Evaluating Information Technology Graduates Employability Using Decision Tree Algorithm

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ABSTRACT
Employability of graduates reflects the quality of skills and competencies gained through a good quality of education provided by the academe that is suitable to the needs of the industry. It is also one of the performance indicators for the level of educational achievement of the tertiary institutions in the Philippines. Hence the importance of giving emphasis to the employability of graduates is imperative. This is the reason why this investigation is being conducted. Descriptive and Data Analysis method were employed in this research. A survey questionnaire was utilized as a data gathering tool to determine the data attributes and employable skills and competencies of the IT graduates. The answers to the questionnaires were tallied and were analyzed and classified using Decision Tree Algorithm of Waikato Environment for Knowledge Analysis (WEKA) Version 3.9.1 wherein prescription of the common skills and competencies for each IT related jobs for IT graduates were obtained.

CCS Concepts
Computing methodologies→Modeling and simulation

Keywords
Decision Tree Algorithm; employability; IT skills and competencies; graduate tracer

1. INTRODUCTION
One of the forefront challenges being faced by the higher educational institutions today is offering quality programs and producing quality results that could be recognized not just in the country but also in the international community. Hence, educational reforms had been introduced specifically in the education parlance that enable a paradigm shift from education to life-long learning, wherein expert knowledge is being spread and learner competencies are formed. Such reforms are spearheaded by the Commission of Higher Education (CHED) in the country through the conversion from inputs-based to an outcomes-based education (OBE) curricula. This has been introduced through CHED Memorandum Order (CMO) No. 46 s. 2012 [1]. The implementation of the CMO requires the curricular offerings and syllabus designs in the higher educational institutions in the country to be anchored on the principles of outcomes-based education by which the emphasis is on quality delivery of its services to the clientele. Further, this memoranda mandates the higher educational institutions in the Philippines to contribute to building a nation through producing graduates with high levels of academic thinking, behavioral skills and competencies that are aligned with national academic and industry and international standards.

Other reforms in the field of education had also been introduced, these are Republic Act 7722 or the Higher Education Act of 1994 [2], Republic Act No. 10533 which is known as the "Enhanced Basic Education Act of 2013, or the K-to-12 Act" [3] and many other regulations issued by the Commission of Higher Education (CHED) purposely for the enhancement of the curricula for the programs offered in the tertiary level. Indeed, higher education's key contribution to the wealth of nations lies in the development of graduates with the competent skills by which they will be ready to face the challenges of this fast changing society (Reich, 2002) [4].

However, the changing nature of work environments, the emergence of technology-driven processes, and the diversified needs of clientele requires the description for employable graduates as being "globally competitive". These are also challenging the ability of higher education institutions (HEIs) to meet the demand for employable graduates (De Guzman and De Castro, 2008) [5]. Such definitions of being employable and employability prompts the tertiary education to revisit their curricula and programs offered and check its usefulness and congruency to the needs of the industries in order to produce proficient graduates that could easily be absorbed by companies. The measurements of being employable also adheres to the human capital theory wherein the personal and professional development of individuals are considered investments in human capital that serve as determinants for his productivity and personal income level. Hence, graduates should make significant investments in their human capital in order to become more marketable to their future employers (Almendarez, 2011) [6]. With the advent of knowledge-based education and economy, globalization and borderless society however, investments in human capital and being marketable should also include knowledge and competencies in technological advancements. There is now a need for retraining or learning new skills and competencies for individuals to cope with the demands of the speedily changing workplace and multifaceted independent world. They should ripen their personal skills, qualities and job experiences and should adopt to the evolving requirements of the labor market.

Evaluating the employability levels of graduates could be done effectively with the aid of data mining and data analytics principles. Data analytics refers to qualitative and quantitative techniques and processes used to enhance productivity and

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business gain. Data is extracted and categorized to identify and analyses behavioral data and patterns, and techniques vary according to organizational requirements. It is the analysis of large volumes of data and/or high-velocity data, which presents unique computational and data-handling challenges. With the application of data analytics the outcomes of graduates were evaluated through: (1) tracking the whereabouts of graduates through sending them triggers and invitations; (2) keep track of each students employability activity for a personalized counselling and (3) know which employability strategies work most effectively in which disciplines and for targeted employers (Kinash, 2015) [7]. Just like data analytics, data mining techniques are being utilized in different areas of discipline because of its ability to rapidly analyses huge amounts of data. This is also being utilized in tertiary schools to analyses academic related data purposely to improve the delivery of its services to the clientele particularly on instruction. Application of data mining are on some researches related to student academic performances, retention policies to improve graduation rate and programs to increase graduates employability. Educational data mining emerges as one tools to study academic data to identify patterns and help for decision making affecting the education.

Although there are numerous researches conducted that determines the competencies in general for the tertiary schools that will make graduates employable and IT competencies in particular that are sought after in the ICT industries and also those that applies data analytics and data mining techniques to academic and employment related data, there is a scarcity of researches conducted that utilizes data analytics or data mining particularly to evaluate the employability level of Information Technology graduates more so in the country and particularly in the province of Catanduanes. This is the gap that is being addressed by this current investigation. This research therefore is being conducted to track graduates of Catanduanes State University from 2010 to 2016 and evaluate their employable IT skills and competencies and then prescribe measures to improve their competitive edge through the use of data analytics technique. Outcomes of this research are the determined skills and competencies of Information Technology graduates that will make them employable in the country and even in the international arena. Likewise this study will have implications on curricular enhancement, reformation and innovation and policy formulation to suit the employable skills of the IT graduates produced to the needs of time. Likewise results this study would enable IT graduates to decipher what IT skills and competencies to possess in order to be employed in their target IT job category.

2. CONCEPTUAL FRAMEWORK

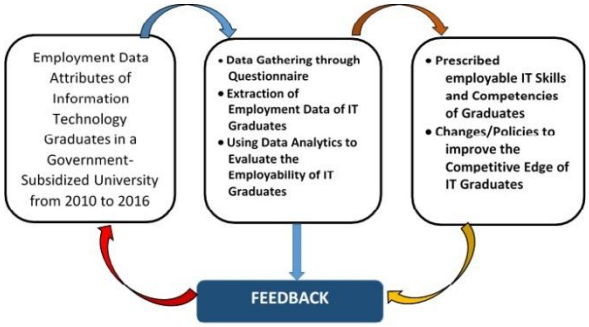

Figure 1. Conceptual Paradigm of the Study

The paradigm of this study is depicted in Figure 1 above. This paradigm followed the input-process-output model of the system theory together with evaluation/feedback wherein refinements could be done for the improvement of the study.

On the input column are the data that were obtained through the responses of the study's respondents particularly their employability attributes. On the process column is the methodology and the manner of analysis that were used in the study. Finally, the output generated by the system which were the IT skills and competencies that makes the IT graduates employable and the recommendations of the IT graduates as regards improving their competitive edge.

3. METHODOLOGY

The study explored the concepts, theories, methodologies and technologies in answering the following questions: (1) What are the employment data attributes of graduates of Information Technology (IT) program of the Catanduanes State University (CSU) from 2010 to 2016? (2) What are the employable IT skills and competencies possessed by the IT graduates of CSU? (3) What are the prescribed employable IT skills and competencies of these IT graduates? and (4) What are the changes/policies needed to improve the competitive edge of IT graduates as regards their employability?

The descriptive and analytical methods of research were adopted in this study. The respondents of the study were all the IT graduates from school year 2010 to 2016. The actual number of graduates, were obtained from the Admission and Registration Office of the Catanduanes State University. Although the population of the study had considered all of the graduates for the specified school year, purposive sampling had been employed in the study since the responses were elicited only from those graduates that had been traced/responded to the questionnaire through their social networking sites and those graduates whose jobs that were landed were IT related jobs during the course of the study. A total of sixty-nine (69) IT graduates responded in our survey.

The questionnaire was utilized as data gathering instrument in this study to gather data and information needed to evaluate the employability of IT graduates. The questionnaire was developed by the researchers with the aid of survey creator website [8] and this link https://www.esurveycreator.com/s/7d64347 had been sent through the social network account(s) of the IT graduates for them to answer online. The responses of the respondents were tallied and extracted and served as input for data analysis. The research instrument is composed of the following parts: (1) Personal Profile of IT Graduates; (2) Employment Data; (3) Employable IT Skills and Competencies Possessed by the Graduates and (4) Suggestions and Recommendations on IT Graduates Employment. It is composed of four (4) pages. The investigation made use of frequency count, weighted mean and data mining algorithm to interpret the data. A data mining technique was utilized through a data mining tool which is the Waikato Environment for Knowledge Analysis (WEKA) Version 3.9.1. WEKA is an open-source data analytics tool that provides various algorithms that can be applied to data sets for analysis [9].

Data analysis using WEKA were utilized in this manner: (a) data attributes of the respondents of the study were tallied in a form of matrix. Cleansing of data had been done through inputting them whenever possible and rectifying inconsistencies with the data. The cleansed data were made as data sets of the study. A data model was constructed as an output of a decision tree

classification technique (J48) and the common IT skills for of IT graduates were determined through this algorithm. Recommendatory measures had been done to improve the competitive edge of the graduates at the Catanduanes State University.

4. RESULTS AND DISCUSSION

The first problem posed in this study inquires about the employment data attributes of the IT graduates from 2010 to 2016. The data attributes of IT graduates that were considered in this study were (1) IT Related Employment (2) Employment Type (employed locally, employed in foreign country and self-employed), (3) Job Status (permanent, contractual, freelancer, casual, consultant and part-time), (4) Nature of Industry of which there were 23 categories cited, and (5) IT Job Categories by which there were 13 job categories cited. Table I presents the summary of responses of the respondents showing the frequency of responses and the corresponding percentage of responses.

Table 1. IT Graduates Employment Data

Employment Variable	Frequency	Percent Bottom
IT-Related Employment		
a) Yes	42	60.87%
b) No	27	39.13%
Total	69	100.00%
Employment Type		
a) Employed Locally	56	81.16%
b) Employed in Foreign Country	6	8.70%
c) Self –Employed	7	10.14%
Total	69	100.00%
Job Status		
a) Permanent	41	59.42%
b) Contractual	9	13.04%
c) Casual	1	1.45%
d) Consultant	0	0.00%
e) Part-Time	8	11.60%
f) Freelancer	10	14.49%
Total	69	100%
Nature of Industry		
a) IT Computer Software	14	20.29%
b) Banking/Financial Services	8	11.59%
c) Education	8	11.59%
d) Government Services	7	10.15%
e) IT Computer Hardware	3	4.35%
f) Advertising/Public Relations	2	2.90%
g) Others	1	1.45%
Total	26	37.68%
IT Job Category	69	100.00%
a) Support/Help Desk	18	26.09%
b) Technicians	15	21.74%
c) Administrators	10	14.49%
d) Analysts	6	8.69%
e) Engineering, Designer, Developer	5	7.25%
f) Consultants, IT Managers, Programmers	3	4.35%
g) Others	12	17.39%
Total	69	100.00%

As to the nature of industry, other industries mentioned by the respondents were Construction Company, Marine Engineering, Media Monitoring, Storage and Distribution (Health Services), computer graphics & lay-out artist, Business Process Outsourcing and Customer Service. On the IT Job Categories, other Job Categories mentioned are on teaching IT related subjects, ticketing/reservation and configuring/testing of equipment.

The second problem posed in the study seek to determine the IT skills and competencies possessed by the graduates. Graduates were asked to tick the specific IT skills and competencies that they possessed to get employed. They were asked to tick as many skills as they possessed. Figure 2 below shows the different skills and competencies possessed by the respondents.

It can be gleaned from the graph that IT graduates skills are focused on IT Support Analysis (24, 39.3%) followed by User Interface,/User Experience Designing (15, 24.6%), Database Administration (11, 18.0%), Business Intelligence and Analysis and Web Development next on Emerging Technologies, Big Data/Data Analysis/Data Mining (8, 13.1%), followed by Application development (9, 14.8%), next is on Technical Writing (8, 13.1%,) this is followed by Agile Methodology, Systems Analysis and SQL Programming (7, 11.5%), next is on Network Security Management and IT Consultancy (6, 9.8%), followed by Mobile Development / Device Management, Program Development, Quality Assurance and Software Development (5, 8.2%) next is on Business Process Modeling and Program Design (4, 6.6%). Cloud Architecture, IT Optimization, Social Media Design and Management, Product Training is rated 3 or 4.9% and the least is on Scripting (2, 3.3%). This implies that the IT graduates possessed the necessary skills that are marketable in the IT fields not just in the country but also in foreign lands.

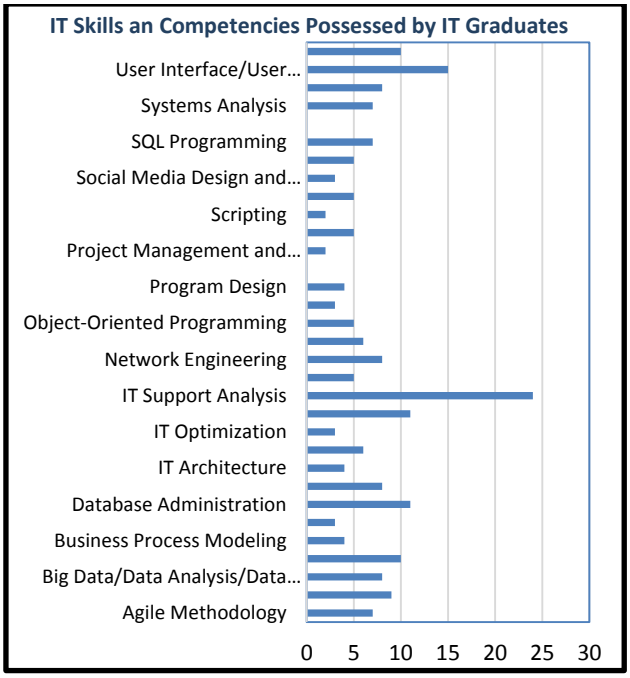

Figure 2. IT Skills and Competencies Possessed by IT Graduates

The third question posed in this study is on the prescribed employable IT skills and competencies of the graduates that could be generated using a data mining tool, method and technique(s). With WEKA 3.9.1 three steps were undertaken, namely: (1) data pre-processing; (2) using the classification model; and (3) prescription as to the employable IT Skills and Competencies of

the IT Graduates. The dataset that was developed in this study was a table composed of 33 columns for the different IT skills specified in the study and the category of the IT graduate's jobs. Matrix of this data was presented using Microsoft Excel. The spreadsheet file was saved as CSV (Comma Separated Variables) file. This file was then converted to an Attribute-Relation File Format (.arff) file as required by WEKA. The next step was building a classifier wherein a model was developed using a classification model in WEKA. This study utilized the J48 Decision Tree Algorithm using Cross Validation with 10 folds test option on IT Job Category. The result is shown in Figure 3.

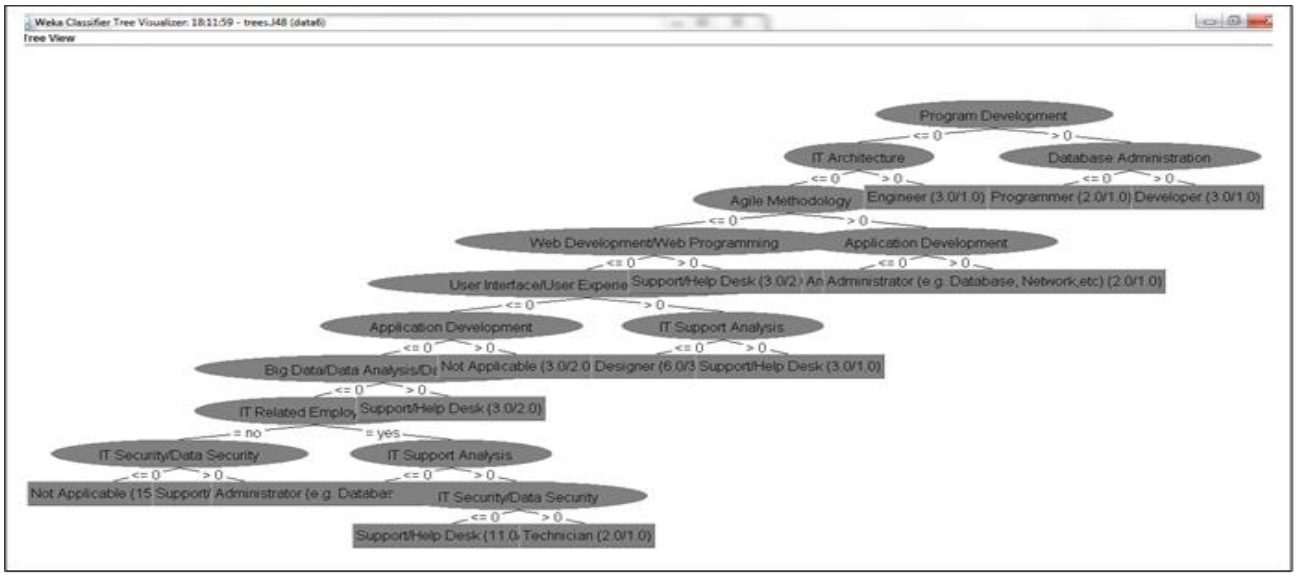

Figure 3. Prescribed IT Skills and Competencies for IT Graduate

Table 2 summarizes the IT Skills and Competencies needed for each Job Category which was based from the Decision Tree classification model shown in Figure 3.

Table 2. Prescribed IT Skills and Competencies for IT Each Job Category

IT Job Category	Prescribed IT Skills and Competencies
Administrator	Agile Methodology, Application Development, Big Data/DataAnalysis/Data Mining, Database Administration, IT Security/Data Security, IT Support Analysis, Object-Oriented Programming, Network Security Management, SQL Programming, Systems Analysis, Web Development/Web Programming
Analyst	Agile Methodology, Application Development, Big Data / DataAnalysis/Data Mining, Database Administration, IT Security/Data Security, IT Support Analysis, Quality Assurance Analysis, Product Training/Product Support
Chief Executive Officer	Agile Methodology, Business Intelligence, Cloud Architecture, Product Training/Product Support, Web Development/Web Programming
Consultant	Big Data/Data Analysis/Data Mining
Designer	Program Design, User Interface/User Experience Designing
Developer	Agile Methodology, Application Development, Business Process Modelling, Cloud Architecture, Database Administration, IT Architecture, Mobile Application and Device Management, Object-Oriented Programming, Program Development, SQL Programming, Systems Analysis, User Interface/User Experience Designing, Web Development/Web Programming,
Engineer	Cloud Architecture, IT Architecture, IT Consultancy, IT Optimization, IT Security, Network Engineering, Network Security Management
Programmer	Agile Methodology, Application Development, Mobile Application and Device Management, Object-Oriented Programming, Program Design, Program Development, Scripting, SQL Programming, Systems Analysis, User Interface/ User Experience Designing, Web Development/Web Programming
Support/Help Desk	Big Data/DataAnalysis/Data Mining, Business Intelligence, Database Administration, Emerging Technologies, IT Consultancy, IT Optimization, IT Security, IT Support, Mobile Application and Device Management, Product Training/Product Support, Search Engine Optimization, SQL Programming, Systems Analysis, Technical Writing

To finally answer therefore the research question on what are the changes/policies needed to improve the competitive edge of the IT graduates as regards employability, the following are postulated. (1) "Review and update BSIT curriculum and syllabi to suit the present labor market needs"; (2) "Add more subjects relative to industry immersion or offer additional elective subjects that will improve the IT skills and competencies of graduates or increase the number of prescribed hours for their on-the-job training"; (3) "Conduct training on enhancement of IT skills and competencies of graduates"; (4) "Provide extensive monitoring of OJT activities to check if the responsibilities given to students are relevant to IT jobs"; (5) "Upgrade IT facilities and infrastructure"; (6) "Provide

extensive monitoring on the teaching and learning activities on the classroom especially for IT professional subjects; (7) "Provide effective faculty development programs to improve IT expertise and teaching competencies of faculty handling IT subjects; (8) "Conduct researches relative to evaluation/improvement of teaching and learning process as well as suitability of graduate skills to the need of labor market and/or tracking of graduates; (9) "Provide a job placement program for graduating students"; and (10) "Limit class size"; the graduates have suggested another policy to undertake and that is "Shaping the student's mindset with vision and goals" which could be considered the 11th policy that should be given the least emphasis and action in the specific university where the study was conducted.

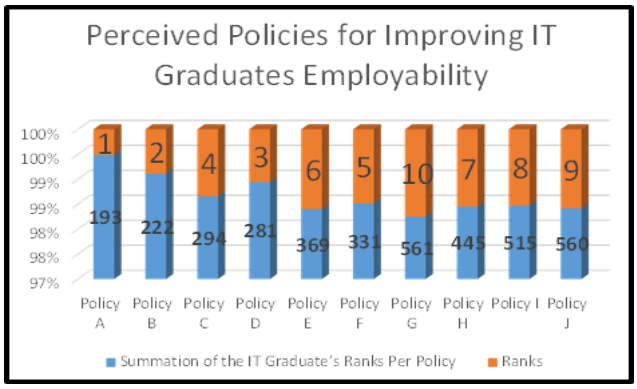

Figure 4. Perceived Policies for Improving IT Graduate's Employability

Figure 4 shows the suggested policies/changes of the IT graduates to improve their employability. The numbers indicated below the bars are the summation as to the ranks made by the graduates and the numbers above the bars refer to the ranking made for each policy

5. CONCLUSION

With the influence of data sciences in the world of work, reports, data and information as regards the daily operations of business particularly the behavior and productivity contributed by the manpower are tracked, monitored, evaluated and predictions and prescriptions are made in order to sustain the competitive edge of one company over its competitors. Along with this notion, this research therefore will have implications for graduating students particularly on the IT field, for the IT graduates, labor marker, educational sector and for the nation's policy makers especially those that are concerned with labor and employment.

The study's significant contribution lies in the fact that the graduates employment data attributes and the skills they possessed were obtained and these data were evaluated and subjected to data analysis by which the prescribed IT skills knowledge, skills and competencies that must be present to each IT graduates to land a certain IT job. The prescribed IT skills and competencies that must be possessed by graduates are those relating to IT Support Analysis, User Interface/User Experience Designing, Web Development/Web Programming, Program Development, Agile Methodology, Database Administration, Big Data Analysis, Application Development, Object-Oriented Programming, SQL Programming, IT Architecture, Emerging Technologies, IT Security/Data Security, IT Consultancy, Social Media Design and Management, IT Optimization, Business Process Modeling and Program Design.

Awareness of the prescribed IT skills and competencies would enable the graduating students to evaluate their level of IT proficiency so that they could easily land a job when they graduate. They could make significant measures to obtain such proficiency level while they are still in school so that when they come out of the university, they are ready for the world of work. They could also suggest or recommend through their On-the-job training programs the measures that could be adopted so that learning outcomes of the OJT will be derived effectively. Awareness of the prescribed IT skills and competencies would enable the IT graduates to hone and update their IT skills so that they could sustain their marketability on the IT labor market.

Awareness also on the prescribed IT skills on the tertiary schools, would enable educational management experts to evaluate their educational systems and policies particularly on the IT programs they are offering so that significant adjustments would be made to suit their teachings to the actual needs of the IT industries.

This research would also have impact on IT industries since they would be aware of the prescribed IT skills and competencies needed for each job category. Hence they could define qualification standards necessary for each job position they will be offering.

Outcomes of this research would enable policy makers especially on educational sector to formulate policies, regulations, laws and even budget appropriations for sustaining IT infrastructures and projects since IT serves as the bridge towards knowledge-based and globally competitive nation. Along with this, new opportunities will be created which will bring changes in the way people live, learn, think, work and do business.

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7. REFERENCES

[1] CHED Memorandum Order (CMO) No. 46 s. 2012.

[2] Republic Act 7722. Higher Education Act of 1994

[3] Republic Act 7722. Enhanced Basic Education Act of 2013, or the K-to-12 Act

[4] Reich, *The Future of Success*, London: Vintage, 2002.

[5] De Guzman and De Castro, 2008, "Employability of Philippine IT graduates," *SEAMEO Innotech Research Updates*.

[6] Almendarez, L., 2011, *Human Capital Theory: Implications for Educational Development*. Belize Country Conference 2010 http://www.open.uwi.edu/sites/default/files/bnccde/belize/conference/papers2010/almendarez.html.

[7] Kinash, S., 2015, "Strategically driving away from dismal graduate employability through data analytics," *Featured Business Intelligence in Tertiary Education, Data Analytics, Embedding Employability in Teaching & Learning, Graduate Employment*, https://www.criterionconferences.com/blog/education/strategically-driving-away-dismal-graduate-employability-university-data-analytics/.

[8] Survey Creator website, http://www.esurveycreator.com Eibe Frank, Mark A. Hall, and Ian H. Witten. 2016. The WEKA Workbench. Online Appendix for "Data Mining: Practical Machine Learning Tools and Techniques," Morgan Kaufmann, Fourth Edition.