled "Assisting the International University of Rabat in Obtaining ABET accreditation." We will describe this study to you and answer any of your questions. This study is being led by Rachael Zmich, Genavieve Lombara, Anthony Algieri, Johvanni Perez, and Tarik Ourdyl, for a student project at Worcester Polytechnic Institute. The Faculty Advisors for this study are Rebecca Moody and Mohammed El Hamzaoui, at Worcester Polytechnic Institute.

The purpose of this research is to learn about your experience at UIR in the Computer Science program and how this may impact the post graduate experience.

We will ask you to complete a short, anonymous survey that asks you about your experience. The survey should take no more than 10 minutes.

We do not anticipate any risks from participating in this research.

Information gained from this study may lead to ABET accreditation in the Computer Science program at the International University of Rabat. We hope to learn the students' perspectives of their program to understand the relationship between postgraduate experience and student outcomes.

There will be no compensation or credit given for this study.

Your privacy and confidentiality will be fully protected. The survey is anonymous, and we are not collecting any identifying information. Signed consent forms will be kept separate from the survey data and the two will have no connection.

Your involvement is voluntary. You may refuse to participate before the study begins, discontinue at any time, and skip any questions you are not comfortable answering.

The main researchers conducting this study are Rachael Zmich, Genavieve Lombara, Anthony Algieri, Johvanni Perez, and Tarik Ourdyl, undergraduate students at Worcester Polytechnic Institute. Please ask any questions you have now.

For more information about this research or about your rights as a research participant, may contact us at gr-ucdiqpgroup@wpi.edu or at +1 (518) 772-9746, the IRB Manager (Ruth McKeogh, Tel. +1 (508) 831-6699, Email: irb@wpi.edu), or the Human Protection Administrator (Gabriel Johnson, Tel, +1 (508) 831-4989, Email: gjohnson@wpi.edu).

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you. You may decide to stop participating in the research at any time without penalty.

Statement of Consent

By signing below, you acknowledge that you have been informed about and consent to being a participant in the study described above.

Your privacy and confidentiality will be fully protected. The survey is anonymous, and we are not collecting any identifying information. Signed consent forms will be kept separate from the survey data and the two will have no connection.

Your involvement is voluntary. You may refuse to participate before the study begins, discontinue at any time, and skip any questions you are not comfortable answering.

The main researchers conducting this study are Rachael Zmich, Genavieve Lombara, Anthony Algieri, Johvanni Perez, and Tarik Ourdyl, undergraduate students at Worcester Polytechnic Institute. Please ask any questions you have now.

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Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you. You may decide to stop participating in the research at any time without penalty.

Statement of Consent

By signing below, you acknowledge that you have been informed about and consent to being a participant in the study described above.

Appendix E

Appendix E.1: Interview Questions for Students

Date:

Program:

Graduation Year:

<u>Criteria 6: Faculty</u>

Do you interact with your faculty?

If so: How do you interact? Is there student advising and counseling options?

Do you have opportunities to interact with industrial and professional practitioners? With employers?

<u>Criteria 1: Students</u>

Is your performance in courses being evaluated?

If so: How is your performance evaluated in your course?

Are you being advised by faculty at UIR to help you in terms of classes and career related issues?

Did you apply to UIR?

If so: How did you apply? What was the process like?

Are you a transfer student?

If so, did you feel that your credits from the institution you came from were appropriately credited by UIR?

<u>Criteria 4: Continuous Improvement</u>

Do you feel like you have seen noticeable and purposeful improvements at UIR since you began at this institution?

If so: what have some of those improvements looked like?

Do you feel like the faculty and administration at UIR are actively seeking to make this institution better?

UIR-ABET

Criteria 7: Facilities

Do you have computing resources such as a library, and information infrastructure?

Do you feel as if these resources are helpful?

Do you use laboratory equipment in labs?

If so: Do you have appropriate guidance and learn how to safely use the equipment?

Criteria 8: Institutional Support

Do you believe your program has the proper funding to provide appropriate tools for you to graduate and be successful?

Appendix E.2: Interview Questions for Alumni

Date:

Program:

Graduation Year:

Current job title/future education:

Criteria 1: Students

When you attended UIR was your course performance evaluated?

If so: How was it evaluated?

Were you advised by faculty at UIR to help you in terms of classes and career related issues?

If so: What resources were available to you for this advising?

Are there ways you wish you had been advised differently?

Are there ways UIR could improve their advising opportunities to better prepare students for entering the global workforce?

Were there career or networking opportunities you wish you had while at UIR?

Criteria 4: Continuous Improvement

During your time at UIR, did you see noticeable and purposeful improvements throughout the years?

If so: What did some of those improvements look like?

Did you feel like the faculty and administration at UIR were actively seeking to make the institution better?

Criteria 6: Faculty

Did you interact with your faculty?

If so: How did you interact? Was there student advising and counseling options?

Did you have opportunities to interact with industrial and professional practitioners? With employers?

Criteria 7: Facilities

Did you use tools, software, and other equipment in labs?

If so: Did you have appropriate guidance and learn how to safely use the equipment?
How did your experiences learning how to use lab equipment impact your ability to be successful in the workforce?
Are there certain types of equipment you wish you had been trained how to use while at UIR that would have benefited you today?

Criteria 8: Institutional Support

Did you feel as if your program had the proper funding to provide appropriate tools that helped you graduate and be successful?

Appendix F

Appendix F.1: Detailed Course Outcome Mapping Chart

Below is an example from the Structures Fundamental Class

Course Outcome Map:

Course Name: Structures fundamental	SO1: Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.	SO2: Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.	SO3: Communicate effectively in a variety of professional contexts.	SO4: Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.	SO5: Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.	SO6: Apply computer science theory and software development fundamentals to produce computing based solutions.
CO1: Solve equations in the set of complex numbers	I	I				I
CO2: Apply the Moivre's formula to linearize expressions	I	I				R
CO3: Apply recurrence method for various mathematical problems	I	I				R
CO4: Understand basics of set theory	I	I				I
CO5:Understand main characteristics of groups components of the operating system.	I	I				I
CO6: Apply the following proof techniques: proof by contradiction, proof by induction, proof by contrapositive	I	I				R

Abbreviated version for overall program curriculum map:

	SO1	SO2	SO3	SO4	SO5	SO6
Structures Fundamentals	I	I				R

[Full Course Outcome Mapping Charts Document Link]

Appendix F.2: Abbreviated Master Course Outcome Mapping Chart

Semester	Concentration	Class	Status	SO1	SO2	SO3	SO4	SO5	SO6
One		Initiation to Computing	Complete	I	I				I
		Structures Fundamentals	Complete	I	I				R
		Analysis I	Complete	I	R				I
		Algebraic Structures	Complete	I	I				I
		Electricity I	Complete	I	I				I
		Initiation to Algorithmics	Complete	I	I				I
		Computer Science Initiation	Complete	I	I				I
		History of Science	Complete	I	I	I	I	I	I
Two		Digitalization and Society	Complete			I	I	I	
		Analysis II	Complete	I	I				I
		Algebra II	Complete	I	I				I
		Electricity II	Complete	I	I		I	I	I
		Electromagnetism	Complete	I	I				I
Three		Computer Architecture	Complete	I	I	I			I
		LA Professional Responsibility From the Engineer	Complete			I	I	I	
		Calculus III	Complete	I	I				I
		Responsibility Professional Engineer	Complete			I	R	I	
		Introduction to Operating Systems	Complete	I	R				R
		Introduction to Computer Networks	Complete	I	I				I
		Numerical Analysis	Complete	I	I				I
		Optics	Complete	I	I				I
Four		Enterprise Knowledge	Complete	I	I				
		Digital Electronics	Complete	R	R				R
		Probability & Statistics	Complete	I	E				E
		Signals and Systems	Complete	R	R				R
Five		Accounting Information Systems	Complete	R	E	I	I		E
		Mathematical Programing	Complete	R	R				R
		Advanced Databases	Complete	E	E	I			E
		Logic	Complete	I					I
		Advanced Networls	Complete	R	E	R	R		E
		Object-Oriented Programming	Complete	R					R
Six		Financial Analysis and Reporting	Complete	R		I	I		
		Integrated Project	Complete	E	E		R		E
		Mathematics for Engineer 2	Complete	E	E		R	I	E
		Advanced Software Engineering	Complete	R	R		I		R
		Advanced Web and Mobile Development	Complete	I	E				E
		UML	Complete	R	R				E
		Language Theory and Compilation	Complete	I	R				I

Full Master Course Outcome Map Spreadsheet Link

Appendix G

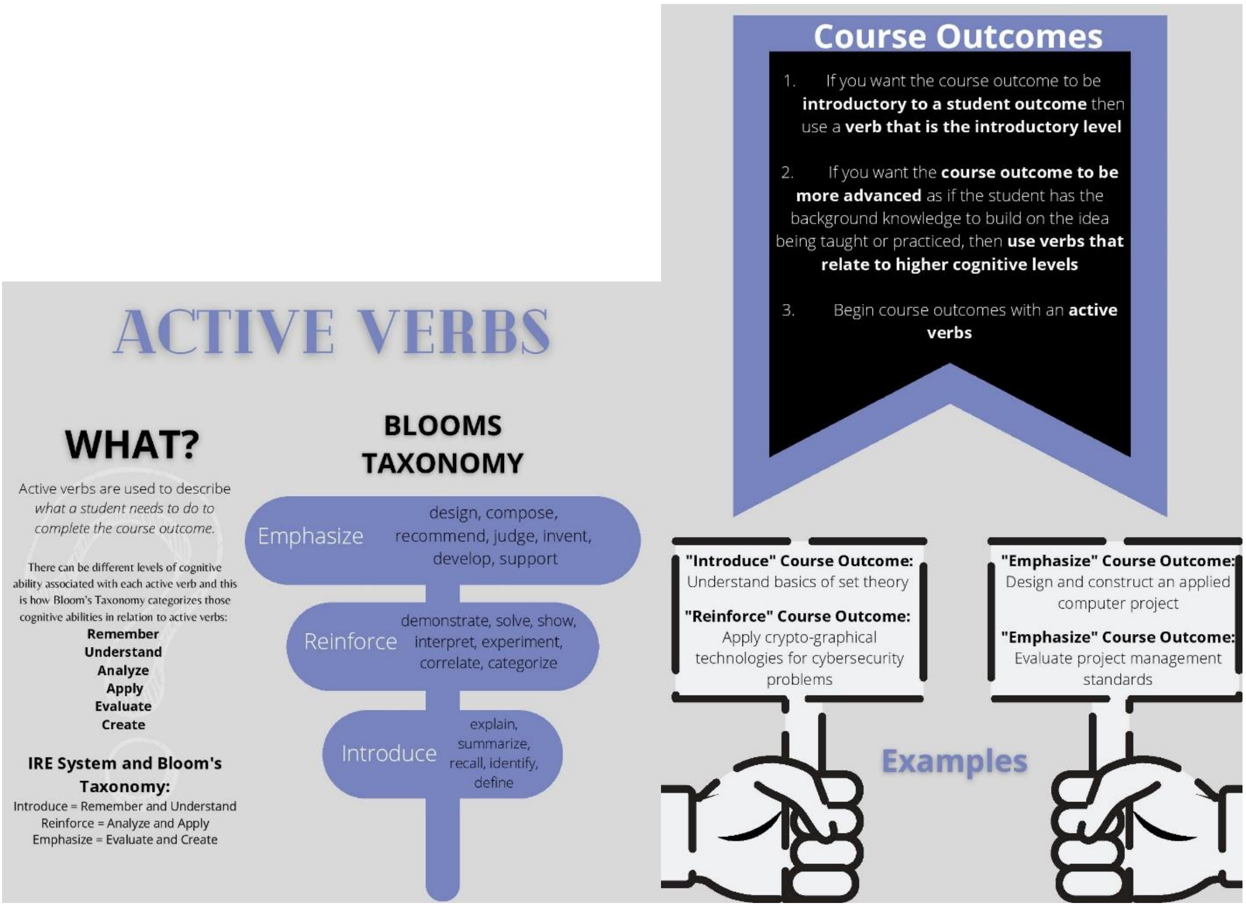
Consistency Table

	A	B	C	D	E	F
1	**Module**	**Class**	**Course Description**	**TP Description**	**Comparison of Course and TP**	**Tools Used**
2	Big Data Technologies II	Big Data Technologies II	Through this module, students will learn other Big Data technologies in order to optimize memory use and computing time. On the other hand, the use of Big Data technologies for streaming would make it possible to process data in real time. Thus the students would be able to develop Big Data applications for various uses.	* Installation of the Spark environment - Spark program (Wordcount,…), Spark operating mode - Setting up of the Spark cluster - Case study using Spark / Mlib 1. E-commerce platform: System of recommendations 2 . Social network analysis 3. Text mining (Analysis of comments on websites) 4. Associations	The topics do not directly line up between course and TP descriptions. The listed assignments are helpful, but the professor could add how the lecture topics inform these assignments.	N/A
3	Data Mining	Data Mining	Data mining aims to identify interesting patterns and associations / relationships hidden in data. These patterns and associations can be used to better understand phenomena and predict the future. This course is designed to introduce fundamental concepts and techniques of data mining, and introduce some of the parallelization methods used in big data. The students will be expected to develop a broad background in the field of data mining and develop skills to solve practical problems. The problems will be presented from various fields, such as social network analysis, e-commerce, stock market, smart city, medicine and life sciences.	* To have hands-on experience with machine learning, the students will apply the different data mining methods presented in the lectures on both simulated and real datasets from different application domains - Using spark / Mlib the dataming algorithms for: associations, clustering, social network analysis ... would be used on large datasets.	The course description has a lot of information and the TP description has helpful information as well. They could be organized more to compare them more easily. There could be a more sequestial topical outline and activities/assignments listed, but they do seem aligned currently.	N/A
4	Deep Learning	Deep Learning	Understand the general principles of neural networks and deep learning, learn how to implement deep learning algorithms using TensorFlow, learn how to accelerate learning using GPUs, and apply deep learning in different application domains.	* TensorFlow layers - Linear models with TensorFlow - Building a convolutional neural network (CNN) in TensorFlow: application to image recognition - Building a recurrent neural network: application to human language Building autoencoders: application to denoising	The course description works well for the TP description because the topics in Course are enforced by the TensorFlow applications in TP. We know TensorFlow is a tool but it is not listed along with any other tools used in the course	N/A
5	Internet of Things	Internet of Things	The Internet of Things (IoT) aims to make real-world things visible and actionable via Internet and Web technologies. The goal of the course is to provide students with a comprehensive understanding of the IoT, from both a technical and economic perspectives. The enabling technologies for the IoT will be explained and existing and developing solutions will be compared. Various real-world applications will be considered to help students gain a practical understanding of the challenges in designing IoT systems. Students will be given the opportunity to apply the acquired knowledge to realize IoT solutions using an experimental platform. At the end of the semester, the teams will present their projects.	* Getting familiar with the provided IoT platform -Implementing simple prototypes -Testing the prototypes as running applications -Project design: * Working as a team to identify an application scenario * Comparing different architectures * Designing the IoT solution * Implementing the IoT solution * Presenting the IoT solution	The course description tells the goal and how and why for the use of the Internet of Thigns (IoT). It talks about how students will be working on projects and the TP description emphasizes this by talking about the IoT platform used by the students needed in their projects	N/A
			The objective of this module is to design a BI project from data extraction to reporting. The different components of the project as well as the tools necessary for its implementation should be mastered by the students. On the other hand, Big Data tools would be integrated into BI in order to provide more possibilities for applications such as NoSQL databases and streaming, to optimize computing	* Talend ETL - Generalized access for students to the IBM BLUEMIX Cloud platform □ Creation of Datawarehouse under DB2 or Informix □ ETL process with IBM Datastage □ Reporting with IBM Cognos □ IBM SPSS Modeler data analysis	The corse description was very vaguage. Dooesn't really talk about the goal and methods in their class. It mentions Big Data Tools. which corresponds to some of the topics in the TP descritpion but no tools were recorded. The TP description is	N/A

Full Consistency Table Spreadsheet Semesters 1-9 Link

Appendix H

IRE System Active Verb Examples and Infographic



Appendix I

Examples of current course outcomes from the Computer Science program, analysis to improve the course outcomes, and suggested new course outcomes using active verbs

Course Outcome	Improvements	New Course Outcome
The student must learn to code algorithms in C language effectively.	This does not include an active verb and does not indicate which level of the IRE system students will be able to use the language in. The verbs used made it unclear for us to tell which level the course outcome was referring to.	"I": Understand how to code algorithms in C "R": Apply C language to code algorithms "E": Create algorithms using code in C language.
Understand the units of measurement in IT. Code numbers in binary. Encode the characters in ASCII encoding. Perform binary operations: Multiplication, division, addition and subtraction. Convert to Binary, Decimal and Hexadecimal.	This addresses many different levels of the IRE system. A course outcome should be a clear statement with one major goal or skill level in mind. This course outcome also addresses topics and tasks rather than transferable skills.	"I": Understand the fundamentals of binary "R": Apply binary to perform operations "E": Create functional binary programs
Laws of Faraday and Lenz	There is no use of active verbs in this course outcome, which makes it difficult to tell what students should gain from this part of the course. Also, this is just a topic, it is not a skill.	"I": Understand the Laws of Faraday and Lenz "R": Solve problems using the Laws of Faraday and Lenz "E": Create a real-world application that utilizes the Laws of Faraday and Lenz

Appendix J

Standardized Outline for Course and Laboratory Content

	Course Description:	Course Topical Outline	Lab Topical Outline
Outline:	The course covers the basic concepts of ________. It's main purpose is to _________. By the end of the course, students will be able to: List 3-4 expected outcomes here using active verbs	List every week and the topics/chapter covered. Week 1: Chapter 1 - Name the topics covered in this chapter Week 2: Chapter 2 - Name the topics covered in this chapter Week 3: Chapter 3: - Name the topics covered in this chapter	Week 1: Activity 1 - Name of the activity and brief description using active verbs Week 2: Activity 2 - Name of the activity and brief description using active verbs Week 3: Activity 3: - Name of the activity and brief description using active verbs
Examples:	**NOSQL DATABASES** The course covers the basic concepts of NoSQL databases, and its main purpose is to familiarize students with their modes of creation, manipulation and interrogation, as well as with tools to perform such operations. Students will be able to: - define, compare and use the four types of NoSQL databases (document, KeyValue, column and graph oriented); - demonstrate an understanding of the detailed architecture, define objects, load data and interact with this data.	**Software Design** Chapter 1: Software Design Fundamentals - General Design Concepts - Context of Software Design - Software Design Process - Software Design Principles Chapter 2: Key issues in Software Design - Concurrency - Control and Handling of Events - Data Persistence - Distribution of Components - Error and Exception Handling and Fault Tolerance - Interaction and Presentation	**Software Requirements and Quality:** Activity 1: Preparation of a Software Requirements Specification (SRS) - The student should elicit, analyze and specify requirements from a stakeholder and then respect the guidelines of IEEE 29148: 2011 for Requirements Specification. The document should contain functional and non-functional requirements.

	Lab Topical Outline	Lab Description	Tools Used
Outline:	Week 1: Activity 1 - Name of the activity and brief description using active verbs Week 2: Activity 2 - Name of the activity and brief description using active verbs Week 3: Activity 3: - Name of the activity and brief description using active verbs	To have technical experience with _______, the students will apply different _______________ for this application. By using tools such as _______, students will be able to participate in the following activities.	Tool 1: Tool 2: Tool 3: Tool 4: Tool 5:
Examples:	**Software Requirements and Quality:** Activity 1: Preparation of a Software Requirements Specification (SRS) - The student should elicit, analyze and specify requirements from a stakeholder and then respect the guidelines of IEEE 29148: 2011 for Requirements Specification. The document should contain functional and non-functional requirements. Activity 2: Preparation of Software Quality Audit Report of Mobile applications. - The student should assess the quality of mobile apps given by the professor according to a checklist. Each student has his / her own checklist that s / he developed by taking into consideration quality sub-characteristics from ISO / IEC 25010 standard. An audit report of the deficiencies identified and recommendations should be prepared.	**Data Mining:** To have hands-on experience with machine learning, the students will apply the different data mining methods presented in the lectures on both simulated and real datasets from different application domains - Using spark / Mlib the dataming algorithms for: associations, clustering, social network analysis ... would be used on large datasets	**Algorithims and Programming II** Tool 1: CodeBlocks Tool 2: Dev C++ Tool 3: Visual Studio Code Tool 4: Sublim Text Tool 5: Microsoft Excel Tool 6: Tableu

Course Outline Spreadsheet Link