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ISECON 2021: Welcome to our Virtual Conference!

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The Information Systems Education Conference (ISECON) provides special opportunities for information technology faculty. For over a quarter of a century, the Foundation for Information Technology Education has been providing this forum of a broad spectrum of presentation topics, and a special camaraderie to be shared by those who attend.

This week and weekend, we are gathering to expand our understanding of information systems education. We are extremely grateful for the efforts of the entire ISECON 2021 conference planning committee for organizing these conferences. Thanks to conference chair Dr. Brian Reithel for making sure it is a great conference and also thanks to Dr. Bart Garner for his tireless service as the Proceeding Editor for ISECON 2021.

The authors, reviewers, presenters, and panelists, in conjunction with the ISECON committees, have collaborated to make this national conference function smoothly. In addition, those involved with registration and virtual conference logistics deserve a special thank you. Anyone who has worked on the planning and execution of a conference like this can certainly appreciate the amount of effort necessary to present such an excellent conference.

The Foundation for Information Technology Education (FITE) exists to advance the state of education and practice in the Information Technology profession. Through conferences such as ISECON and the U.S. IT Collegiate Conference, we offer forums in which IT/IS educators and students can interact, learn, and then return to their classrooms to shape the skills and knowledge of tomorrow's IT professionals. We invite you and your students to join us again in Spring 2022 for the USITCC and ISECON events in Plano, Texas.

We hope ISECON 2021 will be a valuable experience – from both personal networking and professional development viewpoints. We also sincerely hope you will join us at future ISECON events!

Have a great conference and let us know if there is anything that we can do to make your conference experience better not only this year, but in future years as well!

Sincerely,

Nita Adams, CISSP

President, Foundation for Information Technology Education

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Exploring Gender Differences in Motivations for Choosing Information Systems Study Program: Preliminary Results of a Survey Study at the University of Agder in Norway

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Abstract

The underrepresentation of females in information technology-related professions and in study programs is well known. Even in countries like Norway, being recognized as one of the most gender-equal countries in the world, women's representation in information technology-related fields is particularly low. In this study, we explore the potential differences between female and male students in motivations for choosing Information Systems (IS) study program at the University of Agder, given the low number of female student admission. We used an online survey of university students enrolled in an introductory IS course. Preliminary results of the study show that motivating factors for female and male students are very similar in choosing IS. Career-related factors such as job availability and job security are the most motivating factors for students in their study decision.

Keywords: Information Systems, gender, career

1. INTRODUCTION

As the use of information technologies (IT) has become widespread in society, the demand for IT professionals has also increased. Employment in occupations in IT-related jobs is projected to increase (U.S. Bureau of Labor Statistics, 2021). Even though there has been an increasing demand for IT-skilled workers, women are underrepresented in IT-related sectors and study programs in higher education (Anderson, Edberg, Reed, Simkin, & Stiver, 2017). Despite various initiatives taken by the government and industry, representation of females in information systems is still low (Anderson et al., 2017), and female students tend to avoid studying IT-related majors in higher education (Y. Zhang, Gros, & Mao, 2021). A similar gender disparity can also be observed in Norway. Although the majority of students in Norwegian higher education are female (60% in 2020, Statistics Norway (2021)),

male students clearly outnumber their female counterparts in IT-related studies. According to the Norwegian Universities and Colleges Admission Service, in 2021 about 65 percent of those who want to study in IT related studies in Norway were male. Consequently, with the underrepresentation of women in IT related fields we risk losing women's skills, creative talents, marketplace understanding, and perspectives (Beyer, 2008).

Choosing a study program and career is one of the important decisions in life. Numerous factors motivate and affect students' choice of study and career. Downey, McGaughey, and Roach (2011) categorized influencing factors into internal and external. Internal influences include attitudes, beliefs, abilities, and personality such as one's personal image, interest and aptitude in the field, and the influence of others. External factors include job characteristics, prestige of employment, and the degree of difficulty and workload of the major (Downey et al., 2011). While some of these career influences are tangible such as financial rewards, others are not, like prestige or status (Downey et al., 2011). Li, Zhang, and Zheng (2014) grouped factors that may impact students' choice of major into three categories as career-related factors, personal interest factors, and social and referent factors. A recent study by Chipidza, Green, and Riemenschneider (2019) reported intrinsic motivators, such as interest and the potential for a rewarding and satisfying experience, were the strongest influencer of a students' attitude about majoring in Management Information Systems (MIS), followed by job-related aspects of MIS, such as competitive advantage, salary, support structure, and ease of finding a job that MIS careers offer.

The low number of female students enrolling in IT-related study programs have been subject to various studies (Ahuja, Ogan, Herring, & Robinson, 2006; Beyer, 2008; Croasdell, McLeod, & Simkin, 2011; Hodges & Corley, 2016; Joshi & Schmidt, 2006; Sauter, 2012; Snyder & Slauson, 2016; Walstrom & Schambach, 2012; Y. Zhang et al., 2021).

To improve female enrolment in IS, we need to understand what prompts female students to choose IS as a career and what are the motivational differences between female and male students in this decision. So far, however, there has been little research on gender differences in motivation to choose IT-related majors in higher education in Norway. We find this context interesting, since Norway represents one of the more gender-equal societies in the world. Moreover, higher education is free of charge, giving everyone equal access to majors within various fields.

As a part of ongoing research, this current study aims to explore the differences between female and male students' motivations in choosing IS as a career study. This study will help understanding gender differences in motivations for choosing IS to study, why female students choose IS, how to attract and encourage more female students to register IS and increase gender diversity in IT-related professions. Our study will contribute to the literature by exploring gender differences in selecting IS as a career study in Norway, a highly gender-equal country.

2. METHODOLOGY

Sample

The sample of this study is composed of 159 undergraduate students enrolled in an introductory IS course, IS-100-1, The Role of Digitalization within Future Societies. This course is in the first year and obligatory for the students at the Department of Information Systems, the University of Agder in Kristiansand, Norway.

Survey Questionnaire Design

For this study, an online survey questionnaire was prepared based on previous research. The questionnaire includes closed-ended and open-ended

items about demographics, influencing factors in choosing study programs, information sources, and perceptions of IS. On the survey, we listed 21 potential motivating factors (personal, career-related, and social factors) and asked participants to indicate the importance of the items in selecting the department to study with a 5-point scale. In addition, we asked the most important reason in their study decision as an open-ended question. To identify information sources used by students, we used nine items and asked participants to indicate the importance of the items with the 5-point scale. The survey also includes seven items about participant students' perceptions of IS study and profession. Questionnaire items were adapted from Ferratt, Hall, Prasad, and Wynn (2010), Li et al. (2014), Papastergiou (2008), Snyder and Slauson (2014), Walstrom, Schambach, Jones, and Crampton (2008), Walstrom and Schambach (2012) and W. Zhang (2007).

The questionnaire is made available in two languages: Norwegian and English for international students.

Procedure

The pilot test survey was sent to thirteen students via e-post. Suggestions from students were taken into account in the development of the online questionnaire. After the testing procedure, the survey started to be implemented on 13th September 2021. The survey link distributed via e-mail, and it has been administered online through SurveyXact. Participation to the survey was voluntary.

3. RESULTS

A total of 45 completed surveys was analysed for this study. This study is a part of ongoing research, and our data collection continues. 12 (26.7 percent) of the responders indicated they were female and 32 of the responders indicated they were male. One student didn't give his/her gender identity by selecting "preferred not to answer" on the questionnaire. 28 participant (62.2 percent) were 18-21 years old; the remaining students were older than 21. Only 8 students reported that one or both parents in IT-related occupations.

Table 1: *Motivating factors in choosing IS (Average importance, 1=Not important, 5=Very important)*

Factors	Total	Female	Male	p
Job availability	4.42	4.25	4.56	.338
Job security	4.42	4.08	4.63	.050
Career opportunities	4.20	3.75	4.34	.133
Interesting work assignments	4.18	3.75	4.38	.046**
Opportunity to be innovative	4.07	4.00	4.06	.854
Personal interest in subject matter	3.96	3.33	4.25	.005*
Long-term salary and benefits	3.73	3.33	3.84	.143
Geographical location of the university	3.64	3.33	3.84	.346
Starting salary and benefits	3.53	3.50	3.59	.798
Personal skills	3.33	2.92	3.44	.169
Choose a study where I can get the opportunity to work with people	3.24	3.42	3.13	.526
Prestige of profession	3.24	3.00	3.41	.335
Choose a study that gives the opportunity to help others	3.09	2.83	3.13	.517
Reputation of university	3.00	2.58	3.22	.160
Study topics are easy for me	2.87	2.25	3.03	.039**
Reputation of degree program at university	2.78	2.58	2.91	.443
Performance in high school subject matter courses	2.38	2.67	2.31	.407
Influence of friend(s)	2.09	1.67	2.28	.087
Influence of family member(s)	1.80	1.83	1.81	.949
Influence of high school teacher(s)	1.56	1.50	1.47	.912
The counselling service at your high school	1.49	1.50	1.50	1.00

*significant at the 0.01 level, **significant at the 0.05 level

Table 1 presents the average ratings of the students' responses to the importance of each factor in choosing IS. The first two most motivating factors in choosing IS, are job availability and job security. These items are

followed by career opportunities and interesting work assignments. It seems that career-related factors affect students the most when choosing IS. Personal interest in subject matter is sixth on the list. Students rated importance of personal interest lower than importance of job availability, job security and career opportunities in choosing IS.

The least motivating factors on the list for the students are performance in high school subject matter courses, influence of friend(s), influence of family member(s), influence of high school teacher(s) and the counselling service at the high school. Students rated influence of friends and family members as not important for their choice of study program.

It was found that the motivating factors for male and female students in choosing IS were similar. The two most motivating and the two least motivating factors for choosing IS are same for female and male students. While the most motivating factors are job availability and job security, the least motivating factors are listed as influence of high school teacher(s) and the counselling service at high school.

According to t-test results, there were no significance differences between female and male scores for the most items on the list on Table 1. T-test revealed only three significant differences between female and male students on following items; "interesting work assignments", "personal interest in subject matter", and "easy of study topics". For these items male students give more importance than females in choosing IS. Highest difference between males and females appeared on "personal interest in subject matter". Female students did not rate importance of personal interest in subject matter in choosing IS as much higher as males. Females' average ratings were higher than males for only four factors; "influence of family member(s)", "influence of high school teacher(s)", "choose a study where I can get the opportunity to work with people" and "performance in high school subject matter courses", respectively.

Results show that geographical location of the university also influence students' decision. Students rated this item more than average point. As Kristiansand is located on the south of Norway, the University of Agder attracts students also with its location.

As for the open-ended question "the most important reason in study decision", most stated responses were related with job, personal interest, education, and university location, respectively.

4. CONCLUSION

The main aim of this study to explore the potential differences between female and male students in motivations for choosing Information Systems (IS) study program at the University of Agder. Preliminary results of this study indicates that the motivations of male and female students in choosing IS are generally the same. Career-related factors such as job availability and job security are the most motivating factors for both male and female students in choosing IS. According to t-test results, there were only three significant differences between female and male students on following items; "interesting work assignments", "personal interest in subject matter", and "easy of study topics".

Results suggest that to increase females' motivations in choosing IS, more emphasis should be given to future job-related opportunities and advantages in promoting IS. Therefore, providing more information to female high school students about IS professions and future career opportunities, and using women IS worker or managers as role models in promotion of IS can help to increase female students' motivation in choosing IS.

This is a part of ongoing research and for future work, we will continue to collect data.

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OBJECT IDENTIFICATION USING MOBILE DEVICE FOR VISUALLY IMPAIRED PERSON

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Abstract
The objective of this paper is to extract and categorize the information from the live stream and provide audio feedback to the user within the University campus. Convolutional Neural Network (CNN) model is used to classify objects. The classified objects are sent as input for the voice feedback, which is divided into several frames using the OpenCV library and converted to audio information for the user in a real-time environment using the Google text to speech module. Our CNN model built from scratch performs well in object classification with a timely voice alert that stands above the highest accuracy and false-positive rate and in alerting the user with a voice in the real-time environment. The results generated by the CNN model for image classification have an accuracy of over 95 percent, and real-time audio conversion is a rapid transition technique, resulting in an algorithm that performs competing with other prior state-of-art methods.

Keywords- Deep Learning, Natural Language Processing, Convolutional Neural Network (CNN), OpenCV real-time audio conversion, visual disability.

I. INTRODUCTION

The human eye perceives up to 80% of all the impressions and acts as the best shield from threat. While vision is a predominant sense in people, as per the World Health Organization, around 40 million individuals on the planet are blind, and 250 million have some degree of visual disability. As a result, many researchers have been working hard to create accurate and efficient navigation models utilizing computer vision and deep learning approaches. These models should be fast and efficient, and they should be able to run on low-power mobile devices to provide real-time assistance. One of the most challenging aspects for a visually impaired person is gaining independence in handling daily duties and understanding the situation by recognizing objects in her/his surroundings. For blind assistance, many algorithms concentrated on multiple sensors detection, better accuracy, and low computational device models. Since the 1970s, object categorization and detection have improved and grown to the point where intriguing applications for visual replacement are becoming viable. This change leads to ever-changing and advanced methods in deep learning, implemented every year for more accurate results. Getting improved accuracy and latency with a lighter architecture, overcoming constraints from prior work are the essential characteristics of enhancement.

The following are the contributions of this study:

(i) For a blind person to understand his surroundings, we proposed object identification through Convolutional Neural Network (CNN) using Keras framework, followed by a voice alert using gTTS through the video stream utilizing OpenCV. (see Figures 1.1 and 1.2 below).
(ii) We used a pre-trained model Mobilenet network for our image classification with CNN using the TensorFlow Lite framework in one of our approaches.
(iii) We compared a model built from scratch and a Mobilenet based classifier model that could best fit this application.
(iv) We created a dataset, comprised of 10 classes of different outdoor objects, gathered from the University of Dayton campus.

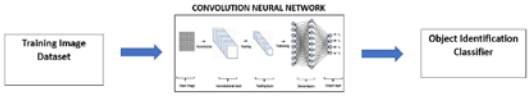

Figure 1. 1: Training Flow of the Object Identification Classifier

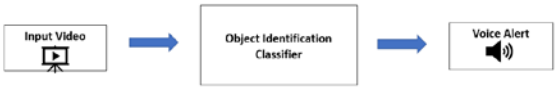

Figure 1. 2: Flow representing the conversion of the video stream to audio alert

The remaining paper is organized as follows: section II summarizes the related works. Section III provides a detailed implementation description of the data collection and preprocessing, algorithm development and inference steps. Section IV presents the experimental results with performance validation using statistical evaluation metrics for classification. The conclusion is drawn in section V.

II. RELATED WORK

Over the past decade, numerable technological methods, including GPS devices, echolocation, sensors and microcontrollers, and smartphones, have replaced the blind stick, and guide dogs. The following are some related works:

Conversion of the image to sound format: This approach was proposed by Krishnan et al., 2013 [17]. They use the image processing - canny edge detection concept that uses a multi-stage algorithm to identify objects by the wide array of edges and compare those values with pre-trained dimensions followed by a speech sound. However, the algorithm worked well for simple images but needs improvements on complex ones especially for overlapping images [17].

Voice-assisted navigation system for the blind: This tool was designed by Noorithaya, Kumar & Sreedevi, 2014 [1], using GPS. However, due to constraints like signal loss and navigation in indoor environments, GPS-based solutions cannot be completely reliable [26].

The third is smartphone-based classification system: Tapu et al., 2013 designed a system to detect obstacles in video streams in any dynamic background for autonomous navigation is emphasized [26]. The implementation of this approach is involved with multiple algorithms creating a complex dependency among them.

The fourth is a proposal based on Raspberry Pi: The Raspberry pi was developed by Durga Devi et al. and comprises a camera and speaker [32]. Raspberry pi has low computation power [25] due to which the voice feedback to the users is delayed, which is the main drawback of this method.

Finally, the smart stick: Rohit et al. proposed a smart stick to overcome the drawback of raspberry pi discussed above by introducing a server for the computations [25]. However, still a raspberry pi is needed which needs external power backup.

Though all the mentioned approaches work well in terms of accuracy, detection, audio

signals, etc., there are certain compromises to consider on the other hand. Complex architecture may be more accurate but requires multiple resources which cannot be implemented on a low computing device. A finer and straightforward implementation that has reduced steps of transfers between capturing, processing, sending the output is more accurate considering factors like timesaving, less complexity between connections, and their reduced dependencies resulting in good latency. Hence, a well-trained classification model that detects objects followed by voice alert, deployed onto a mobile application is an approach that can be emphasized more for future research.

We performed a comparative study to decide on the potential approaches. The key takeaways of this section involve choosing CNN based approach for the object classification due to its high-level feature representation and promising outputs, using the Keras and TensorFlow frameworks to make it deployable onto a smartphone, a small but efficient computing device. The pretrained model Mobilenet known for its speed and lighter architecture is chosen for another approach which is based on transfer learning using the TensorFlow Lite framework and deploy it onto the TF Lite built ready-made classify android application.

III METHODOLOGY

This section consists of 2 modules as follows: Data Collection, and Object Classification.

3.1. Data Collection

Dataset collection has been an ongoing process throughout the project. The initial dataset comprised of 5 classes with 100-150 images per class for training the model and measuring the accuracy and later added additional data for tuning the model to result in better performance. The final training dataset consists of 10 classes with 625 RGB images per class having the highest camera resolution setting of 4:3, concentrating majorly on outdoor environments within the University of Dayton campus premises. Stratified data sampling [16] technique has been followed to transform the dataset to balance each class distribution i.e., the total images within each class are equally divided into groups based on common characteristics that are present within the campus for the required classes to avoid classification imbalance.

The ten class labels in this work are Bench, Building, Bush, Campus car, Door, Person, Staircase, Trashcan, Tree, and Window. The images for Class ‘Person’ were taken from the NTU Pedestrian dataset that was collected from Nanyang Technological University Campus [21] [22] [23] and some from the Google images [24]. All the rest of the classes were collected manually with good resolution using an Android phone version 10 with 16 +20 MP Dual Camera. All the images are set to be in the JPG/JPEG format with portrait orientation. The following are the sample images of the dataset classes and their characteristic type used in this work:

Figure 3. 1: Sample images for the Class Bench with rectangular type (left), round type (right)

Figure 3. 2: Sample image for the Class Building

Figure 3. 4: Sample image for the Class Campus Car

Figure 3. 3: Sample image for the Class Bush

Figure 3. 5: Sample image for the Class Door

Figure 3. 6: Sample images for the Class Person from Google (Left), NTU dataset (right)

Figure 3. 7: Sample image for the Class Staircase

Figure 3. 8: Sample image for the Class Trashcan with a round type (Left), square type (right)

Figure 3. 9: Sample image for the Class Tree

Figure 3. 10: Sample image for the Class Window with type 1(left), type 2 (right)

3.2. Object Classification

The classification method is implemented using Keras in python3 script. Keras is an extremely popular high-level API that uses TensorFlow in its backend for building and training deep learning models. It is used for fast prototyping, state-of-the-art research, and production [27] [7]. This model is trained on GeForce RTX 2070, CUDA version 11.2 with 16GB memory.

3.2.1 Data Loading

The input for the model contains 6250 images belonging to 10 classes splitting 5000 images for training and 1250 images for validation in 80-20 split ratio resizing the images into 224 * 224 size with a batch size of 16. Batch size is the number of training images used in one iteration. The key concepts followed when loading the data are cache(), shuffle() and prefetch(). Buffered prefetching is used so that the data can be taken from the disk without having I/O become blocking, cache() keeps the images in memory after they have been loaded off disk during the first epoch ensuring the dataset does not become a bottleneck when the model is being trained. prefetch () will overlap the data preprocessing and model execution while training [12].

3.2.2 Data Augmentation

The augmentation techniques used in this work are horizontal flipping, random rotation at a degree of 0.1, and random zoom at a degree of 0.1. Rescaling is done to standardize the data making the input to smaller values in the range of [0,1] which is ideal for the neural networks [7].

3.2.3 Classification using CNN Network from scratch:

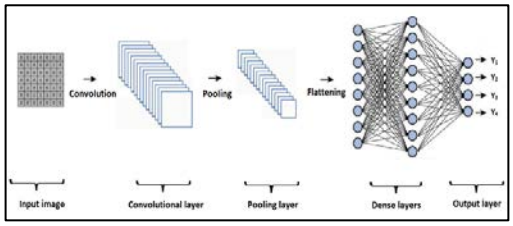

Figure 3. 11: CNN Network Architecture

The architecture of this work consists of 12 layers – four convolution layers, four max-pooling layers, one dropout layer, and two dense/fully connected layers as shown in Figure 3.12. The fine-tuning process includes the setting of the hyperparameters of the network, figuring out the number of layers, kind of activation function and optimizer, rate of learning, dropout range, batch size, and the number of epochs.

The present network uses 16 filters of kernel size 3*3 with a stride of 1-pixel unit, which scans over the image, producing 16 sets of activation maps. This continues to be with the
next layers of filters i.e., 32, 64, and 64. Padding is set to be 'same' that fills zeros evenly and activation function as 'ReLU' [5] for all the convolution layers. ReLU (Rectified Linear Unit) helps in making all the negative values zero.

After each Convolution layer, Max pooling layers are present alternatively that work on each feature map resulting in subsampling. A dropout layer is present at the degree of 0.2 i.e., 20 percent of the neuron connections are randomly removed to regularize the model and prevent overfitting in the dense layers. The flattening step is done using flatten function after the dropout to convert/ flatten the 2-Dimensional arrays to a single linear vector.

In dense layer, the first dense layer has 128 hidden neurons declared with the 'ReLU' activation function followed by the final dense/output layer with 10 neurons representing the 10 classes of the dataset along with the 'Softmax' activation function.

The compilation step uses the 'Sparse_Categorical_Crossentropy' loss function along with the 'Adam' optimizer in this network. Adam [23] is known to have the best properties of AdaGrad and RMSProp algorithms to handle the sparse gradients on noisy problems. Metrics is 'Accuracy'. The whole network built is having 1,667,562 parameters.

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
sequential (Sequential)      (None, 224, 224, 3)       0
_________________________________________________________________
rescaling_1 (Rescaling)      (None, 224, 224, 3)       0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 224, 224, 16)      448
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 112, 112, 16)      0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 112, 112, 32)      4640
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 56, 56, 32)        0
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 56, 56, 64)        18496
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 28, 28, 64)        0
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 28, 28, 64)        36928
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 14, 14, 64)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 12544)             0
_________________________________________________________________
dense_2 (Dense)              (None, 128)               1605760
_________________________________________________________________
dropout_2 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_3 (Dense)              (None, 10)                1290
=================================================================
Total params: 1,667,562
Trainable params: 1,667,562
Non-trainable params: 0
```

Figure 3. 12: Model Summary of the CNN Network

During training step, the number of epochs ranges between 35-40 resulting in significant results. The final trained model weights are saved in the 'hdf5' file format. The hdf5 model can be converted into the tflite model using the 'TFLite Converter' [33] which can result in reduced file size. The plots generated for graphical representation of the training and validation accuracy and

loss in Tensorboard [8] can be viewed in the next section.

3.2.4 Classification using Mobilenet Pretrained Network

Mobilenet uses depth-wise separable convolutions which means it performs a single convolution on each color channel rather than combining all three channels and flattening it. As explained in [38], "For Mobilenet the depth-wise convolution applies a single filter to each input channel. The pointwise convolution then applies a 1×1 convolution to combine the outputs of the depthwise convolution. A standard convolution filters and combines inputs into a new set of outputs in one step. The depthwise separable convolution splits this into two layers, a separate layer for filtering and a separate layer for combining. This factorization has the effect of drastically reducing computation and model size."

Type / Stride	Filter Shape	Input Size
Conv / s2	$3 \times 3 \times 3 \times 32$	$224 \times 224 \times 3$
Conv dw / s1	$3 \times 3 \times 32$ dw	$112 \times 112 \times 32$
Conv / s1	$1 \times 1 \times 32 \times 64$	$112 \times 112 \times 32$
Conv dw / s2	$3 \times 3 \times 64$ dw	$112 \times 112 \times 64$
Conv / s1	$1 \times 1 \times 64 \times 128$	$56 \times 56 \times 64$
Conv dw / s1	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 128$	$56 \times 56 \times 128$
Conv dw / s2	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 256$	$28 \times 28 \times 128$
Conv dw / s1	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 256$	$28 \times 28 \times 256$
Conv dw / s2	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 512$	$14 \times 14 \times 256$
$5\times$ Conv dw / s1 Conv / s1	$3 \times 3 \times 512$ dw $1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$ $14 \times 14 \times 512$
Conv dw / s2	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv / s1	$1 \times 1 \times 512 \times 1024$	$7 \times 7 \times 512$
Conv dw / s2	$3 \times 3 \times 1024$ dw	$7 \times 7 \times 1024$
Conv / s1	$1 \times 1 \times 1024 \times 1024$	$7 \times 7 \times 1024$
Avg Pool / s1	Pool 7×7	$7 \times 7 \times 1024$
FC / s1	1024×1000	$1 \times 1 \times 1024$
Softmax / s1	Classifier	$1 \times 1 \times 1000$

Figure 3. 13: Mobilenet Network Architecture

Transfer Learning saves a lot of training time, which could usually take days or weeks depending on the complexity of the task, requires lesser training data because the pre-trained model would already be trained on huge amounts of data and better performances comparatively. The only requirement is to choose the right model based on the dataset.

In this image classification process, the feature extraction method is used to make the classifier model. 'DataLoader' class is used to load the data and the 'from folder()' method is used to load the data from the folder. JPEG- and PNG- encoded images are supported. The whole dataset is split at once into training, validation, and testing data in the desired ratio using the data_split() function [14]. The customized model is defined in the required specifications using the 'create' method. The train data and validation data are given along with the pre-trained model and the number of epochs.

The dataset division followed for this method is 5000 images for training, 1249 images for validation, and 201 images for testing completely shuffled by the inbuilt function. The whole network sums to 3,550,285 parameters out of which 10,020 are the trainable parameters from the last dense/classifier layer which is customized to the present dataset. The default model is EfficientNet-Lite0. The model is switched to MobileNetv2 using the 'model_spec' parameter and is set for training for 5-10 epochs. The number of trainable parameters is less in this as we are calling in the trained weights. The trained weights are saved in the '.tflite' format.

```
INFO:tensorflow:Retraining the models...
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
hub_keras_layer_v1v2 (HubKer (None, 1001)              3540265
_________________________________________________________________
dropout (Dropout)            (None, 1001)              0
_________________________________________________________________
dense (Dense)                (None, 10)                10020
=================================================================
Total params: 3,550,285
Trainable params: 10,020
Non-trainable params: 3,540,265
_________________________________________________________________
```

Figure 3. 14: Model Summary of Classification Network using Mobilenet

3.2.5 Implementing voice alert to the video stream

Each frame of the video is accessed and processed using the OpenCV [28] library and the voice alert is initiated using the gTTS module [20] [30]. The frame grabbed from the video stream is being classified using the trained classifier model to identify the objects present in the frame. The trained model predicts the class name of the identified object in the text format which is sent to the text-to-speech converter to generate a voice alert.

Only the class name of the first frame is given out as a voice alert ignoring the rest of the consecutive frames with the same class name until a change in prediction with a new class name occurs. This helps in avoiding voice overlap of the alerts between the frames. The results obtained from both the trained classifier models and their corresponding prediction of the objects on the test data, the output video clippings showing identification of the object followed by voice alert inferences within the university campus can be viewed in the next section.

IV PERFORMANCE EVALUATION

Any useful and reliable model with the proper distribution between train and test would result in a score of above 90% accuracy. On the other hand, there is a loss function that measures the distance between the current and expected output. It is inversely proportional to accuracy and guides the model to move towards convergence [36] during which the loss is minimized virtually supporting model fitting of the training data and good accuracy. Both the accuracy and loss are represented graphically to visualize the training and validation of the model every epoch, given in Figures 4.1 through 4.4.

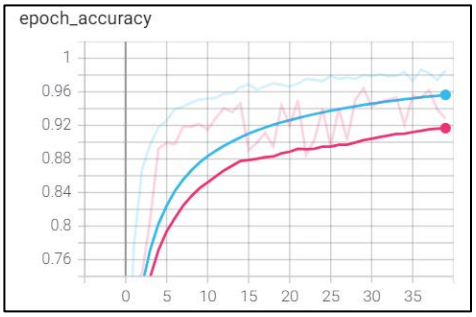

Figure 4. 1: Training (blue) and Validation (pink) accuracy plot of CNN Network

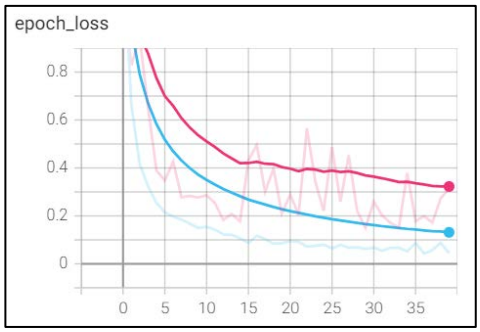

Figure 4. 2: Training and Validation loss plot of CNN Network

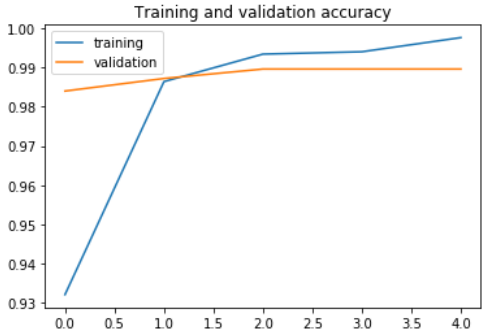

Figure 4. 3: Training and Validation accuracy plot using a pre-trained model

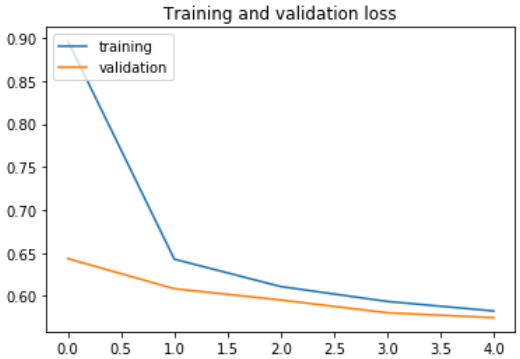

Figure 4. 4: Training and Validation loss plot of using a pre-trained model

A classification report [10] has been generated for the models which will display the precision, recall, F1 score, and support score for the model. A confusion matrix [10] is generated which is an N*N table that contains the number of correct and incorrect predictions of the classification model. The rows represent the real classes while the columns represent the predicted classes. These both solely depend on the calculation of the predictions from the model. The four types of predictions that a model could result are as follows:

True Positive (TP): outcome where the model correctly predicts the positive class.
True Negative (TN): outcome where the model correctly predicts the negative class.
False Positive (FP): outcome where the model incorrectly predicts the positive class.
False Negative (FN): outcome where the model incorrectly predicts the negative class.

4.1 Results from the classifier trained using Mobilenet pre-trained model

The test data for the model trained using Mobilenet consists of 201 images. There are 201 images since the inbuilt function used divides the images based on the rates we give in, to even out all the images between training, validation, and testing within 6450 images. And due to the shuffling nature of the inbuilt function, the test images are shuffled in the test dataset, and they vary in number per class making sure not to reach beyond an average value of 20. Hence, the number of test images sent for prediction for each class are as shown in Table 3:

Table 1: Test images divided per class by split() function

Class 0 (Bench)	14
Class 1 (Building)	17
Class 2 (Bush)	24
Class 3 (Campus car)	24
Class 4 (Door)	22
Class 5 (Person)	17
Class 6 (Staircase)	24
Class 7 (Trashcan)	24
Class 8 (Tree)	19
Class 9 (Window)	16

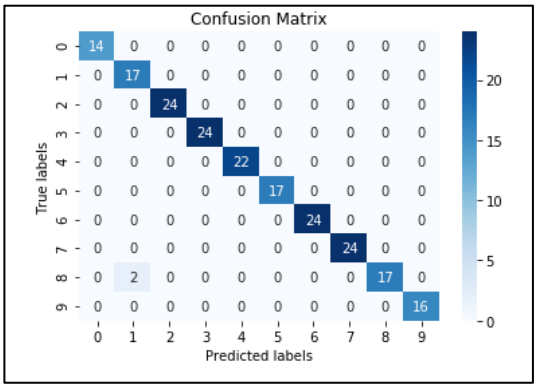

Figure 4. 5: Confusion Matrix from Network using a pre-trained model

	precision	recall	f1-score	support
Bench	1.00	1.00	1.00	14
Building	0.89	1.00	0.94	17
Bush	1.00	1.00	1.00	24
CampusCar	1.00	1.00	1.00	24
Doors	1.00	1.00	1.00	22
Person	1.00	1.00	1.00	17
Staircase	1.00	1.00	1.00	24
Trashcan	1.00	1.00	1.00	24
Tree	1.00	0.89	0.94	19
Window	1.00	1.00	1.00	16
accuracy			0.99	201
macro avg	0.99	0.99	0.99	201
weighted avg	0.99	0.99	0.99	201

Figure 4. 6: Classification Report from Network using a pre-trained model

Based on the observations from figures 4.5 and 4.6, the classifier model could correctly predict all the classes but one. Two test samples of the class tree are mispredicted to be class 1 that is building. Overall, the model trained through transfer learning performs well having an F-1 score of 100 percent for almost all classes and above 90 percent for the rest.

The size of both trained networks varies due to the differences in the overall parameters involved within the network. The .h5 Keras model built from scratch holds a size of 19.17 MB. When the .h5 model is converted into the .tflite model, it comes down to 6518 KB. The size of the '.tflite' model trained using pre-trained model results to be 4144 KB.

Figure 4. 7: Predictions from a model trained with Mobilenet

The predictions on images of test data from the classifier trained from pre-trained can be viewed in figure 4.7.

4.2 Results from the classifier trained using CNN network from scratch

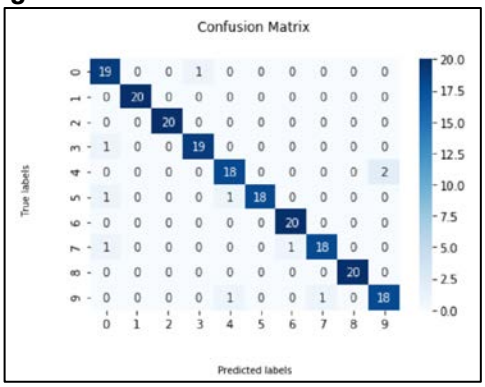

Figure 4. 8: Confusion Matrix from CNN network trained from scratch

The test data consists of 200 images in total which accommodates 20 images for each class. As seen in figure 4.8, the diagonal line elements represent the number of correct predictions which means the predicted label matches with the true labels. The off-diagonal elements show the number of mislabeled predictions for all 10 classes. In short, the diagonal elements are representing recall/sensitivity scores. The CNN model is resulting in a decent number of predictions with one or two misclassifications with an overall accuracy of 95 percent.

	precision	recall	f1-score	support
Bench	0.86	0.95	0.90	20
Building	1.00	1.00	1.00	20
Bush	1.00	1.00	1.00	20
CampusCar	0.95	0.95	0.95	20
Doors	0.90	0.90	0.90	20
Person	1.00	0.90	0.95	20
Staircase	0.95	1.00	0.98	20
Trashcan	0.95	0.90	0.92	20
Tree	1.00	1.00	1.00	20
Window	0.90	0.90	0.90	20
accuracy			0.95	200
macro avg	0.95	0.95	0.95	200
weighted avg	0.95	0.95	0.95	200

Figure 4. 9: Classification Report from CNN network trained from scratch

Generally, the classes with higher recall than the precision mean that the false positives are higher than false negatives and vice versa. Based on the results from the confusion matrix and classification report in figures 4.8 and 4.9 respectively, the model correctly predicted all the observations of classes 1,2, 6, and 8 which means the buildings, bushes, trees, and staircases have the same precision, recall, and F-1 scores as 1. For class bench, one test sample is incorrectly predicted as campus car (class 3). And for class campus cars, one test sample is incorrectly predicted as a bench (class 1). For class Door, two test samples are incorrectly predicted as the window (class 9). For the class person, one test sample is incorrectly predicted as a door (class 4) and the other sample as a bench (class 0). For the class trashcan, one sample is incorrectly predicted as staircase (class 6) and the other one as a bench (class 0). For the class window, one test sample is

incorrectly predicted as a door (class 4) and the other one as a trashcan (class 7). Overall, the model performance is rated to be pretty good to reach the expectations, having the F-1 score above 90 percent for all the classes. The predictions on images of test data from both the classifiers, the CNN model trained from scratch can be viewed in Figure 4.10.

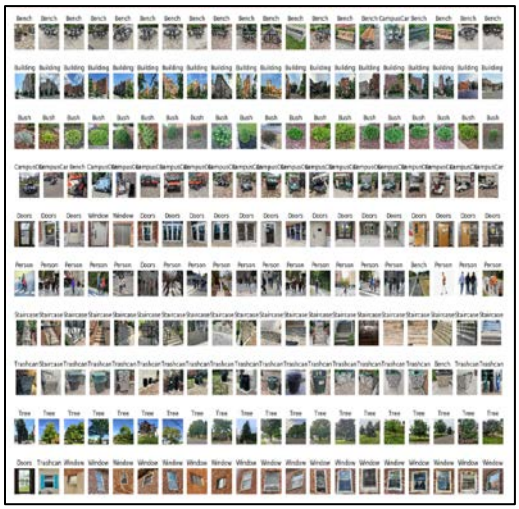

Figure 4. 10: Predictions from CNN network trained from scratch

The video stream sent to the object identification classifier will be divided into several frames, the object is identified, and the class name is displayed on every frame of the video followed by a voice alert. The timely voice alert is given for the objects which change one after the other ignoring sequence of consecutive same class names. Below are the sample screenshots of a video output showing the prediction of the objects printed on each frame.

Figure 4. 11: Inference results from video frames displaying the object predicted by the classifier trained from scratch

Therefore, the above sections deduce the methods used in the implementation of classification and the potential results obtained. The initial work as a part of this research was an attempt to build an object detection model over the same university campus dataset using the TensorFlow 2.0 Object Detection API. All the requirements from beginning with preparing the annotations for the images, generating the tf records, configuring the training pipeline to training the model, and exporting the resultant model to detect objects were followed as per the API documentation [6]. The proper setup for TensorFlow object detection installations with python packages was time-consuming but is a one-step installation. Huge memory space and high-performance graphics card were a mandatory requirement for supporting long training hours and numerous package downloads such as pre-trained model's zoo repository and TensorFlow Object detection API along with its dependencies such as COCO API, protobuf, etc.
The GPU [9] configuration with the API for training is not well-defined in resources which challenged customizing the framework source codes. Despite of overcoming all the concerns and challenges, the training for object detection could not load in more than 300-400 images along with their annotations summing up to 700-800 files in total, requiring more memory. The idea of introducing audio processing to this object detection model would lead to higher complex architectures turning down the feasibility to deploy onto the low-computing device.
For this very reason, this chapter concludes that the object identification through CNN classification is set to be convenient with lesser complex architecture and computations, cost-effective, reliable and a user-friendly approach showing scope for more advancements in its optimization further.

V. CONCLUSION

The present method consists of a clear and simple approach where the CNN classifier is trained on the dataset collected from the university.

Our CNN model built from scratch performs well in object classification with a timely voice alert that stands above the highest accuracy and false-positive rate and in alerting the user with a voice in the real-time environment.

Reading the video frames giving fast predictions and aligning the voice alert only at the required time avoiding the voice overlap between the alerts to not confuse the user was the most challenging concern. The implementation of this work relies solely on deep learning methods and computations which involves no external hardware setup units like sensors, camera modules, microcontrollers making it cost-effective, reliable, and user-friendly. The deployment of this model onto the mobile application compatible with both android and IOS will be taken as a priority for future works in this research.

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The Good, The Bad, and The Ugly: Learning and Analysis from the Capture and Exploration of Stories

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ABSTRACT

Stories are simple, and timeless, and because they are memorable can be an excellent means of training and learning. Stories can also be fun. Thanks to this richness, stories can be a method for teaching about and exploring various management topics (cf. Peterson, et al. 2016. "Storytime for Business Students"). Stories can also be an important part of the analysis and design process. This session is focused on how students can capture and interpret stories about the experiences of others (in various circumstances and settings) related to information systems and information technology. An exploration of the strengths and limitations of this approach will be presented as we develop and examine the stories from others and discover how to use them in our classes.

Keywords: Stories, Requirements, Agile, Waterfall, Scrum, Daily Scrum

INTRODUCTION

Storytelling is part of a powerful tradition of human interaction. Stories were used in ancient, pre-literate times to communicate history, impart knowledge, to share and shape values and culture, and to entertain (Rosile, 2016; Tate, 2012). Boyd (2009) has noted that stories have been a part of oral and written tradition from Homer to Dr. Seuss (Comer & Holbrook, 2005), for indigenous populations (Rosile, 2016) and beyond.

An often significant part of management (and leadership) consists of the attempt to guide and direct the development of individuals, often without their direct recognition of that effort (Billsberry & Gilbert, 2008; Stevenson, 2016; Verbos, Kennedy, & Gladstone, 2011). But an understanding of what people are thinking and talking about can be important. Armstrong (1992) has noted that stories can be effective tools, as they are simple, timeless, an excellent means of training, empowering, memorable, and can be fun. Further, stories are often much richer and more engaging than communication based primarily on numbers and analytics (Denning, 2004). A story (both real or fictional) "increases the range of our vicarious experience and behavioral options" (Boyd, 2009, p. 192). Stories can provide a way for us to anticipate, frame, or guide work toward the future (Boje, 2011). For example, a quote attributed to Abraham Lincoln, well known for his stories and 'yarns,' suggests that: "The most reliable way to predict the future is to create it." In

sum, stories are one way in which to support, understand, and enact this effort.

While always popular, the capture and sharing of stories has become more widespread in recent years. For example, StoryCorps (www.storycorps.org), a non-profit organization whose mission is to collect stories of people in all walks of life from around the U.S., and the world, has permanent booths in San Francisco, Atlanta, Chicago, and New York's Grand Central Station, plus two mobile booths. Almost half a million stories have been collected on personal topics and on focused themes, with several anthologies being published. (Look for works by StoryCorps founder David Isay.) As another example, Allison and Gediman (2007) have developed and published a well-received collection of stories (cf. *This I Believe*) leading to several additional books.

Beyond the popular reading, stories are also being used for design and analysis. Mueller and Quednau (2016) report on how architecture and urban design projects evolve through narrative. Fred Dust, a partner at the design firm IDEO, has been advocating "Design Dialogues" of "well-crafted personal exchanges" (p. 46, *Fast Company*, Issue 222, Feb 2018) consisting of stories to aid in design to solve problems (Anzilotti, 2017). This fits within the concept of 'narrative design,' or design through storytelling. Stories can provide a means of 'sensemaking' for the members of an organization (Weick, 1995). Further, a story from the user(s) "is a promise for a conversation" (Cockburn, 2017).

One challenge in analysis and design is that the approach(es) used tend to be rational and engineering-focused in their approach and structure. People perceive and interact with their environments in different ways, and stories provide an approach to recognize and understand those different types of interactions at a more personal, individual level. Stories have long been a part of information systems analysis and design (Brooks, 1995), or at least a part of a thorough analysis effort. Capturing, evaluating, and understanding stories is part of the approach being used to design better organizations and more usable systems. In particular, one approach can focus on the question "what keeps you up at night?" or "what do you dream about how a system should, or should not, operate?"

With the introduction and growth of Agile methods in the last two decades (cf. Agile Manifesto, 2001), based in part on the recognition that requirements are difficult to fully capture and define, stories have become an even more important method to capture and more deeply explore the needs and desires of the clients and users. As software has evolved into a major component in products large and small (Andreessen (2011), it has become increasingly apparent that the requirements for software projects can evolve quickly and rapidly become outdated (cf. Boehm, 2001). The consistent involvement of the client/user provides many opportunities to have their input in capabilities and design, often through stories. For example, one Agile approach, SCRUM, works with a 'backlog' of tasks that have been identified but not yet completed. Regular, often daily, meetings (e.g., a "daily standup" or "daily scrum") occur among the development team members to communicate progress, share solutions, and coordinate future work to accomplish completion of the system or components desired by the Product Owner (i.e., the client or client representative/liaison).

Specifically, stories have a narrative emphasis, focusing on experiences and implicit knowledge (of a technology, a situation, an event, etc.) that can be difficult to disclose or articulate. They can be used to share knowledge or experiences that often cannot be easily conveyed through facts alone or to establish a shared meaning or understanding in an organization. Stories

can create impressions, or evoke a vision. Stories can be used to share and voice emotions.

Boyd (2009) has noted that "stories help train us to explore possibility as well as actuality, effortlessly and even playfully, and that capacity makes all the difference (p. 188). This session is focused on how to help our students capture, analyze, and use the stories obtained from others.

ACTIVITY DESCRIPTION

In many, and perhaps most, situations, the stories used for inquiry come from already-developed resources (e.g., case studies, news articles, etc.) and are mined for and applied to a topic or concept of current emphasis or inquiry. In this activity, participants will be asked to seek the stories of others. While there can be a great deal of variation possible, one approach is to have students ask about a particularly good experience from those they are interviewing. Bad stories, i.e., stories on problems encountered, can also be explicitly sought. Further, 'ugly' stories, i.e., stories about 'really bad' situations can be captured. (The particular focus—good, bad, ugly, etc.—can be specifically assigned. This is to simulate the story-interrogation process students' use when acquiring stories from other individuals.) Students can spend time assessing and drawing conclusions from the stories that have been captured (e.g., what has been learned? What gaps exist in what has been learned? What else do I need to know? How can I use this information to guide my design decisions? Etc.).

Time will be spent during the session noting the difficulty students often have in just eliciting stories from others and exploring ways to assist with and guide this process. Opening and follow-up questions are provided (see Appendix A), and new questions will be developed and shared. Details on the current activity and assignment structure (see Appendix B) being used will be provided.

One overall goal for this activity is generating a student-centered environment for accomplishing the task(s) and then exploring how to make sese of the material collected and to draw conclusions. Once stories have been generated and collected, we explore how to apply and use the stories for diagnosis and learning, as well as how to generate follow-up questions from the data that was received. These initial general stories typically lack sufficient detail, focus, and structure to guide design decisions, a common limitation in capturing requirements. Further, the activity then explores how to use these stories and translate them into requirements to guide system design and development.

'User stories,' informal descriptions of 'features' for a software product, have emerged as an approach to make sense of and understand the system and its desired context. They are written from an end-user's or stakeholder's perspective, although multiple perspectives can exist (e.g., end user, client, manager, development team, implementation team, etc.). Several templates or formats for user stories exist, including the "… so that …" approach (Cohn, 2008), a "hunting value perspective" (Marcano, 2016), and "the Five W's" template (User Story, 2020), as well as a broader perspective on User Story Mapping. A few selected samples from student assignments will be shared.

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APPENDIX A – Opening Guidance and Questions

- Capture the story … if possible, capture the story in detail, word-for-word
- Provide (at least a brief) description of the Context (of the story, and even where/when the story is captured).
- Be sure to capture and record follow-up questions as they occur.
- Note whether this is a work-related story, or something that is more personal.
- Be sure to observe and note the body language (including gestures, etc.) as the story is being told. Try to capture/describe these.
- Story prompts (i.e., initial questions) and follow-up questions might be :
  - Tell me a story of your first experience(s) with (the topic under consideration)
  - Tell me about your best experience with _____
  - Tell me about your worst experience with _____
  - Tell me about your most memorable experience with _____ (This may overlap w/ the questions immediately above.)
  - What are stories you have heard (or been told) about experiences with or use of _____?
  - When did this occur?
  - Why do you think you remember this story?
  - What, if anything, did you (i.e., the storyteller, or his /her audience) learn?
  - What keeps you awake at night?
  - What do you know now that you wish you knew 'then?'

APPENDIX B – Interview-Results Template

Details from the student's assignment that are supposed to be filled out and completed from each interview.

Person / Position Description (name is not required) _____

General (geographic) location _____

Business / Industry / Activity _____

Gender M F

Age <15 15-17 18-21 22-24 25-34 35-44 45-54 55-64 65-74 75+

The story (or stories) from the interview session.

> The body of the story goes here … The body of story, including questions and follow-up questions, can be single-spaced. Double space between questions (and try to clearly mark each question) and answers. Work to ask questions that require more than a yes/no answer or a single-sentence answer. Those types of questions may be a start, but they will not be sufficient.
>
> [Be sure to include the questions that were asked and the answers that were given. Both pieces of information are important to understand what you capture and record/transcribe. Include follow-up questions and their answers.]

Sustainable development in the field of IoT-focused network engineer education based on simulation tools

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Abstract

The paper analyses the possibilities of using computer network environment simulators in the context of skills acquired by engineers in the education process at the level of higher education. The analysis of employers' needs in the area of knowledge and skills of future staff in terms of design, construction, configuration and management of the network environment was made in the context of conditions resulting from Industry 4.0, and in particular the integration of distributed resources based on IoT technologies. The current requirements as well as new trends and future needs of the changing labour market evolving towards enabling IoE implementation have been taken into account. The possibilities of selected IT tools supporting the education process were compared in this area. The analysis and results presented in the paper allow to determine the optimal conditions for the use of simulators in the process of educating engineers in relation to the formal framework of education and the needs of employers. The results of the work are particularly important in the context of the current situation related to the COVID-19 epidemic, in which a large part of the practical classes must be carried out remotely, e.g. using simulators.

Keywords: computer network simulation; computer networks; IoT; IoE; education process

1. INTRODUCTION

Network communication systems, including IoT, are constantly changing and developing, both in the area of transmission media, passive solutions, as well as efficiency and functionality of active network devices. This development forces adaptation of curriculums and education processes to newly emerging solutions. One of the key challenges of the coming years is the introduction of engineers to the market who are aware of the needs and challenges associated with the next industrial revolution 4.0, and above all have necessary competence in the field of design, implementation, configuration, management and optimization of the IoT environment. Computer network engineers are one of the most important and numerous groups of

specialists in this area. It should be noted that currently all social, financial and educational services use technologies based on computer networks, including the Internet. Another area which expands considerably is the industry, especially aviation, automotive, as well as processing and logistics industries, including industrial clusters, as well as new R&D cooperation concepts based on distributed laboratory and manufacturing resources (Oleksy et al. 2019, Mazur et al. 2019). The integration of resources as part of remote prototyping processes is an excellent example of this (Paszkiewicz and Bolanowski 2020). All these areas now have two common features - automation and computerization. Therefore, universal realization of the idea of industry 4.0 or more generally IoE (Qu et al. 2019) requires ensured influx of high-class specialists to the labour market. Obviously, the issue discussed in the paper can be attributed to many specializations and professions. From the perspective of widespread 'networking', our paper focused exclusively on the specialization of computer networks. The process of educating a computer network engineer requires consideration of many issues as well as ensuring a complex test environment. The continuous development of technology requires constant modernization of laboratory resources to implement new teaching scenarios for new technologies. An important problem is also the need to multiply the real education stations to enable their simultanous use by several laboratory groups. It also generates high costs frequently exceeding financial capabilities of institutions and organizations involved in education. Moreover, contemporary trends related to the so-called convergence in the field of technology (Ham et al. 2019; Lee et al. 2016; Albano et al. 2015), as well as heterogeneity of most network environments requires consideration of diverse hardware and software platforms. An approach based on access to individual network devices can be implemented only at the initial stage of the education process (Figure 1 in Appendix).

The following stages of the education process require access to diverse educational environments to gain an adequate level of knowledge and professional skills. Two scenarios/variants can be implemented in the classic approach based on real manufacturing solutions:

- In the first scenario, the elements of the educational infrastructure are embedded in a real manufacturing environment, e.g. a university network, in a manufacturing company network, etc.
- In the second scenario, a complete test and laboratory environment is created, equipped with all necessary hardware and application components, allowing to carry out defined tasks and didactic experiments. This approach corresponds to PoC (Proof of Concept) solutions known from the business environment. However, it requires access to a heterogeneous test environment.

Each of the above solutions has certain limitations related to the functional scope of the tests carried out as well as costs and limited access to real hardware and software platforms. This is especially important nowadays in the era of the COVID-19 pandemic, during which the majority of classes (including practical classes) are carried out remotely. This restricts students' access to real laboratory equipment. Therefore, one of the possible alternatives with high functional potential is the use of computer network environment simulators and emulators (Pal 2012; Fahmy 2016). It enables easy construction of various test scenarios, allows to make changes, design and configuration errors without consequences, and can be tailored to the needs and requirements specific to individual stages/levels of education. Therefore, the paper presented a correlation of the potential functionalities of the above mentioned IT tools with the requirements of education at Eng and MSc level. In addition, a correlation of education levels with Polish qualification framework, European

Qualifications Framework (EQF) and E-competence framework (e-CF) was presented in the context of the possibility of using this type of solutions in educational process. Moreover, the presented areas of network simulators application are embedded in a set of needs and conditions of the industry, in particular the IT industry.

1.1 Labour market factors

The demand for IT services is still growing and this trend will probably continue in the coming years. The commencement of the fourth industrial revolution and the "transfer" of many aspects of social and business life to the virtual reality of the Internet and computer networks is important in this respect. Obviously, such global changes are associated with an increase in the demand for qualified specialists, and it necessitates the adaptation of educational programs tailored to the needs of the labour market. Reliable assessment of current and future needs reported by employers regarding the knowledge and skills required in IT involves analyses in several areas. The research area includes i.e. reports, scientific papers, press and internet publications. It contains opinions of IT experts defining current and future trends in the field of professional skills. They are necessary to meet specific needs allowing creation of new services and products and developing existing technologies. A separate issue within the research area can be the analysis of documents that are guidelines forming employee's attitudes at the education stage. Another aspect of research area is the IT industry itself, represented by various employers ranging from global corporations to large national enterprises, as well as medium and small companies of a local and regional reach.

The analysis indicates several top IT areas that will lead in the coming years: cloud computing (eGospodarka 2018; CompTIA 2018; Gartner 2018; Columbus 2018-1; Van der Meulen 2018), artificial intelligence/machine learning (Van der Meulen 2018; Czubkowska 2018), Internet of Things and network infrastructure (Nordrum 2016; Cisco 2019; Bolanowski et al. 2015; Columbus 2018-2; Bolanowski and Paszkiewicz 2018), Big Data/Data analysis (DOMO 2017; Columbus 2018-3), Cybersecurity (Hunt; Gartner 2019; Petty 2018; Marszałek 2016; Strefa Biznesu 2018; Sanocka 2018), Quantum processing (Biedrzycki 2018; Musser 2018; Długosz 2019; Hurley 2018; Economist 2017; Prisco 2018). The analysis of citations of scientific papers in the IT area confirms the trends indicated above. Based on the analysis of the SCOPUS (Scopus database) and WoS (Web of Science database) databases, artificial intelligence/machine learning, bioinformatics, system architecture, IoT and communication in computer networks are very promising areas from the perspective of modern researchers. Various reports and studies on the demand for specific IT specialists both on the American (Glassdoor 2020; Thebestschools 2019), European (Błaszczak 2018) market as well as Polish conditions (Niezależna 2018) in the IT industry clearly indicate that in addition to all kinds of programmers, there is a great need for specialists in artificial intelligence, data processing (Big Data) and of course IoT systems. The conducted data analysis allows to draw conclusions of IT development directions, and thus areas in which companies will need specialists. The present study obviously focuses on the issue related to network engineers education, and as the analysis indicated, this is one of the 3-4 repetitive specializations of great importance. This is especially true in the context of the universality of computer networks, and in particular the huge potential of IoT. Therefore, the issues raised later in the paper were limited to this problem.

1.2 Formal education framework in the context of computer network education

The educational process, especially in the field of technical sciences, is time and cost consuming. The market constantly needs specialists whose qualifications will change

over time and meet the expectations of new technologies introduced to the market. The figure on the website (Majchrzyk 2018) informs about how much time does it take for a given technology to get 50 million users. According to these data, telephony took 50 years to reach this large number of users. Such a long period of time allowed the development of standards and the education of engineers supporting this solution. Web services need only a few years, or, in special cases, even days to reach this potential of users. Therefore, it is so important that educational process is flexible, but also allows continuous development along with the evolution of technologies available on the market. The process of formal education in the European Union is defined by the European Qualifications Framework (EQF), which in case of Poland, translates into the National Qualifications Framework(NQF). It describes eight qualification levels identified in Poland corresponding to the respective levels of the EQF described in in (EU documents 2020; European Parliament Council 2008). Both documents define levels directly related to knowledge, skills and social competences. The analysis of employers' needs (Paszkiewicz 2019) clearly shows that persons who have graduated from the first cycle engineering studies are particularly sought after on the labour market. Level 6 of the NQF and EQF corresponds to this stage. The Masters degree students i.e. Msc studies, are particularly valuable for research teams and sought in new technology development departments and R&D sectors. They reach level 7 and partly 8 in the educational process. Both the NQF and EQF define the requirements in a very general way. The documents state i.e. (level 6, knowledge section) that the graduate "knows and understands at an advanced level - facts, theories, methods and the complex relationships between them". This approach allows flexible adaptation of subject programs and the curriculum at universities. On the other hand, this level of generality may be incomprehensible to employers and engineers themselves who are looking for specific, named elements of knowledge and skills required for a given job position in the company. The direct application of EQF or NQF raises several issues in this case.

In order to specify the abovementioned framework and the possibility of its direct application in the HR departments of companies recruiting IT engineers, more detailed recommendations have been developed: E-competence framework (e-CF) (European Norm 16234-1; European Digital SME Alliance 2018) and SFIA framework (SFIA; Von Konsky 2016). Therefore, their application allows to create universal job names with a precisely defined set of competences that is understandable for university bodies, a self-educated engineer and a company seeking an employee. The correlation between EQF, e-CF and their relationship with education levels is presented in Figure 2. The analysis of market needs allows to assume that the level of advancement of engineers supporting activities in the field of communication systems for industry 4.0 should oscillate in the area of e-4 and e-3 levels (blue area in Figure 2).

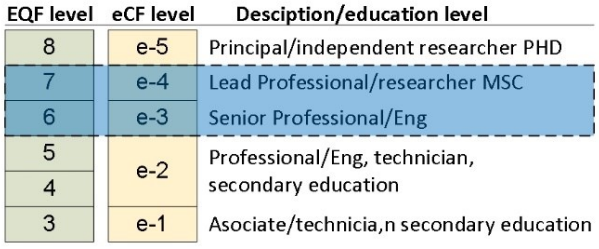


Figure 2. Correlation of EQF and e-CF with descriptions of the advancement of individual levels

The e-CF framework identifies 40 e-competences grouped in 5 areas: plan, build, run, enable, manage. When defining a specific role (e.g. a network specialist) one should specify what level (e-1 to e-5) of advancement for a given position should be mastered in specific e-competences. For the network specialist, the above combination is shown in Figure 3 (Appendix) (European Committee for Standardization 2018).

Reaching level 3 for the role of network specialist for specific e-competences can be accomplished during engineering studies. When organizing the educational process, both the "Task" field in Fig 3 and the "e-Competence" area should be taken into account. Therefore, it is necessary to define a set of methods and measures to achieve the learning outcomes assumed in these areas. Research in this area was conducted at the Rzeszów University of Technology. Classes using real equipment were carried out in two dedicated network laboratories equipped with real network equipment and computer network simulators. The educational process within the specialization of computer systems and networks at the first and second degree studies was analyzed. The process of shaping the graduate's profile at the university is characterized by interaction with the socio-economic environment, including the employers' needs. Based on the analysis of these needs, the requirements presented in Figure 1(Appendix) were determined. They are the result of the current curriculum and dynamically changing employers' needs. Figure 4(Appendix) presents the curriculum shaping process taking into account the main factors affecting its final form. First, the desired definition of the role of a given specialist in the market is determined using the e-CF qualification framework. Analysis of levels (e-1 to e-5) for a given role allows to determine which education level (MSc or Eng) to educate a specialist in. In the case of a predominance of e-competences developed at e-3 level, Eng studies will be appropriate, in the case of a predominance of e-4 and e-5 levels, the education process should be completed at MSc or doctoral studies. The arrangement of training modules for a given specialization changes relatively rarely in 5-year cycles, while the educational content defined in modules can be changed in a semester cycle. This creates the opportunity to update the curriculum content every six months. Information on current market needs is obtained directly from employers, during meetings and through dedicated organizations, e.g. The Polish Information Processing Society (PIPS), IT Sector Council (Paszkiewicz 2019), etc. Based on this data, specific knowledge and skills requirements for a given candidate profile are defined. In the next step, educational stations are created for each module, which enable conducting classes in shaping practical skills. For the case of the network engineer, this stage can be accomplished in two ways: using real network devices and servers, or using simulators. Research conducted at the Rzeszów University of Technology allows to formulate the following conclusions:

- The use of real network devices requires significant financial expenditure for the preparation of the station. In an extremely unfavourable case this process may take up to two years.
- It is possible to lease network devices from manufacturers or companies interested in educating students with a given profile. However, this involves the need to reduce the number of laboratory groups (maximum 4 to 6 people).
- The use of network simulators as a substitute for network devices creates the possibility of rapid response to technological changes. In this case, however, it is interesting to determine whether the use of simulators at the training stage can completely replace contact with real devices. Preliminary studies conducted in 2018-2019 have shown that the time needed to prepare new simulated laboratory stations in response to the new demand of the labour market takes no more than 2 months.

The process of modifying the curriculum content presented in Figure 4 is continuous and cyclical. It seems natural to choose simulators as tools for practical students training. The study, however, analyzed the possibilities of using simulators in educating network engineers for particular levels of higher education.

2. RESEARCH AREA

In order to conduct research, it was necessary to analyze the available network simulators and their functionalities. Proper analysis of this area will allow for matching and classification of individual tools in the context of education stages/levels. In addition, groups of students who will be analyzed in the research were specified. This chapter describes these aspects.

2.1. Analysis of selected simulators

In order to conduct empirical research, at first tools potentially used need to be defined, that is simulators and emulators of computer network environment. The authors analyzed and compiled the simulators available on the market to determine their operation parameters and their characteristic features. The following is a brief description of selected software solutions in this area (Humayun Kabir et al. 2014; Mishra and Jangale 2014):

- OMNeT++ a modular tool based on open source licenses, used to simulate discrete events based on many different components. The variety of modules and simulation templates allows to use this program not only to simulate computer networks, but also in queuing systems, P2P systems, wireless and mobile networks and complex IT systems (Omnet++; Virdis and Kirsche 2019; Achunala et al. 2017).
- J-Sim is another free simulation environment based on Java. The tool architecture is based on autonomous components (ACA). It is mainly intended for the design of quantitative numerical models and their analysis based on reference data (JSim; Sobeih et al. 2006).
- NS-3, like earlier programs, J-Sim and OMNET ++ is an open source solution and is completely free of charge. This is the latest version of a series of tools for simulating discrete events in network systems. NS-3 allows to integrate an external (or virtual) infrastructure with that created inside the application. The simulator itself supports many models of devices and network connections. This functionality is still being developed (NS-3; Casoni and Patriciello 2016).
- NetSim is a stochastic simulator of discrete IT networks events, it is a tool used to emulate, design and plan computer networks. Thanks to its functionalities, it is a good solution for beginner network engineers to learn the configuration of specific network devices (NetSim; Brand et al. 2014).
- Packet Tracer is a tool to simulate mainly a computer network based on Cisco solutions. It allows creating various network topologies, configuring network devices and simulating the operation of individual network protocols and mechanisms. A friendly graphical interface based on dragging and dropping allows to easily build a variety of network topologies from very simple to complex structures (Vijayalakshmi et al. 2016).
- Riverbed Modeler is a leading simulation software with a large number of libraries and available models used for modeling test and functional scenarios. The program implements many technologies and network solutions and also has a library of ready-made network devices from different manufacturers that match real solutions. Moreover, this environment allows to simulate the operation of various types of network services, as well as create own models of devices, protocols and network mechanisms, including defining own models of network traffic. It also allows to analyze the use of network resources to identify trends, situations of exceeding limits or other unusual behavior and anomalies (Riverbed Modeler; Chakraborty and Telgote 2018; Oulahyane et al. 2018).
- GNS 3 is an emulator which operation is based on simulating real network devices using virtual machines. During research, it was mainly used to simulate Cisco and Open vSwitch devices. In the case of complicated scenarios, problems occurred

with its functioning and unclear licensing policy (GNS3; Neumann 2015).
- QualNet is the last tool discussed. It is a simulation platform for planning, testing and training that simulates the behavior of a real communication network. QualNet provides a complete environment for designing protocols, creating and implementing network scenarios, and analyzing their effectiveness and network performance (QualNet; Gong et al. 2014).

Not all available tools were presented above, but only the most popular and used. In addition, the full spectrum of functional capabilities of individual simulators has not been presented, as they are available on the websites of manufacturers or organizations caring for their development.

There are also Computer Algebra System (CAS) tools that can be used to determine and solve design tasks defined by mathematical models. Examples of such applications are Mathcad, Mathematica, Maple, SciLab. Thus, these tools provide an environment enabling simulation and modeling of the behavior of network structures and phenomena occurring in them. However, they require extensive theoretical knowledge not only in the field of computer networks, but also in many areas of mathematics, programming, etc.

Considering the above possibilities of individual solutions used to simulate the computer network environment, reference should be made to Figure 1 and Figure 4. In this regard, the authors have classified the tools for simulating computer networks from the perspective of stages/levels of education and their correlation with e-CF and EQF.

The classification presented in Figure 5 (Appendix) illustrates the usefulness of individual solutions, which results from the observation of performance and interviews with students. The figure attempts to illustrate the level of suitability of a given solution for education at the level e-4 or e-3. As shown in this figure, Riverbed Modeler and OMNeT++ are suggest-ed for e-4 level. This is due to the fact that they have advanced capabilities to simulate the network environment, along with phenomena occurring in it, as well as to develop and test new network mechanisms. As a part of these functionalities, it is possible to model and analyze IoT environments. This level of configuration sophistication requires a good knowledge of the basics of functioning and configuration of network devices and protocols. Obviously, these tools can be used at the e-3 level, but only to a small extent of their functionalities. Therefore, according to the authors, at the early level of education of network engineers one should focus mainly on simulators such as Packet Tracer, GNS3, which intro-duce the user to the environment of configuration and maintenance of computer networks. At Eng level, the RiverBed Modeller simulator can be also used, but it must be preceded by an extensive theoretical introduction. There is a group of NS-3, J-Sim and QualNet tools that can be introduced at an intermediate level within the level e-3. However, it should be remembered that their potential can be fully utilized only at the level e-4.

2.2. Analysis of the possibility of using simulators in the educational process

The studies on the use of simulators for the implementation of educational classes was carried out for both the first and second cycle studies. The research was based on observation of performance and analysis of work results for both regular laboratory classes and additional specialized courses. For both education levels were studied in the period from 2019 to 2021. Before carrying out research tasks, the following assumptions were made:
- Three types of student groups have been identified: groups that use real equipment for the implementation of laboratory scenarios during classes (G1), groups that had the option of using real network devices or network simulators (G2), and groups that only used simulation environment (G3).
- In the case of first-cycle studies, both G1 and G2 groups operated as a part of the classes. It should be noted that in the

case of G2 groups, students could change their decision at any time.

- In the second-cycle studies, mainly G2 groups were present. As a part of this type of studies, students are prepared to conduct scientific research independently. One of the requirements of the research is the ability to select and prepare the research environment independently, and thus the student must be able to make an independent choice between the virtual and real research environment.
- It should be emphasized that students had complete freedom in the choice of simulators. In some cases, in consultation with the research team, solutions were purchased. In a few isolated cases, students used dedicated software to perform simulations.

3. RESULTS

This chapter presents the results of the analysis of the use of simulators and real devices by students in relation to the needs of employers and the level of study (Eng or MSc).

3.1. First cycle Eng studies

During laboratory classes in the computer networks, students of Eng studies were classified into groups G1, G2 and G3. As part of these classes, they carried out tasks covering basic and intermediate configuration of network devices and protocols, as well as creating simple network topologies. Figure 6a presents the percentage share of students using real network devices and network simulators during 15 classes (group G2). Initially, it was assumed during the first and second class that each student has to start working with real devices, and then be able to decide whether they want to continue working in the device environment or in a dedicated network simulator. As can be seen in Figure 6a from the fifth class, few students began to use network simulators. Starting from topic No. 9. more students used simulators. At the end of the training cycle, when some students began to use both the simulation and the real environment. The reason for this was the de-sire to compare the system in both variants.

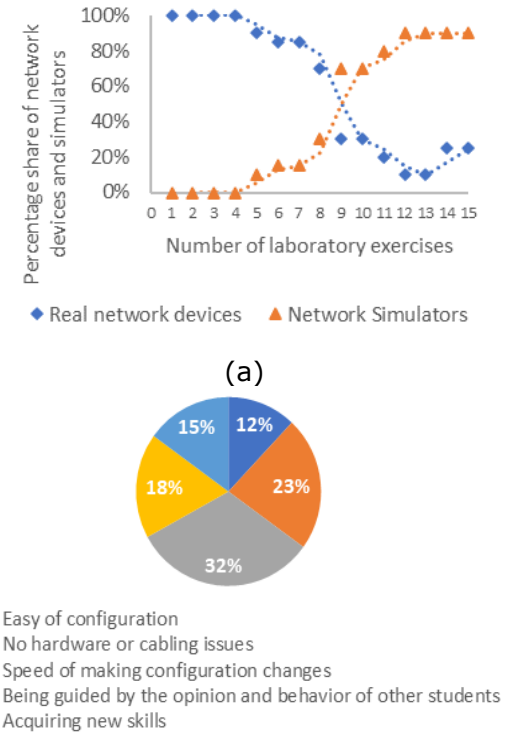


Figure 6. (a) Percentage share of students using real network devices and network simulators during laboratory classes in computer networks at Eng studies; (b) the reasons for changing the working environment from real infrastructure to a simulation environment.

As shown in Figure 6b, there are several premises that students followed in order to change the work environment from real network devices to network simulators. On the grounds of the results obtained, it can be concluded that the speed of testing new configurations, introducing changes, and analysis of network behavior for various parameter values was the most important factor motivating students to change the working environment. The second reason chosen by students was the elimination of problems arising from the use of real equipment. An important aspect was also a kind of pressure from groups that had

previously changed the working environment.

Analyzing and comparing the results of credits among students belonging to groups G1, G2 and G3, it can be seen that they are similar to each other (Figure 7). On this basis, it could be stated that for the development and acquisition of specialist skills there is no requirement for the availability of real devices, and each of these forms of education allows obtaining similar results.

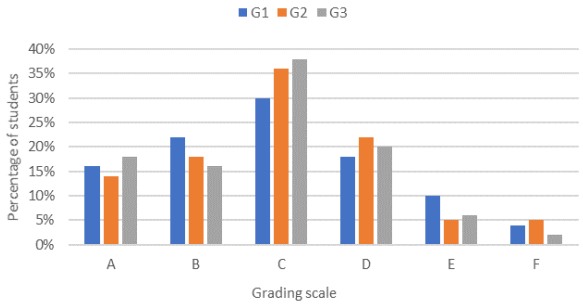


Figure 7. Percentage distribution of grades (A to F) obtained by students carrying out classes in G1, G2, G3

3.2. Second-cycle master studies

As a part of educational classes at the Master's degree, students received at least two project tasks for independent implementation in groups of maximum two people. It should be noted that all students have completed their first degree studies in which they participated in at least one class using real network devices. As part of Master's degree studies, students participated in a course in which they implemented test scenarios using the RiverBed Modeler simulator. After this course or in parallel with it, students received two project tasks covering issues in the field of design and operation of computer networks and management of distributed systems, with particular emphasis on IoT solutions and supporting IoE. Students chose design issues from the list, but also could suggest project topics themselves. The thematic scope of the project determined the possibilities of its implementation using simulators or real IT systems. The average distribution of topics was presented in Figure 8. The largest group of students chose topics that could be implemented on simulators (SR group) or using real devices (R group). People deciding to choose topics from the R group motivated their choice by wanting to deepen practical skills, obtain a certificate or the inability to implement a given issue using simulators (e.g. proprietary standards not available in simulators).

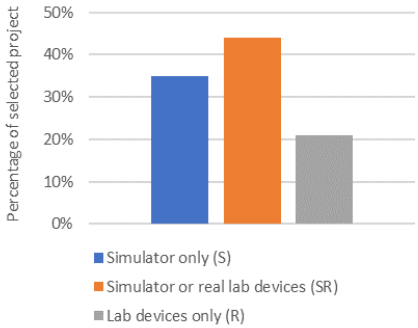


Figure 8. An average distribution of topics selected by students in groups S, SR and R.

Figure 9 presents the average selection of simulators in S and SR student groups. During the talk with students, the following main reasons for the initial selection of a given simulator were identified: availability of ready-made scenarios underlying their task, extensive documentation, and a community of users on discussion forums. In both groups, students most often chose the RiverBed Modeler simulator. The students from the S group chose it almost twice as often as students from the SR group. CAS solutions (Computer-aided Solution) were also quite popular. In this group, most students used the Matlab and Mathematica packages to analyze the structural properties of networks (e.g. topology) and issues related to MESH networks and radio communication. Talk with the students from the SR group and analysis of the chart in Figure 9 showed that before the final selection of a given simulator, they considered other real and simulation solutions more thoroughly. During the project, the students had the opportunity to change the initially selected simulator many times. Figure 10 shows how often students

discontinued using a given simulator during the implementation of project tasks and whether the implemented tasks were successful or the project did not meet all initial assumptions. Interestingly, the most completed projects were in the CAS group. This solution was most often chosen by students who had good knowledge of the CAS application and had specialized knowledge of the task being carried out. The most often abandoned simulator was NSx (NS2 or NS3). Unfortunately, the attempt to run even ready projects often ended in failure due to incompatibilities between NS2 and NS3 and dependencies between libraries. In the case of RiverBed Modeler and GNS3 simulators, a large group of projects was successful. The interface offered by these solutions is relatively simple and accessible.

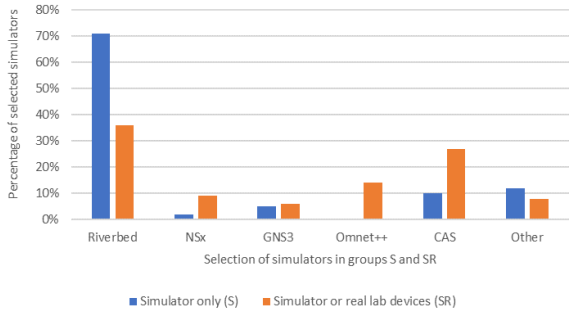


Figure 9. An average distribution of network simulators selection in groups S, SR

A lot of auxiliary materials and ready projects are available. In the case of these solutions, students very quickly overcame the "entrance barrier" and proceeded to the implementation of the prop-er project task. A significant group of unsuccessful projects is noticeable in the "Other" group. In this group, students often chose simulators or solutions that were adapted to solve a narrow group of problems. Despite their initial compliance with the subject of the project, it turned out that their adaptation is very labourintensive, the results obtained are far from expected or inconsistent with the actual functioning of the devices.

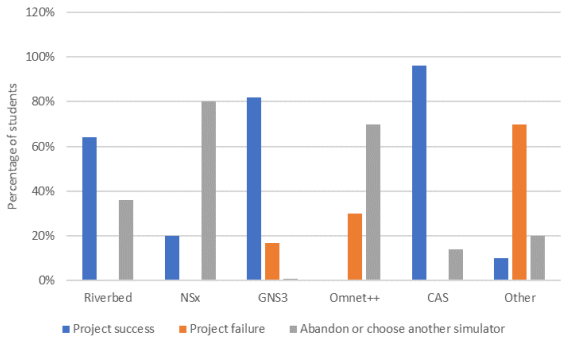


Figure 10. An average distribution of projects completed with success or failure and the change of the simulator in the distribution into individual simulators

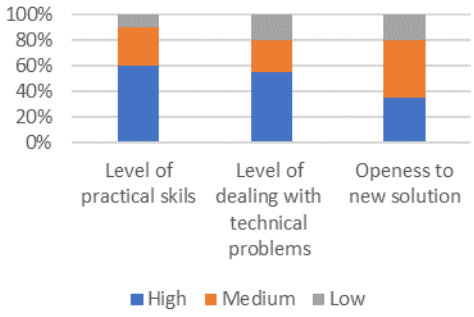
A large group of students also abandoned the Omnet++ simulator, which resulted from the need to have considerable programming skills needed to prepare test scenarios.

3.3. Feedback from employers

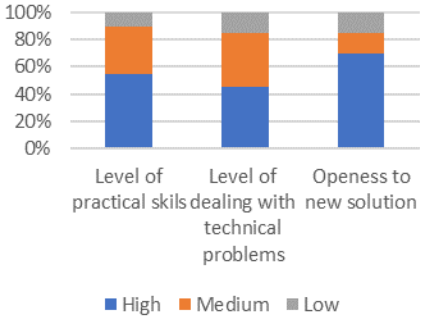
The very significant measure of the effectiveness of the educational process implementation and educational methods and means used in it is the level of graduates' adaptation to the needs of future employers. Therefore, to verify the acquired skills of network engineers, an interview was conducted with employers who employed students or had apprenticeships or internships with them. This interview was aimed at obtaining feed-back whether the use of network simulators in the educational process has an impact on the skills of future employees in the implementation of real tasks and solving current engineering problems.
The interview concerned two groups of students: the first related to the Eng while the second to the MSc level. Figure 11 presents the results of the assessment made by employers and experts from the IT industry in the context of skills of network engineers. As can be seen, in terms of practical skills, i.e. network configurations, most students were rated at a high level in the G1 group, slightly less obtained this level in the G2 group, and the least from the G3

group. So, in this respect, teaching methods based on real devices and a mixed environment are similar. As could be expected in the case of real technical, the lowest ratings were given for students from the G3 group. According to employers and experts, students from this group that did not deal with real devices repeatedly did not even notice minor configuration errors and faults at the hardware level. Interestingly, the same group of students was the most open to testing new configuration and solutions.

Analyzing the qualifications acquired by MSc students (2nd cycle), the EQF, and basically level 7 need to be considered. This framework covers the areas of knowledge, skills, responsibility and autonomy (European Commission 2020). The results of the analysis carried out in this regard are presented in Figure 12. On their grounds, it can be concluded that students participating in the educational process based on network simulators obtain very high marks in three areas defined by EQF level 7. It follows that the use of network simulators makes it possible to create an advanced work environment that allows the development of creativity and testing of various solution scenarios, which at first seem unlikely. This, in turn, is an important factor in the development of innovation and acquisition of specialized skills, which is highlighted by EQF level 7.



(a)



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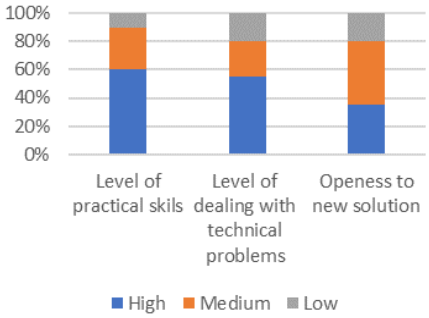

(c)

Figure 11. Assessment of the skills level of students at the Eng level in the field of computer networks made by employers and industry experts: (a) group G1; (b) group G2; (c) group G3.

When assessing the learning objectives achieved at the second cycle studies, reference was also made directly to European e-Competence Framework 3.0. In this case, the ranges (A-E) were selected, which must be addionally implemented for the e-4 education level compared to the e-3 level, and for solutions ensuring the integrity of the communication of distributed IoT systems. The following were selected: A.7. Technology Trend Monitoring; A.9. Innovating; D.1. Information Security Strategy Development; D.2. ICT Quality Strategy Development. In addition, the ability to independently plan and perform basic research in the area of communication systems for IoT and IoE networks was assessed (indicated on the chart as IoE Research design and carry out). The results are presented in Figure 13.

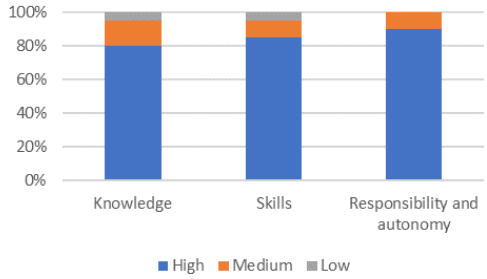

Figure 12. Evaluation of acquired knowledge and skills of second-cycle students by employers in relation to the area of knowledge, skills, responsibility and autonomy.

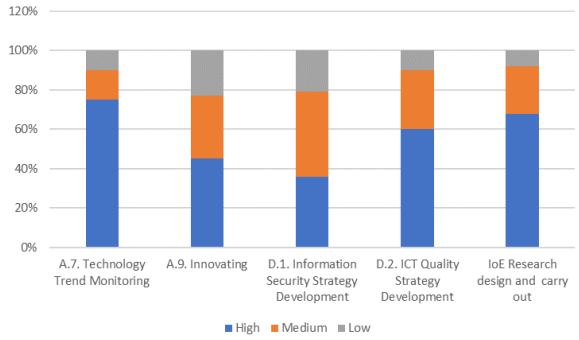

Figure 13. Student assessment for areas: A.7. Technology Trend Monitoring; A.9. Innovating; D.1. Information Security Strategy Development; D.2. ICT Quality Strategy Development; IoE Research design and carry out.

As already mentioned, the E-CF framework specifies the requirements for knowledge and skills a bit more precisely. Assessment showed that students were rated well (high and medium) in most cases in the analyzed fields. The lowest scores were in the areas A.9 and D.1. However, it seems that students can gain experience in this field only directly in industrial practice. Students participating in the study carried out most of the design work using simulators. This approach allowed them to achieve relatively good results in the analyzed areas and facilitated more flexible educational process and its current and faster adaptation to market needs.

4. Conclusions

The paper provides the analysis of both formal requirements for the training of network engineers at two levels of Eng and MSc studies, and also studied the possibility of using didactic tools in the form of network simulators in the context of meeting these requirements in relation to NQF, as well as EQF and e-CF. Based on the results obtained, it can be concluded that the use of this type of tools creates great opportunities for educational development, testing various scenarios, and allows easier and faster adaptation of curriculum to the changing needs of the labour market. This is particularly important in the context of preparing potential staff employed in the Industry 4.0, IoT, IoE and smart city systems. On the basis the results and their correlation with the needs reported by employers, Sectoral EQF should be developed for the IT industry taking into account the diversity of professional specialties. The research results may be useful in the design of training courses carried out remotely and stationary. The paper indicates the areas of simulator applications, at the same time indicating limitations in their implementation in the education process. The results of the work are particularly important in the context of the current situation related to the COVID-19 pandemic, in which a large part of the practical classes must be carried out remotely, e.g. using simulators. The use of simulators as a substitute for real laboratory equipment in the engineering education process seems like a tempting prospect. Such an approach may, however, limit the students' acquisition of practical skills in the area of design and construction of IT systems. Therefore, from the point of view of educating engineers, it seems optimal to use a hybrid environment which includes both real devices and simulators. Currently, the authors are conducting research aimed at developing the third component of practical training for engineers – a network laboratory stand built in virtual reality and in augmented reality.

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APPENDIX

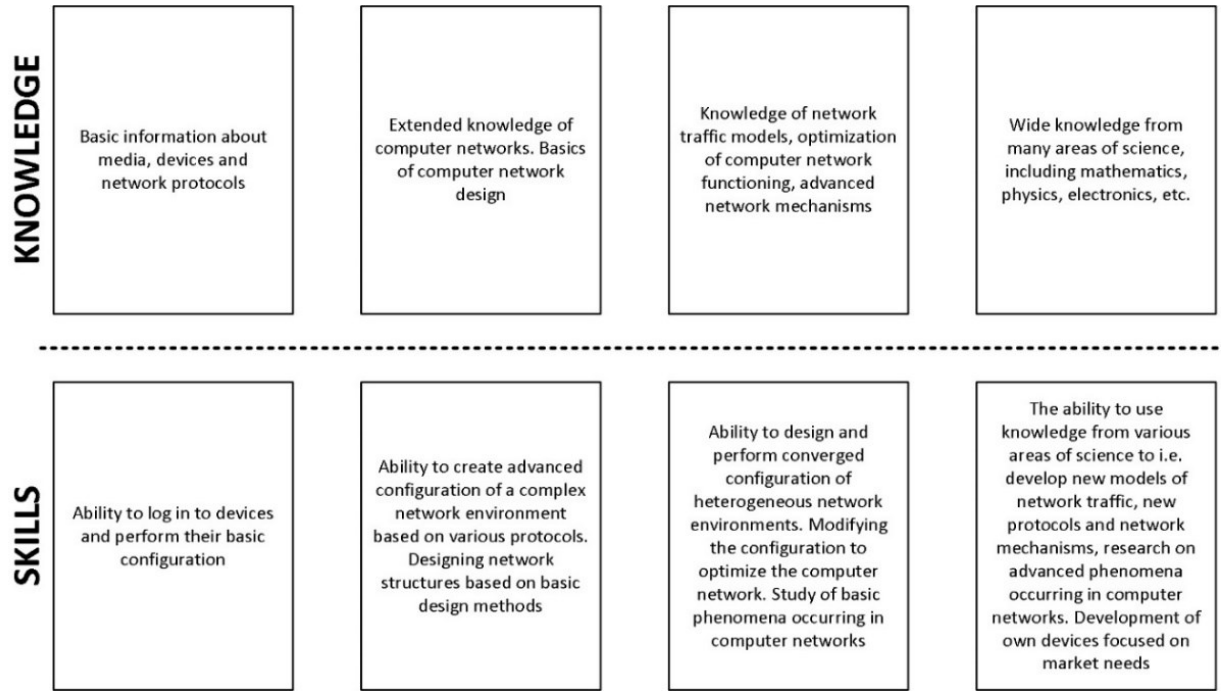


Figure 1. Stages/levels of education in the field of computer networks

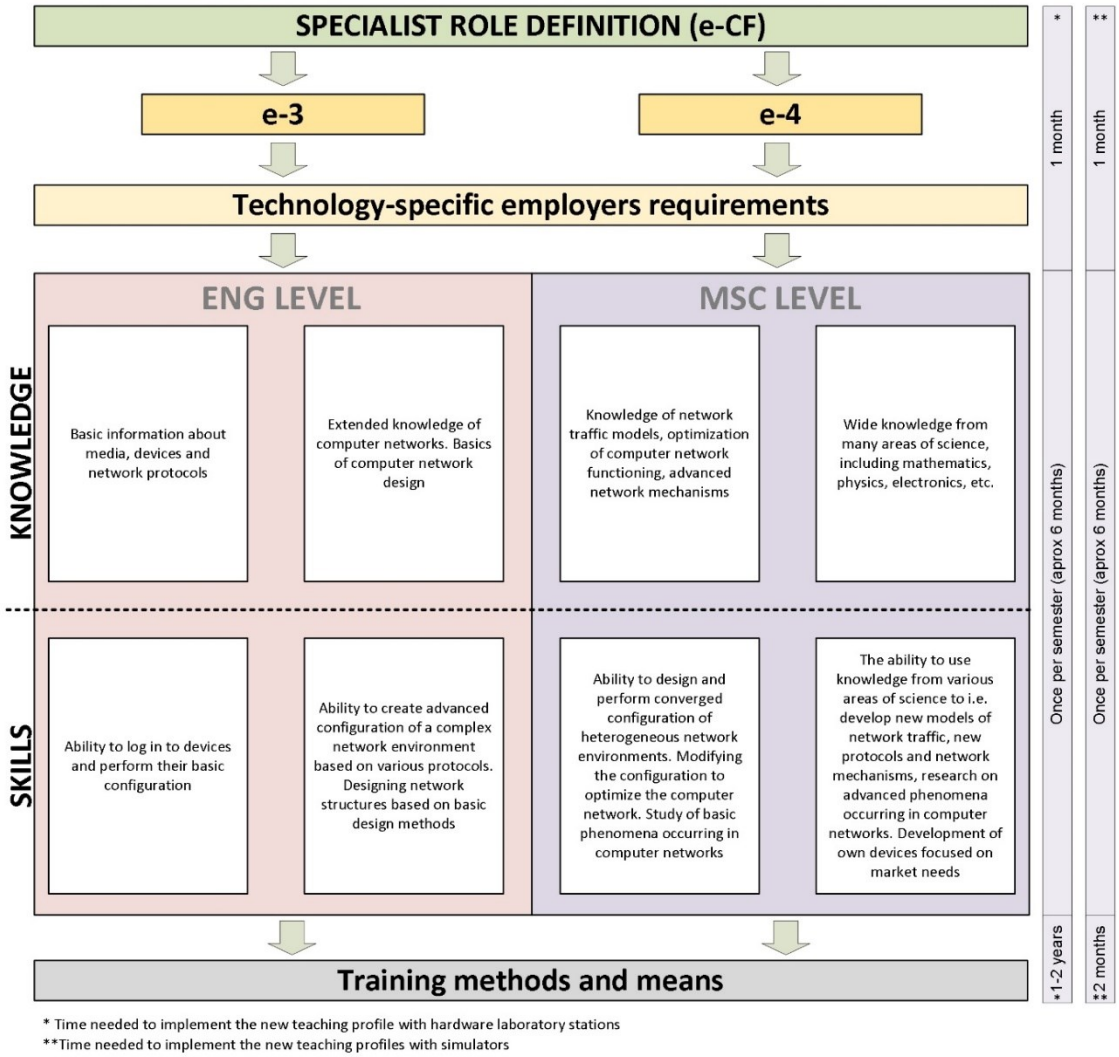
NETWORK SPECIALIST ROLE

TASKS CWA 16458-1:2018 (E)

- Ensure communication performance, recovery, and security needs meet agreed service agreement standards
- Contribute to define network design policies, philosophies and criteria
- Investigate, diagnose and solve network problems
- Use network management system tools to determine network load and model performance statistics
- Maintain awareness of relevant legislation affecting network security
- Configure network to protect against security threats
- Monitor network to identify and address traffic bottle necks

e-competence (e-CF)	e-CF level	EQF level
A.6. Application Design	**e-3**	**6**
B.2. Component Integration	**e-3**	**6**
B.4. Solution Deployment	**e-3**	**6**
C.4. Problem Management	**e-3**	**6**
E.8. Information Security Management	**e-3**	**6**

Figure 3. The role of network specialist according to (European Committee for Standardization 2018)



* Time needed to implement the new teaching profile with hardware laboratory stations
**Time needed to implement the new teaching profiles with simulators

Figure 4. Combining education stages with e-CF in relation to curriculum changes

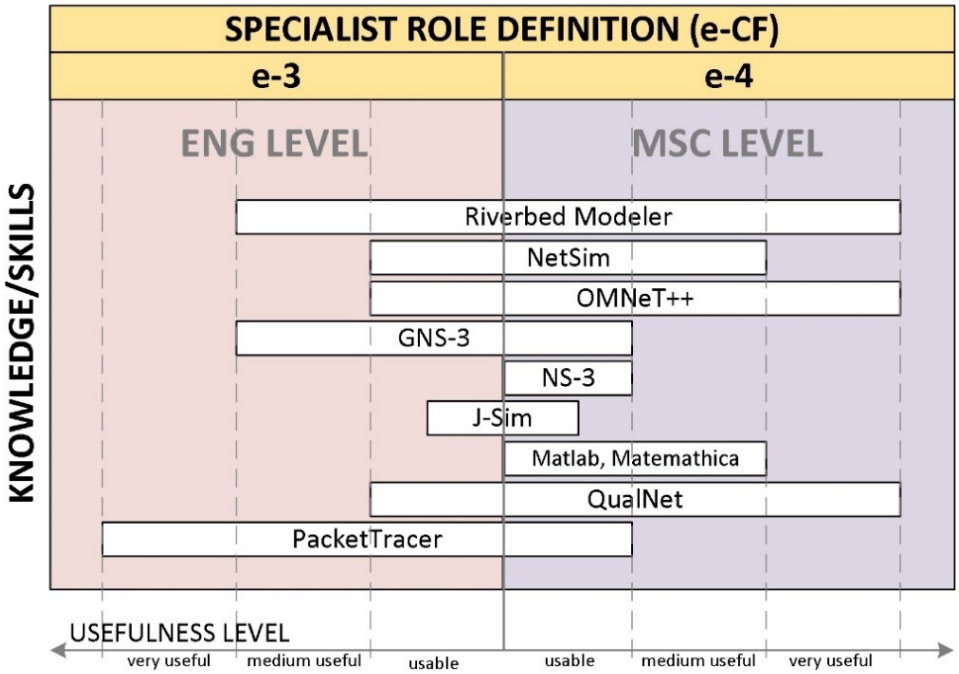


Figure 5. Classification of tools for simulating computer networks from the perspective of stages/levels of education

Experimental Teaching Deep Learning with TensorFlow Case Studies

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Abstract

This paper is discussing a set of continuing developing lessons for high school and college students to learn deep learning through a set of examples while learning the main fundamental theory. The neural networks and deep learning are framework that can process large data by learning algorithms. Students will start with learning the capability of just a simple neural network with only one node. Then they progress to a network with only one layer and multiple nodes. Later, training a simple network with one layer. Finally extending the training techniques to two layers and more layers. Students will learn a step-by-step method to load and preprocess data and build, compile, and train models to solve deep learning problems. At last, practicing on some real applications using TensorFlow and its varieties of products, such as TensorFlow Lite, and TensorFlow.js.

TensorFlow provides an easy and open-source platform for beginners to build and deploy machine/deep learning models. In addition, many companies, such as Airbnb, Google, GE healthcare, DeepMind, and Tweeter, use TensorFlow [1]. These offer students many interesting cases to study how to solve real-world, everyday deep learning problems. Examples include ranking tweets, "identifying specific anatomy during a brain magnetic resonance imaging (MRI) exam to help improve speed and consistency", helping to advance the guest knowledge by images and objects classification and detection at scale [2][4]. Even students who are interested in space application can locate case studies in this area. For example, Airbus delivers valuable insights to clients by information exaction from satellite images for "urban planning, fighting illegal construction and mapping damage and landscaping changes causes by natural catastrophes" [2].

TensorFlow Lite provides machine/deep learning tools for users to deploy their applications in mobile, embedded, and IoT devices [5][6]. TensorFlow Lite pre-trained models make it easier to use in a wide variety of machine/deep learning applications such as image classification, object detection, speech recognition, gesture recognition, recommendation, and text classification.

TensorFlow.js provides pre-trained models in JavaScript for deep learning to run in the browser or in Node.js. Students can convert Python TensorFlow models to achieve this goal too. There are a wide variety of applications as well by using TensorFlow.js. The models include pose detection, text toxicity detection, semantic segmentation, face landmark detection, hand pose detection, and others.

Keyword

Deep Learning, TensorFlow, Education, Artificial Neural Network, Backpropagation, Python Programming, JavaScript Programming, Neural Network Architecture,

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Crowdsourcing awareness in South Africa

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Abstract:

Crowdsourcing has gradually become a popular phenomenon where organisations ask for help from the public to complete tasks that would usually be performed by employees. These tasks can include scientific problems and tedious tasks that are sometimes too monotonous for employees. While the popularity and benefits of crowdsourcing are undeniable; and it has been adopted by developed nations like America, United Kingdom, Denmark and Finland; developing nations like South Africa, are still lagging behind compared to the developed nations. There could be a myriad of factors that could be contributing this slow uptake in South Africa. This paper investigated the awareness of crowdsourcing in South Africa. A survey was conducted with 147 ordinary citizens on their awareness of crowdsourcing. The findings of the survey suggest that not many people and organisations are aware of crowdsourcing.

Keywords: crowdsourcing, awareness, crowds, task, internet, crowd contributions.

1. INTRODUCTION

Organisations are continuously searching for ways to improve their services to customers, and also to meet the increasing demands of Information Technology (Ikediego et al., 2018). Because of the current global wave of technology advancement, many organisations have realised the remarkable power of the web and the opportunities it brings especially when trying to reach out to external sources of information. Many sourcing models have been used in the past, but the current sourcing model that is gathering steam is Crowdsourcing – whereby organisations harness the power of the crowd to get done using the web.

Naturally, a crowdsourcing process would include an organisation identifying tasks, then making those tasks available to a crowd of interested individuals to perform those tasks on behalf of the organisation, for an incentive or a fee. The activities to be completed could consist of anything from conducting simple data, verification, data corroboration and research to more subjective tasks like participation in surveys, moderation of content, and more. Conventionally, tasks like these would be accomplished by appointing a large temporary labour force, which could be time consuming, costly and difficult to measure. Crowdsourcing offers a good avenue to divide a manual, time-consuming project into small, more manageable tasks, (also known as 'microtasks') to be performed by distributed labour force over the Internet or physically.

The benefits of crowdsourcing are overwhelming, especially in developing nations. With unemployment being one of the biggest socio-economic challenge affecting the world, for developing nations the situation is more detrimental. Crowdsourcing, being a co-creation model that is capable of generating a shared value that is both economic and social, allows participation from different tiers of the population.

This population, who may be living in geographically remote, and marginalised areas, and who may have never before participated in value creation activities, now have the opportunity to do so via crowdsourcing.

The widespread popularity and benefits of crowdsourcing are undeniable. To bring an insightful understanding on the awareness of crowdsourcing in South Africa, the following research question will be investigated:

What is the level of crowdsourcing awareness in South Africa?

The paper is structured in the following manner. First crowdsourcing is defined. Then we explain the methodology undertaken, and present the analysis of results; followed by a discussion of the results in this research. Lastly the limitations and future research is presented.

2. CROWDSOURCING

Crowdsourcing, is acknowledged in media as well as in the Internet as an innovative form of value creation (Hammon & Hippner, 2012). It usually takes place online, though not exclusively because offline cases are abound. An example of an offline case was the making of the movie "The Lord of the Rings", by Peter Jackson; where a physical crowd was used to create sound of the orc armies rather than a virtual one as a norm. The director, Jackson requested 20,000 cricket fans from the West Pac Wellington stadium in New Zealand to shout, and the sound was used to represent the Uruk-hai orcs armies in the movie (Ikediego et al., 2018).

The term crowdsourcing was created in 2006 by Jeff Howe (Howe, 2006), and since then it has been used a variety of domains including scientific research, marketing,

business and biology. Crowdsourcing uses the crowd to provide solutions to diverse problems, and can provide valuable information that can assist in decision making.

The tenets of crowdsourcing are to dispense work ranging from harnessing crowd participation in product development (Djelassi & Decoopman, 2013), conducting research (Bates & Lanza, 2013), to idea generation (Simula, 2012). The crowd is usually made up of decentralised group of diverse voluntary individuals.

There is currently no generally adopted definition for crowdsourcing. The foundational definition is that of (Howe, 2008). He defined crowdsourcing as the "act task of taking a task traditionally performed by a designated agent and outsourcing it by making an open call to and undefined but large group of people". Saxton, Oh, & Kishore, (2013) however argues that Howe's definition leaves a lot of space for understanding, in that it lacks practicality. This led to other researchers coming up with new definitions of crowdsourcing that suits its practicality. In their analysis (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012) created a list of definitions related to crowdsourcing. The common elements mined from their analysis of the definitions are: "*participative online activity, the involvement of individuals of varying knowledge, heterogeneity, voluntary undertaking of a task and some kind of reward".* Irrespective of which definition one follows, the basics principles of crowdsourcing are that work is discharged to the crowd to perform the work for the organisation's benefit for some reward.

Although there are numerous descriptions of the crowdsourcing process (Pedersen et al., 2013), the process is relatively generic and involves the following key elements:

- An organisation that has a task that needs to be solved.
- A crowd that is eager to perform that task.
- An online environment that will allow work to be done and allow the crowd to communicate with the organisation.
- Mutual benefit for the organisation and the crowd.

The literature on crowdsourcing distinguishes a crowdsourcing system based on the nature of the crowd contributions (Schenk & Guittard, 2009). There is integrative crowdsourcing which is complementary in nature because a single contribution has little value on its own, and the value is usually derived from a large input from the crowd. The other is selective crowdsourcing where a requester chooses and may reward the best contribution solicited from the crowd for a particular task or problem (Schenk & Guittard, 2009) Figure 1 represents the general approach to crowdsourcing.

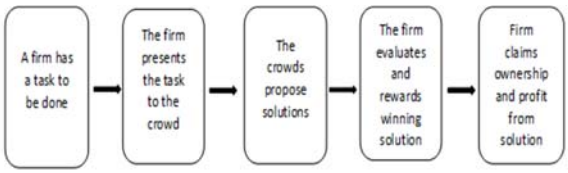

Figure 1: General Approach to Crowdsourcing. *Source*: (Ikediego et al., 2018)

3. RESEARCH METHODOLOGY AND ANALYSIS OF RESULTS

3.1.Methodology

The objective of this was to investigate the awareness of crowdsourcing in South Africa. A questionnaire was designed based upon the concepts crowdsourcing awareness. Ethical clearance for the survey was applied for and granted by UNISA. The questionnaire was distributed to a general population who could read and write English, and had access to the internet. The questionnaire was distributed using a traditional method of physical distribution. The other methods used were email, and an online survey tool called Survey Monkey[1]. A total of 147 people responded. After the administration of the questionnaires, the data was organised, collated, summarised, and analysed using IBM SPSS Statistics tool and Microsoft Excel.

3.2.Analysis of results

3.2.1. Biographic data

The biographic data of the respondents was analysed to determine the occupation and organisation to which they belonged to. Table 1, shows the occupation summary. Of the 147 people who responded, 110 were employed, 24 were students, and 13 respondents did not indicate their occupation (shown by "missing" in the table).

Occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employee	110	74.8	74.8	74.8
	Missing	13	8.8	8.8	83.7
	Student	24	16.3	16.3	100.0
	Total	147	100.0	100.0	

Table 1: Biographical data of respondents.

3.2.2. Knowledge about crowdsourcing

Respondent's responses to the question "*Have you heard of crowdsourcing before?*" show that the majority of the respondents had not heard of crowdsourcing before. Ninety-six respondents indicated that they have not heard of crowdsourcing before.

Fifty-one of the 147 respondents indicated that they have heard of crowdsourcing before, as indicated in Table 2**: Knowledge about crowdsourcing**. The fact that 96 respondents, representing 65% of the total respondents to this

[1] **SurveyMonkey:** A free online survey tool. See: https://www.surveymonkey.com/

question, have not heard of crowdsourcing may indicate the small inroads crowdsourcing has made in South Africa.

Heard of Crowdsourcing before?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	96	65.3	65.3	65.3
	Yes	51	34.7	34.7	100.0
	Total	147	100.0	100.0	

Table 2: Knowledge about crowdsourcing

3.2.3. How respondents knew of crowdsourcing

Results to the question, "*How did you learn about crowdsourcing?"* show that most respondents who answered "yes" to the previous question, learnt about crowdsourcing from a variety of sources. Thirty-seven respondents learnt about crowdsourcing from the Internet, seven from social media; and then 10 from other means Radio and the Newspaper had two respondents each. Ninety-two (i.e., 62.6%) respondents' responses were flagged as Not Applicable; these are mainly the respondents who answered "*No*" to the question "*Have you heard of Crowdsourcing before?"* **Error! Reference source not found.** closely ties up with Table , (i.e., 65%) of people who indicated that they have not heard of crowdsourcing before.

How did you learn about Crowdsourcing

	Frequency	Percent	Valid Percent	Cumulative Percent
Internet	37	25.2	25.2	25.2
Missing	1	.7	.7	25.9
Not Applicable	92	62.6	62.6	88.4
Other	10	6.8	6.8	95.2
Social Media	7	4.8	4.8	100.0
Total	147	100.0	100.0	

Table 3: How respondents learnt about crowdsourcing

3.2.4. Crowdsourcing use by respondents

In response to the question *"Have you personally used crowdsourcing?"*, 134 respondents indicated that they had not used crowdsourcing and only eight indicated that they had used it. Five respondents' answer to this question was missing. The fact that 134 respondents have not used crowdsourcing further confirms the slow penetration of crowdsourcing in South Africa, this time at an individual level. Table shows a representation of the results.

Have You Personally used Crowdsourcing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Missing	5	3.4	3.4	3.4
	No	134	91.2	91.2	94.6
	Yes	8	5.4	5.4	100.0
	Total	147	100.0	100.0	

Table 4: Respondents who have used crowdsourcing before

3.2.5. Organisations using crowdsourcing

The last question enquired of the respondents if their organisations were using crowdsourcing. The results showed that 107 respondents did not know if their organisations use crowdsourcing, 32 indicated that their organisations were not using crowdsourcing, there were four missing answers, and only four indicated that their organisations were using crowdsourcing. The results are depicted in Table .

Does your organisation use Crowdsourcing?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do not know	107	72.8	72.8	72.8
	Missing	4	2.7	2.7	75.5
	No	32	21.8	21.8	97.3
	Yes	4	2.7	2.7	100.0
	Total	147	100.0	100.0	

Table 5: Organisations use of crowdsourcing

In order to gauge the correlation between the variables in this survey, correlation analysis was performed using Microsoft Excel spreadsheet. Correlation discovers and measures the relationship between two or more variables (Chalil, 2020). Appendix A shows the correlation among for the survey dataset.

The following correlations were observed from the table:

- Occupation and Q4: the correlation coefficient of 0.237 shows a weak correlation between Occupation and the question whether the organisation they belong to used CS. It is mostly people who are employed who responded in the affirmative to the question whether the organisation they belong to used CS.
- Q1 and Q3: a correlation coefficient 0.259 shows a weak correlation between people who have heard of CS and the question if they personally used CS. the rationale was that people who have heard of CS would likely use it.
- Q2 and Q4: the correlation coefficient of 0.395 between how people learned about Cs and the use of Cs by organisations they belong to shows a moderate positive correlation. This could be because they may have learned about CS via their organisations.
- Q1 and Q2: the correlation coefficient of -0.659 there is a strong negative correlation between whether participants heard of crowdsourcing, and how they learned about crowdsourcing. This is because participants would probably be unable to indicate how they learned about crowdsourcing if they have not heard about it. This is in line with the data analysis results which showed that 62.3% of the participants indicated that they have never heard of crowdsourcing before, and 62.6% responding in the negative to the question how did you learn about crowdsourcing.

The overall observation is that most of the coefficient values are negative and near zero, which implies no meaningful relationships between variables; except for the correlation between Q1 and Q2 which has a coefficient of -0,659.

3.3. Discussion of results

Based on the survey, what could be drawn out of the analysis and the results of the correlation analysis is a lack of crowdsourcing awareness by the majority of the participants in the

survey. An overwhelming number of respondents, 96 out of 147 respondents had not heard of crowdsourcing before. Additionally, 139 of the respondents indicated that their organisations are not using crowdsourcing. This research is significant because it provides empirical evidence on the awareness of crowdsourcing in South Africa.

The majority of the respondents in this survey were employed, and the fact that they or the organisations they are working for have not heard of, let alone, use crowdsourcing indicates the lack of awareness of the technology by organisations as well.

4. LIMITATIONS AND FURTHER RESEARCH

As with any study, this research has limitations. The sample size used in this study is small; further research using a larger sample size is necessary to test the result gotten from this study. Another limitation is that the data was obtained only from a population in the Gauteng and Limpopo provinces of South Africa. We would encourage further studies to be done countrywide in order to broaden the understanding of crowdsourcing awareness in South Africa.

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Appendix A

		Correlation			
	Occupation	*Q1. Heard of CS before?*	*Q2. How did you learn of about CS?*	*Q3. Used CS personally?*	*Q4. Does your Organisation use CS?*
Occupation	1				
Q1. Heard of CS before?	-0,026771963	1			
Q2. How did you learn about CS/	-0,014515197	-0,659752723	1		
Q3. Used CS personally?	-0,05359654	0,259411938	-0,275625937	1	
Q4. Does your Organisation use CS?	0,237125533	-0,362073063	0,395518862	-0,139908436	1

Early warning and disease surveillance: anew Model

Research-in-progress

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Abstract

Since the early stages, the COVID-19 pandemic has shown us the importance of having an accurate and reliable system for early warning and disease surveillance.
Unfortunately, most countries worldwide don't have an appropriate system to detect diseases and respond to them. The ones that exist approach the subject from many perspectives, also having different results.
Here a Model about how to perform disease surveillance, and, have a good early warning system with a systemic and time-spatial perspective will be presented.
The proposed Model includes creating epistemic communities at the national and international level and a Resolution from the United Nations Security Council (UNSC) to help implement the disease surveillance database (and dashboard), having data governance and business intelligence tools as the backbone.
The UNSC will lead the implementation of this Model, considering the importance not only to healthcare but also to the security of an epidemic, but all the relevant international organizations will be involved.

Key words

disease surveillance, early warning, data governance

1. Introduction

Diseases are part of our life -and death- since the living beings started to populate the planet, they had a different impact. Still, they had influenced and shaped human history in many ways, even led to many scientific discoveries.
Our ongoing challenges are posed by human activities (international travels, migration, and trade) and the consequences of climate change, inequities between countries regarding their healthcare systems, and aspects that favor disease transmission (1).
Because we live in the information age, the amount of information available regarding disease outbreaks is gigantic, especially if we consider the diverse data sources on hand. But it doesn't mean that the data are good and accurate, but the contrary (2).
The SARS-CoV-2 pandemic was and is a wake-up call to identify and deal with problems related to early warnings, disease surveillance, gathering relevant historical information, the role of the high interconnectedness (3), among others.

The Model presented here has these underlying assumptions:

- A systemic approach (4) including all living beings is necessary to understand the web of connections and how an outbreak could affect its balance.
- An extraordinary event could jeopardize and affect any country stability
- Developed and developing countries have so many differences when it comes to disease surveillance and early warning systems (5, 6).
- The pathogens and vectors usually living in the countries vary significantly among them.

Systemic thinking is the dominant approach to analyze the problem of disease surveillance and early warning because it allows to include a time-spatial perspective, the living beings, and all the other components, such as the environmental, political, economic, social cultural.

The sequence of events considered in this Model, considers information about past outbreaks and usual presence of pathogens and vectors (background information which will allow to detect anomalies), the outbreak itself (which could be unusual, anomalous, unexpected, or extraordinary), and the response to it and the result.
Since the outbreaks could be of different origins, the bio risk spectrum developed by Terence Taylor (7) helps to understand them (Figure 1).

Natural	Accidental		Intentional		
Naturally occurring diseases, Re-emerging and new infectious diseases	Unintended consequences of research,	Laboratory accidents, lack of awareness, negligence	Biocrime	Bioterrorism	Biological warfare

Figure 1: Bio risks spectrum, adapted from Terence Taylor (7)

Even having all the possibilities mentioned in Figure 1, it is a relief to know that considering the data and information available, and the indicators that could be built using them, the origin of an outbreak could be identified with high certainty.
The first challenge is to detect the outbreak early, in this Model, since is data-based, the event will be considered as an anomaly and treated and analyzed like that.

2. Disease surveillance and anomalous events

Any country or region has its own "disease ecosystem" and could be affected by natural and non-natural events that affect the prevailing situation.
A customized and robust disease surveillance system is the key to having an appropriate response to an outbreak. But it should also include the specific characteristics of the culture and society that could affect the disease propagation, such as burial rituals, caring for sick people, etc. (8).
In this Model, the definition of disease surveillance is: "the routine and continuous collection of passive and active data of a given population (human, animal, plant) followed by analysis, interpretation and dissemination of information to detect the occurrence of disease for control purposes or public health actions.
Sources of surveillance can be formal or informal and originate from the media, laboratory scientists, clinicians, hospitals, veterinarians, farmers, abattoirs, morgues, wildlife rangers, pharmacies, and the public" (9).
Other relevant definitions related to diseases outbreaks are (10):

- Signs: something that is physically observable by medical staff or the patient (e.g. rash, bruising, swelling, etc.);
- Symptoms: experienced feeling, discomfort or pain. They can be measured semi-quantitatively; and
- Syndromes: articulation of signs and symptoms that together indicate or characterize a disease.

Al the concepts defined above are relevant because they frame the data

and information input to the Model, considering the broadest spectrum possible. Therefore, data and information about all the infectious diseases would be gathered, not only the listed diseases by international organizations, so the big picture about the epidemiological situation can be prepared. It interesting to point out, that the Model also is relevant to non-transmissible diseases, and ideally, both categories or diseases would be included, and correlations could be identified.

Many researchers (11), organizations and countries (12, 13) already have identified parameters, criteria, and indicators to detect outbreaks out of the usual conditions, here some elements of them will be considered and new added. The objective of the indicators in this Model provides not only an early warning alert but also the possibility to double check data and corroborative evidence.

The Model proposes the creation of a real-time database of outbreaks, and all relevant related information for humans, animals, and plants. In this way, the current silo perspective is broken, following a similar logic to One Health's (14). Having together human and animal diseases is significant because the human infectious diseases mostly start in animals (15).

Even when countries have differences in outbreaks and healthcare systems, the people get sick in the same way, with the same symptoms. So, this Model will allow to compare and analyze together all the data available, allowing to reach out more relevant and accurate conclusions and make trustable predictions.

The anomalies (outbreaks) will be detected through data mining techniques, which will help to identify deviations of the usual patterns, facilitating a prompt reaction and response.

3. Early warning indicators

The indicators selected to perform disease surveillance (Tables 1) will allow to detect deviations from the expected behavior, anomalies (16), and then follow the decision-making path. In this context one of the biggest challenges is the definition of the usual situation which is critical to identify the anomaly (17).

This Models includes two categories of indicators for both humans, animals and plants: direct evidence (where all the health care linked information will be listed) and indirect evidence (all the other indicators, that evidence the impact of the disease on other sectors).

The Model presented here consists of implementing the systemic thinking to the infectious diseases surveillance and early warning system, from a data governance perspective. In this sense, "Modelling is more than computation: it is a method for abstraction and understanding complex systems, systematically" (18).

This innovative methodological perspective includes the following subject area:

- Systemic thinking: or ecosystem perspective, aggregates and analyses all the indicators and other relevant information.
- Data governance: the change in viewpoint, moving from the sanitary perspective to a data-driven one, would help in finding new sources of information, reducing the collecting and analytic biases, and having, so a better input to the decision-making process. Another relevant aspect of this Model is the transition from the current silo perspective (where the focus is on data ownership), to a broader, comprehensive, non-hierarchical one, where the stress is on data sharing because of a common goal as it is fighting

diseases. The data anonymization is a critical procedure to avoid sharing no relevant personal information.

- Data quality: the data and information will be scrutinized to determine their quality. For that, all the available tools, such as big data, artificial intelligence and data mining will be incorporated. This will allow to use mostly primary sources of information (19).
- Infectious diseases database: at this point, many databases about diseases exists, so they will be compiled and integrated to help to develop the background information, and later, the new information will be added. Having all this information together will help to confirm a diagnosis or as search tool.
- Stakeholders' involvement: the Model has two levels: national and international (under the Security Council). The latter will involve not only country representatives but also the participation of an epistemic community that will advise on technical matters, recommending the countries about the data gathering and implementation of this Model along with improving better their disease surveillance respecting and understanding their social and cultural values. Having an epistemic community with representatives from the pertinent organizations and sciences (biology, economics, politics, security, anthropology, etc.) will create valuables synergies, leading to innovative and unique analysis and hypotheses. Other actors at the international level will be WHO, OIE, FAO, and NGOs.

Considering the advantages and accomplishments made by the countries helped by the UNSC 1540/2004 Resolution (20) and Committee, this Model follows the same direction, suggesting issuing a UNSC Resolution for Disease Surveillance and early warning, with a transdisciplinary epistemic community to advise the countries and databases that will actas both a repository and as an analytical tool (21).

The Model for disease surveillance (Figure 2) has two levels or phases:

First phase: Continuous disease surveillance, using indicators of direct and indirect evidence (Table 1) that will help to identify the anomalous event, and at the same time, help to update the background information database. This information will be gathered in each country's databases and shared internationally to integrate the data warehouse at the international level.

When integrated and analyzed against the historical (background) information, this set of indicators will act as anomaly detectors and early warning alerts.

One outstanding feature of this proposal is the information will be gathered in their raw condition; any further process is required. In this way, no extra burden will be generated, and the impact of the bias will be minimum.

At the same time, the different variables will be cross-checked: it is expected that if an anomalous event happens, all the indicators move away from the expected parameter. So, in this way, errors would be quickly and early identified, and events corroborated.

At this phase, there are two levels, national and international:

- National: data gathering and anonymization. If an anomalous event is detected, an alert will be issued, and the response to the outbreak will start, and the second phase will be triggered. The less developed countries could ask for help from the epistemic community and the support team. The database could also have a dashboard to monitor the situation of selected diseases.

A database with historical data from previous outbreaks will be developed to detect anomalies since it will act as a baseline.

- International: all the data from countries will be collected and sent to the data warehouse at the devoted area under the Security Council. Data consolidation, cross-checking between countries, pattern discovery, and data analysis will take place at this level. At the data warehouse, a dashboard will show the situation around the world for a more straightforward follow-up.

Direct evidence	Indirect evidence
Data from the disease identified and/or signs/symptoms/syndrome (to be matched with the infectious diseases database): date, place, transmission mode, patient age, virulence	Pharmacy sales of over-the-counter drugs (to lower fever, antidiarrheal antinausea, etc). Also, sales of equivalent veterinary products and for treatment of plant diseases
Laboratory tests preliminary results and confirmations	Weather information (contextual)
Emergency room visits (increase in number and location) and equivalent for veterinarian and agronomists	Search pattern on internet or twitter (22) (social media)
Morgue and cemetery (and equivalent for veterinarian)	

Table 1: early warning indicators, data to be gathered about the usual and listed or reportable diseases in the countries.

The data will be collected mostly from primary sources of information: health caretakers (e.g., all the spectrum of medical doctors regardless of their employer will be involved, veterinarians, agronomists), laboratories (disease testing), treatment providers such as hospitals and clinics, NGOs and other organizations that work in the field healthcare field. In addition, information about indirect indicators will also be gathered, such as pharmacy sales or change in search patterns. They may also provide early warning, which could be cross-checked against the direct evidence.

A multidimensional GIS will be developed to include the location of the hospitals and other healthcare centers, number of physicians and nurses per habitant (by district), population density (again by district), and location of the diseased individuals. This map will help the decision-makers -and the epistemic community- to understand the outbreak situation and its geographical evolution; and would be relevant if resources must be reallocated to improve the response. This system will be included in a dashboard.

The appropriate corrections could be made since the disease parameters change seasonally, plus variations on the pathogen's dynamics and days of the week vs weekends on visits to emergency rooms.

In the background information, available models about disease progression and pathogens dynamic will be included, along with other epidemiological information, to help to understand better the usual situation. Using this database, together with the input of the Table 1 indicators, the anomalies detection will take place.

Second phase: Once and if an anomaly is detected, so an unusual outbreak is taking place, it is time to identify its

origin: natural, accidental, or intentional. To do that, more data is needed, so new direct and indirect (Table 2), and contextual (Table 3) indicators or evidence will be collected.

Real-time and historical information could also have to be merged into the disease surveillance databases at the national and international levels.

Direct evidence	Indirect evidence
Blood donors' screens	School absence record
NGO alerts, like PROMED, increase in volume or requests of information	Work absenteeism record
Strain identification: one or multiple strains presence in the sick or dead affected beings and genetic fingerprint	Other changes in usual social patterns (decrease in use of cars or public transport, attendance to restaurants or to other public places, etc)
Vaccines or other available treatment	
Nurses advise calls or similar (increase in number and other relevant information) and the equivalent for plants and animal health if exists	
For animal and plant diseases, the geographical distribution of the disease is a critical element to figure out the origin of the outbreak	
Reports of abnormal situations from slaughterhouses and silos and grain collectors	

Table 2: data linked to the disease outbreak to be gathered in case of an anomalous outbreak of disease

Contextual evidence
Existence of a conflict (internal or international)
Movement of people (migrants, planned events, etc)
Presence of terrorist groups, with suspicious of past chemical or biological weapons programs
Presence of high containment laboratories in the area
Environmental changes (natural and manmade)
Presence of hubs airports or high volume of passengers
Weather information (extraordinary)
Change in the social habits

Table 3: relevant information to be gathered in case of an anomalous outbreak of disease

Putting together the evidence collected from tables 2 and 3 along with the one from table 1 that triggered the process will be enough to solve the puzzle and diagnose if the origin of the outbreak was natural, accidental, or intentional.

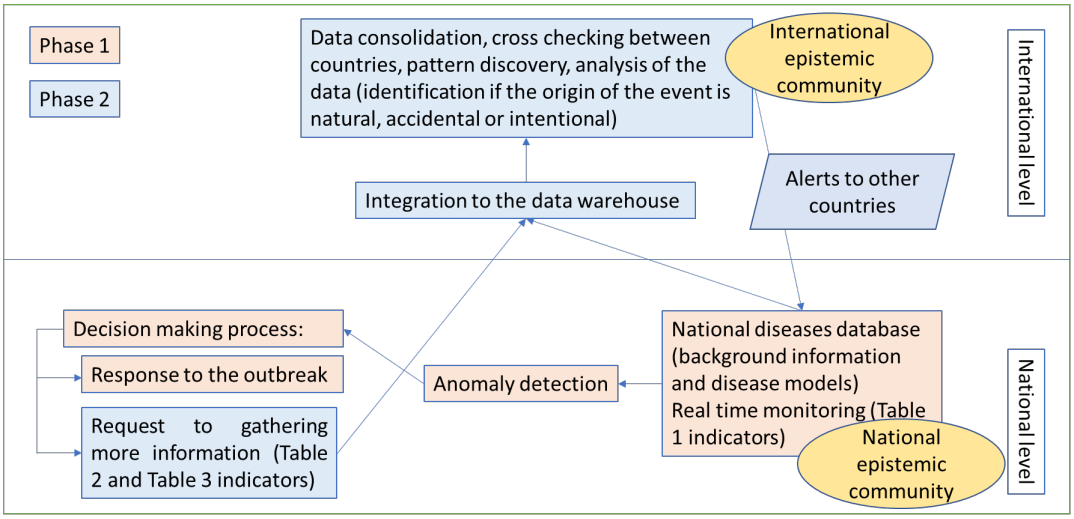

Figure 2: Disease surveillance and Early warning Model, adapted from Lauria &Taji (23)

Considering that having quality data and information is critical to an efficient decision-making process, the proposed Model considers collecting data from different sources and integrate them at two levels, national and international. Also, the 2-phases process allows a rapid response using only a few indicators, and a later more complex analytical stage to determine, among others, the origin of the outbreak and its potential impact.

This agile system to deal with disease data and information enables access to information in any context, it can create new knowledge, store it, so it makes the retrieval easy, facilitating its use for analytical purposes.

At national and international levels, both epistemic communities will advise the decision-makers on the aspects of each member competence and also to build the databases, GIS and dashboards needed.

4. Conclusions

The Model proposed here for disease surveillance and early warning considers that, because of its relevance to health and security should be under the jurisdiction of the UNSC. Sweden already in 2004 already mentioned the importance of having an international organizational structure with some characteristics included in this Model (24).

Having databases, a warehouse, dashboards and interactive GISs at the national and international level and the multidisciplinary epistemic communities, the current silo perspective will be disarticulated, favoring a prompt decision-making process. Besides the experts from different fields, representatives from international organizations, such as the WHO, OIE and FAO- plus the BTWC through the Implementation Support Unit to the BTWC (ISU) will cooperate at the international level. There will be many challenges at the national level, mostly related to the legal and bureaucratic aspects of collecting data and information, but it is worth trying.

Some countries like the US (25) or some European countries already implemented a system that includes collecting a massive amount of data to understand the epidemiological situation. But, unfortunately, detailed information about how their programs work is not openly available.

This Model poses an advantage to the developing countries since collecting raw data will reduce the impact of the bureaucracy. But for the developed countries, no significant challenges are foreseen. Even when working with data

from different sources could be challenging, but many tools are available to create trustable models (26, 27).

One of the outstanding innovations of this proposal are the epistemic communities as advisory groups. Learning from the past outbreaks and how they were managed and understood will help to deal with future ones, the critical factor identified was how the people acted and reacted to diseases outbreaks (28). In addition, the key issue was to understand the social and cultural dynamics involved (29). Together, both elements will help to control and eradicate the disease in a sustainable way, even if there are no vaccines or antibiotics.

At the national level, the real-time dashboard will help the countries follow up the epidemiological situation and improve their disease surveillance; and early warnings will be provided if anomalies are detected locally and in neighboring countries or transport hubs. At the international level, to cooperate with the epistemic community is suggested the participation of all the international donors working on the disease management around the world. Finally, today coexist many diseases surveillance and early warning systems, and since considering the implementation of a unique arrangement is not only a utopia but something not necessarily ideal, the proposed Model here resembles a plausible and optimal solution to the problem. It creates databases and a data warehouse where all the data from all the countries, in any format are harmonically integrated, with no constrain about the structure. As consequence, this Model becomes easy to build and maintain bringing many benefits to all the world.

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Does Students' Adoption of Block Mode of Teaching Boost Positive Learning Outcomes in Tertiary Sector?

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Abstract

Block Mode teaching delivery, or intensive mode teaching, is a condensed style of teaching in which classes are scheduled in an intensive period. This paper examines the impact of students' utilisation of the Block Mode of teaching on positive learning outcomes such as student's retention, satisfaction, learning outcomes and graduate outcome. Data is collected via an online questionnaire from 74 participants studying in Block Mode in one of Australia universities. The findings shows that students' utilisation of the Block Mode of teaching significantly and positively impacts positive learning outcomes in terms of student's retention, satisfaction, learning outcomes and graduate outcome. The findings of the current study have important implications for researchers and practitioners.

Keywords: Block mode of teaching; intensive mode of teaching; positive learning outcomes; innovation adoption.

1. Introduction

Block Mode (BM) teaching delivery, or intensive mode teaching, is a condensed style of teaching in which classes are scheduled in an intensive period that could be as short as 1 week, where students focus on less number of subjects at a time, usually one subject at a time (Male et al., 2016). Implementing Block Mode of teaching has attained high popularity and interests in recent time (Sidiroglou & Fernandes, 2019). This mode of delivery has been extensively used by postgraduate students who work full-time or students who need more time off-campus for practical experiences (Davies, 2006).

Block mode of teaching has potential to enhance student performance (Karaksha et al., 2013) and higher students' satisfaction with their subjects (Burton & Nesbit, 2008). Many studies have addressed the educational benefits and costs of block scheduling though few have documented its impact on the students learning outcome and academic success. There seems to be limited recommendations for the impact of intensive mode on student positive learning outcome, and current literature mostly focus on comparing intensive mode with the traditional mode in terms of different factors such as efficacy and popularity (Burton & Nesbit, 2008; Mitchell & Brodmerkel, 2021) . This study however focuses on investigating the impact of students' adoption of the Block mode of teaching on students' positive learning outcome. The research question underlying this study is:

> *RQ) What is the impact of students' adoption of block mode on positive learning outcomes in tertiary sector?*

Although many higher education institutions across the world utilize the BM for their teaching and learning activities, there seems to be a lack in research which examines the impact of Block Mode adoption on positive learning outcomes of learners. This study has investigated the impact of students' adoption of BM on student's retention, satisfaction, learning outcomes and graduate outcome.

The remainder of this paper is as follows. Following this present introduction section, research background and hypotheses development are explained. Next, research design is introduced, followed by analysis and research results. Finally, discussion of findings and conclusions are presented.

2. Research Background & Hypotheses Development

Higher education has experienced different challenges and changes where the traditional modes of teaching delivery have not been efficient enough to cater the needs of the current learners (Burton & Nesbit, 2008). To embrace these changes and provide more efficient teaching method, educational sectors offer various modes of deliveries such as intensive mode, also calls Block Mode (BM) of teaching (Dexter et al., 2006; Karaksha et al., 2013; Lawrence & McPherson, 2000). Block scheduled class is described as "accelerated, time shortened, block format, compressed, or intensive modes of delivery"(Davies, 2006). The authors makes the definition of block mode as "very large chunks of teaching time, for example whole day sessions, offered in weeklong mode, two or three week long mode and weekend mode" as stated by Davies (2006, p.1).

The educational benefits and advantages of the block scheduling have been investigated in the literature by many studies though few have focused on its impact on the learning outcomes and student's satisfaction. Argawu (2020) discuss the factors like schedule type, gender, father's education level, class attending status, group activity participation, and friendship status have significant association with students'

marks in introduction to Statistics course in two different departments at Ambo University, 2018/19. The impact of condensed delivery on the academic achievement, learning experiences in Bachelor of Nursing Science course at an Australian regional university is explored by Reinke (2018). The researcher has also concluded that development of students' awareness of how they study, and the effectiveness of their study practices may help them to develop self-regulated learning.

Views, practice and challenges of block mode teaching approach are also examined in the literature and the results show students background, scarcity of resources, mode of delivery, teachers workload and students lack of awareness on the approach, discovered to be the main factors which are hindering the effective implementation of modular teaching approach (Shemelis & Eba, 2017). The influence of BM on student participation and learning (Ibrahim, 2018), satisfaction and performance (Loton et al., 2020; Sidiroglou & Fernandes, 2019), engagement and quality of learning (Li & Antiohos, 2021), and academic success along with their positive perceptions toward it (Klein et al., 2020) are also investigated. Burton and Nesbit (2002) discussed that there are some factors affecting the student's acceptance of Block Mode (BM). Their results show that there is a positive trend for those students working full time to choose a block course. Students' beliefs about their own ability and their prior experiences with blocked courses can positively impact their choice of doing a blocked course as well.

3. Research Design

Our literature review shows that there is a lack of research which investigate the impact of students' adoption of Block Mode on students' positive learning outcomes. Therefore, the objective of this research is to explore the impact of students' adoption of Block Mode on student's retention, satisfaction, learning outcomes and graduate outcome. Figure 1 shows the conceptual model underlying the present research.

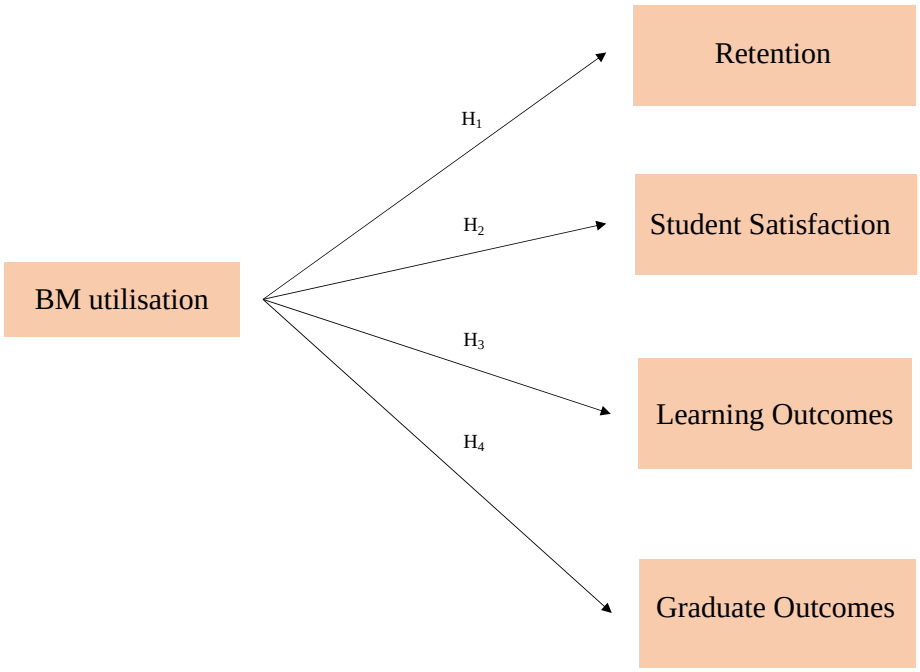

Figure 1. The conceptual model for the current study

3.1 Hypothesis Development:

Dynamic Capabilities (DCs) model that was developed during 1990s, is very popular when it comes to evaluate the impact of capabilities on performance. It was proposed formally by Teece et al. (1997) for the first time. They conceptualized DCs as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (p. 516). DCs are capable of purposefully creating, amplifying, and modifying their resource bases (Teece, 2019; Teece et al., 1997). They later revealed articles to shed more lights on the DCs as develop new products, processes, and services; create, adapt, improve and, if necessary, substitute business models; perfect absorptive capacity through learning activities and accumulation of skills." (Teece, 2007, 2014).

Considering BM of delivery as a new processes of organization's DCs (based on new DCs mentioned above) and the student's retention, satisfaction, learning outcomes and graduate outcome as organizational performance, we could hypothesise that the BM of delivery can impact positive learning outcomes according to DCs model (Figure 2).

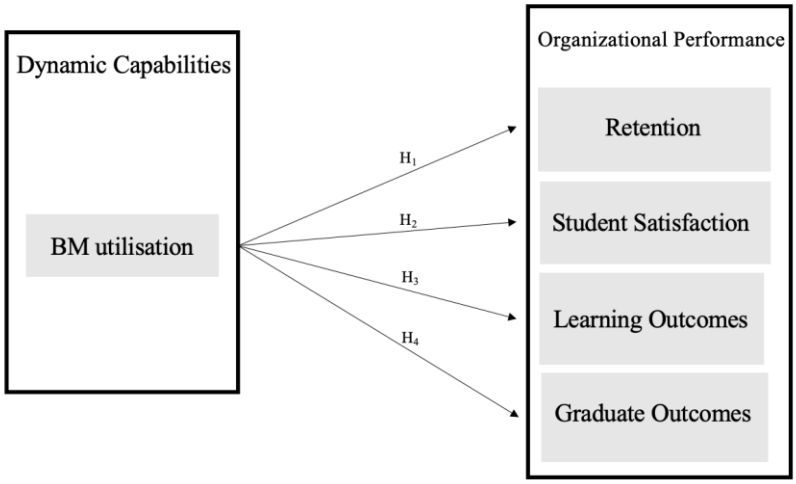

Figure 2. The conceptual model for the current study

Working from these arguments, and within the research framework shown in this study, we raise the following hypotheses:

- H1: There is a positive and significant relationship between BM utilization and student's Retention;
- H2: There is a positive and significant relationship between BM utilization and student's satisfaction;
- H3: There is a positive and significant relationship between BM utilization and student's learning outcomes;
- H4: There is a positive and significant relationship between BM utilization and student's graduate outcome.

4. Data analysis and Results

One of the main Objectives of this quantitative research study is to measure, investigate, and validate the proposed research hypotheses. To do so, a questionnaire has been developed through a careful review and evaluation of related instruments in the literature. Previously developed questionnaires in the literature have been reviewed and through a selection process, several indicators have been selected for the selected constructs. The data were collected from undergraduate students studying in block mode in a faculty in one of Australian universities. The survey includes concept-based questions and analysed participants' level of agreement with various questions based on a five point Likert scale approach (Matell & Jacoby, 1971), and 74 participants completed the survey.

To analyse the hypotheses and research model, Partial Least Squares (PLS) was used due to its ability to predict the variability of the dependent construct and to manage reflective measures (Eikebrokk & Olsen, 2007). This method can predict the interrelationship between multiple independent and dependant variables while supporting unobserved or undefined variables (Gefen et al., 2000). PLS is a component-based technique that "focuses on maximizing the variance of the dependent variables explained by the independent ones instead of reproducing the empirical covariance matrix" (Haenlein & Kaplan, 2004, p. 290).

Figure 3 illustrates some demographic statistics about the respondents. It shows that 81.3% of the respondents were male and 18.7% were female. 62.7% of the respondents were domestic students and 37.3% were international students. 26.7% of the respondents were aged 18 to 20, 40% were aged 21 to 25, and 33.3% were 25 or older. Among all participants, 97.3% were studying full-time.

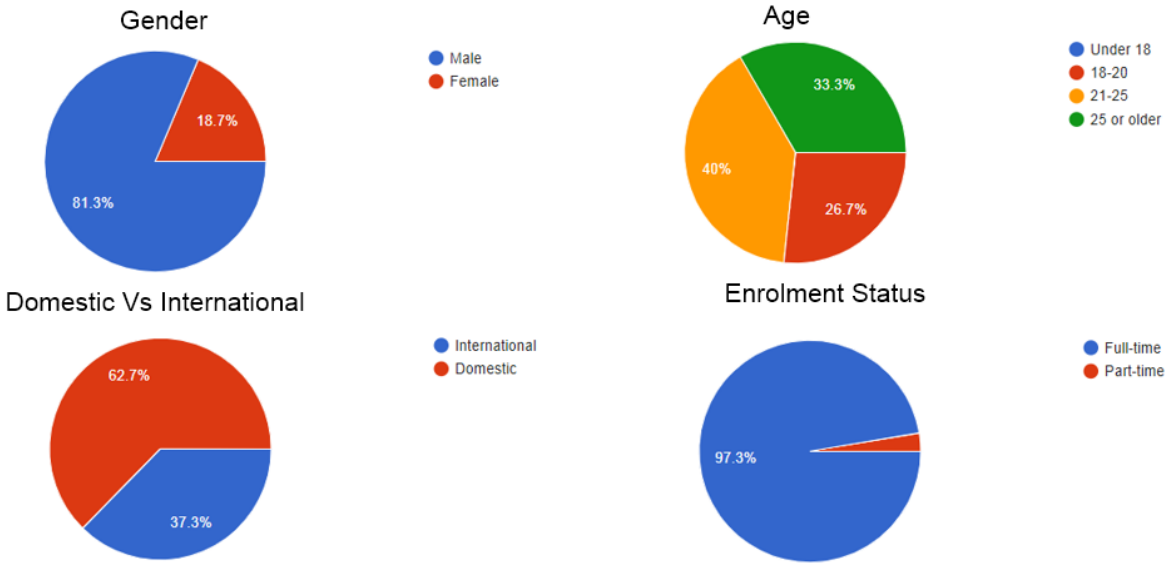

Figure 3. Demographic statistics regarding the pool of respondents

To validate the proposed hypotheses, Confirmatory Factor Analysis (CFA), which is a form of factor analysis, is employed to use factor loading to find out whether the data fits a hypothesised measurement model (Brown, 2015). Based on Chin et al. (2003) and Hulland (1999), the factor loadings assessment is the first criterion to decide whether or not to include or exclude an indicator in the CFA. Indicators' loading on their associated factor should be higher than

0.60 or preferably 0.70 or above, which shows that each indicator explains at least 50% of the variance of the corresponding latent variable (Chin, 1998; Hulland & Business, 1999). Table 1 shows the results of CFA for the proposed model and it represents that all of the indicators have loading factors above 0.7, which means that all of them are accepted at this stage.

Table 1 Error! No text of specified style in document.**.** Factor Loadings

Variable/indicator	Loading
BM Utilisation	
BMU1	0.947
BMU2	0.958
Retention	
RET1	0.984
RET2	0.981
Students' Satisfaction	
SAT1	1.000
Learning Outcomes	
LO1	0.911
LO2	0.959
Graduate Outcomes	
GRADO	1.000

Table 2 shows the outcome of hypothesis testing. It presents the path coefficient, which is produced to indicate the strength of interrelationships between the independent and dependent latent variables (Hair et al., 2011) and T-values for each hypothesis.

Table 2. The results of hypothesis testing

Hypothesis		Path Coefficient	T Statistics	Confirmed/Not conformed
H_1	BM Utilisation => Retention	0.669****	10.031	Confirmed
H_2	BM Utilisation => Students' Satisfaction	0.648****	7.836	Confirmed
H_3	BM Utilisation => Learning Outcomes	0.602****	6.537	Confirmed
H_4	BM Utilisation => Graduate Outcomes	0.558****	5.665	Confirmed

** significant at 0.05 level; *** significant at 0.01 level; **** significant at 0.001 level

Hypothesis 1: Table 2 indicates that "BM utilisation" has a substantial positive effect on "Retention". The path coefficient between "BM utilisation" and "Retention", is 0.669 (T-value=10.031), which is confirmed at the significance level of 0.001.

Hypothesis 2: The results show that "BM utilisation" can positively impact "Students' Satisfaction" with a path coefficient of 0.648 (T-value=7.836), which is confirmed at the significance level of 0.001. Thus, Hypothesis 2 is supported and confirmed.

Hypothesis 3: According to Table 2that "BM utilisation" has a remarkable positive impact on "Learning Outcomes" (path coefficient 0.602, T-value 6.537). Therefore, hypothesis 3 is confirmed at the significance level of 0.001.

Hypothesis 4: The result verified "BM utilisation" has a positive direct effect on "Graduate Outcomes" at a 0.001 significance level with a path coefficient of 0.558 and T-value 5.665. Therefore, hypothesis 5 is also confirmed.

5. Conclusion and Discussions

This study examined the impact of students' utilisation of the BM of teaching on positive learning outcomes in terms of student's retention, satisfaction, learning outcomes and graduate outcome. The findings show that BM utilisation significantly and positively impacts all these Four constructs and can play an important role to improve these outcomes. The findings of the current study can have important implications for top managers in tertiary sector institutions, curriculum designers, subject instructors, lecturers, conveners and so on. They can assure an improved student learning outcomes by enhancing students' utilisation of block mode (intensive mode) delivery in their subject designs. Thus by employing various strategies, such as providing an orientation session in the beginning of the block to enhance students' awareness of block mode of delivery, providing enough resources to assist students with their study, having a balanced workload for students throughout the block, such practitioners can ensure increased students' performance.

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Addressing Accountability in Information Technology Education

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Abstract

The rising cost of higher education has lead parents, employers, and politicians to question the need for a college degree. Skills Infusion is a professional development program in which faculty review a course they teach to identify the career readiness competencies defined by the National Association of Colleges and Employers (NACE). The NACE competencies are skills that are expected by employers across all sectors of the economy. In addition to describing the Skills Infusion program, a description of how an information technology undergraduate program is expanding on the program to incorporate skills mapping to provide further evidence of accountability in higher education.

Keywords: Career Readiness, Skills Mapping, Curriculum Mapping, Higher Education, Accountability

1. INTRODUCTION

The expectations that society places on higher education is evolving. It can be argued that the purpose of higher education has been to challenge one's beliefs (Busteed, 2019) through the quest for knowledge. This lends credence to college and university mission statements that talk about global citizens and lifelong learning (Pasquerella, 2020). Lately, the question has arisen as to whether these continue to be the only expected outcomes of higher education.

The rising cost of higher education (Hanson, 2021) has prompted politicians and parents to question whether the outcomes of obtaining a degree justify the costs (Kelchen, 2018). Effectively, higher education is being held accountable. A shift has occurred in which employability is an additional outcome expected of higher education (Sin, Tavares, & Amaral, 2019).

In the Fall semester of 2019, Ball State University introduced its Skills Infusion Program (2021) as a strategy to enhance job skills that will transfer to the workforce across academic disciplines. The remainder of this manuscript will expand on the issue of higher education accountability and the Skills Infusion Program.

2. ACCOUNTABILITY IN HIGHER EDUCATION

As the cost of attending college continues to rise (Carnevale, 2020), the need for higher education is being questioned (Carapezza, 2021; Quiroz-Gutierrez, 2021). For students not receiving a full scholarship, the rising cost of higher education presents a challenge and a debate to many, not to mention the time invested in it. While there are other benefits presented with the attainment of a college degree, the potential to earn more than is likely attainable without a degree is the main reason.

According to the U.S. Bureau of Labor Statistics (2021), education attainment and earning potential are directly related. Jobs that require higher-level education and higher skills get paid very high wages, jobs that require little to no education and low-level skills get paid lower wages. Unemployment rates are significantly lower for college-educated personnel, whereas lower educated personnel face very high-level unemployment rates. Similar to the 2009 inflation crisis, the COVID-19 pandemic followed the same trend mentioned above across multiple industries. Earnings, bonuses, and other benefits increase significantly for workers with college degrees compared to those without.

The government and other stakeholders that invest in higher education have increased expectations of accountability (Zumeta, 2011). These stakeholders are asking institutions of higher education to provide evidence that students are learning marketable skills that lead to high paying jobs.

3. NATIONAL ASSOCIATION OF COLLEGES AND EMPLOYERS (NACE)

NACE was established in 1956, connecting over 9000 college service professionals, 3200 universities, and 300 business solution providers. NACE is a major source of information on employment opportunities for college students.

NACE (2021) identified eight career readiness competencies that are essential for college graduates in order to secure high-paying jobs. These competencies include career and self-development, leadership, communication, professionalism, critical thinking, teamwork, equity and inclusion, and technology in the workplace.

- Career and Self-Development: Continuous professional and self-development abilities include awareness of their strengths and weaknesses, building relationships, and progress in job growth.
- Communication: Includes strong verbal, written capabilities, and communicates in a clear precise manner through various media.
- Critical Thinking: Making decisions through reasoning and judgment without bias.
- Equity and Inclusion: Engage and include people from local and global cultures, awareness racial policies and laws.
- Leadership: Inspiring and motivating self and teams towards organization goals.
- Professionalism: Integrity and accountability towards self, others, and organization.
- Teamwork: Working in a team to attain common goals and objectives.

- Technology: Embracing technology, and constantly updating themselves with newer technologies, knowledge of technology usage policy.

NACE (2021) asserts that when higher education incorporates these core competencies, students are better positioned to successfully start their careers, independent of academic discipline. Career readiness includes the essential skills and competencies that students will need to enter the job force and build on their careers (Department of Education, 2016; Zook, 2018). The issue of competency has more recently been identified as a priority with ACM and IEEE in their joint Computing Curriculum 2020 Task Force report (2020). The report further defines competency to be the summative outcome of knowledge, skills, and disposition. It is commonly accepted that higher education is a purveyor of knowledge. To be competent, the task force is stating that students must also have the ability to go from theory to practice by applying work-related skills and to have the appropriate individual character to appropriately and professionally carry out those skills.

4. CURRICULUM MAPPING

Curriculum mapping refers to the process of identifying what is being taught across the curriculum of an academic program (Uchiyama & Radin, 2008). The process starts with assessing what is being done within individual courses. These individual assessments are aggregated to map out where topics are being taught throughout the curriculum. This comprehensive mapping can then be used to identify core competencies, skills gaps, or areas of overlap within the curriculum.

While primarily used for program review associated with both internal and accreditation program assessments, curriculum mapping can also provide evidence of accountability in higher education. A curriculum map and student artifacts can be shared with parents and politicians to exemplify how a program is fostering the skills that will enhance student employability.

5. SKILLS INFUSION PROGRAM

The Skills Infusion Program is a professional development experience that takes place for one semester and focuses on reviewing course syllabi, mapping course outcomes to the NACE career readiness skills, and reflecting this on syllabi with input from the Career Center and an Indiana employer/alumni partner. The goals are to help students better articulate transferable skills learned in concert with course content and to provide a gap analysis tool that students can use to reflect on skills not yet practiced or learned.

Each faculty participant is tasked to select one of their existing courses for the duration of the workshop. At the end of the workshop, the course (with the newly infused learning outcomes) will be presented to the group.

Faculty participants are tasked with reviewing the NACE competencies and mapping them to the assignments in their course. This is a preliminary exercise that serves to prime the actual mapping of skills that take place during the program.

The first workshop begins with introductions and goal setting for the program. Breakout sessions are conducted with faculty participants and a faculty mentor. The Career Center selects mentors from among the faculty members who were exemplary during previous sessions of Skills Infusion Program. The mentor guides the first iteration of the NACE mapping process, addressing questions by the participants. The intent is for faculty to reflect upon how their course

design addresses the eight Career Readiness competencies. For each assignment, faculty will need to identify the competencies that are being addressed and reinforced. These should then be incorporated into the syllabus as part of the student learning outcomes. After the first workshop, the entire group reconvenes and presents their progress.

The second workshop is dedicated to introducing faculty to alumni and BSU Career Center personnel. These individuals serve to provide faculty with insight into the expectations of employers. Faculty share the competency mapping they identified for their course. Keeping in mind that the final outcome is to have a syllabus that shows students how the assignments translate into career readiness competencies, the alumni and Career Center personnel then provide the faculty with suggestions on how to improve and clarify the student learning outcomes.

The final workshop serves as a wrap-up. Faculty present their new syllabi with the NACE mapping embedded in the document. The faculty answer questions on how the mapping took place and the rationale behind the decisions. This final workshop concludes with an "ah-ha" session where faculty present their biggest takeaway from the program.

CT 211: System Administration Fundamentals
One of the authors of this article utilized the CT 211 course for the focus of the skills infusion workshop. The course is designed to introduce students to Windows Server systems administration. Topics covered in the course focus on enterprise technology solutions for organizations. Specific topics include service configuration (e.g., DNS, DHCP), high availability, and systems scalability. The course is quite technology-centric, and a required course for all CIT students.

CT 466: Capstone in Computer Technology
The second class revised through the Skills Infusion Program was the Capstone Course in Computer Technology. The class serves as the culminating course of the program. It is designed to foster a systems thinking approach to information technology infrastructure design and preparation for the transition from student to working professional. With the latter goal in mind, each assignment in the course was reviewed for the NACE skills that it fostered.

6. EXTENSION OF THE SKILLS INFUSION

The NACE competencies provide a good starting point to identify the transferable skills that are universal to jobs across disciplines. This was the extent of the expectations by the university for participation in the Skills Infusion Program. However, this seemed insufficient for an information technology program whose students will need to show that they have knowledge, skills, and abilities in specific technologies as they apply for internships and full-time employment.

In addition to the NACE competencies in the CT 466 capstone course, specific technology skills were mapped out for each of the course assignments. This skills mapping was based on the instructor's personal experience and interactions with employers. To provide context for what was done, an explanation of the term project is in order. The purpose of the degree in Computer and Information Technology is to prepare students to be the next generation of IT professionals. To reach this goal, students need to be able to integrate the diverse technologies required by employees across departments and job functions. The capstone course presents teams of students with a fictitious retail company for which they have to develop the technology infrastructure and systems required for the company to be operational.

It may be unlikely that students will have the opportunity to build an organization from scratch; it provides them with an opportunity to develop a more comprehensive, systems approach to information technology. This fosters an understanding of the connections and interdependencies between the diverse technologies that are taught in previous classes.

The progression of the project contains the following stages:

1. Design and build a virtualized data center infrastructure
2. Design and build a network infrastructure
3. Install and configure core infrastructure services (e.g. DNS, DHCP, Active Directory, website)
4. Install and configure enterprise (e.g. email servers), departmental (e.g. human resource, accounting, finance, point-of-sale server), and individual software (e.g. office suite applications, email client, anti-virus, point-of-sale client).
5. Secure the previously listed components in this design.

So how does all of this relate to Skills Infusion and skills mapping? For each stage of the project, the specific skills and technologies that were required were identified. The data center infrastructure alone consisted of several technical skills. To build the skills mapping for the project, an engineering journal was used to document the skills used at each step in the process. Upon review of the engineering journal, the marketable skills were listed for each assignment throughout the project. The marketable skills were identified based upon reviews of job descriptions related to associated positions in information technology. This skills mapping will provide students with a list of projects/assignments and the corresponding skills developed.

The purpose of the skills mapping is to provide students with a tool to assist them in building resumes and cover letters for internships and jobs that accurately reflect their skills development. A common refrain among students is, "What do I put in my resume?" Frequently, the answer is that students list the overarching topic for each of the classes they took. The result is a generic list of operating systems and applications.

It is recommended to students that they customize the content of a resume and cover letter to address the specific knowledge, skills, and abilities indicated in the job description and responsibilities (Doyle, 2021; Weickmann, 2021). Students do not typically have the relevant work experience to bolster that aspect of their resumes. Instead, students are encouraged to draw upon their roles in projects to highlight how they applied the skills that correlate with the internship or job to which they are applying. The skills mapping gives students an inventory of the specific technologies and skills that were associated with those assignments. Students can draw upon this to customize the education and/or skills sections of their resumes with activities that are relevant to the internship/job.

In addition to students, the skills mapping also addresses the concerns of other stakeholders. Students can show parents documentation of the marketable skills that were developed in the course. The skills information can also be used as evidence to politicians that student tuition results in gaining identified marketable skills that will positively impact student employability and career development.

7. STUDENT SURVEY

A typical collegiate course will present the student learning outcomes in its syllabus. These outcomes indicate what students will

know or be able to do at the end of a course. These student learning outcomes are important for conveying the larger goals and objectives for the course. They do not, however, provide the granular identification of marketable skills offered through the skills mapping.

Of concern is whether students can independently identify the technology skills embedded in courses. A preliminary exercise was conducted with the students in CT 466. The project groups were asked to review their assignments to identify the NACE outcomes and technology skills that they thought the assignments developed. To help in this process, they were provided with the NACE career readiness outcomes and a discussion of marketable technology skills. The skills mapping conducted by the instructor was not provided to the students in advance of the assignment.

A review of the submissions yielded some interesting observations. The first observation is that students did not identify the technical skills with sufficient specificity. For example, an assignment required project groups to build a project plan using an online, collaborative project management tool that they were to use throughout the semester. Instead of stating the tools they used, such as Asana or Trello, students indicated that they used "project management software" or "online digital technologies". These generalizations were evidenced by most of the groups for all of the assignments. There are possible causes for this observation. It may have been a lack of clarity or misinterpretation of the instructions. It could also be as simple as a lack of motivation. The class was primarily enrolled with students in their last semester before graduation.

Another observation was that students were able to articulate how the assignments aligned with the NACE career readiness competencies. Students from each of the project groups were able to write action statements indicating how the assignments fostered specific NACE competencies.

8. WHERE DO WE GO FROM HERE?

The deep skills mapping was only conducted in the Spring 2021 capstone course. As a capstone course, the higher-order skills should be critical thinking, technology integration, and systems thinking.

The program intends to conduct NACE and technical skills mapping throughout the Computer and Information Technology degree's curriculum. Once the faculty have completed the skills mappings of their assigned classes, the collected data will facilitate three program initiatives.

Student marketable skills database
The priority of the skills mapping is to provide students with a comprehensive database of the marketable skills they should expect to develop in individual courses throughout the curriculum. Students will be provided a tool by which they can look up the classes they have taken and review what marketable skills they were to have acquired.

In light of the preliminary data suggesting that students have difficulty identifying the marketable skills in a given class, providing a database of marketable skills for the curriculum should provide multiple benefits to students. Students entering the Computer and Information Technology program do not always know what area of information technology they would like to pursue. Being able to review the marketable skills associated with courses in the curriculum will provide students with insight into the responsibilities associated with the different technology areas. The extended set of marketable skills in the database will also have a broader selection of skills to choose from as students create

customized cover letters and resumes for internship and job applications.

Curriculum mapping
Students will not be the only stakeholders to benefit from the marketable skills database. At the time of the Spring 2021 semester, curriculum mapping for the Computer and Information Technology program was based on the Student Learning Outcomes defined on the course master syllabi. This has provided a broad overview of the content throughout the program. The problem has been that the student learning outcomes are written to address the larger concepts or topics. When working with information technology the details are critical in determining where there are skills gaps. For example, the student learning outcome may indicate that a course will "develop a complex Active Directory domains design that meets organizational needs". At a broader, conceptual level, the statement conveys the intended outcome. What is not provided are the technical details. To effectively manage the overall curriculum in an information technology degree, the program director needs to know the version of the operating systems being used; in which classes are they being taught; are the Active Directory designs incorporating both Organizational Units and subdomains?

This is not a criticism of student learning outcomes. They are not intended to provide granular detail about the content of the course. Highlighting the limitation of the student learning outcomes simply reinforces the programmatic value of the skills mapping. The skills mapping will answer the questions presented about the mentioned student learning outcome about Active Directory. Being able to analyze the details of the content across courses will help identify the gaps in skills desired by employers and those that are taught in the curriculum.

Accreditation
The process of skills mapping will also support assessment associated with accreditation. The U.S. Department of Education (2021, par. 1) states, "The goal of accreditation is to ensure that institutions of higher education meet acceptable levels of quality". The accrediting bodies for respective academic disciplines typically present broad learning objectives that degree programs in their field of study should accomplish. It is up to the academic program to reflect those student learning outcomes in their programmatic goals and objectives. The academic programs are then required to conduct periodic assessments to provide evidence that it is accomplishing the learning objectives set forth by the accrediting body.

The purpose of assessment is to determine whether an academic program is effectively meeting its stated goals and objectives. The skills mapping can aid in identifying key points across the curriculum that will provide the most relevant assessment data. If the accrediting body requires specific skills or competencies, the skills map will identify the courses where assessment should be done. It may be that the program administrator wants to show the progression of competency in a skill across the curriculum. The skills map will pinpoint where assessment can be conducted to gather data on student competency for that skill.

9. CONCLUSION

The Skills Infusion Program was designed to encourage instructors to identify how their courses will foster the career readiness competencies identified by NACE. The competencies, which include critical thinking/problem solving; oral/written communications; teamwork/collaboration; digital technology (literacy); leadership; professionalism/work ethic; career

management; and global/intercultural fluency, are relevant to all academic disciplines. Students are then able to use this information to highlight how they have developed these universal competencies as they apply for internships and jobs. The Computer and Information Technology program is taking this process a step further by also identifying the technical skills developed in its courses. The identification of competencies in specific technologies will benefit both students and administrators. It will provide all stakeholders with data to show that the program is effectively preparing students for their careers upon graduating.

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A Case Study in the Use of Salesforce Trailhead to Teach a Course in CRM Implementation

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Abstract

Customer relationship management (CRM), the information system used to manage those relationships that improve customer loyalty and generate repeat sales, remains a booming market, and organizations regularly compete for CRM administrators, developers, and analysts. Even students seeking a non-technical role, such as a sales or marketing analyst, will benefit from CRM knowledge. Despite the benefits of CRM acumen, teaching CRM implementation is challenging in a classroom setting due to the complexity of popular CRM platforms and students' unfamiliarity with CRM's business context, and such challenges may be compounded during virtual course delivery. The transition to mandatory virtual learning environments resulting from COVID-19 has led to the need for numerous innovations in teaching, and courses on enterprise systems such as CRM are no exception.

Because of these challenges, we chose to utilize Salesforce's proprietary online learning environment, *Trailhead,* as the foundation for content delivery and competency assessment. In this teaching case study, we present the context of *Trailhead*, its approach to gamification, our rationale for its selection, and our course design & learning objectives. We present students' performance metrics along with qualitative and quantitative feedback from an end-of-course student questionnaire.

Results indicate that students found the gamified platform, Trailhead, to be both easy to use and effective at increasing their motivation to learn. Students assessed the course as being average in difficulty and well-balanced between theory and practical exercises. Overall, this case study contributes to existing gamification literature as well as the literature surrounding CRM and enterprise systems pedagogy and may serve as a template for other instructors interested in teaching CRM.

Keywords

IS pedagogy, CRM, customer relationship management, Salesforce, gamification, online learning.

Introduction

The quick transition to an all-virtual learning environment as a result of COVID-19 led to the need for innovations in teaching. During the preparation of a 16-week course on CRM implementation to be delivered virtually during Spring semester 2021, it became clear we needed to make enhancements to curriculum developed for a prior course on CRM. Even in a classroom setting, it was challenging to keep students engaged given the vastness of a CRM platform and students' relative unfamiliarity with CRM's industry context. Student feedback from previous course evaluations revealed a desire for more substantive hands-on implementation exercises. Designing, completing, and evaluating implementation exercises in any enterprise system quickly becomes unmanageable, from both student and instructor perspectives, without the aid of some automated mechanisms. For example, in a declarative development (i.e., 'clicks not code') environment, submitting assignments is not so straightforward as submitting a script of code. Rather, students need to submit multiple screenshots demonstrating various configuration decisions. Further, realistic data cannot simply be mocked-up in meaningful ways with any sort of efficiency or scale. It is also difficult to aid students in debugging declarative development on any sort of scale. Quite simply, it is overwhelmingly inefficient to administer Salesforce implementation exercises of substantive complexity, which can be meaningfully defined, completed, and evaluated, without the assistance of real-time, automated troubleshooting assistance and automated grading.

As a result of these necessities, we chose to utilize Salesforce's proprietary online learning environment, *Trailhead,* as the foundation for content delivery and competency assessment. *Trailhead* employs classic elements of gamification, such as points, badges, and ranks. In this paper, we present the context of gamification and *Trailhead,* our rationale for selecting Trailhead, and our course design. Next, we report metrics on student performance and qualitative and quantitative feedback obtained from an end-of-course student questionnaire surrounding the gamified aspects of the platform and the course's efficacy in general.

Background

4IR and Education 4.0

The emergence of the 4th industrial revolution (4IR) has led to paradigm shifts throughout many domains (Kinnett & Steinbach, 2021; Salmon, 2017; Samans, 2019). Higher Education has been required to adjust to the socioeconomic pressures brought about by this latest transformation of the means of production. The construct of Education 4.0 was proposed by the World Economic Forum (WEF) to encompass proposed dimensions of curriculum and student learning experiences, which would both harness 4IR technologies and also prepare students to obtain gainful careers in a 4IR world (World Economic Forum, 2020). Examples of Education 4.0 dimensions include the flipped classroom (Ke, 2018), the use of serious games and gamification (Almeida & Simoes, 2019), smart campuses, digital assistants, online learning, and Massive Open Online Courses (MOOCs) (Bonfield, Salter, Longmuir, Benson, & Adachi, 2020).

Although many aspects of Education 4.0 require systemic changes, instructors can incorporate one key aspect of Education 4.0, gamification, which has received increasing attention in the academic literature. For example, the proliferation of mobile devices brought about by the 4th industrial revolution (4IR) has contributed to the increased use of gamified elements in e-learning contexts (Grinshkun & Osipovskaya, 2020).

Gamification

Gamification is the use of aspects of game design, such as points, ranks, and achievements in non-gaming contexts (Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011). Academic settings represent one example of a non-gaming context, so it is a natural candidate for the incorporation of these techniques. Existing studies of gamification in academia display mixed results. For example, a 2015 longitudinal study comparing the teaching of a gamified course compared to a non-gamified version of the same course revealed gamification resulted in less motivation and lower final exam scores compared to the control (non-gamified) class (Hanus & Fox, 2015). Similarly, a 2020 study found that the use of badges during introductory computer programming courses resulted in decreased intrinsic motivation, despite qualitative feedback revealing positive perceptions of the introduction of badges (Facey-Shaw, Specht, van Rosmalen, & Bartley-Bryan, 2020). In another paper, a gamified e-learning system was reported as effective at improving system adoption (Bouchrika, Harrati, Wanick, & Wills, 2019).

Customer relationship management (CRM) & Salesforce

Customer relationship management (CRM) is the process of managing customer relationships using information systems in order to generate repeat sales. CRM can be considered an application of relationship marketing (RM) (Peppers, Rogers, & Dorf, 1999; Ryals & Payne, 2001). CRM systems have grown from their infancy as simple marketing databases to become enterprise platforms. Salesforce (NASDAQ: CRM) is a customer relationship management (CRM) vendor offering a suite of cloud-based products to a variety of industry verticals. The company is sometimes referred to as *Salesforce.com*, its original name. The noted industry research firm, Gartner, Inc., lists Salesforce consistently as a market leader for various aspects of CRM, including sales force automation (SFA) solutions (Travis, Hilbert, Zijadic, & Hansen, 2019), the foundation of most CRM platforms, and configure-price-quote (CPQ) solutions (Lewis & Ford, 2020). Its position as a market leader suggests knowledge of implementing the platform would be useful to undergraduate or graduate students in Information Systems. To these ends, exposing students to CRM technology is not entirely new in academia. A 2018 study explored how best to integrate these concepts into a sales curriculum (Jelinek, 2018). The Salesforce platform, in particular, does not appear to be studied widely in academic settings, though a 2019 study recommended the platform to business school academics in order to help them manage a business internship program (Eason, Nathan, & Cartedge, 2019).

A recent paper suggests that successful CRM courses incorporate aspects of business, marketing, and information systems acumen, but many CRM courses take myopic views of each domain and thus may not incorporate all aspects robustly, which leaves students deficient either in CRM technical knowledge, the underlying marketing theories, or in the contextual business concepts (Lokuge, Sedera, Kumar, Ariyachandra, & Ravi, 2020). Trailhead has been proposed as a useful component to educate marketing students on CRM technology (Harrison & Ajjan, 2019).

Course Design

Prior Course Context

The decision to utilize the gamified platform, Salesforce *Trailhead,* to implement the CRM concepts and best practices outlined in class lectures resulted not only from the need to innovate for the virtual classroom, but also from lessons learned from a prior 16-week course on CRM taught in Spring 2018, to 10 graduate students at a private university in the Midwest. The course relied primarily on instructor-created materials drawn from a professional handbook on CRM as well as the

instructor's professional experience implementing Salesforce in industry. Typical class sessions included 50% lecture on CRM fundamentals and 50% walkthroughs of various configuration scenarios. By the end of the course, it was clear that students had mastered a large amount of the theoretical and contextual CRM content. On the other hand, student feedback from the course revealed a sentiment that the course was too theoretical and did not have sufficient technical depth. In order for students to achieve the level of mastery needed to achieve a Salesforce certification without sizable, subsequent self-study, the next version of the course would require a greater technical focus, including a number of hands-on implementation exercises. Of interest, one student nevertheless attested, approximately one year later, that the theoretical content was far more useful than originally perceived.

Selection & Integration of Trailhead

In order to teach a course on CRM implementation, it is necessary to choose a specific CRM platform. Its position as a market leader is one argument for teaching the Salesforce platform. Although perhaps in some respects a course in CRM ought to be platform agnostic, there seems to be little controversy in giving students hands-on practice with a well-known and popular CRM platform. The instructor's professional background in Salesforce implementation and related certifications were other factors in the selection of Salesforce as the CRM platform to be taught in the course. We do not evaluate the suitability or benefits of teaching CRM via a different platform in this paper.

Trailhead is an ideal candidate to teach a course in implementing Salesforce since it was designed primarily for just that purpose. The *Trailhead* platform is free and available to the public. It is composed fundamentally of learning modules and projects. Collections of modules and projects are curated and combined by Salesforce in order to form *Trails*, which are specific paths through a given set of learning objectives. Modules and projects may be combined by platform users to create unique curricula called *Trailmixes*. *Trailhead*'s gamification model embraces the representation of Salesforce trainees as *Trailblazers*. Students begin their journey with the rank of *Scout* and progress through *Hiker*, *Explorer*, *Adventurer*, *Mountaineer*, and *Expeditioner* before reaching the highest rank, *Ranger.* Criteria for achieving new ranks are based on the successful completion of badges and points. A user's profile displays user's rank, badge count, point count, and number of trails completed (see Figure 1).

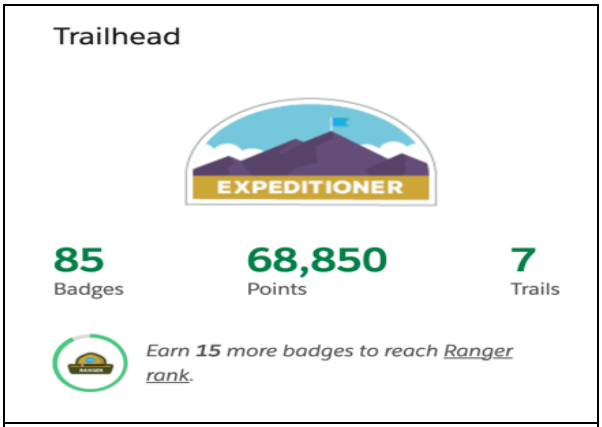

Figure 1: Progress Summary on a Trailhead User Profile

Even though any would-be Salesforce learner can access *Trailhead* and complete modules, at least one prior paper suggests the added effect of human guidance through learning material is valuable (Kirschner, Sweller, & Clark, 2006). In *Trailhead* parlance: students benefit from an experienced *Trailblazer*, who can help trainees select the best modules and provide the moral support to persevere through challenges.

Competency Evaluation & Grading

Course grades were determined based on a combination of Trailhead learning modules and implementation projects, quizzes on

supplemental content delivered in lecture, a midterm exam, and a final exam (see Figure 2). We will now explain the particulars of each evaluation method.

Trailhead Badges	40%
Quizzes	10%
Midterm Exam	20%
Final Exam	30%

Figure 2: Grade Determination

Trailhead Badges

Badges are one of the most visible gamified aspects of Trailhead. Badges correspond directly to completed modules or projects, a distinction that is not always clear within the Trailhead platform. Badges are submitted as screenshots showing both the student's profile name and relevant badges. Although some badges are more difficult than others, we treat each badge equally, with the exception of super badges, which are particularly difficult. See Figure 3 for an example submission with student name redacted.

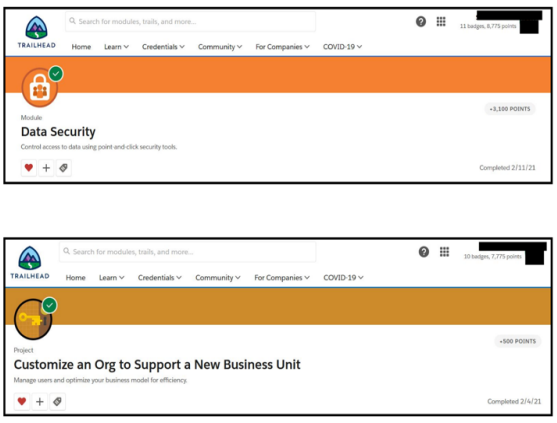

Figure 3: Example Trailhead badge assignment submission

Trailhead ensures students are able to be accurately graded on complicated Salesforce implementation exercises in a way that would be virtually impossible for an instructor to do manually, which would be especially unscalable. One limitation of using the Trailhead platform in an academic setting is that answers can be obtained online via Web searches. Another limitation is there are few opportunities to give partial credit. In an attempt to balance the benefits and limitations, we decided not to accept late badge submissions, encouraging students to focus on completing as many badges as they could rather than be partially through multiple badges. Although some Trailhead modules administer quizzes, which grant 100 points if successful on the first attempt, 50 on the second attempt, and 25 on subsequent attempts, we found it impractical to utilize this structure for grading. The badges included in our course curriculum generally mirror Salesforce's recommended curriculum for those studying for the Administrator credential.

Quizzes

Quizzes were administered through the university online learning management system every few weeks. The purpose of quizzes was to provide students an opportunity to answer different type of questions more aligned to what a certification might look like. Quizzes also have the potential to increase grade distribution since exact answers are not available online in the same way students can find answers to Trailhead questions. Students are permitted to take the quiz multiple times with the highest grade recorded at the due date. They are still able to use the quiz after the due date to practice for exams, but the scores are no longer recorded.

Exams

The midterm and final exams are written with the attempt to mimic some aspects of a Salesforce Certified Administrator exam. For example, both exams are closed book and rigorously timed. A combination of factors prohibited the use of student internet-

blockers or other proctoring methods, so we were not able to enforce the highest levels of academic integrity. We attempted to correct for this by writing exam questions in a markedly different tone and using different language than students would have encountered on the presumably result from exam scores, given the availability of information available to help students complete badges, we recognize our grading structure might induce exam anxiety.

Course Evaluations

We sought to gain student feedback on several dimensions: CRM acumen, platform perceptions (perceived ease of use and perceived usefulness), efficacy of gamified elements, and summative course perceptions (e.g., appropriateness of theory vs. practice, course difficulty). To measure these dimensions, we developed a 10-question survey questionnaire, the completion of which was worth one extra credit badge and also as a standard portion of the cumulative Quiz score. The questionnaire (Appendix A) was administered anonymously at the end of the course. The questionnaire uses a combination of 5-point and 3-point Likert scales to gather quantitative feedback along with a single open-ended question to gather qualitative feedback. We also report the final grade distribution for undergraduates, graduates, and a total distribution for the entire course.

Results

We now share the results of our case study, including grade distributions and summarized questionnaire responses. Of an initial class of 11 enrolled students, one student withdrew from the course without commentary prior to the Midterm exam. Of the remaining 10 students, 9 participated in the course evaluation survey.

Student Performance & CRM Acumen

Graduate students performed slightly better than undergraduate students, as we would expect, with graduates obtaining four As and one C (see Appendix B, Figure 1). Undergraduate students obtained three As, one B, and one D (Appendix B, Figure 2). The combined grades resulted in seven As, one B, one C, and one D (Figure 4).

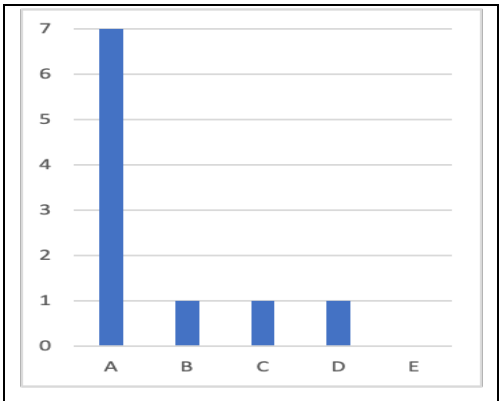

Figure 4: Total Grade Distribution

Student perceptions of their CRM knowledge and acumen generally aligned to the grade outcomes. Prior to entering the course, four students considered their existing CRM knowledge to be either extensive or approaching proficient, while four students reported no pre-course knowledge at all of CRM/Salesforce (Appendix B, Figure 3).

After completing the course, five students ranked their post-course knowledge as 'approaching proficiency' and one student ranked post-course knowledge as 'proficient'. Three students considered themselves to have moderate knowledge of CRM after taking the course (Appendix B, Figure 4).

Platform Perceptions & Efficacy of Gamified Elements

All students agreed the Trailhead system contained useful information, which aided

student learning (8 strongly agreed, 1 agreed, see Figure 5).

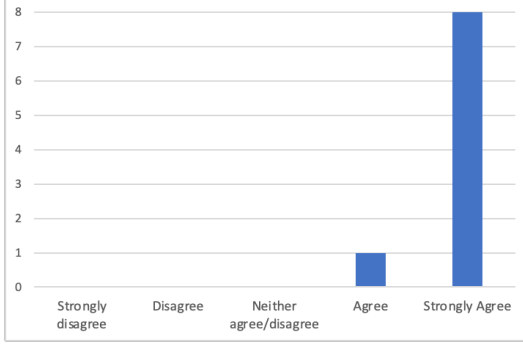

Figure 5: Platform Usefulness

Eight students strongly agreed, and one student agreed, that the Trailhead system was easy to use, representing 100% agreement in Trailhead's ease of use (Figure 6).

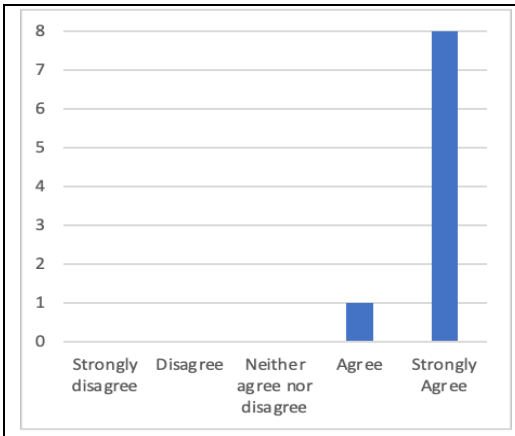

Figure 6: Platform Ease of Use

Eight out of nine respondents reported that the Trailhead system's gamified aspects, such as badges, points, and ranks, increased their motivation to learn, while one student reported the gamified aspects had no effect on motivation (Appendix B, Figure 5).

Seven students strongly agreed when asked if they would be interested in using Trailhead to continue their Salesforce education after the conclusion of the course, and two students offered neutral responses (Appendix B, Figure 6).

Summative Course Perceptions

Six students indicated the overall course was of average difficulty, with two students considering the course to be easy and one student considering the course to be extremely difficult (Figure 7).

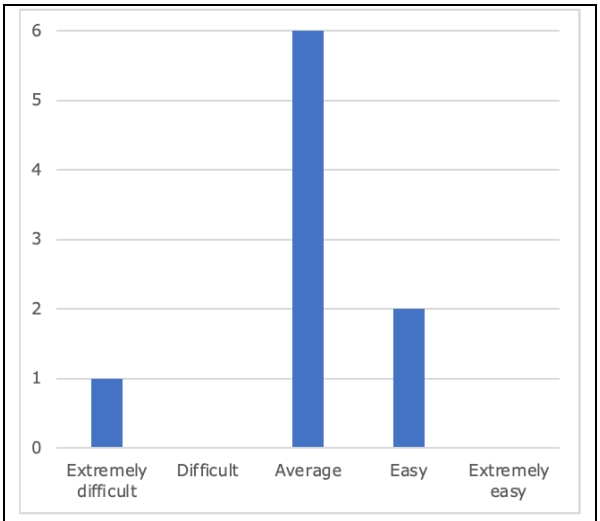

Figure 7: Level of Difficulty Assessment

Eight out of nine students also indicated the balance of theory and practice was appropriate; one student indicated the course was heavy on theory (Appendix B, Figure 7). Ultimately, eight out of nine students strongly agreed, and the remaining student agreed, in recommending the course to other students (Appendix B, Figure 8).

Discussion

The results generally support the efficacy of the Trailhead system and the course curriculum and delivery overall. This discussion explores the key dimensions evaluated by the course questionnaire: performance & acumen, platform

perceptions & efficacy of gamified elements, and summative student perceptions & course outlook, including evaluation of this course's approach to addressing previous student feedback from the prior course offering.

Performance and acumen

Students entered the course with a variety of perceived CRM expertise. Due to the nature of the questionnaire data collection, we did not measure the specific student by student changes in perceived CRM acumen; however, all students considered themselves to have at least moderate knowledge by the end of the course, which was a marked improvement considering four students considered themselves to have no knowledge at all of CRM and Salesforce prior to entering the course. One explanation for the bulk of students considering themselves as having either moderate or approaching proficient CRM acumen compared to the pre-course self-assessments, in which almost half the class self-assessed acumen as proficient or approaching proficient, is the realization of 'the more you know, the more you know you don't know.' By the end of the course, students likely had gained confidence in their abilities, but had a more sober, realistic reflection of their abilities given their greater exposure to the broader CRM landscape.

Competency assessment in the form of final grades appears to confirm general student mastery of the course material, considering 70% of students earned an A. Graduates and undergraduates performed about the same in competency assessment. One explanation for the skewed distribution toward higher grades is the known concern that students can 'brute force' their way through some exercises, as well as obtain guidance or even answers online. We attempted to address this on the front-end via the inclusion of quizzes and exams, but the uneven grade distribution suggests perhaps the course material is too easy or the weighting of quizzes and exams ought to be increased.

Platform perceptions/efficacy of gamification

Another goal of this case study was to evaluate the Trailhead platform's usefulness, ease of use, and use of gamified elements to increase student motivation. The unanimous agreement or strong agreement of students in answering both usefulness and ease of use questions suggests the platform is designed effectively and is robust in its content. The student responses to the question about the platform's gamified elements and impact on motivation adds to existing gamification of research by demonstrating another example of gamification as a positive contributor toward motivation. A future iteration of this course could examine more nuanced dimensions of motivation to gain a more comprehensive view of the efficacy of Trailhead's gamified elements.

Summative Perceptions & Outlook

Key goals for this course included addressing student feedback from a prior iteration of the course. In particular, we wanted to enhance this course offering to provide a better balance of theory vs. practice via the assignment and evaluation of more complicated implementation exercises as well as ensure a robust curriculum, which would provide students a viable opportunity to complete an official Salesforce Administrator certification exam. Eight out of nine students said the course was appropriately balanced between theory and practice, with only a single student suggesting the course was heavy on theory. These results suggest that the shift toward implementation exercises was effective, and future offerings of this course ought to strive to preserve this balance. Trailhead's automated sandbox environments, troubleshooting, and grading made the assignment of complicated implementation exercises possible, a reality that is implicitly reflected in student feedback about the course's balance.

Although the prior course offering was not necessarily perceived as either too difficult or too easy, it can be instructive to other offerings of this course that students considered its current offering to be of average difficulty. Given the course is a low-enrollment elective, it was not necessarily intended to be overly difficult, so these results are encouraging in that they demonstrate an alignment between instructor intentions and student perceptions.

It is difficult to entirely interpret students' responses surrounding their intention to continue using Trailhead to continue their Salesforce education. Two students had neutral responses, while the remaining seven strongly agreed they would keep using the system. It is possible that, after learning about CRM, two students simply did not see it aligned to their interests or intended career path. That the remaining students strongly agreed with the idea of continuing Trailhead and CRM education speaks perhaps both to the strength of the platform and the intrigue of CRM.

Exploring students' qualitative feedback (Appendix B, Figure 9) confirms positive course perceptions and exposes meaningful suggestions for future offerings, however challenging the implementation of such suggestions might be. For example, student feedback suggesting more practice or other materials besides Trailhead badges presents a challenge. Because of the comprehensiveness of the content on the platform, along with its auto grading and troubleshooting capabilities, the only exercises – aside from quiz questions – that could be meaningfully assigned would likely be theoretical exercises, such as CRM case studies. While not unvaluable, adding these types of exercises risks disrupting the theory/balance aspects of the course.

It was surprising to see feedback suggesting more group exercises, but actioning this feedback would not be particularly difficult, and we plan to consider it in future course offerings. Student desire for a final project (i.e., the construction of a comprehensive Salesforce application) is well taken. At the same time, utilizing existing Trailhead content for this purpose increases the odds that students can obtain answers online, which is counterproductive to the goals of a final project. To address this student request would require developing the very sort of content that Trailhead was procured in order to avoid and would introduce significant overhead. Nevertheless, we consider it to be valuable feedback. One student's suggestion that the functional domains discussed in the course be expanded from Sales to other aspects of an organization is also well taken and should be easy to incorporate into future lecture content.

One student's qualitative feedback suggested the course could be improved by incorporating aspects of Salesforce development, which would involve writing code in Salesforce's proprietary programming language, APEX. Although Trailhead is robust and contains ample learning modules on this topic, we suggest that exploring code-based Salesforce development is better handled in an advanced, follow-up course once students have a firm grasp on declarative (clicks not code) development and the general foundations of the platform.

It remains clear that the automated, real-time feedback and grading indeed increased the ability to assign more implementation exercises and cover important topics in greater breadth and depth. Provided that student performance is indeed reflective of mastery of the curriculum, we can have confidence that the course successfully achieved its intended goals: more sophisticated exercises, more rigorous technical exposure, and realistic context (e.g., a system populated with meaningful data, where configuration exercises could be meaningfully tested).

Limitations

Students were generally supportive of the course and communicated positive feedback,

both formally and informally. It is nevertheless possible students answered more positively because they believed it would somehow help their grades, though the anonymity of the survey was emphasized to them. It is possible that the small class size contributed to some aspects of the results, and it would be useful to perform a follow-up case study with a larger class size. It may be useful to perform more comparisons between undergraduate and graduate distinctions in using gamification platforms. The survey questionnaire in this study did not identify graduate vs. undergraduate status. We are also keen to evaluate a future offering of this course in a face-to-face setting. This course was delivered entirely online, and it is unclear what impact, if any, this had on student performance or course perceptions.

Conclusion

In this paper, we present a teaching case study on the use of Salesforce's gamified learning platform, *Trailhead*, to teach students CRM implementation in Salesforce. We have discussed the benefits and limitations of our approach along with details on course design, grade distributions, and student quantitative and qualitative feedback.

The Trailhead platform was perceived as both useful and easy to use and appears to use gamification effectively to increase student motivation. The case also demonstrates the benefits of Trailhead functionality beyond its gamified elements (e.g., troubleshooting assistance). Although only one student expressed interest in taking the Salesforce Administrator certification examination, it still appears that students valued their acquired knowledge of CRM and felt the course was generally effective at facilitating student learning. While we are humble in our self-assessment, we remain especially encouraged by the results of this case study. When evaluating how to best prepare a future course, we cannot ignore one student's glowing feedback (Appendix B, Figure 9): "I do not think it needs to make changes [sic] to this course because everything in this course was awesome."

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Appendix A: Course Evaluation Survey Questionnaire

1. My level of CRM knowledge prior to taking the class was
    a. Extensive Knowledge (heavy user or configure of CRM systems, well-read in business context and CRM strategy)
    b. Approaching Proficiency (used a CRM system and understood the purpose and context of these systems)
    c. Moderate knowledge (Read a blog or article, was exposed to a CRM system)
    d. Basic, low-level knowledge (general idea of the domain, minor technical exposure)

    e. No knowledge at all
2. After taking the course, I assess my level of CRM knowledge as: (Note: assume your Salesforce knowledge applies to other CRM systems for the purposes of this question)
    a. Proficient
    b. Approaching proficient
    c. Moderate knowledge
    d. Basic, low-level knowledge
    e. Below average/almost no knowledge at all
3. The Trailhead system was easy to use
    a. Strongly Agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
4. The Trailhead system contained useful knowledge that helped me to learn
    a. Strongly Agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
5. The ranks, badges, points and other 'gamified' aspects of the Trailhead platform increased my motivation to learn
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
6. I am interested in continuing my Salesforce education by using Trailhead on my own
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
7. The level of difficulty of this course was:
    a. Extremely difficult
    b. Difficult
    c. Average (not too easy, not too difficult)
    d. Easy
    e. Extremely easy
8. I would recommend this course to other students
    a. Strongly agree
    b. Agree
    c. Neither agree nor disagree
    d. Disagree
    e. Strongly disagree
9. The balance of CRM theory to Salesforce implementation exercises was:
    a. Too much theory, not enough hands-on exercises
    b. Good balance of theory and hands-on exercises
    c. Too much hands-on implementation and not enough theory

10. If you were asked to make changes to this course in order to improve it, what changes would you make?
    a. [Free text answers]

Appendix B: Figures

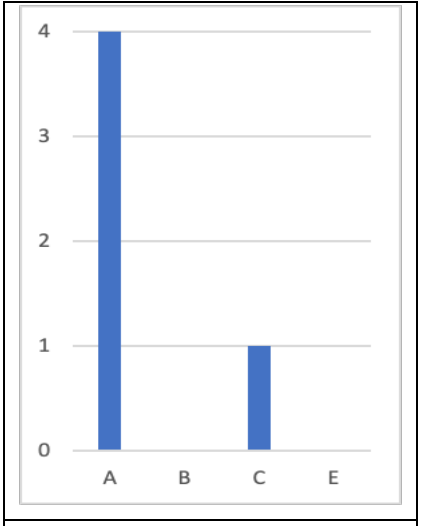

Figure 1: Graduate Grade Distribution

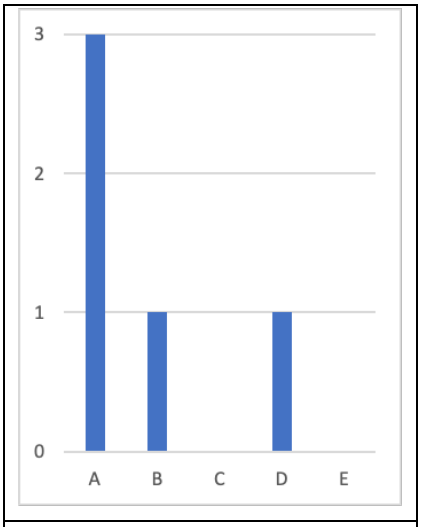

Figure 2: Undergraduate Grade Distribution

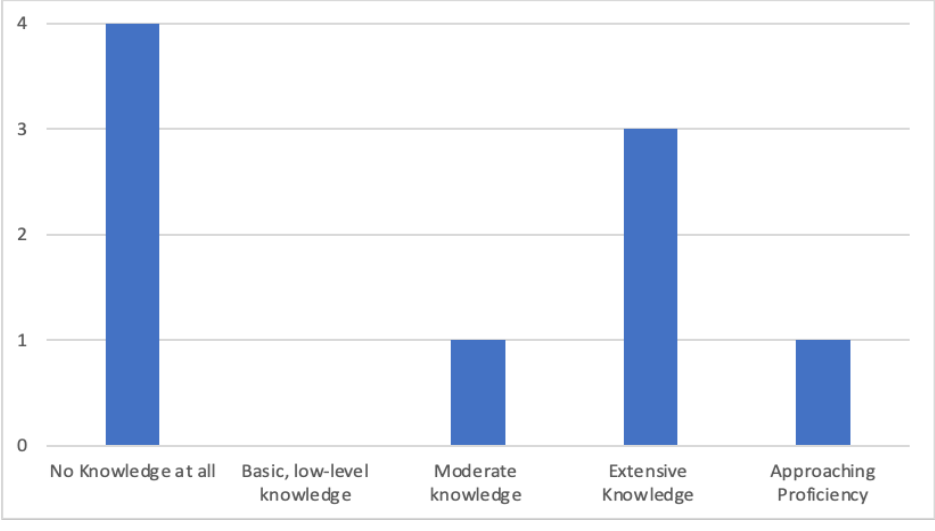

Figure 3: Pre-course CRM Knowledge Assessment

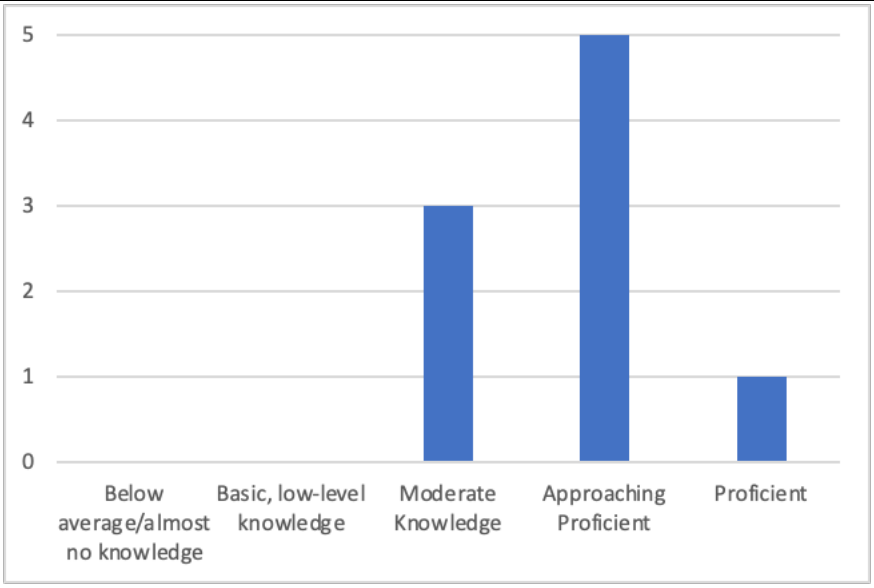

Figure 4: Post-course CRM Knowledge Assessment

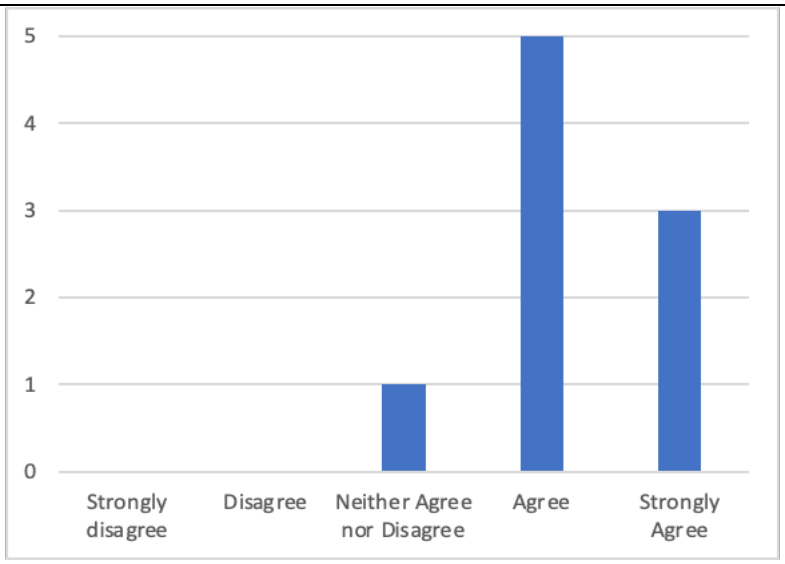

Figure 5. Efficacy of Gamified Elements in Increasing Motivation to Learn

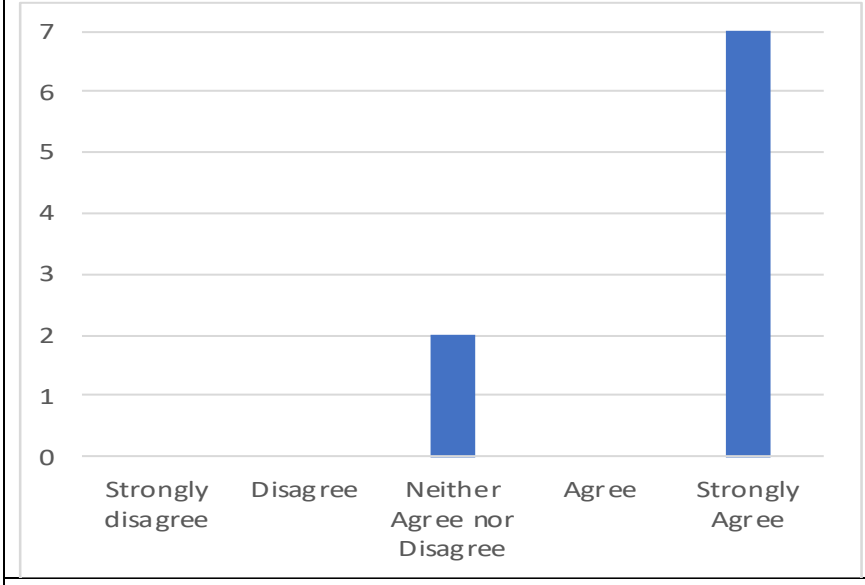

Figure 6: Interest in Using Trailhead to Continue Salesforce Education

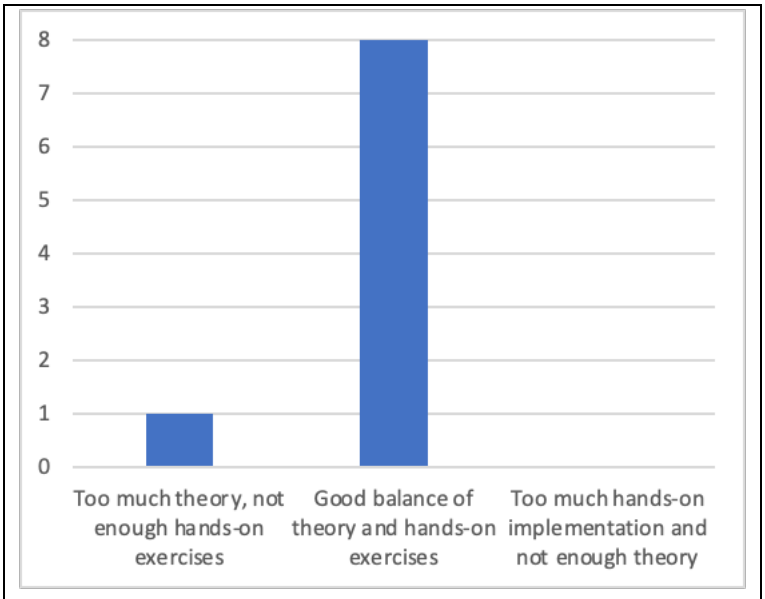

Figure 7: Perceptions on Theory/practice Balance

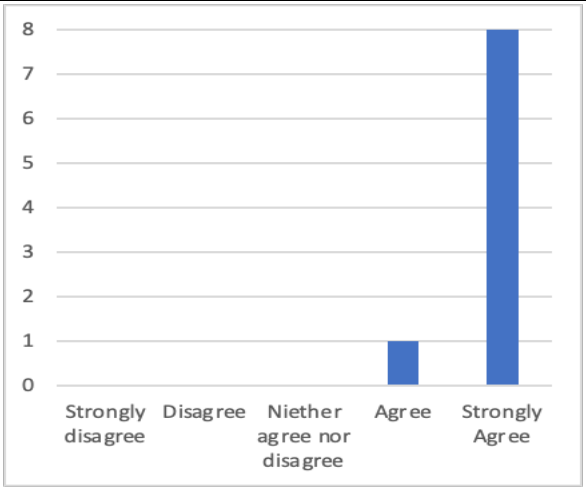

Figure 8: Interest in Recommending Course to Other Students

I can't really think of anything I would improve, I greatly enjoyed the course and felt that I learned exactly what I was hoping to learn. I have a better understanding of Salesforce and can easily navigate some of the more important areas of the platform. I think it would've been nice to have completed something similar to superbadges in a small group setting, larger companies may have more than one person working on the admin side. Some exposure to development in Salesforce would've been nice, otherwise everything was great!

I do not think it needs to make changes to this course because everything in this course was awesome.

I would say that the course was well thought out and informative. I would say there is not much to change.

Maybe include a final project where we apply everything we learned, choose a topic of our interest, and create a salesforce app.

More information on how the use or implementation of Salesforce can influence other departments outside of Sales. For example how would HR or IT benefit from the use of Salesforce.

none

None, the course was just as it should be. The professor was very knowledgeable about the subject matter and the system of using the Trailhead learning was great

nothing all is good

To have more practice or different materials on the same topic other than badges.

Figure 9: Students' Qualitative Feedback on Course Improvements

Teaching ART (drawing and painting class) in the form of virtual classroom using TRELLO tool.

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Abstract

In this abstract we describe how we started and proceed to use Trello (www.Trello.com) – typically a project management tool – to serve as classroom tool for teaching drawing and painting class, during forced distance learning in 2020/21.

Classical form of drawing and painting basics, during the first year of study at the Academy, covers an individual work in the studio (workshop classroom) during group classes, under the constant and ongoing supervision of the teacher. Tasks to be realized by students are drawings and paintings from nature, working with a model and still life. Students work in small groups of about 10 people, typically in a studio of about 40 m2, where each student has her/his own workplace, easel and own tools. During the class the teacher provides corrections, often referring the whole group to individual works, so that it's possible by all the students to observe and discuss corrections that are made. Classes are held in the form of several-hour blocks (3-6h), during which all students must complete the assigned work.

In 2020, due to pandemic, education had to pivot quickly and figure out how to change this traditional and well-known models of work at school studios and workshops into distant and virtual ones. This was a demanding time period for schools, organizations, teachers and tutors. In Poland most of schools implemented Microsoft Office tools such as Outlook and Teams. The most common way to proceed with classes

of various topics were online activities such as online meetings in Teams. Tasks and other results achieved by the students were then uploaded onto a platform in respective folders, whereby teachers could evaluate and determine results.

This method of teaching was lacking visual presentation and shared knowledge, as the outcomes in the art teaching process are not 0-1 (wrong-correct), but the more difficult process of observing, forming and refining student's sensitivity, simultaneously improving their drawing and painting skills.

For this class during the distance learning, it was quite impossible to provide a real form model or still life for students. Additionally, assigning tasks for observation, making art interpretations and group corrections were very challenging and time-consuming in this time. Thus, the need emerged to develop other tasks and to find satisfying ways to present them, to let the students be inspired by others and to create a common, easily accessible, visual environment, where all works could be uploaded, common corrections and discussions then could proceed. That's when the Trello tool came into consideration.

The use of Trello tool varies from personal use by freelancers, social media specialists to group work – small and medium enterprise projects teams, using scrum and agile projects workflows and management boards. In education, there are lots of templates for structuralized subjects as math, biology, languages, etc. as a lot of teaching material can easily be transformed from a semester plan into a Trello board. A lot of the projects organized in Trello are based on the workflow: TO DO – DOING – DONE, but these features were not used in our case - for painting and drawing classes. The key component of the Trello platform for us was the visual structure that could be achieved, giving users the impression of co-creation of virtual galleries and art catalogues, that could be constantly developed throughout the semester.

Students were given access to the shared, preorganized board and after a short training session they could operate on the platform, where tasks were uploaded weekly and organized visually. Students contributed their works within given timeframes, described them, discussed and tracked their progress in collaboration with the teacher. Each task was described in separate visual cards along with other materials attached such as images, videos and music. To raise the interest and creativity also board elements, structures, lists, cards, covers and backgrounds were adjusted accordingly to each week's task. Each card gives a possibility of commenting on works, conducting discussions, directing comments to other users – individual or the group, linking works, examples, corrections and showing other students' important aspects of their work, displayed in the form of some kind of visual blog with easily accessible content.

Constant increase in content volume and appearances from week to week gave continual opportunity of individual expression along with comparison of individual and group progress and evaluation.

Due to the pandemic, specific situations caused students to separate from the groups. When creating works, students had no access to common space only their own environment and/or their personal residence, which obviously changed the learning process and possibilities. In response to those circumstances, the whole class had to adapt and restructure. Students could choose a timeframe to complete their work, as tasks were often stretched over several days and changed to a more open, flexible subject with the possibility of creating artworks using night light, working outdoors and more focused subjects such as working with the contents of household refrigerators, create artworks around "my breakfast" - stretching the process of converting given tasks into the given timeframe facilitating the final result an

individual approach to set the stage, make detailed process documentation and refining final artwork.

Strengths of Trello (to be developed and researched):

The Trello boards develop as jointly created galleries, forms of virtual exhibitions and art catalogs (using backgrounds and covers that visualize subjects enriches the look), which seems to be the right form for presenting processes and achievements, motivating, inspiring, surprising and stimulating creativity.

Tasks description could be very detailed and enriched with examples such as images, videos, music, pdfs, links. This could build a continuously developed, easily accessible, well-structured and accessed knowledge base.

Dynamic possibilities, various views of an individual or group achievements; the ability to manage workflows and to organize boards according to topics or individual achievements are key features. Detailed view of the activity of each student, along with dates of published works, comments and corrected tasks give the perspective on every single student progress. Discussion and corrections accompanying works are attached in well-structured form.

Adding checklists and copying them to individual progress cards helps to organize work.

Attendance list could be proceeded as a creative task, e.g. during the first class, adding a selfie as confirmation of presence, or adding a comment related to the topic of the class confirming the presents in form of various attachments added to a card.

Easy backup and copy of content, duplication, clear archive, various premises levels for users help to manage resources and users.

Weaknesses:

The possibility of accidentally erasing teacher's resources, own files and others files by mistake. It seems crucial and necessary to train students and encourage them to develop best practices using this tool.

This work will be continued and further researched to improve the structure, learning process and student’s satisfaction.

The importance of sustainable development in technological education

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Abstract

The main aim of the article is to evaluate the concept of sustainable development in relation to the information society. The article should provide an answer to the fundamental question: do we appropriately use the latest technologies available on our smart devices, especially in today's digital world? The most important concerns facing the information society, including the problem of Internet addiction, will be discussed. The empirical research was carried out in the form of a direct method, using a questionnaire. Based on research, we do not observe the balance that a sustainable information society speaks for. The time spent in front of the computer does not correlate with the acquired skills. The obtained results will influence the development of the policy of effective and secure use of the Internet.

Keywords: research paper, information society, sustainable information society, sustainable development

1. INTRODUCTION

Nowadays consumers are faced with an unprecedented growing range of information. Society generates sizeable amount of unstructured content every day, but the obstacle is to access the proper information among a variety of data which aren't really needed. The rise of the information society and the early process of information transferring was rather primitive in the beginning, but it broadened the possibilities of man to a great extent. This is the period in which man reigned over the technology he invented. The passage of time forced him to be innovative and creative (Dompke, Geibler, Göhring, Herget, Hilty, Isenmann, Kuhndt, Naumann, Quack and Seifer, 2004). The wide development of technology, including the World Wide Web expansion began with carrying of various types of threats. This allowed for the development of intelligent systems having a hybrid character (man - machine). Today not only our devices can be constantly connected to the Internet, but the technology development also went a step further. Today not only our devices can be constantly connected to the Web, but the technology development also went a step further. One example might be the brain-implant company, Neuralink Corporation (Drew, 2019).

The concept of sustainable development of the information society has recently gained in importance, and at the same time it has become a great economic challenge. Due to

the constant and rapid development of society, social and industrial changes and their consequences in the area of media and communication are often discussed. One should also pay attention to the issue of technological determinism, which applies to electronic media and the so-called new media that are ubiquitous, i.e., in private and professional life. They are designed to facilitate our life, our existence. The situation of technological development has put society not only in front of educational and development opportunities, but also carrying a number of threats and new technologies with it, on which their users get comfortably dependent, in a way that gives as much virtual space as is needed or wanted. It can be said that technologies are developing at a pace that is beyond the adaptive or cognitive abilities of humans (Baecker, 2019). Researchers are very interested in the subject of information society. As a result, several important academic centers throughout the world have undertaken substantial study. In research and science, numerous information society dimensions: technology, economics, the professional, space and culture are distinguished and studied (Ziemba, 2013). It is evident that the sustainable information society represents a new stage in the evolution of the information society, in which IT is becoming the main element for sustainable development (Wątróbski, Ziemba, Karczmarczyk, Jankowski, 2018). The adoption of information and communication technologies by stakeholders from society such as families, businesses and public administrations, is a vital aspect in sustainable development and in its several aspects, namely economic, social, cultural, political and environmental (Ziemba, 2018).

The following research questions are addressed in the paper. Do we make efficient use of the current technologies provided on our digital devices, or do they make us more skillful, especially in the digital world? Can we appropriately use the latest technologies? Are we effectively spending our time in front of the computer, or are we just passive users who only use in unproductive way the digital devices and become addicted to the Internet? What is the importance of "sustainable information" for us today, and how does the sustainable information society should look like? For the needs of empirical research, a following hypothesis was formulated: Spending more time on computers or digital devices connected to the Internet improves our technological skills. The main objective of the study is to identify the current state of knowledge related to IT skills in relation to the time spent at computers or digital devices connected to the Internet. The presented problem related sustainable information society was examined with the help of the study.

After the above introduction, in the second chapter of the article, we find the description and state of current research and an analysis of the literature. In this chapter, we will focus on such concepts as the information society and further aspects of the sustainable technology. The most important challenges of the information society will also be presented, including the topic of Internet addiction. The third section will present the research methodology and the methods of analysis used on the example of the study conducted on a student group. In chapter four we find an analysis of the results. Chapter five presents a summary and the most important conclusions that should be applied so that the concept of a sustainable information society will be properly and effectively developed.

2. STATE OF ART/LITERATURE REVIEW

2.1. INFORMATION SOCIETY

The concept of the information society dates back to the 1960s and it is primarily related to the information technology

revolution (Steinbicker, 2011). The father of this concept is considered to be the Japanese sociologist Y. Masuda, who devoted his first debates and then a book to the subject of information society, in which he talks about the emergence of a new information era supported by computer and communication technologies. The age of information is marked by the rapid advancement of technological innovations, which are the basis of social transformation, in which we can observe the growth of information and its quality (Masuda, 1980).

The information age is a specified period of time when innovations took place (especially in the *information architecture*), information technologies became a latent force of social transformation, capable of causing an increase in the quality of information and a significant increase in the scale of information storage. The scientific concept of the information society is perceived in many dimensions, from its classification to the underlying concepts of sociology. The American sociologist D. Bell in 1973 noticed that in the American economy in the decision-making process a significant role of information (Bell, 1974). The US National Academy of Sciences also contributed to the creation of the concept of the information society by publishing a report in 1979 about the emergence of a new era that focused on information technology and communication (Wilk, 2009). When speaking of the information society, Lumann invokes the fact that more and more time is used to create and consume information, which is ultimately understood as goods that are transformed through their use (Luhmann, 1996).

The definition of the information society can therefore be understood as a phase of development, in which we are dealing with the continuous creation, processing and dissemination of information, which ultimately has the status of a commodity and has a large impact on contemporary economic growth, which is largely based on knowledge. The information society influenced, first of all, the economic breakthrough that led us from industrial production to the production of knowledge, creating a kind of culture where the speed of information processing and its universality are the determinants. Information society is influenced largely by the networks and systems, characterized with the mobility and flexibility.

Mansell discussed the concept of the information society in relation to sustainable development, highlighting the potential applications of information and communication technologies in sustainable development, which primarily support the improvement of public service provision, quality of life, and access to information (Mansell, 2010). Schauer provided an overview of the influence of ICT on sustainable development, including definitions of sustainable development in ecological, social, economic, and cultural aspects, as well as in the context of the information society (Schauer, 2003). Johnston, on the other hand, provided approaches to the development of a sustainable information society that integrate technological, regulatory, and implementation actions, as well as greater spending in public services (Johnston, 2006).

2.2 THE EQUILIBRIUM IN THE SOCIETY THE INFORMATION

Notion of sustainable development was first used by H, C, Carowitza in 1713 in relation to the development of forestry. While in relation to the whole economy could be found in 1952 with the Interdisciplinary Working Group on Natural Economy, which called for the use of the natural economy in a sustainable way, so that future generations could benefit from their goodness (Wey, 1982). Today, the term sustainable development was used in the World Strategy Protection, published in 1980 and in the Global 2000 study (Time to Act 1981, 420 et seq.).

In his idea of communism, Marx also sees a world that should be used and improved by man, so that future generations could also correct it in an undeteriorated state, since man, not being the owner of the land, but only can take care of the infrastructure he has built, but he has no privileges to destroy the world (Marx, 1984). Nowadays in discussions about the concept of sustainable development the changes in the definitions are observed. We are not only talking about the protection of natural resources but also about inclusion and extension to all kinds of social and economic problems, including the information problem (Fuchs, 2006). According to Dalal and Bass, sustainable development strategies are dependent primarily on human awareness, coordination and communication (Dalal-Clayton and Bass, 2002).

Mario Dompke understands sustainable development to be a principle that represents a certain direction of action that can only be defined in a very broad social discourse. Dompke presents three basic criteria for balance (Dompke, Geibler, Göhring, Herget, Hilty, Isenmann, Kuhndt, Naumann, Quack and Seifer, 2004): Compatibility with humanity. This means that no human actions should harm other people and protect their dignity, Social awareness, including the relationships between people who build the social system to be protected. Exclusions from the system, i.e., social exclusion, should not be allowed, and Respect for nature. The natural environment should be protected and not permanently damaged. The natural foundations of life must be preserved. Schauer describes the ecologically, socially, economically and culturally sustainable development as four aspects (Schauer, 2003). Furthermore, Fuchs investigated the five pillars of sustainable development: environmental, technical, economic and cultural sustainability (Fuchs, 2006). Consequently, a sustainable information society may be concluded with four categories of sustainability: environmental, economic, socio-cultural and political. Ziemba has confirmed and verified this approach (Ziemba 2017).

Information technology is described as the set of software and hardware which execute collectively the several roles of information creation, storage, processing and delivery. Computers, the Internet, mobile technology and especially apps are included. The design, implementation, stabilization and continual improvement is characterized as information technologies. It encompasses the entire spectrum of work from the moment of adoption till information technology reaches its full potential (Nord, Riggio, Paliszkiewicz, 2017). Increased durability of the goods and services throughout their life cycle is connected with sustainable developing informatics technology, which is done by lowering material, energy flows and related matter. Responsible IT growth allows and encourages sustainable patterns of production and consumption and is a vital engine for sustained, harmonic and adaptable economic advantages. Information technology is booming to promote sustainable socio-cultural development, including job creation, culture promotion and social exclusion reduction (Ziemba, (2018). Grunwald has shown that IT may play a significant role to promote cooperation, networking, and partnerships between public authorities and households (Grunwald, 2017).

Access to information is an important issue in developing a concept of social acceptance limited to the information community category. Well available data and open technical standards expand the public space and the audience. They facilitate democratic participation and support sustainable economic activity through the use of digitized knowledge. Recommendations for further research on the concept of social acceptance, which the author sees, is the need for research into the complexity of IT systems, their security management and the associated risks. Is important to define how efficient and

effective they are. A significant question is the usefulness of systems in education, defining their role, setting certain standards and ensuring more effective security and efficiency of use (Dompke, Geibler, Göhring, Herget, Hilty, Isenmann, Kuhndt, Naumann, Quack and Seifer, 2004).

2.3. UPSET THE BALANCE OF THE INFORMATION SOCIETY

The term Internet is most often defined in the literature as a "global computer network" (Hofmokl, 2009). It forms a huge network surrounding the entire world that is constantly changing and evolving. It is a global network, thanks to which millions of users have access to and exchange information. As a rule, we use two terms to describe the Internet network, i.e., wide and distributed. We are talking about extensive because it connects many computer systems. We speak of distraction because it cannot be distinguished from a central point that supervises its work. We can confidently say that each and every part of it is capable of independent operation (Mendalka, 2004). Technically, the Internet is a network of networks, a global computer network - it is a group of many computers, their resources connected by data transmission lines, which bind them around the world and enable fast communication. The Internet consists of three different elements that complement each other, this is: a network of interconnected networks, a community that uses this network, develops it, a set of resources that are on the network**.** J. Zieliński, in this definition, points to three closely interrelated layers of the Internet: technical, social and information. When we talk about the Internet, we must realize that it is one of the most rapidly developing systems on our globe. All the time we observe an increase in the number of devices connected to the network, and thus - an increase in the quantity and quality of services offered on the network. The Internet is now used in almost all areas of our lives. Formerly, it was available and reserved exclusively for the world of science. The internet network can be described as the "overpopulated global village". The Internet is not only a culture, but also a huge community joined by people from all over the world and from all walks of life. It should be emphasized that the Internet has a huge impact on children and youth as a new educational environment. Nowadays, children and adolescents can be classified as the e-generation. The media space surrounding our children gives them the opportunity to use new technologies, including the Internet and computer, and thus to use them every day for communication and learning entertainment (Zieliński, 2018).
We observe the progress in the use of the network all around, it is happening right in front of our eyes. When analyzing the use of the Internet, attention should be paid to the functions it performs in the information society. According to HD Lasswell, the following functions should be distinguished (Walter, 2012): informational (observation of the environment), interpretive (correlation of reactions to the environment), socialization (transmission of heritage) and entertainment. Cyberspace is a computer network with a global reach, enabling common access to information and its exchange. The Internet is a community of Internet users who communicate via satellite links, optical fiber lines, telephone lines and others. Its strength lies in the global reach and unlimited number of applications - many networks have already been created, e.g., banking, news websites, in shops, libraries, offices, etc.

Researchers observed the addiction of Internet use and its negative consequences appeared in the world of science at the end of the 90s, and in recent years it has been one of the stormiest topics of scientific discussions: psychologists, psychiatrists, sociologists, educators and other researchers. At present, the existing phenomenon has not been fully identified

and defined. We come across terms like: "network addiction", "addiction", "abuse". Addiction as a term in the scientific literature was introduced by Kimberly Young of the University of Pittsburgh (Wołpiuk – Ochocińska, 2006). There was a great deal of debate among researchers of the subject. According to some, the use of the term "addiction" is reserved only for physical addictions, namely nicotine, alcohol, drugs. Others emphasize that they can be included and included in the classification of behavioral addictions, i.e., addictions to activities, e.g., from gambling (Wójcik, 2013). Regardless of the terminology used, research by psychologists, psychiatrists and therapists clearly shows that the problem is becoming more and more serious. It is of a medical and social nature. Symptoms of computer disease are experienced by people who do not have access to a computer, and they are equal to the feelings of people with withdrawal syndrome. These people feel agitated, have trouble sleeping, and develop depressive states (Przybyszewska and Jagodzińska, 2012).

We are witnessing the development of a new generation of addictions. The literature on the subject describes an avalanche of all kinds of disorders and dysfunctions that handicap our children, young adults as well. They cause permanent or temporary psychological or somatic disability. The widespread use of the web affects individuals and sometimes entire specific communities. Allowing our children to use the Internet uncontrollably leads to changes in the functioning of a young person within the intellectual sphere, causing changes in his behavior, loosening interpersonal ties, incorrect attitudes and behavior. Consequently, all these elements affect the child's self-isolation. This dynamically developing phenomenon affects, first the youngest users, then teenagers but also elderly are impacted. Polish researcher, K. Kaliszewska, defines Internet addiction as "a dysfunctional pattern of cognitive elements and behaviors related to Internet use, the result of which is loss of control over behavior (when and how to use the Internet) and a significant deterioration in social, professional or other a significant area of the entity's operation" (Kaliszewska, 2007). The Internet, entering all areas of our life, causes that if it is improperly used, it becomes a "time thief" (Wallace, 2005). From the other side, a computer is a calculating machine used to process any information that can be written in the form of a series of digits or a continuous signal. Irena Pospiszyl summing up the scale of the phenomenon of addiction to digital media states, inter alia: "The most surprising thing is that with the increasing social awareness of the dangers of Internet addiction and easy access to a possible research group, there is still little work on this problem. Most often, such research is carried out by various Internet companies or on behalf of this type of institution, and of course have significant drawbacks. Firstly, they show great freedom in their approach to research methodology, not always consistent with the requirements of reliable scientific work, so research results differ significantly. Secondly, research concerns limited areas - most often issues related to the use of a specific medium. Therefore, the results are only an approximation of the scale of the phenomenon, not a reliable assessment (Pospiszyl, 2008)." We talk about abuse or addiction to the Internet especially when the time and intensity of using the Internet is not controlled by the user or using the Internet leads to the neglect of other aspects of our lives, causes problems on various levels or it causes suffering both for the addicted person and the immediate environment.

Sustainable development should be treated as a prevention, i.e., activities in the field of education and information, i.e., prevention of undesirable phenomena. For many years, actions have been taken in Poland, which include, inter alia, the diagnosis of the risk of computer and

Internet addiction, as well as prevention, which is to definitely prevent the negative effects of their use. Internet guides, social campaigns, filtering for one of the many forms of prevention in this area (Przybysz-Zaremba, 2008). Educational activities undertaken are also of great importance. Online media is a great opportunity for development and educational hopes for our children. It is a very useful source of knowledge and new information; it is an educational tool that should be under the constant control of adults - because it can become a big threat

As part of the sustainable development of the information society and prevention, comprehensive educational and media activities for the safe use of the Internet should be implemented and new technologies, in the event of threats related to the use of the Internet and mobile phones. As a Polish example in order to meet the information society expectations, the Ministry of National Education introduced the obligatory subject of Media Education to schools, due to the very dynamic development of mass media and hypermedia, and to a great importance in the ongoing cultural changes. The media intensify the processes of globalization, they also favor the reverse process - that is, personalization of production and reception. The media play a very important role in institutional, parallel and continuous education, education without age, social, cultural and national boundaries. The very fast development of the media, their rich program offers forces them to undertake educational measures, i.e., effective learning to use their offer. We want the selective choice and active reception to allow us to acquire and assimilate all kinds of information, develop our intellect and develop the desired social attitudes.

3. METHODOLOGY AND DATA

3.1 RESEARCH INSTRUMENT

The study was conducted using a questionnaire. The bipolar replies and a four-point scale with no neutral point called the forced choice scale were applied in the evaluation of student technology capabilities. A technique with two or more assertions comparatively is the forced choice form. The items are coupled with the preference and discrimination indices in each block. The responders must select "most like me" and "least similar to me," respectively, from over two assertions in a block (Xiao, Liu, Li, 2017). Respondents who were asked, "How familiar are you with the usage of a certain technology?" replied on a scale of 1 to 4. Where the scale's description stated: 1 - I know exactly what it is and how to apply it or I have very good skills, 2 - I know how to do it but sometimes have problems, 3 - I need help, 4 - I don't know what it is, I can't apply or I don't use.

The regular single-choice scale was utilized in the remaining questions on time spent with Internet-connected devices. The questions were designed in structured way, so that respondents' answers were based on their feelings and current knowledge. The research began with a series of basic descriptive research questions and allowed us to determine whether the respondent has the student status.

3.2 PROCEDURES AND DATA COLLECTION

The study focuses on empirical research was carried out in 2019 among Polish students at the University of Szczecin and the European University Continuing Education Network. The collection of data from target groups was carried out using a direct method, through a survey, which was uploaded to the website. There was a random nature to choose the search sample. Students from two universities have been issued the survey. Student status was established as a criterion for participation in the study and student status was set as the criterion for study participation. Total participation in the

study was 110 students (complete responses). The questionnaire was only available to the students and no other samples of another status were available.

- Research sample of size N = 110
- Characteristics: status of student

The purpose of the interviews was to gain the data, which will help to determine the state of experience and obtain independent comments.. The subject of the research was to analyze the technological skills of students and the effectiveness of time spent in front of digital devices. An important indicator allowing to determine technological skills is checking the experience of students in this field. After conducting the research, the information will be collected and analyzed using selected methods of knowledge processing, such as correlation analysis and comparison methods (Hanneman, 2010).

3.3 DATA ANALYSIS

Basic quantitative methods were used to analyze the survey data. Data were exported and processed in Excel statistical packages to the Microsoft Excel format. The data was subjected to correlation analysis. In order to investigate the relationship that allows for the effectiveness of the time spent with devices connected to the Internet and their educational functions, related to the development of technological skills. The correlation analysis examines the relationship between the individual features X and Y, which is characterized by the fact that the values of one feature are assigned to strictly defined mean values of the other feature. The purpose of the correlation analysis is to examine the existence of relationships between variables and to determine their strength (Bartuś, 2020).

When examining the correlation of variables, we will analyze how the data behave in relation to each other. The linear correlation coefficient is described as the range <1, -1>, where 1 means a strong positive correlation (variables react in the same direction) and -1 means a strong negative correlation (variables react in the opposite direction). If the coefficient is 0, we mean no correlation. In order to be able to assess the level of dependency, we use the following dependency scale (Wróblewski, 2020):

- below 0.2 - no dependency
- 0.2 - 0.4 - weak dependence
- 0.4-0.7 - moderate dependence
- 0.7-0.9 - quite strong dependence
- above 0.9 - very strong dependence

The correlation coefficient equation used by Excel is as follows (Microsoft, 2020):

$$\mathrm{Correl}(\mathrm{X},\mathrm{Y}) = \frac{\sum(\mathrm{x}-\bar{x})(\mathrm{y}-\bar{y})}{\sqrt{\sum(\mathrm{x}-\bar{x})^2(\mathrm{y}-\bar{y})^2}}$$

Where Syntax:

CORRELATION.COE (array1, array2).

The CORRELATION function syntax has the following arguments:

- arguments Required. A range of cell values.
- array2 Required. Second range of cell values.

$\bar{x}$ and $\bar{y}$ are the results of AVERAGE (array1) and AVERAGE (array2).

4. RESULTS

The research was aimed at determining how long and how effectively students spend their time using digital devices that are connected to the Internet.

When using online technology, we should first of all pay attention to data security. The security of data may be compromised by viruses, hackers or spam is also a challenge. Social media, internet banking and instant messaging are particularly vulnerable to data theft due to the lack of knowledge about the proper use of

websites and computer protection against external attacks. This category of questions examined whether respondents use online services and whether they can use online software that processes sensitive data, such as personal data, banking data or third-party data.

4.1. TIME SPENT IN FRONT OF DEVICES WITH INTERNET ACCESS

In the first part of the survey, students were asked about the time spent in front of devices with Internet access. The results developed as follows. Figure 1 shows the results of the time spent using devices with internet access.

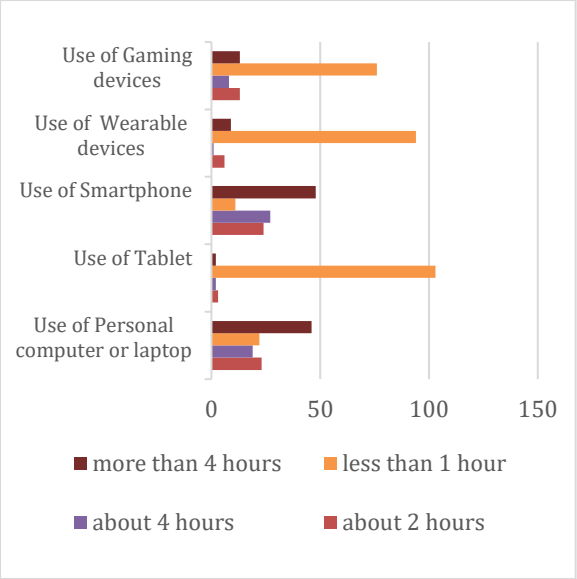

Figure 1. Time spent using devices with internet access[1]

Following the results analysis, the preceding was observed:

- Section "Time spent using personal computer or laptop" - more than 59% of students report using a computer four or more hours a day. 41% of respondents use the devices two or less than two hours a day.
- Section "Time spent using tablet" - more than 96% of students report using a tablet two or less than two hours a day.
- Section "Time spent using Smartphone " - more than 68% of students report using four or more hours a day.
- Section "Time spent using Wearable devices" - more than 90% of students report using a tablet two or less than two hours a day.
- Section "Time spent using Gaming devices" - more than 80% of students report using a tablet two or less than two hours a day.

The average time spent in front of internet-enabled devices is 4,88 hours. Devices that are most often used by students are usually personal computers, laptops and smartphones

4.2. STUDENTS' TECHNOLOGICAL SKILLS

As the first series of questions shows, personal computers, laptops and smartphones are the basic tools that students use in their everyday lives. In order to test the effectiveness of using these devices for acquiring technological skills, the skills related to selection and use of proper software. This is a very important aspect because it allows us to freely use digital devices. The next series of questions were used to identify selected technological skills of students that may be acquired while using data processing devices.

In this section, students answered questions such as How familiar are you with/in: Find and/or choose adequate tools to share your content online, install any software on mobile devices, install any software on a desktop computer, install some software on a server or use appropriate software to open files in specialized formats. The results of this section show mostly good or very good knowledge of the software and demonstrate good skills with the selection

[1] Own elaboration

and no problem with the use of this software.

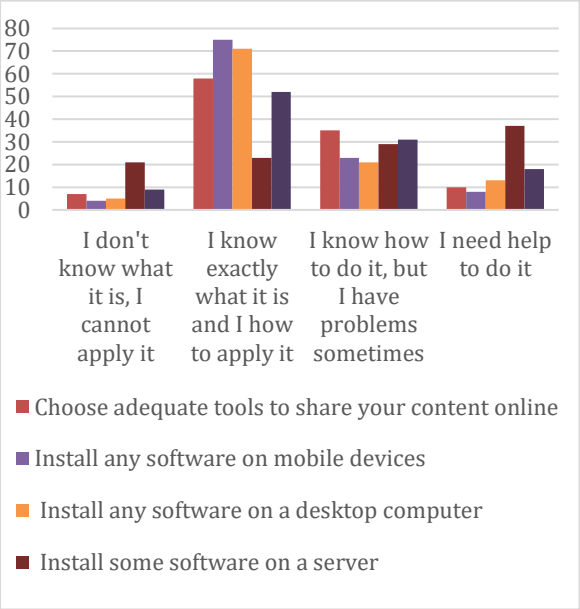

Figure 2. Students' selected software skills[2]

For the second section, students were asked about the skills that are used when using the devices for major activities online. Questions were asked such as: how familiar are you with using: Communication software, Online Banking, Online Shopping, Social Media, Web development technologies or Data analytics. In this section, we can see that students demonstrate the greatest skills in the use of communication programming, online shopping and the use of social media.

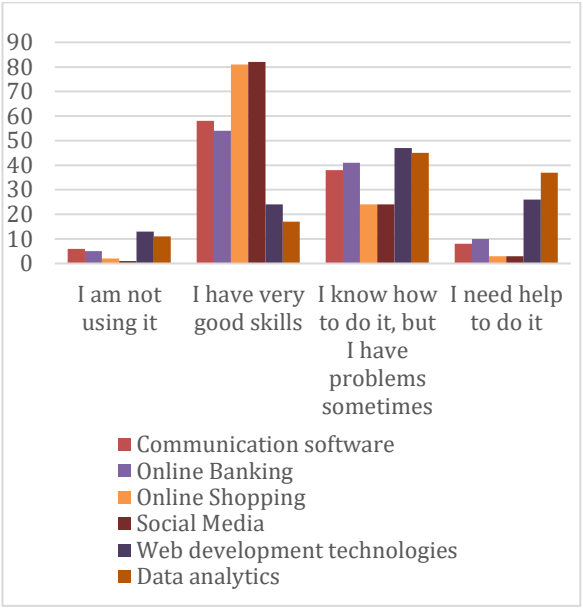

Figure 3. Ability to use online software[3]

4.3. EFFECTIVENESS OF USING DIGITAL DEVICES

In the analysis below, an attempt was made to prove the following hypothesis: Spending more time on computers or digital devices connected to the Internet improves our technological skills. The obtained results of the questionnaire, which showed how much time students spend in front of the computer and what technological skills they declared, were compared and correlated. The analysis presented in Table 1 analyzed the technological dependencies that were the outcome of the summary of the hours spent front Internet access devices. Correlation coefficient calculation results reflect the relationships between the variables based on how near the coefficients are to zero on the stated dependent scale.

[2] Own elaboration

[3] Own elaboration

Correlation **[skills/time]**	Number of hours spent using internet-enabled devices
Choose adequate tools to share your content online	0,0605
Install any software on mobile devices	0,3258
Install any software on a desktop computer	0,3402
Install some software on a server	0,0757
Use appropriate software to open files in specialized formats	0,2396
Use of communication software	0,0296
Use of online Banking	-0,1117
Use of online Shopping	0,0046
Use of Social Media	0,0344
Use of Web development technologie	-0,0545
Use of Data analytics	-0,0772

Table 1. Correlations among technological skills and time on digital devices connected to the Internet [4]

When analyzing the results, we notice that the above hypothesis cannot be confirmed. The correlation between the time spent in front of digital devices and the individual skills declared by students does not indicate a dependency. We can see a weak relationship in the ability to select appropriate programs and applications for a computer or smartphone, as well as the ability to select appropriate programs to open files. We notice the lowest correlation for the ability to use communication programs. Over 72% of students use digital devices for more than 4 hours a day. Nevertheless, no dependencies have been shown that would confirm the effectiveness of the time spent in front of the digital devices, which would translate into the development of technological skills.

5. CONCLUSIONS AND DIRECTIONS OF FURTHER RESEARCH

5.1. CONTRIBUTION

Summarizing the topic of the sustainable information society in terms of the efficiency of using digital resources and the threats that we encounter on a daily basis in the Internet space, we can say that we are dealing with a serious and constantly growing problem. Based on the presented study, we also notice that among students we do not see the balance for which a sustainable information society speaks. We can see that students also spend ineffectively a lot of time on the Internet, being at the same time exposed to many dangers, including Internet addiction. The described phenomenon can be classified as a problem of a wide scale, although it is relatively young, and thus the assistance offered is small.

Therefore, the findings of the study should be used to educate and equip children, adolescents and adults with specific knowledge and skills, allowing for conscious and critical reception of media and media messages, as well as for the use of technologies and media as tools for communication, education, acquiring, collecting and information processing.

The study indicates a very crucial aspect that media education has to be practiced. It contributes to the development of communication skills, which is important for the proper functioning of the relationship in the workplace i.e., between the boss / management and employees. Obtaining the appropriate communication qualifications is a requirement and a condition for the competence of both the management and the staff. Mass media influence direct contacts and interpersonal relations shape a specific vision of a person and their place in society, i.e. at work, at home, in a social group - creating a sense

[4] Own elaboration

of community, blurring all kinds of boundaries between the private sphere and public spheres. Progressive education in the field of understanding the importance of the media in the process of building social bonds is a need, even a necessity, especially in countries continuing economic transformation.

The results of the various researches include analysis of the diversity of ICT applications in many categories of social, cultural or ecological life, in other studies that deal with the notion of sustainability and performance. Ziemba's work in these areas shows that the information society needs to become improved (Ziemba, 2018). Several researches also shows the significance and influence of a sustainable IT society on several sectors of life (Anser, Osabohien, Olonade, Karakara, Olalekan, Ashraf, Igbinoba, 2021). We also notice as Goswami that ICT has a vital role in planning and implementing the solutions required to achieve a green and sustainable economy (Goswami, 2015). The researchers also stress the necessity to construct workshops and ready-made tools to make the use of and implementation of assumptions necessary to create equilibrium in the information society easier (Kostoska, Kocarev, 2019).

5.2. RESEARCH LIMITATIONS AND FUTURE WORKS

There are limitations to each of the research. Due to the little amount of study, generalization may be unavoidable. Respondents in additional institutions should be addressed and research efforts increased. Work is also limited to areas in Poland, which also lead to the results being generalized. We need not limit ourselves to the academic community, in order to investigate the phenomena that is being presented among the youth to influence development policies. The analysis should include more data from various locations, considering all levels of education.

When asked if we effectively use the latest technologies that are delivered on our smart devices, we can answer that no. The time spent in front of the computer is not correlated with the skills we acquire. We are passive users. What effect does it have on a person, then a long time in front of the computer, what do we do at this time. What is the importance of "sustainable information"? What recommendations should be ordered in order to achieve a state of sustainable information society? These are questions that should be raised in future research, bearing in mind the problems and risks that the broad concept of the Internet brings.

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Open Source Collection of Gamified Programming Exercises

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Abstract

Computer programming courses are considered difficult. They can be made more engaging for students by incorporating game elements in a process known as gamification. In order to make it easier to facilitate this process in practice, several European universities collaborated in a joint project aimed at developing a framework for application of gamification to programming education. The framework includes the specification of the gamification scheme and the exercise definition format, an open source toolkit for preparing the gamified exercises and an interactive learning environment to present them to the students, and, last but not least, an open source collection of gamified programming exercises. In this paper, we present a work-in-progress on the last element, describing the current contents of the collection and planned directions for its extension.

Keywords: open educational resources, gamification in education, programming exercises, teaching computer programming, e-learning

1. INTRODUCTION

The progress of the ongoing digital revolution depends on the availability of skilled programmers. Their supply is limited, and one of the reasons for that is the difficulty of learning to program, both perceived by students and reflected in the measured average pass rates in comparison to other STEM subjects (Simon et al., 2019). The difficulty often leads to students' disengagement, and, consequently, to dropout.

Gamification, consisting in enriching education with game-inspired elements, has been proven to be capable of counteracting such problems (Ghaban & Hendley, 2019). The practical implementation of gamification to programming education requires several components, such as: an agreed gamification scheme (to provide guidelines to the exerecise designers on what gamification elements they can use and define requirements for the supporting software), a standardized exercise definition format (so that the gamified exercises could be exchanged between tools and people), an open source toolkit for preparing the gamified exercises by the designers and an interactive learning environment to present them to the students and handle automatic assessment of solutions submitted by students and processing of gamification rules. The development of such components was the aim of the Framework for Gamified Programming Education (FGPE) project financially supported by the European Union's Erasmus Plus programme (FGPE, 2020). While all above-mentioned components are technically necessary to develop and make use of gamified programming exercises, what the students and teachers actually need are the exercises themselves. For this reason, the FGPE project included the development of 480 gamified programming exercises under open-access license. In this paper, we describe the development and the current structure of this collection as well as present the plans for its extension.

2. DEVELOPMENT PROCESS

The development of the exercises has been preceded with devising the general scheme for gamification of programming education, based on results of a survey of what forms of gamification are appealing to students (Swacha et al., 2019), and defining data format for exercises – actually, two distinct formats were defined: YAPExIL for non-gamified programming exercises (Paiva et al., 2020a) and GEdIL for the gamification data (Swacha et al., 2020).

The development work has been equally shared among the four partners of the FGPE consortium: University of Szczecin (Poland), INESC TEC (Porto, Portugal), Aalborg University in Copenhagen (Denmark), and University of Naples Parthenope (Italy).

The basis for the gamified exercises were mostly non-gamified exercises used earlier for teaching programming by the FGPE partners, some interesting exercises were adopted from existing open repositories, and also some were created from scratch to allow testing of various gamification concepts.

The exercises were developed using the AuthorKit webtool for collaborative authoring (Paiva et al., 2020b). Following the user-centered design principles, from the very beginning, the students were involved in the development of exercises by each of the partners. Initially, there was a problem with testing the exercises, as the software components necessary to run the exercises: the gamification service (Paiva et al., 2021a) and the interactive learning environment (Paiva et al., 2021b) were developed in parallel to the exercises. Later, the testing was bidirectional (exercises were helpful in finding bugs in the software handling them, and vice versa).

3. COLLECTION CONTENTS

Due to different educational needs of the respective FGPE partners, the contents of the collection varies. University of Szczecin developed two sets of exercises, the main

counting 94 exercises supporting a course on Introductory Python, the second with 26 exercises supporting the final exam for the same course. Both Aalborg University and INESC TEC developed one collection each with 120 exercises to be used for supporting education of students at subjects such as Algorithms and Data Structures or Introduction to Programming, which are taught using various programming languages, therefore an effort was made for the exercises to be programming-language-agnostic, i.e., have no elements designed to teach or test knowledge of specific features of specific language, but rather of algorithmic problem solving in general. University of Naples Parthenope developed one collection containing, however, exercises designed for various languages (of which 36 can be most suitably solved in Python, 28 in Java, 28 in C++, 18 in C, 10 in JavaScript) to let students practice different programming languages.

All exercises were developed in two languages of instruction: English and the national language of the respective partner.

The exercises are free to use by any educational institution, as they are published under Creative Commons – Share Alike license. The up-to-date version of the collection is available for download at GitHub (FGPE, 2021).

4. EXTENSION PLANS

Although the FGPE project ended on 31st May 2021, the work on extending the collection continues as a part of the new FGPE Plus project (FGPE Plus, 2021). In the forthcoming year, the collection will be extended with 520 new gamified exercises. While the collection is currently focused mostly on supporting introductory programming and algorithms and data structures courses, the focus of the new exercises will be more on learning how to apply programming in the areas of other subjects. For instance, one of the envisaged gamified exercise sets is “Machine Learning with Python, Keras, and Tensorflow”.

We also hope that the spread of news about the collection will help involve third parties from outside the FGPE consortium to contribute their own exercises to the open collection and stimulate its further growth.

5. CONCLUSION

The novelty of the presented collection is that its exercises contain embedded gamification-related data. This way various institutions may benefit from application of gamification techniques in their educational activities with a very limited effort.

With the help of the software tools developed in the FGPE project, the exercises can be used as they are in different educational contexts (in-class learning, e-learning, and blended learning). Thanks to the open license, individual exercises can be extracted from the collection and re-arranged into courses prepared by different instructors.

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CS vs. IS students' reactions to learning programming with mobile educational game

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Abstract

Computer programming courses are within the scope of both Computer Science (CS) and Information Systems (IS) studies. Considering, however, the various educational aims and backgrounds of these two types of studies, there is a question whether the same teaching methods and tools could and/or should be used for both. In this paper, we investigate a specific instance of this problem, with regard to the use of educational mobile games, which were proven as effective tools supporting computer programming education among CS students. In particular, our research question is whether the same educational game for learning JavaScript programming evokes similar or different reactions to training depending on the type of studies. In a strive to provide an answer to this question, we compare the reactions to training of 54 CS students of a technical university and 69 IS students of two business schools. For the measurement of reactions to training, we used the tool provided in the Technology-Enhanced Training Effectiveness Model.

Keywords: game-based learning, m-learning, teaching computer programming

1. INTRODUCTION

While both Computer Science (CS) and Information Systems (IS) curricula include computer programming courses, there are obvious differences between them, not only in the context of other subjects in which programming is presented, but also in characteristics of CS and IS students. According to Quilling and Warren, the former are focused on "abstraction, not examples, technology rather than applications", with activities mostly limited to working alone with computers, and thus requiring very little interpersonal skills, whereas the latter is associated with the so-called soft skills, and

activities such as "documentation, organisational analysis and team management" (Quilling & Warren, 2002, p. 7-8). This is supported to some extent by the results of the survey by Alexander et al., finding CS students to consider "working with people" much less important than IS students (Alexander et al., 2014). Although we are aware of the results of Seymour et al. (2004), revealing misconceptions of the South African IS students about their future work (supposed to be mostly consisting in writing computer programs and designing new computer hardware), yet even there, the ratio of such answers among the CS students was much higher.

The IS students often fail to treat computer programming with necessary attention as they have different plans regarding their professional career than Computer Science (CS) students and consider future job titles such as project manager or business analyst rather than software developer (Goschnick & Balbo, 2005). Consequently, this subject is even considered as an "IS student's worst nightmare" (Woszczynski et al., 2005).

There are various ways of making programming courses more appealing for the students, one of which is game-based learning (Long, 2006). Mobile games are especially promising as they offer opportunity for learning anytime and in any place, thus, helping to bridge the gap between learning that takes place in school or university and learning that takes place in students' free time (Siakavaras et al., 2018).

In the following section, we present several examples of games that were successfully applied to support teaching programming to CS students. It remains an open question whether the differences between CS and IS studies large enough to necessitate different educational games for computer programming to be developed. If that was true, it would place additional burden on educational game designers. In a strive to answer this question, using the case of our educational game for learning JavaScript programming (presented in section 3), we investigate whether it evokes different reactions to training depending on the type of studies. Section 4 describes the method of the study, section 5 presents the obtained results, which are then discussed.

2. RELATED WORK

Although there are many educational games supporting the learning of programming presented in the literature, not all authors report students' reactions to using them. We were yet able to identify several such works.

Eagle and Barnes (2009) introduced Wu's Castle, a game where players interactively construct C++ code to solve in-game problems. The 26 CS students learning with the game more frequently agreed that the task helped them understand loops and arrays than the 29 students of the control group, learning in a traditional way.

Jiau et al. (2009) describe Resource Craft, a real-time strategy game, in which players program the logic behind production and action orders for four types of units. They report that more than 60% of the 57 CS students had fun learning programming using the game and that half of the students declared that using the game had improved their programming skills.

Baker et al. (2012) introduced Garden Gnomes from Planet 9, a game in which player fights extraterrestrial gnomes with light of specific color at the same time learning the use of arrays and loops in Java language. Feedback has been received from 19 CS students, 90% of them declared that the game improved their motivation to learn programming and 100% that they would recommend it to others.

Wong and Yatim (2014) developed a simple yet narrative-rich role-playing game in which players move their avatar around the game map, fight terrorists and solve puzzles at the same time learning basic concepts of object-oriented programming. They tested it on 40 CS students and report that "all of them

agreed that game-based learning is an effective tool for learning and teaching object oriented programming".

Nga et al. (2015) describe Mistake Chasing Game, in which players have to spot mistakes in Java code. Of the 56 CS students who answered the questionnaire, over 70% at least moderately agreed that the game met its purpose.

3. THE ECO JSITY GAME

As the base for our experiment, we used our educational game Eco JSity for learning JavaScript programming (Swacha et al., 2021). The game has been developed as a mobile app in two parallel versions: native for Android devices (Kaunas Technical University & University of Szczecin, 2020a) and web app for all other platforms (Kaunas Technical University & University of Szczecin, 2020b). There are no functional differences between the two except for that the former requires prior installation but then can be played without Internet connection, whereas the latter does not require installation but can only be played when Internet connection is available.

The Eco JSity game has been designed following all 13 principles of good learning as defined by Gee (2005). The game progress comprises 19 levels of increasing difficulty of JavaScript programming exercises. The choice of programming exercise topics was based upon the well-established guidelines of The Joint Task Force on Computing Curricula Association for Computing Machinery (2013), covering common computer science problems, such as: linear algorithms, branching (conditional) algorithms, iterative algorithms, search and sorting algorithms, recursion, tree traversal, and graph algorithms. We modeled the development of the app content after the proposal of Integrating Gameful Learning in the Classroom (Brunvand & Hill, 2019), clearly defining the pedagogical objectives, which are to acquaint the students with introductory concepts in programming, and determining the technological competency of our target students, and identifying the teaching content to offer in further studies or stages of advancement.

The theme of the Eco JSity game is put within the context of ecology within a living city environment. The player has the role of a commercial advisor to build a quarter of the city to start generating income while avoiding excessive pollution, which decreases the game score. The more programming exercises the players solve, the more building permits they get; the slower they solve the exercises, the more pollution is generated.

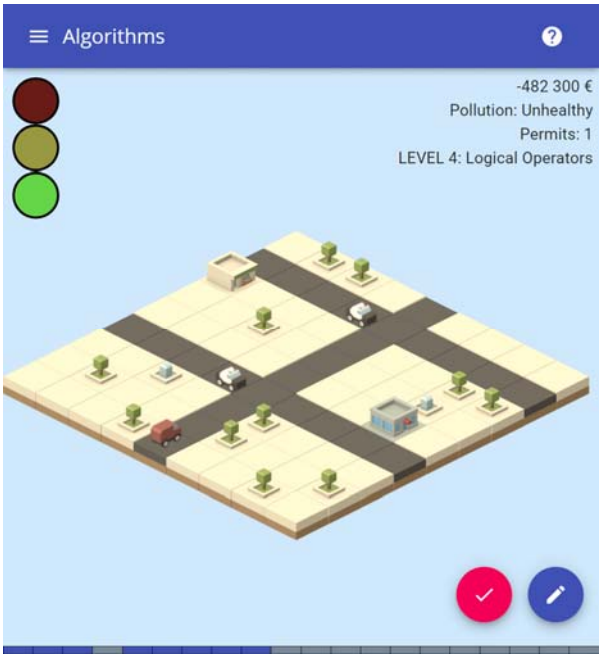
The player edits the solution code in the embedded code editor (see Figure 1), whereas its execution is visualized on a city map using elements adequate to the specific problem.

Figure 1: *Eco Jsity: solution code editor*

Figure 2 shows how the execution of the code visible in Figure 1 (solving a simple problem of controlling car movement depending on traffic lights) is visualized in the game: when the code is run, the red van starts moving from the bottom part of the

screen and collides with one of the police cars if either red or yellow traffic light is not observed in the solution code. If the solution considers moving the van only at green light and stopping it otherwise, the van completes its route through the city.

Figure 2: *Eco Jsity: exemplary execution visualization*



4. METHOD

In order to measure the student's Reactions to Training (RET) after playing the game, we decided to use the Technology-Enhanced Training Effectiveness Model (TETEM) model (Landers and Callan 2012) as it provides a validated instrument to measure RET. The relevant questionnaire consists of five items which were adapted (by replacing training with "the app") to the following form:

- RET1: "I am satisfied with the used app",
- RET2: "The app allows for effective learning",
- RET3: "Learning using the app is fun",
- RET4: "I enjoy the learning",
- RET5: "The learning provided useful examples".

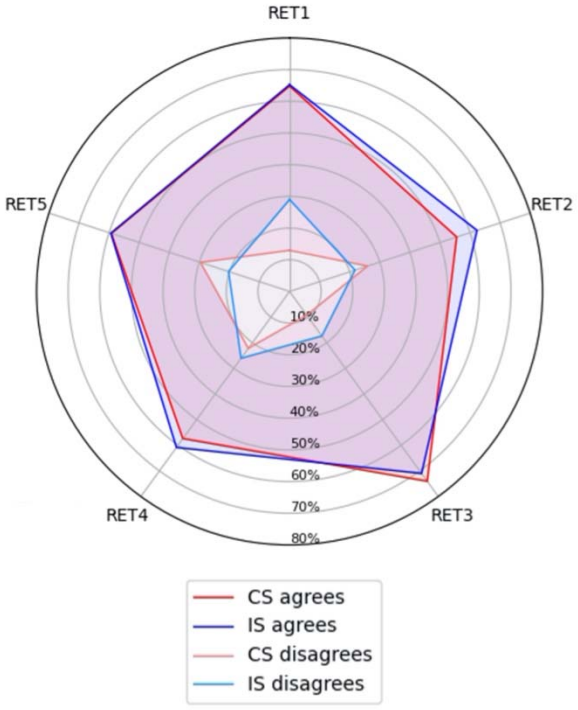
Each item was assessed with a 5-point Likert-type scale from 1 (strongly disagree) to 5 (strongly agree). The survey was administered online. One group of CS students from a technical university and two groups of IS students from two business schools were invited to learn with the app.

5. RESULTS

In total, we have received 54 questionnaires from the CS students and 69 questionnaires from the IS students.

As can be observed in Figure 3, the Reactions to Training of CS and IS students are overwhelmingly similar and mostly positive. Each of the RET measures was assessed positively (4-5) by more than 50% of the respondents.

Figure 3: *Comparison of Reactions to Training of CS and IS students*



There are, however, some differences in the grades given, more apparent among negative than positive answers. The analysis of negative responses (1-2) shows that RET5 and RET2 measures were assessed more

negatively among the surveyed CS students: 30% of them do not agree with the statement that learning using the application provides the user with useful examples (RET5), and according to every fourth CS student, learning this way is not more effective (RET2). Among IS students, there was a higher general dissatisfaction with the application used (RET1), at the level of 29% of negative responses, while this position was expressed by 13% of the CS students.

Among the positive responses, the highest recorded disproportions, although still very low overall, exist in the assessment of the app in terms of learning effectiveness (RET2), which was better assessed by the IS than CS students. There are only slight differences in the satisfaction with learning with the use of the app (RET4), which the IS students are more satisfied with, and the entertainment dimension of the app (RET3), more appreciated by the CS students. Equally positive measurements were obtained for RET1 and RET5.

6. DISCUSSION

The presented results show that the new educational game yielded mostly positive reactions to training from both the CS and IS students participating in the survey: their substantial majority agreed with each of the five relevant statements, considering learning using the app as both funny and effective.

Comparing the reactions to training between IS and CS students, while the differences in the share of positive assessments for all five of the component measures were very slight, the differences in the share of negative assessments were noticeable for some measures; particularly, there was a larger group of generally dissatisfied with the app among the IS students than among the CS students, whereas there were more CS than IS students who negatively assessed the effectiveness of learning using the app. While we did not ask the students to explain their opinions, we have found possible explanations at least for the former observation in the literature. In particular, Muganda et al. (2017) who tried to teach programming to IS students using games as case studies, received feedback including statements such as: "I don't think that it is easier using games because some of the concepts are much more intense and much more difficult than in business programming" and "the fact that we stick to the game concept that has begun to just get on my nerves as it has no application to business systems design at all".

Nonetheless, the large difference between the share of positive and negative answers in both groups of students clearly indicates that the game has proven successful regardless of the type of the studies. This result indicates that educational games can be designed for supporting programming education in both CS and IS courses. The generalization of the results is obviously limited by the fact that they pertain to merely one game, whose topic (city management) was (a) comprehensible for general audience and (b) its narration or contents did not include elements that would require knowledge of other subjects, specific to either CS or IS studies. Also, the survey involved only 69 IS and 54 CS students from just three universities, though the similarity of the results obtained among IS and CS students may allow for some level of generalization.

7. CONCLUSION

Educational games, including mobile games, are useful tools for supporting the learning of computer programming. The presented study has shown that despite the known differences between Computer Science (CS) and Information Systems (IS) students, the game about solving algorithmic problems in JavaScript presented to both groups of students resulted in similarly positive reactions to training. While the obtained results could seem predictable, so far, such expectations were not confirmed in the literature. The value of the reported results

lies in the fact that the opposite results would mean that extra effort from game designers was necessary to customize games on programming education to respective types of studies which would both complicate game design and hurt game consistency.

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Teaching Python programming with a MOOC: Course Design and Evaluation

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Abstract

Massive Open Online Course (MOOC) is an effective and convenient means for online teaching, also proven in computer programming education. In this paper, we describe the design and implementation of a novel MOOC titled "Introduction to programming in Python 3" and report its participation statistics as well as results of its evaluation by students.

Keywords: MOOCs, e-learning, teaching computer programming, open educational resources, Python language course

1. INTRODUCTION

The current large demand for computer programmers worldwide (Hussein & Trautman, 2021) fuels interest in effective and convenient forms of teaching programming. One such form which gained large popularity are MOOCs: Massive Open Online Courses (Luik et al., 2019). This popularity grew even more with the outbreak of COVID-19 pandemic (Pinto et al., 2020) and forced switching to online education in many countries.

MOOC has been defined as "an online course open to anyone without restrictions, usually structured around a set of learning goals in an area of study, which often runs over a specific period of time on an online platform which allows interactive possibilities that facilitate the creation of a learning community" (European Commission, 2014, p. 2). The inherent openness of MOOCs makes it possible to base one teacher's programming course on a MOOC developed by a third party – see, e.g., the work by Saari et al. (2017) who describe the adoption at Tampere University of Technology in Pori, Finland, of a MOOC developed at University of Helsinki. While such an approach is reasonable considering the large effort and high costs of developing one's own MOOC (Hollands & Tirthali, 2014), it is not always feasible due to various reasons, e.g.:

- language of instruction unknown to the target audience,
- difficulty level inappropriate for the target audience,
- content coverage incompatible with defined learning objectives,
- numerous errors and/or poor technical quality of the content.

Consequently, despite the availability of many computer programming MOOCs (see, e.g., Koutsakas et al., 2020, and sources cited therein), new ones are developed every year. Publishing description of their design and development along with evaluation results can help in promotion of practices which proven successful and, consequently,

make it easier to develop new MOOCs as well as improve the quality of newly developed MOOCs. Guided by this motivation, in this paper, we provide the key facts regarding the design, implementation and evaluation of our "Introduction to programming in Python 3" MOOC (Swacha et al., 2020).

2. RELATED WORK

In order to provide the context for the information presented further on, in this section, we briefly review selected research in similar vein.

Spyropoulou et al. (2015) describe a methodology for a collaborative MOOC development by a multidisciplinary team of professionals on an example of a MOOC titled "Programming fundamentals using ANSI–C". In the discussion, they note the far-exceeded course design time, yet point to the standardization of design sections, educational activities and educational objects in tables as helpful and practical.

Friss de Kereki and Manataki (2016) present a programming MOOC collaboratively developed by University of Edinburgh and Universidad ORT Uruguay for teenager high school students in English and Spanish. In the reported results, based on 85000 student participants, they note that more than 93% of them found that the course met or exceeded their expectations, and more than 90% stated that they plan to continue programming in the future.

Canou et al. (2017) introduce the technical innovations implemented in their "Introduction to Functional Programming using OCaml'" MOOC, especially praising the fully in-browser development environment with an integrated grader for providing an exceptional level of feedback to the learners.

Grandl et al. (2018) describe the development and provide course completion statistics of the "Learning to code: Programming with Pocket Code" MOOC intended to teach coding skills to Austrian school children and teachers. They report that 64 out of 571 participants completed the 2016 course edition (which amounts to dropout rate of 88.79%) and 38 of 626 participants completed the 2017 course edition (dropout rate: 93.93%).

Luik et al. (2019) analyze in various dimensions the populations of students who participated in three Estonian-language MOOCs about programming provided by University of Tartu primarily for their students: "About Programming" with over 10000 learners, over 65% of whom having completed it by the time of reporting, "Introduction to Programming I" with more than 5500 learners and the completion rate of around 50%, and "Introduction to Programming II" with about 2000 learners and the completion rate of around 30%.

Koutsakas et al. (2020) report the planning, implementation, and results of analysis of data obtained from a computer programming MOOC "PROG15" provided to Greek Secondary Education students. They note high learning expectations of the students before their involvement in the MOOC, an average degree of collaboration among students and the relatively low completion rate.

Perach and Alexandron (2021) report the results of using an academic-level "First Steps in Computer Science and Programming in Python" MOOC for teaching programming to Israeli middle-school students in a blended-learning environment. Their key finding is that the pupils were able to successfully complete the academic MOOC, achieving summative assessment scores on par with undergrads taking this MOOC for credit.

3. COURSE TARGET AUDIENCE AND STRUCTURE

The "Introduction to programming in Python 3" MOOC has been conceived in response to requests from the IT in Management students of University of Szczecin, Poland, who asked for a more comprehensive and up-to-date version of an

online Python course developed by this author in the past (Swacha, 2018). While it was the university students who constituted the main component of the target audience, the course was designed as an open educational resource, therefore an effort was made that its contents were comprehensible for other user groups, such as high school students or self-learning programming enthusiasts. The course does not require any prerequisites other than basic computer skills.

The course was developed in two language versions: Polish (original) and English (translation). While there is abundance of high-quality MOOCs on introductory Python in English, the translation was necessary due to English-speaking groups as well as international exchange students learning at University of Szczecin who should be given access to learning materials same in scope to those offered to the Polish-speaking students.

A three-level structure has been adopted for the course, consisting of:

1) modules, grouping lessons from basic to more advanced topics,
2) lessons covering topics in a specific thematic area,
3) units, which convey material belonging to individual topics or verify its mastery.

The whole course consists of introduction (organizational module, including an opening test to assess the level of knowledge of the topic at the beginning of the course), main modules (each ending with a module summative test) and conclusion (including a closing test to assess the level of knowledge at the end of the course).

The length of semester at the university (15 weeks) and the workload required from students (60 hours) have determined the size of the course content. However, taking into account the needs of users whose schedules can be irregular, it was decided to avoid elements enforcing the pace of learning (slowing down, e.g., making the content or tasks available only from specific dates, or speeding up, e.g., requiring to complete a part of the course by specific dates) apart from setting the general time frame of the course (its beginning and end). This way, by studying in a highly intensive mode (6 hours a day), one can finish the course in just two weeks.

4. COURSE SCOPE AND CONTENTS

The course scope was designed in a way to achieve that a participant completing the course will:

- know the syntax of Python and its most important keywords, operators, and embedded functions,
- know the basic rules of formatting code in Python and creating identifiers,
- be able to write programs requiring communication with user,
- be able to create compound statements containing conditional instructions and loops,
- be able to use built-in Python data types, including multi-value types,
- be able to define own functions and classes and use them,
- know the basic sources of information on the Python language and its practical use.

In consequence, the course consists of the following modules:

1. Introduction.
2. First contact with the Python language.
3. Character strings.
4. Programs.
5. Sequences.
6. Loops.
7. Sets and dictionaries.
8. Functions.
9. Object-oriented programming.
10. Python standard modules – overview.
11. Data processing.
12. Algorithms in Python.
13. Storage of data.

14. Use of PYPI modules.
15. Python in practical applications.
16. Conclusion.

Note that while modules 1-9 are necessary to achieve the expected learning objectives mentioned earlier, modules 10-15 were included in the course for two reasons:

- they provide practical information on solving typical computing tasks using Python and its libraries, which makes it a valuable reference for students who finish their semester with a larger programming project;
- even though their presentation in the course may be too superficial for the students to grasp full control of relevant programming concepts, the students become aware of what they need yet to learn to accomplish more complex tasks and thus can better direct their further self-learning.

The basic form of content presentation in the course is textual, sometimes with illustrations. Several clearly different text formats were used, distinguishing: keywords, syntactic patterns, correct examples of instructional use, incorrect examples of instruction usage, longer code fragments that are programs or parts of them, and code fragments intended to be executed in the Python interactive mode.

The 102 course units selected as crucial for achieving the learning objectives have been enriched with instructional videos, usually lasting several minutes. The audio track of each of these films corresponds to the basic text of a given unit and, possibly, parts of neighboring units, for which no separate films were recorded. All videos are provided with subtitles.

A discussion forum is provided as an element of cooperative learning among the course participants.

There is at least one exercise included in each lesson of the course for the purpose of the ongoing verification of the acquired knowledge. In the second course edition, all of the exercises are graded automatically. In the first edition, there were also exercises that were graded by other course participants on a peer-assessment basis, but they were replaced as most of the course participants did not understand the idea and skipped them. Most of the automatically graded exercises are in the form of puzzles solved by dragging and dropping pieces of code, usually to obtain a correct program, much less frequent are open questions (usually asking for the name of the correct Python instruction), there are also few multiple-choice closed questions.

The results of exercise assessment are not included in the final course grade, which is determined solely by the results obtained in the module summative tests and the closing test. Each course participant who provides correct answers to a number of the test questions passing the specified threshold receives an electronic certificate of successful completion of the course. The threshold was set to 75% in the first course edition and reduced to 70% in the second due to relatively notable number of first-edition students who missed the threshold by just few percent. The points acquired in module summative tests and the closing test are treated equal, based on the assumption that participants who were committed to systematic learning (thus achieving good results in the module summative tests) could take the final test lightly, while those who did not do well during the course should have a chance to gain the missing points and pass the threshold by preparing better for the closing test.

It should be noted that the adopted course elements are fully in line with the results of Wong's research on the factors influencing the course completion, respectively with regard to (Wong, 2016):

- encouragement to learn (detailed introduction – indicated by 100% of Wong’s respondents),

- engagement (availability of multimedia – 97% indications),
- online interaction (discussion forum – 100% indications),
- consolidation of knowledge (automatically graded tests – 81% indications).

The elements which were not included in the course were indicated by a much lower percentage of Wong's respondents, e.g., live streaming (in the context of engagement) was indicated by only 3% of them (Wong, 2016).

5. COURSE IMPLEMENTATION

The course has been implemented on the Polish MOOC platform navoica.pl (Swacha et al., 2020). The platform runs on Open edX (2021) software.

To give an idea about the course look, Fig. 1 presents a sample course unit (the instructional part is shown as black text on white background, whereas the program code and output are shown in inverse) and Fig. 2 shows an example of a drag-and-drop exercise, in which the user has to match function calls to their respective results.

Figure 1: Exemplary course unit

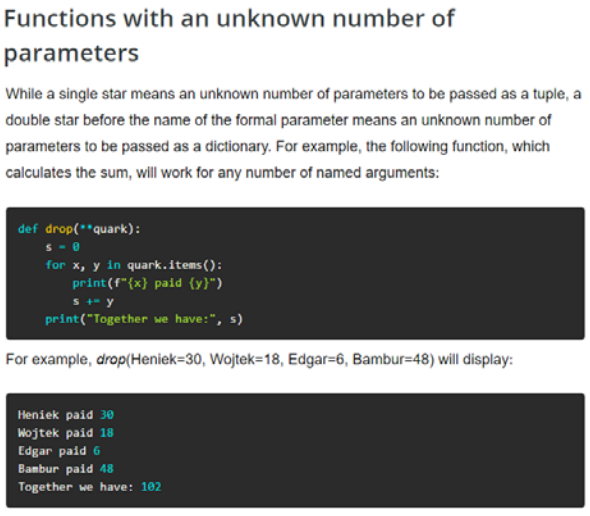
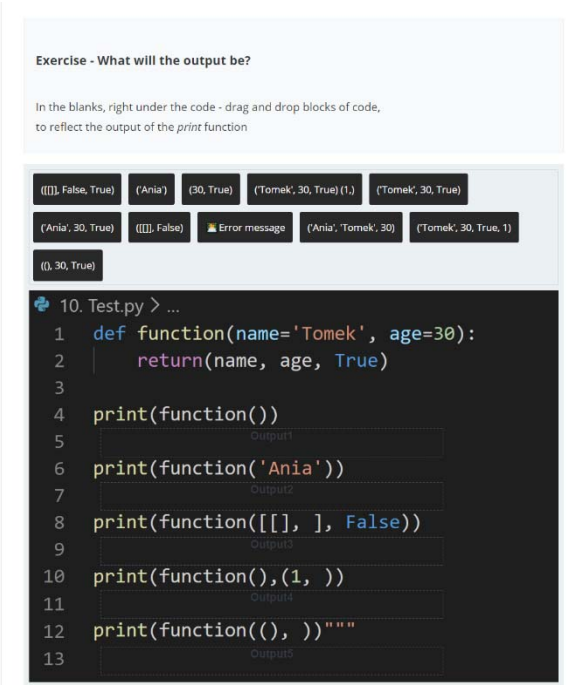


Figure 2: Exemplary course content: drag-and-drop programming exercise



The preparation and implementation of the two editions of the bilingual course took a total of about 2000 man-hours, which means about 33 hours of work per 1 course hour, i.e. approx. 40% of the average (84 h) reported by Defelice (2020) in the last edition of his study for 138 e-learning courses "with partial engagement" (that is containing, e.g., drag-and-drop exercises). Obviously, the above-average fast course development time was made possible by starting the work with content elements acquired from previous Python programming course of this author (Swacha, 2018).

6. RESULTS

The first edition of the course lasted from October 2020 till February 2021; the second edition started in March 2021 and is near its finish in September. There were 390 users who registered for the first edition of the course, of whom 80 have completed it, which gives the dropout ratio of 79.5%. As of 16 September 2021, there were 433 users who registered for the second edition of the

course, of whom 54 have completed it, which gives the dropout ratio of 87.5% (although it may eventually get lower, as the course is still open till 30 September 2021). Note that the reported numbers are based on data reported by the platform (e.g., contain multiple records for single users who registered using different identifiers; we are aware of such cases, but they were rare). The dropout ratios are nonetheless similar to those reported by Grandl et al. (2018).

Regarding the gender of the users registered in both course editions, 39.6% of them were women. This ratio is similar to the one of those reported by Luik et al. (2019) and in contrast to earlier researches mentioned therein, which reported much lower ratios of women participating in computer science and related MOOCS.

Over 61% of the course participants were employed at the time of registration (the remainder being students and unemployed). The average age of a course participant was 30 years, with almost 59% of users younger than the average. This nonetheless indicates a large interest in learning Python programming from adults.

The participants were asked to participate in a survey evaluating the course after completing the closing test; note that the survey was listed as a standard course unit available for everyone who registered for the course, and only its placement at the end of the course contents discouraged users who left early from answering it. Only 86 users completed the survey till the day of reporting – this amounts to 64.2% of those who completed the course, but for the reason given above we do not know if all survey respondents have completed the course.

The survey consisted of 15 questions; for the sake of brevity, here, we report only answers for selected questions, those that we considered as the most interesting.

Over 72% of the respondents answered positively ("Completely" or "Mostly") to the question "Has this course helped you achieve your primary goal?", further 16% gave a neutral answer to this question ("Somewhat"). About 71% assessed positively the length of the course, with over 22% considering it to be too long. Over 88% of the respondents assessed positively the difficulty of the course, whereas about 78% considered it as interesting. Finally, over 80% would recommend the course to their friends.

While the survey results picture a generally positive reception of the course by its users, it must be considered that the respondents were most probably those who completed the course, not those who left it early.

7. CONCLUSION

The MOOCs provide a cost-efficient way of online education, allowing to teach multiple students with a very small involvement of teachers. The results reported here support the previous research reports that MOOCs can be successfully applied also to programming education, known to be a difficult subject. The course structure and contents described here can be useful for designers of programming MOOCs, whereas the presented data can be exploited in a comparative analysis of MOOCs.

8. ACKNOWLEDGEMENT

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Helping Our Students Pay Attention in Class by Boosting their Interruption Self-efficacy

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Abstract

Attention is a limited resource. While our students frequently pay attention to distracting information such as instant messages and Facebook likes during class time, the attention that they pay to the class material is often more limited. This is especially problematic in the context of online learning (e.g., during pandemics) when the students are attending class while they are at home. This paper tests a research model indicating that interruption self-efficacy can provide a buffer against the negative effects of technology-mediated interruptions on attention by reducing the amount of stress that these interruptions create. To test the model, data were collected from 40 undergraduate students. The results supported the model and indicated several ways that IS educators can help students improve their capacity to pay attention to the class material during class time.

Keywords: Learning, Self-efficacy, Interruptions, Stress, Attention.

1. INTRODUCTION

Research and personal observation demonstrate that students pay less and less attention in class. This is a major problem because learning outcomes depend on the ability of students to pay close attention to the instructor so that they can assimilate the relevant classroom material effectively (Darowski et al., 2008).

Prior research has suggested that technology-mediated interruptions such as instant messages, text messages, and various notifications reduce the cognitive capacity available to perform various tasks like learning (Addas & Pinsonneault, 2018; Tams et al., 2018). These interruptions are likely to be a key factor in the decline of learning outcomes because they can reduce the amount of attentional capacity that the students have left over to participate actively in class. This may be especially true in the context of pandemics due to the need for distance learning, which makes it even easier for students to distract themselves with technology. Therefore, it is necessary to investigate the following research question:

RQ: How can we help our students pay attention in class despite the proliferation of technology-mediated interruptions?

The present investigation contributes to the literature on IS education by examining one

of the causes of students' reduced attention in class and by proposing ways of helping them.

This article is structured as follows. The next section develops a model that identifies the mechanism likely responsible for the problems that our students experience. The third section describes the data that were collected to examine this model, and the fourth section then presents the results from the data analysis. The final section discusses these results and indicates several ways that IS educators can help students improve their attention in class.

2. Background and Research Model

Technology-mediated interruptions can reduce attention because they often cause feelings of anxiety and stress (Addas & Pinsonneault, 2018; Galluch et al., 2015; Tams et al., 2018). This means that factors that decrease the potential of technology-mediated interruptions to cause stress will likely reduce the negative impact of these interruptions on student attention. One particularly relevant factor in this context is interruption self-efficacy (Tams et al., 2015).

This factor has been considered previously as a moderator of the relationship between mental workload and stress, but no research to date has examined whether it can provide a buffer against the negative impacts of technology-mediated interruptions on attention (Tams et al., 2015). Moreover, prior research has investigated this factor in an organizational context rather than in an educational one.

In line with Bandura (1997) and Tams et al. (2015), we define interruption self-efficacy as the extent to which students believe that they can be successful at their tasks even in the presence of interruptions.

When students have higher interruption self-efficacy, they will make a greater effort not to divert their attention from the instructor to the interruption (Tams et al., 2015). Moreover, these students will be more motivated to manage technology-mediated interruptions effectively so that these interruptions do not impact their classroom performance. At the same time, self-efficacy promotes positive thinking, which should help the students remain optimistic despite a lot of incoming interruptions (Bandura, 2006). As a result, they should feel less stressed, and they should have more attention left over for the classroom material.

Therefore, in an interruption context, we expect that there exists a positive indirect effect of interruption self-efficacy on attention by way of stress. In other words, interruption self-efficacy increases the amount of attention that students have left over for the classroom material by reducing the amount of stress that they experience in response to technology-mediated interruptions. This is shown in Figure 1.

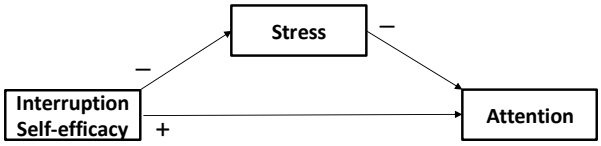

Figure 1. Research Model

3. Methodology

To establish the link between interruption self-efficacy and attentional capacity in students who encounter frequent interruptions, we conducted a correlational study. We recruited 40 undergraduate students from a large university and invited them to come to a laboratory, where they provided data on various measures.

Attentional capacity was evaluated using the Stroop color-word task (Bench et al., 1993). This task is a widely accepted test

for attention because it requires the students to pay close attention to relevant signals. More specifically, the Stroop task presents the students with color names that are printed in non-consistent ink colors. The students have to pay close attention to react to the ink color in which the words are printed. For example, a student could have to name the ink color white for a word that reads black (see Figure 2). This task has wide support in the literature, with test–retest reliabilities between 0.83 to 0.91 (Spreen & Strauss, 1998).

Figure 2. The Stroop Task

Stress was assessed using a three-item measure. Card sorting exercises and a pilot test were used to develop this measure. A sample item is: "I feel nervous." Interruption self-efficacy was assessed using the three-item measure developed by Tams et al. (2015). A sample item is: "I believe I have the ability to be successful at the things I am faced with despite the presence of interruptions."

As control variables, we used the perceived interruption frequency, the personality, and the computer game experience of the students because these variables have been shown to impact stress and attention among students (Galluch et al., 2015; Tams et al., 2018).

4. Results

The mediation model was tested using PROCESS version 3 for mediation analysis in SPSS (Hayes, 2018). The tests were conducted with a 95% confidence interval and 5,000 bootstrap resamples in SPSS v27. PROCESS model 4 was used for the mediation analysis with one mediator (stress).

The results supported the proposed model. First, interruption self-efficacy was found to have a significant negative effect on stress ($b = -.2302$, $SE = .0930$, $LLCI^1 = -.4189$, $ULCI^2 = -.0415$, $p < 0.05$). Second, stress was found to have a significant negative effect on attention ($b = -64.4359$, $SE = 20.7971$, $LLCI = -106.7014$, $ULCI = -22.1703$, $p < 0.05$). Finally, interruption self-efficacy was found to have a significant positive indirect effect on attention by way of reduced stress ($b = 14.8326$, $SE = 8.1432$, $LLCI = 2.7969$, $ULCI = 35.3290$, $p < 0.05$).

5. Discussion

This article has demonstrated that interruption self-efficacy provides a buffer against the negative effects of technology-mediated interruptions on student attention because it reduces the stress that these interruptions otherwise generate. This means that educators should devise training programs to help students develop interruption self-efficacy. Indeed, training is a primary means of developing self-efficacy (Campeau & Higgins, 1995; Marakas, 1998; Tams et al., 2018).

Based on informal discussions with experts, the following list indicates several ways in which interruption self-efficacy can be developed in students. This list can be used for the creation of training programs, but individual educators can also employ some of its items directly in their classrooms to improve student participation:

1. Asks students to keep an interrupters log in order to track interrupters and the interruptions they cause (including who

[1] Lower Limit Confidence Interval
[2] Upper Limit Confidence Interval

interrupted, when, why, and whether the interruption was valid and urgent);
2. Ask students to designate themselves as busy during class time;
3. Ask the students to set clear "available" and "unavailable" times;
4. Ask students to better organize their inbox and to schedule messaging time;
5. Ask students not to multitask and to focus on one task at a time;
6. Ask students to learn to say "no" to messaging requests;
7. Ask students to set better expectations with their friends and allow for response gaps or time lags before responding;
8. Ask students to use helpful browser extensions such as StayFocused.

Informed by these eight strategies, future research should devise a comprehensive training program for the development of interruption self-efficacy in our students. This is especially important in the context of online learning, where students are naturally distracted more.

6. Conclusion

Based on the premise that technology-mediated interruptions are omnipresent on students' phones during class time and that they reduce the attention that students have left over for the class material, the present investigation has shown that interruption self-efficacy provides a buffer against the negative effects of these interruptions on student attention.

In addition, this investigation provides a list of items that IS educators can use to increase students' interruption self-efficacy and the attention that students will pay in class.

It is hoped that this research will lead to more work in this important area to help us as IS educators ensure that our students pay more attention during class time (and outside of it) and that they achieve better learning outcomes.

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Improving the Learning Outcomes Associated with the Use of Serious Games in IS Education: The Role of Computer Game Self-efficacy

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Abstract

Serious games are increasingly being used by IS educators to improve student attention, education, and associated learning outcomes. A major factor in these outcomes is student enjoyment. Indeed, the effectiveness of serious games for learning depends in large part on the enjoyment that the students experience when playing the game. The literature has suggested that student enjoyment is higher when performance is higher. In other words, higher performance in the game leads to greater enjoyment. However, it remains unclear how to help students perform better. This research tests a mediation model showing that computer game self-efficacy improves student enjoyment by increasing gaming performance. Based on this finding, the paper indicates three ways in which IS educators can help their students develop computer game self-efficacy and improve learning outcomes.

Keywords: Serious games, Learning outcomes, Performance, Enjoyment.

1. INTRODUCTION

To teach Information Systems (IS) topics more effectively, IS education makes heavy use of serious games such as ERPsim. Indeed, past research indicates that these games can help students better understand IS topics like ERP systems (Thériault et al., 2021).

However, prior research has also shown that the effectiveness of serious games for learning depends on the enjoyment that the students experience while playing the game (Breuer & Bente, 2010; Prensky, 2007). Student enjoyment in turn can be increased by helping the students perform better (Thériault et al., 2021). In other words, greater performance in the game leads to higher enjoyment and, ultimately, to better learning outcomes.

Unfortunately, not all students perform well when playing serious games (Thériault et al., 2021). Thus not all of them enjoy the experience or even learn a great deal. This is problematic because—in an educational context—all students should perform well, enjoy playing the game, and learn as much as possible about IS topics.

Despite the importance that performance has for perceived enjoyment and associated learning outcomes in the context of serious games, it remains unclear how IS educators can help their students perform better at playing these games (Thériault et al., 2021).

Therefore, the present investigation examines the following research question:

RQ: How can we help our students perform better at serious games so that they enjoy them more (and ultimately learn more)?

By answering this question, the present investigation contributes to the IS education literature. Specifically, it examines one of the causes of higher student performance at serious games and the downstream impact of this cause on student enjoyment.

This article is structured as follows. The next section develops a model that identifies the mechanism likely responsible for higher performance at serious games. The third section describes the data that were collected to examine this model, and the fourth section then presents the results from the data analysis. The final section discusses these results and indicates three ways that IS educators can help their students achieve greater performance and enjoyment when playing serious games in class.

2. Background and Research Model

As explained above, serious games can significantly improve learning outcomes in IS education (Thériault et al., 2021). One of the key drivers of learning outcomes in this context is student enjoyment (Breuer & Bente, 2010; Prensky, 2007). Student enjoyment depends in turn on student performance such that higher performance levels increase student satisfaction and enjoyment (Thériault et al., 2021).

This means that factors that increase student performance are likely to also increase the enjoyment that the students experience when playing the game. We maintain that computer game self-efficacy is a particularly relevant factor in this context.

Because serious games in IS education resemble computer games and are usually played using digital technologies, the context of computer games is relevant to student performance. Moreover, as we explain next, self-efficacy is highly relevant to performance in just about any context (Bandura, 1997).

In line with Bandura (1997), we define computer game self-efficacy as the extent to which students believe that they can be successful at playing computer games.

When students have this belief, it has a fundamental impact on their ability to perform tasks (Bandura, 1993). Indeed, the positive relation between self-efficacy and performance has been established in many fields of research, including IS (Compeau & Higgins, 1995; Marakas et al., 1998).

It seems clear that computer game self-efficacy should help students perform better at serious games. Persons with high levels of self-efficacy are strongly motivated, and this leads them to make a greater effort when performing a task (Bandura, 2006). Moreover, such persons often set higher goals for themselves and make firmer commitments to achieving these goals (Bandura, 1993). By contrast, persons with lower levels of self-efficacy tend to dwell on the difficulty of performing tasks. This undermines their overall effort to perform by diverting their attention from the execution of a task to concerns about potential problems. In a word, it causes them to perform more poorly (Bandura, 1989).

Therefore, if students have higher levels of computer game self-efficacy, they will be motivated to make a greater effort when playing serious computer games in class, and this additional effort will help them perform better. As a result of performing at higher levels, the students should also

experience higher levels of enjoyment, which ultimately increases learning outcomes (Kwak, Forthcoming).

Overall, we expect that there exists a positive indirect effect of computer game self-efficacy on perceived enjoyment by way of performance. In other words, in the context of serious games computer game self-efficacy increases perceived enjoyment because it improves gaming performance. This is shown in Figure 1.

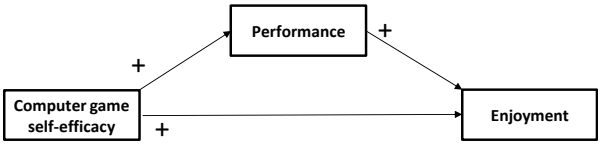

Figure 1. Research Model

3. Methodology

To establish the indirect relationship between computer game self-efficacy and perceived enjoyment through performance, we conducted a correlational study.

We recruited 49 undergraduate students from a large university and invited them to come to a laboratory, where they played a serious game and provided data on relevant measures. The serious game in question was an adaptation of the well-known memory game Concentration. This adaptation was designed to teach basic math skills, which are especially relevant to business analytics classes and database classes.

When playing the game, the students had to search for matching pairs of symbols in a matrix of computer-generated cards. In a limited amount of time, they had to find the matching pairs by memorizing the individual symbols and their location in the matrix. Each matching pair of symbols consisted of an equation and its result, for example, "7*12" and "84."

Performance refers to the extent to which task output is effective in meeting task objectives (Burton-Jones & Straub, 2006). The task objective was to match as many pairs of digits and symbols as possible within the allotted time. Thus performance was measured as the number of successfully matched pairs of digits and symbols achieved within the allotted time.

Perceived enjoyment was assessed using the measure "I enjoyed doing the memory task," and computer game self-efficacy was measured using a three-item scale developed for this research. The scale was established using card-sorting exercises and a pilot test. A sample item is: "I believe I have the ability to be successful at most computer games I try to play."

As control variables, we used the personality of the students, their mental capacity, their health, and how often they engaged in mental activities like solving crossword puzzles. These variables have been shown to impact performance and perceived enjoyment (van der Heijden, 2004).

4. Results

The mediation model was tested using PROCESS version 3 for mediation analysis in SPSS (Hayes, 2018). The tests were conducted with a 95% confidence interval and 5,000 bootstrap resamples in SPSS v27. PROCESS model 4 was used for the mediation analysis with one mediator (performance).

The results supported the proposed model. First, computer game self-efficacy was found to have a significant positive effect on performance ($b = 2.8750$, $SE = 1.3919$, $LLCI^1 = .0678$, $ULCI^2 = 5.6821$, $p < 0.05$). Second, performance was found to have a significant positive effect on enjoyment ($b = .0333$, $SE = .0134$, $LLCI = .0062$, $ULCI =$

[1] Lower Limit Confidence Interval
[2] Upper Limit Confidence Interval

.0604, p < 0.05). Finally, computer game self-efficacy was found to have a significant positive indirect effect on enjoyment through performance (b = .0958, SE = 0.0597, LLCI = .0058, ULCI = .2397, p < 0.05).

5. Discussion

This article has demonstrated that computer game self-efficacy can boost perceived enjoyment in the context of serious games because it improves student performance. This means that IS educators should create training programs to help students develop computer game self-efficacy. Indeed, training is a primary means of developing self-efficacy beliefs (Campeau & Higgins, 1995; Marakas, 1998; Tams et al., 2018).

Based on informal discussions with experts and consistent with self-efficacy theory (Bandura, 1997), the following list indicates three ways in which students can develop computer game self-efficacy. This list can be used for the creation of training programs. Individual educators can also employ some of its items directly in their classrooms to improve perceived enjoyment and associated learning outcomes when serious games are being used for teaching purposes:

1. Provide the opportunity to students to succeed in the serious game before the learning experience fully begins. In other words, have the students practice with the game and master it before using it for teaching purposes. Mastery experience is an extremely important means of developing self-efficacy;

2. Pair low-performing students with high-performing ones for informal coaching; and

3. Create teams that combine students with different performance levels. Watching their peers succeed will help low-performing students to believe that they, too, can succeed.

The basic idea here is to have the students play an educational, serious game until they have mastered it fully. Only after all students master the game should it be used for teaching purposes. This means that students are given the chance to fully understand and master the game before the learning begins.

Informed by these three strategies, future research should devise a comprehensive training program for the development of computer game self-efficacy in our students.

6. Conclusion

Serious games are an important means of improving learning outcomes, and the present investigation has shown that computer game self-efficacy improves enjoyment with these games by increasing gaming performance. Perceived enjoyment leads in turn to better learning outcomes (Kwak, Forthcoming; Thériault et al., 2021).

In addition, this investigation provides a list of three levers that IS educators can pull to boost the computer game self-efficacy of students and the associated learning outcomes when the students play serious games in the classroom.

It is hoped that this research will lead to more work in this important area to help us as IS educators ensure that our students get more out of playing serious games in the classroom and that they achieve better learning outcomes.

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Teaching Tip: An Innovative Approach to Teaching Software Design and Selection

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Abstract

Many educators find it particularly difficult to assure learning outcomes in the areas of systems design and software selection. It does not help that most textbooks treat this topic too simplistically and require students to learn a lot of concepts by heart. This approach often hinders full understanding of relevant concepts, and it raises the question of what we as faculty can do to improve learning outcomes related to these topics. One especially promising approach is to improve the structure of our classes and the assessments that are used. Students can be given interesting assignments that are stimulating and thought-provoking rather than asking them to regurgitate textbook knowledge in an exam. Such assignments can improve learning outcomes while increasing student motivation at the same time. Therefore, the present teaching tip develops a novel delivery method that allows faculty to teach systems design and software selection in a more effective manner. It also provides concrete guidance on how to do so by giving recommendations for an innovative class structure and assignment. Feedback from students over five semesters suggests that the proposed assignment stimulates student learning and yields better learning outcomes.

Keywords: Systems analysis, Systems design, Learning outcomes, Assignments.

1. INTRODUCTION

Bonnie and Clyde, two undergraduate students who major in Information Systems, understand the importance of learning about software design and selection. Nevertheless, the two students don't succeed in fully grasping these topics from their textbook alone, and at the end of the semester—once they have regurgitated their textbook knowledge in the corresponding quizzes and exams—they feel like they've learned little about these topics and are ill-prepared for the job market. Bonnie and Clyde believe that they would have benefitted more from applying the corresponding concepts to a real-world business problem. Many students have a similar experience and indicate that systems design and software selection classes often leave them with little gain in applicable knowledge.

This vignette illustrates a common problem when educators require undergraduate

students to learn about the software design and selection process: many students are disheartened and demonstrate a complete lack of interest in the corresponding material (Strong et al., 2006). However, student learning can be improved when the right assignments are used. Research has shown that meaningful assignments can greatly improve student motivation and associated learning outcomes (Lending et al., 2010). But teaching tips are lacking that propose useful assignments in the area of systems design and software selection. Therefore, our objective with this teaching tip is to provide faculty with an assignment they can use to teach software selection in a more stimulating and effective manner.

The present teaching tip proceeds as follows. The next section provides a background on the structure of the class and how the proposed assignment fits into it. The third section provides details on the assignment. This discussion is then followed by the assignment mechanics (i.e., grading, class and group sizes, assignment flexibility, and additional resources). Finally, this teaching tip presents student reactions to the assignment.

2. Assignment Focus: Build or buy?

Both the software design process and the software selection process rely on a thorough analyses of functional and non-functional requirements (Howcroft & Light, 2010; Rasmussen et al., 2002; Tams, 2008). This means that they have many elements in common. However, they are also quite different in important ways, and a company will usually adopt only one approach. It will either design a new system or purchase an existing one (of course, hybrid approaches also exist). Designing a new system is referred to as the "build" option, whereas purchasing an existing system is referred to as the "buy" option. Depending on the business process that the new system will support and on the organizational situation, one option can be far more appropriate than the other. This means that the decision of whether to build a new system or to buy an existing one is a fundamental aspect of any system implementation effort (Hung & Low, 2008).

Since the decision of whether to build or to buy a system is an essential element of any software project, the class is structured in accordance with this important decision. The class begins by introducing a rigorous method to make this vital decision. This method is referred to as the "3C model," which was adapted from Hung and Low (2008) and Buchowitcz (1991). The decision model consists of three phases: the first phase specifies criteria that are "crucial," the second phase adds criteria that are "complementary," and the third phase presents additional criteria that are less important but can still "contribute" to the decision-making process.

In the first phase, five criteria have to be considered. The recommendation is to build a system if:

1. The business process to be supported is strategic to the organization and relates directly to the mission statement;
2. The business process to be supported can provide a competitive advantage to the organization because it is unique;
3. The IT department of the organization is sufficiently mature to accompany a software development effort;
4. The solutions available on the market meet less than 80% of the requirements;
5. The development is economically feasible.

If none of these criteria is met, then the recommendation is to buy a system. If there is ambiguity such that some criteria indicate to build, while others suggest buying, then the decision maker enters the second phase. In this phase, the criteria are as follows:

1. Risk;
2. Timing;
3. Organizational politics;

4. Continued technical support; and
5. Type of system.

While these criteria are less important than those in the preceding phase, they do shed additional light on the issue. Finally, if after consideration of these additional criteria there is still ambiguity as to whether a system should be built or bought, the decision maker enters the final phase. Here, the criteria are:

1. Standards;
2. Intellectual property rights;
3. Availability of open source solutions;
4. Security considerations.

At the end of Phase 3, ample information should be available to make a rigorous, informed decision as to whether to build or buy the new system.

At this point, the students are ready to apply what they learned to a real-world case, which is designed to lead them to conclude that a "build" decision is more appropriate. This means that the next class sessions teach students all they need to know about standards like UML that allow them to design robust and effective systems. In this class, we focus on the UML use case diagram, the activity diagram, and the class diagram, given that all three are complementary and can provide developers with sufficient information on the system to be build.

Once the students have learned about systems design and have actually designed the new system for the real-world case study mentioned earlier, the focus of the class shifts from build to buy.

The students are presented with an alternate scenario in which fewer resources are available to the client firm and fewer unique system requirements have to be built into the system. The students reanalyze the situation and notice that a buy decision is now more appropriate. At this time, the "3P model" is introduced to the class. This model was adapted from Ranjan et al. (2016) and discusses in detail the software selection process. According to this model, software has to be selected based on three groups of criteria that are evaluated through four phases. In each subsequent phase, more detailed decision criteria are considered. During the last phase, an invitation to tender including detailed requirement specifications is sent out to a handful of the most promising software vendors, and their offers are evaluated in detail using the analytic hierarchy process tool (Saaty, 2008). This tool makes the selection process even more rigorous and objective.

3. The Assignment

Assignment Preparation

A recent real-world case is selected that contains ample information to allow for a thorough application of the 3C model as well as the 3P model. In addition, the business process under consideration in the case must be sufficiently complex to allow for the creation of UML diagrams with at least half a dozen use cases and a dozen classes.

Then the instructor divides the class into groups and asks each group to prepare an analysis of whether, based on the 3C model introduced earlier, the system should be built or bought. Next, the student groups assume the roles of independent consulting firms, such as Pricewaterhouse Coopers or KPMG, and the instructor assumes the role of a decision maker from a client organization asking them to evaluate whether a build decision or a buy decision is more appropriate for the case in question. Consistent with the class structure introduced earlier, the students next propose a design for the system under development and apply the 3P model to the alternate scenario, which includes sending an invitation to tender and evaluating the submissions based on Saaty's (2008) analytic hierarchy process.

Overall, the presented approach of asking the students to (1) fully understand a

complex real-world case related to software design and selection, (2) apply multiple rigorous models to the situation described in the case, and finally (3) derive conclusions about whether to build or to buy, what to build, and which system to buy requires independent thought and reflection on the part of the students, and this motivates them greatly and improves learning outcomes.

Assignment Presentation

Three presentations of the assignment are scheduled: one to present—based on the 3C model—whether the company should build or buy, one to show what the system to be built should look like, under the assumption that the build decision is preferable, and a final one—based on the 3P model—to indicate which software vendor the client company should choose.

The groups present their work in two formats: a software selection poster and a video. Concerning the former, the groups prepare a 36" x 60" poster to present their conclusions during a poster session (much like poster sessions at academic conferences). This can also be done online through videoconferencing tools.

The students will have difficulty understanding why they should prepare a software selection poster and not a PowerPoint presentation, which many of them deem far more modern. The answer that instructors can give to the students is simple: posters and PowerPoint presentations serve entirely different purposes in organizations.

PowerPoint presentations are used when the presenters follow a Push principle, which means that they push the information onto those who listen. This means that PowerPoint presentations follow a "talk and listen" structure, often with questions being asked only at the end of the presentation. This approach assumes that the presenters always know best what the clients want to hear, and it is mainly useful for larger audiences when interaction has to be limited so that presenters can cover all the relevant information.

By contrast, poster presentations follow a Pull principle, which means that individuals in the audience drive the presentation with their questions about the information that is presented on the poster. Therefore, poster presentations are more suitable for smaller audiences, and they have the tremendous advantage that they make it easy to interact. For example, using a poster an independent consultant from Pricewaterhouse can easily interact with a decision maker from a client firm like the one in the case study.

During the software selection poster session, each student team obtains valuable advice from the instructor and from the other student teams. To ensure that the students learn the most from this advice, they are asked to integrate it in the second part of the assignment, which is the software selection video.

The video should be about ten minutes long, and it can be submitted to the instructor in the form of a commented PowerPoint presentation (the students can also use Microsoft Photo Story 3 or any other software available to them, but for various reasons they should not be asked to film each other with a camera). When the students create the video and integrate the advice from the poster session, this allows them to deepen their understanding of the software selection process.

In summary, creating the software selection poster and the video enables the students to learn about the software selection process in an innovative and more intuitive manner. This is particularly true when their learning outcomes are compared to those from classes that use more traditional assignment formats such as exams, written reports, or regular PowerPoint presentations. The students have a more interesting, thought-provoking, and rich learning experience about software design and selection.

4. The Assignment Mechanics

Grading

Harris and Rea (2009) maintain that it can be difficult to grade team assignments because it is often impossible to establish the contributions of the individual team members accurately. Therefore, in this assignment the emphasis is placed on the creation of thought-provoking and rigorous software selection posters and videos, and not on evaluating the quality and quantity of the work of individual students. This means that the emphasis is on the final products of the assignment rather than the process that led to them. This is in line with Lending (2010), who advocated this approach.

However, all students fill out worksheets that show what they each contributed to the final products (poster and video). Although this method is simple, it is quite effective in identifying appropriate grades because students seldom over-report their work (Lending, 2010). The advantage of proceeding in this way is that the individual contributions of students can be assessed whenever a detailed assessment is desirable, for example, when there is a dispute within teams.

The course credit given for the software selection poster and video together should not exceed 20 percent of students' course grades. This helps ascertain that the students interpret this assignment as an opportunity to learn about software design and selection and not as a way of getting a good course grade easily.

Based on the learning objective of the poster session, the grades of all student groups will be determined by (1) the instructor's evaluation of the posters, (2) the evaluations that a group has received from the other groups, and (3) the fact that a group has submitted its evaluation sheet (which evaluates all the other teams) to the instructor. The instructor's evaluation should have a weight of approx. 50%, the average evaluation a group has received from all of the other groups should have a weight of approx. 40%, and the submission of the evaluation sheet to the instructor should have a lower weight of approx. 10%.

Concerning the software selection video, the students are asked to integrate what they learned from the poster session into the video. This means that the video should be graded more strictly than the software selection poster. We recommend the following grading structure:

- 30% for the extent to which the 3C model, the 3P model, or the UML diagrams were understood;
- 60% for the extent to which the models were applied rigorously or the UML diagrams were developed systematically; and
- 10% for the professionalism of the video. Points can be deducted if the video exceeds the recommend duration.

Group and Class Sizes

The assignment has been tested with as few as four groups and with as many as twelve across multiple sections of the same class over several semesters. When there are fewer than four groups, then the assignment is less exciting and useful for the students so that their learning experience is reduced. Yet when there are too many groups, then a few elements of the assignment are repetitive, and this can also lead to reduced learning outcomes. Therefore, we recommend the assignment for classes that are large enough to allow for the creation of between four and twelve student teams.

As regards the number of students per team, we recommend between four and six students. When there are less than four students in a team, then the assignment quickly becomes too complex. As a result, the students can lose interest. But when there are more than six students, the coordination effort increases drastically so that the students may also lose interest.

Assignment Flexibility

The assignment can easily be changed to address specific teaching needs. For instance, data security and privacy concerns are treated more generally in the original version of the assignment. These concerns can be elaborated on in much more detail when another case is selected in order to increase learning outcomes related to these particular topics. For example, the students could be required to assess the security issues of open-source software (AlMarzouq et al., 2005). The same holds true for the other elements of the assignment. The assignment is quite flexible and can address various changing teaching needs.

Additional Resources

Detailed guidance and Power-Point slides on the 3C model and the 3P model can be obtained from the authors. Moreover, a Microsoft Excel file can be requested from the authors that includes the grading rubrics and corresponding calculations. In addition, the authors offer PowerPoint slides on the advantages and disadvantages of poster presentations vis-à-vis PowerPoint presentations. These slides can be added to a lecture to prepare the students for the assignment.

5. Student Reactions

The assignment was given to three sections of a class over ten consecutive semesters from September 2016 to Mai, 2021. Student responses to the assignment were positive and included:

- "I had a systems design class before, but I learned a lot more in this one;"
- "Thanks to the poster presentation I learned a great deal about effective communication, which is crucial for systems analysts;"
- "I really liked that we could take the advice that we received for the poster and use it to make the video. I understood the concepts much better this way;" and
- "The assignment was stimulating and different. I learned a lot from it and really enjoyed this class."

In general, the students were positive about their learning experiences with this class and assignment. We received few negative comments, and those were often about the inconvenience of making a poster or a video. The students are so used to giving PowerPoint presentations that they sometimes don't see the value of creating presentations in presumably "old" presentation formats like posters. Yet discussing the elements presented in Section 3 of this teaching tip usually addressed the students' concerns effectively.

We would also like to mention that problem-based learning—as suggested in this teaching tip—is typically beneficial for students. For example, the students gain a deeper understanding, they are more satisfied with their learning, they obtain more confidence related to systems design, and they improve their lifelong learning skills (Weimer, 2009).

6. Conclusion

Software design and selection are key elements of the Information Systems curriculum (Topi et al., 2010). We as faculty have the responsibility to teach these topics in the most stimulating and effective way possible so that students fully understand them and can apply them to real-world situations. With the right assignments, we can help students move from passive listeners to active learners who master the concepts and can apply them in their daily work after graduation (Lending, 2010). Thus we have taken a first step to help students such as Bonnie and Clyde, the two Information Systems students in our opening vignette, to understand software design and selection more effectively. We hope that future work continues to develop teaching material on this important topic.

7. Acknowledgements

We would like to thank the hundreds of students who have participated in this assignment over the years. Their enthusiastic responses have encouraged us to continue using and improving this assignment.

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Solving the Gender Disparity Puzzle in Computing Disciplines at a Commuter State College

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Abstract

FSC is an undergraduate institution within a larger state university system, serving about 10,000 students where 94% are commuters, 57% are awarded financial aid, 45% are from minority populations, and 43% are women. The Computer Programming and Information Systems (CPIS) program enrollment has doubled in the past ten years reaching about 550 students but the percentage of women in the program has remained flat at 10% during the same period. This paper analyzes the journey of initiatives to engage and retain women in the CPIS program in the past decade, details the high and low periods of such activities, and examines why the high periods were not sustained. A matrix model is developed to categorize and classify each period based on its activities and where they fell in the matrix tracking successes and failures. The paper summarizes lessons learned from the past inconsistencies to with suggestions on how to move forward to initiate and sustain the women centric activities to increase engagement, retention, and recruitment of women in the program.

Keywords: Gender Disparity, Computing Education, Women in Computing, Broadening Participation, Diversity in Computing

I. Introduction

FSC is an undergraduate institution, classified as a technical college within a larger state university system. FSC serves about 10,000 students where 94% are commuters, 57% are awarded financial aid, 45% are from minority populations, and 43% are women. Being under the umbrella of a large state system, FSC can benefit from vast resources, but FSC budget activities are tied to the state's overall fiscal climate.

The Computer Programming and Information Systems (CPIS) program enrollment has doubled in the past decade and has reached about 550 students. However, the percentage of women in the program has

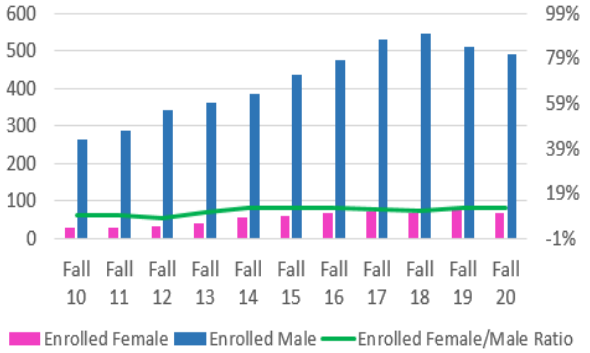

Fig. 1. CPIS Enrollment Data by Gender (includes Transfer, Part-Time and Full-Time students)

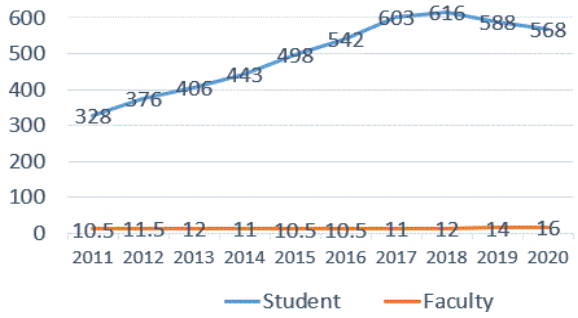

Fig. 2. Number of Full Time Faculty vs. Enrolled Students in the past decade

remained flat at 10% during the same period (Fig. 1). CPIS students choose FSC because of the small class sizes of approximately 25 per section, and easy access to and availability of faculty. The majority of CPIS students are employed (part-time and full-time) in addition to attending classes and commuting which is consistent with the college demographic. Another characteristic of the CPIS student population is the high number of transfers (52-69%) which is mainly from the nearby community colleges (Table I).

CPIS program has a dedicated group of faculties (50% female) where for the tenure-track position the teaching load is 4:4 (50%) with service (25%) and research (25%) requirements. Over the past decade, the CPIS full-time faculty headcount (Fig. 2) and composition changed due to various reasons (retirement, not retaining, hiring), however, a high number of adjunct faculty cover a majority of sections offered per semester, in excess of 75% on average in the last decade.

The long-term plan and strategic vision for FSC Computer Systems Department is to ultimately close the long-lasting gender gap in the CPIS enrollment. The strategic vision is threefold.

1. to achieve 50/50 female/male enrollment in the program
2. to be the college of choice regionally and nationally for students due to the focus on Women and Diversity in Computing
3. to have FSC CPIS graduates be candidates of choice by the computing technology community

Although the first vision item above may seem lofty, inspiration for these goals has come from Anita Borg's vision 50/50 (Borg, n.d.) (Whitney, 2004) and other relevant and recent efforts such as BRAID: Building, Recruiting, and Inclusion for Diversity initiative (https://anitab.org/braid). Immediate success is not expected in achieving the gender balance at FSC, but with focus, persistence, funding, and support from faculty and leadership, a positive and long-lasting impact can be made in closing the gender disparity like the success of BRAID Beacon schools.

Table I. INCOMING STUDENT DATA INCLUDING TRANSFER AND NEW FROSH.

	Fall 2010	Fall 2011	Fall 2012	Fall 2013	Fall 2014	Fall 2015	Fall 2016	Fall 2017	Fall 2018	Fall 2019	Fall 2020
Incoming New Frosh	22	30	39	26	48	44	69	63	65	59	59
Incoming Transfer	32	37	58	58	47	76	75	86	81	83	63
Total Incoming	54	67	97	84	95	120	144	149	146	142	122
% Transfers	59%	55%	60%	69%	49%	63%	52%	58%	55%	58%	52%

This paper reviews initiatives and activities that have been taken over the last decade to address the gender disparity in the CPIS program. Analysis of these activities revealed the identification of four factors (faculty involvement, funding, student leadership, student/faculty ratio) influencing the success and sustainability of the initiatives. Five periods (Period 1-5) are identified within the last decade in terms of high vs. low level of activity to support Women in Computing in the CPIS program. A matrix model is developed to categorize and classify each period based on its success factors. The organization of this paper is as follows. Section II describes the characteristics of each period. Section III talks about impact of COVID19 global pandemic on Women in Computing (WiC) initiatives and additional efforts toward balancing the gender gap. Section IV explains the matrix model. Section V details some of the external factors (college and beyond) affecting the initiatives and activities during each period. Section VI concludes the paper with lessons learned and future work.

II. A LOOK AT THE PAST DECADE: HIGHS AND LOWS

Over the past decade, inconsistent actions and initiatives have been taken by the CPIS department at FSC to address the gender gap in student enrollment. Despite these efforts and total student enrollment doubling, the female enrollment numbers remained flat at 10% (Fig. 1), thus concluding that the efforts did not have any impact, at least on the numbers. In this paper, a focused analysis of the past decade has been completed to understand why the activities were not sustained and why there was little impact on the enrollment numbers. This time is broken into five periods (Period 1-5) based on whether the momentum in actions gained or fizzled in terms of faculty involvement, funding, student leadership, and student/faculty ratio.

It all started when the Computer Systems Department Self-Study covering the years 2007-2012 raised the gender disparity as an issue to be addressed by the department in the upcoming years (Period 0, Fig. 3). At the time, there were about 300 students in the program with the student/faculty ratio of 30:1, which is a ten year low for CPIS (Fig. 4). The female Chair had a long tenure and was in full support of women in computing initiatives but the number of faculty close to retirement was high, so motivation to advance initiatives was low.

A. *Period 1 (Spring 2013 – Spring 2014)*

This period launched the first concerted effort in recognition of the gender disparity, when in Spring 2013, two faculty applied for and were awarded $2,500 from on campus Student First Grant (SFG) supported by Title III - Strengthening Institutions Grant awarded to FSC by the Department of Education. The funding was to cover the establishment of a Women in Computing Association led by faculty and to accompany students to a women focused field trip. Eight female students and two faculty attended ACM NY Celebration of Women in Computing (NYCWiC 2013). The impact of the trip on the attendees was notable as seen in collected testimonials.

During summer of 2013, the two faculty prepared a calendar of monthly activities (such as guest speakers from alumni, wellness center, industry) spanning the academic year fall 2013 and spring 2014. There was energy and enthusiasm among the student attendees. The expectation, before the funding ran out, was to sustain these women centric activities by establishing a Women in Computing (WiC) student club led by students and funded by the FSC Student Government. However, first there were a low number of female students to recruit from the student pool for the leadership positions. Second, unexpectedly, there was negative aggression from the only established coed student club of the department which had a male-dominant membership and leadership and strong presence at that time. Additionally, some

female students preferred to move to the leadership and member roles in the coed club rather than creating a new club for supporting women. As funding ran out, and no female students stepped up to take over, the efforts and activity of instituting a WiC club halted.

B. *Period 2 (Fall 2014 – Fall 2015)*

This was a period of low activity with no funding, though toward the end of this period, a female student began to express great interest in women centered activities and starting a student club. During this period, the enrollment numbers started to climb while existing faculty was burdened with teaching and service which further increased as more faculty retired, and multiple faculty hiring processes were underway. This low period was also to recover from the push back from the other established student club and wait for the climate to change (some students graduated). The female student with great interest managed to recruit a student leadership team and completed the paperwork and required training with the college to establish the club by the end of Fall 2015. It was interesting to observe the tenacity of one student to rally the others to establish a WiC club.

C. *Period 3 (Spring 2016 – Spring 2017)*

This was a high period of student driven activity. The student leadership from the end of Period 2 succeeded in getting a WiC club funded and recognized by the Student Government Association (SGA) at the college in spring 2016. The funding from SGA was small ($500 per semester) but it was used carefully to provide funds for hosting an active calendar of activities during this period. Student leadership also raised additional funds (cookie sale, crowdfunding) for club activities and the field trip for eight female members to attend ACM NYCWiC 2016. Two WiC officers presented at the conference about their experience on successfully starting the club. An interesting note during Period 3 was that the WiC student leadership team initiated connection and collaboration with the other established coed student club. As a result, many male students and leaders also attended and supported WiC club events.

D. *Period 4 (Fall 2017 – Spring 2019)*

This was another period of low activity. There were no upcoming student leaders following the graduation of WiC club officers from the high momentum and activities in Period 3. The enthusiasm and energy of strong student leadership waned. As a result, no funding from SGA was received since WiC club paperwork was not filed. During this period, the student/faculty ratio was at an all-time high, part-time department chair was interim, one of the earlier faculty leaders in WiC had retired, the entire department had shifted focus working on the next cycle Self-Study report, and the other WiC faculty leader was co-chairing the Self-Study. The department faculty that was already stretched thin could not step in to sustain and push the high momentum of activities student leaders had accomplished from Period 3.

E. *Period 5 (Spring 2019 - Present)*

This period is where we are now, a good place. A renewed commitment by faculty to address the gender disparity began with collecting data (enrollment, female/male ratios, transfer and graduation rates, etc.) to understand the issues. In spring 2020, two faculty hosted seminars for female students to make them aware of the opportunity and to oversee their applying for scholarships to attend the Grace Hopper Celebration. A byproduct of these activities was that it prompted open discussions amongst the students and an acknowledgement of the gender disparity in their classes. In turn, female students were excited and found a great sense of camaraderie. Even then, some female students were so excited while planning to attend the conference that it strengthened the connection among them and eventually drove them to reinstate a Supporting Women in Computing (SWiC)

student club. They formed a leadership team, processed the paperwork and attended training, and secured funds from FSC SGA. Most of this planning activity took place during summer 2020. The club had an active calendar of meetings throughout the fall 2020 semester. Two student leaders graduated December 2020 and new officers were assigned to fill the seats left vacated by graduating officers. The spring 2021 semester had an even more successful calendar of quality events, robust attendance to meetings and events. SWiC members attended, and officers presented a poster at the virtual ACM NYCWiC 2021 conference. Faculty Advisors were also actively involved in NYCWiC 2021 by presenting and hosting a Birds of a Feather session and moderating panels. The Club leadership and Advisor communication was lower during break before and during spring 2021 semester and there was some scheduling and communication mishaps and fallout of club leadership as a result.

III. Additional Initiatives Pursued to ensure success beyond Period 5 and The Impact of COVID

The same faculty leadership spent the summer/fall 2020 and spring 2021 pursuing various methods to move the initiatives forward. They applied and were accepted for National Center for Women & Information Technology (NCWIT) Academic Alliance membership which allows exclusive access to the annual summit and women centric opportunities. Faculty leadership was invited and attended to AnitaB.org BRAID (Building, Recruiting, And Inclusion for Diversity) Summit to learn how to become an affiliate to learn how to balance the gender imbalance in the CPIS enrollment by implementing their four commitments (https://anitab.org/braid).

The faculty leaders partnered with campus constituents to address women's causes. Meetings were held with the college Admissions Office to share the numbers and discuss strategies to increase the number of females admitted to the Computing programs. The meetings led to joining forces with leaders the in School of Engineering Technology and Admissions Office to host an inaugural Celebration of Women in Computing event online where CPIS students and alumni served on a panel to share their stories and encourage incoming students to enroll in computing disciplines. In addition, guest speakers of renown women in technology and the female Dean of the School of Engineering Technology the leadership and advisors of the RAM (Research Aligned Mentoring - a prestigious program funded by a major grant awarded to the college by the United States Department of Education) Program on campus, all participated, so that incoming female Frosh and transfers were made aware of SWiC and resources available to women in computing. There was discussion of creating a female only incoming Frosh seminar to foster camaraderie of incoming students. In spring 2020, the two-faculty applied for and was awarded a campus SFG ($3000) funding to take 30 female students and three faculties to ACM NYCWiC 2020. Unfortunately, the entire trip was cancelled due to COVID19 and grant funding rescinded. Subsequently, faculty met with the Research Foundation Sponsored Program Operations office at FSC and other successful grant officers to investigate options for external funding. Faculty leaders submitted an application for external funding to conduct incoming (frosh and transfers) female student orientations, implement a mentoring program for the incoming cohorts that attend the orientation sessions and for funding to attend women centric events (field trips). Additionally, an NSF S-STEM grant was submitted for scholarship funding for students in the Computing Disciplines. Response to these recent requests for funding is pending at the time this paper is written.

It would be remiss not to mention the unique challenges of period 5 due to the global COVID19 pandemic. As successful as the reinstatement of the SWiC club was amid the pandemic, there were observations worth noting. It is believed that COVID19 had a

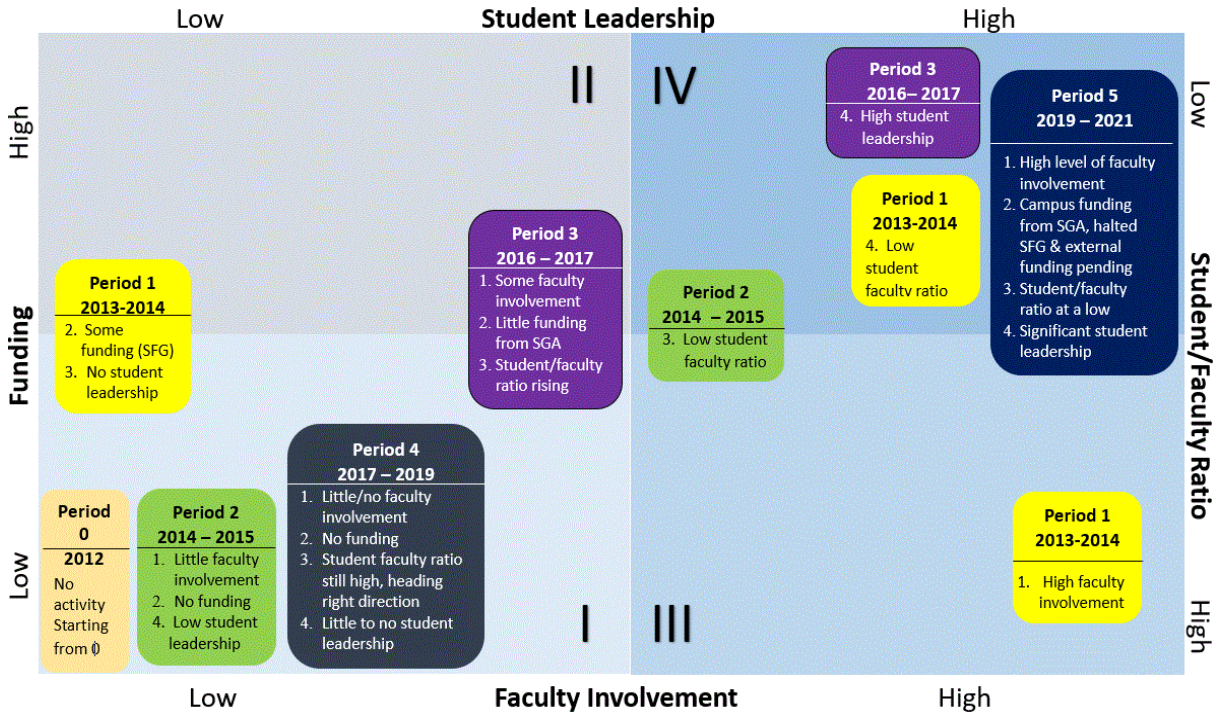

Fig. 3. Matrix Model of Success Factors (Quadrant I is all negative factors -Low Faculty Involvement -Low Funding -Low Student Leadership -High Student/Faculty Ratio. Quadrant II and III is a mix of positive and negative factors. Quadrant IV is all positive factors +High Faculty Involvement +High Funding +High Student leadership +Low Student/Faculty Ratio).

positive impact. The overall Club leadership had a unique opportunity to pay special attention during the initial summer planning as meetings that took place among officers virtually were valued because there was a lack of normal interactions due to quarantine and social distancing. Planning meetings were a welcome diversion and sense of normalcy planning for the upcoming semester. There was energy and excitement among the officers. An active calendar for fall 2020 was created, planned and pursued throughout the fall semester. Club interest and attendance was high which can also be attributed to lack of interaction with peers due to remote classes and low-level commitment to attend the club meetings remotely. When fully on campus, students dash off to work and other places and can't commit to attend meetings held on campus.

During the second semester there were two featured events of female alumni speakers who were recent graduates working in industry which was of great interest to club students and many other students. Both had record numbers of faculty and students attend the events. Sourcing guest speakers to remotely present was much easier and lower commitment for the guests eliminating travel, time and expenses normally involved

The Club officers and advisors presented virtually at an ACM NYCWiC 2021 which again was a lower cost to attend without travel and lodging expenses which also had a reduced registration fee. The Club was able to support club members attendance with the club seed money provided by the student government association which would not be entirely possible if travel was required.

A downside of COVID19 was that campus funding has been at its all-time low. The campus grant funding awarded in Spring 2020 to take students to ACM NYCWiC 2020

was also subsidized with department funds was rescinded. Due to the impact of COVID19 on the state and state university system budgets, there has been no funding available on campus for any activity but the bare necessities to running the college and the department.

IV. MATRIX MODEL OF SUCCESS FACTORS

A matrix model containing four success factors and four quadrants is developed to organize and analyze the high and low periods mentioned in Section II, (Fig. 3). The four success factors are as follows.

1. Faculty involvement: as reported by the authors based on the women centric initiatives faculty took at FSC.
2. Funding: amount of funding asked or granted from on-campus or external sources.
3. Student leadership: as reported by the authors based on the women centric initiatives students took at FSC.
4. Student/faculty ratio: as depicted in Fig.4.

Quadrants are defined based on the combination of the success factors and explained under Fig. 3 caption. The ultimate goal is to be in Quadrant IV where all four success factors are positively impacting the initiatives such that faculty is highly involved, funding is secured both from internal and external sources, student leadership is great where under classwomen are being cultivated to assume leadership roles when strong leaders graduate. The low student/faculty ratio provides faculty time to better connect with students and nurture the women initiatives.

Each Period 1-5 (in Section II) is positioned in the matrix to a quadrant according to its success factors. Period 1 was a *high* level of women centric activities but was entirely faculty driven where faculty planned, organized, and executed the events, using funding from SFG. Although students attended events, they were not involved in the leadership and planning. Student/faculty ratio was at a low for the department. Period 2 was a *low* activity period due to little faculty involvement, little student leadership developing, no funding, and student/faculty ratio on an uphill climb.

Period 3 was a *high* activity period such that despite little faculty involvement, the strong student leadership and small funding from the SGA augmented with fundraising by the student leadership resulted in a great momentum and support for Women in Computing. However, the student/faculty ratio was at an all time high at this period. Period 4 was a *low* period due to almost no faculty and student involvement and non-existing funding. Student/faculty ratio was decreasing but still high. As a result, no women centric activities were performed at CPIS department.

Period 5 is the present with the *highest* level of activities of all time and close to being in the ideal Quadrant IV due to renewed level of faculty and department chair commitment to support Women in Computing, strong student leadership, a small level of funding from SGA through the club, and additional external funding pending. The student/faculty ratio is lower than in the past few years due to a slight decrease in enrollment due to COVID19 but mainly due to newly hired faculty. The Periods 1-5 followed a zigzag pattern of high level of activities for a while followed by low to no level of activities until to this present day. The goal is to enrich and sustain the high level of activities to achieve the three-fold long term vision for CPIS program (Section I).

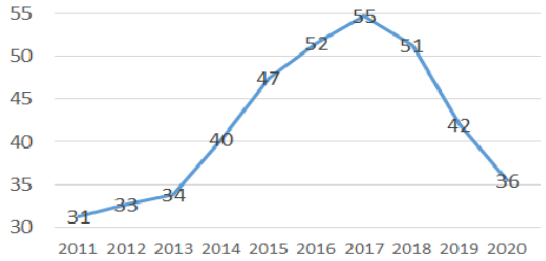

Fig 4. Student to Faculty Ratio over the past decade

V. EXTERNAL FACTORS

External factors are surrounding conditions (college and beyond) that have impacted the success initiatives.

First, the CPIS department chair changed twice during the analyzed periods from 2013. A long-term chair of fifteen years retired in spring 2016 as an interim and part-time chair from outside the department held the position for two academic years. In fall 2018, the current female department chair from the department faculty assumed the position. The college leadership changed in spring 2016 when the President of nine years retired. There was also a time where the Provost and associate Provost were also interim.

Second, overall faculty headcount was not keeping pace with retirements and resignations (not retaining the newly hired faculty) while student enrollment was rising (Fig. 2). Often a visiting Professor was the temporary placeholder (skewing the numbers because a visitor counts as a faculty, but isn't committed as a full-time permanent faculty member may be) to replace the draining headcount which put more pressure on the full-time tenured and tenure-track faculty. The student/faculty ratio over the ten-year period spiked at one point in 2017 (Fig. 4) which coincided with a self-study being completed and part time Chair. Full time faculty were burdened with added work that may customarily be performed by the Chair. More recently (three years) with new hires, faculty headcount has increased.

Third, there were years of no salary increases, furloughs, and hiring freezes due to the State Budget. As a result, there was an unfortunate salary compression issue for CPIS faculty, incoming hires were being placed at a higher salary rate than long term faculty. This was bad for morale and with a 4:4 teaching load, the Women in Computing Club and initiatives took a lower priority until recently.

Fourth, the commuter, working student population doesn't have as much free time for clubs and campus activities as compared to residential colleges. In addition, transfer students in the CPIS program have a shorter stay at FSC (Table I). Therefore, maintaining a steady pipeline of student leaders is challenging.

VI. LESSONS LEARNED & FUTURE WORK

It is interesting to look back and glean information from past experiences. The five key takeaways are as follows.

1. *Nobody should operate in a vacuum.* Efforts should be orchestrated by faculty and students. Faculty can initiate the efforts, but also mentor inexperienced students to take the lead. It should be a partnership where faculty and students work together and share the ownership and responsibility for success. In addition, the entire department should be behind the efforts to ensure that progress is made when there are negative external factors.

2. *Nurture the pipeline of upcoming students.* The pipeline of under classwomen should be nurtured so they learn from upper classwomen what needs to be done to keep the momentum going. The ideal situation is to have some under classwomen in leadership roles to work with upper class women and faculty mentors in maintaining forward motion.

3. *It is hard to make a difference without funding.* Funding is necessary and fosters accountability. Figuring out where to apply for funding and how is daunting. It is best to start small (local, campus and seed funds). Success breeds success. When activities are so well received, ways will be figured out to accomplish more.

4. *Learn from the past and modify going forward.* The example of learning from the past is upon observing and living through the male student dominated student club's adverse reaction to an earlier initiative to start a Women in Computing Club. Currently,

SWiC club cohosts events and partners on initiatives rather than competing for resources of the department as inspired by the Male Allies pilot program of AnitaB.org (https://community.anitab.org/allyship).

5. *Address negative influences head on.* There are bound to be some bumps along the way. It is essential to address negative influences early on, if possible. Acknowledging that some may be beyond control of constituents involved, when negative factors are recognized (e.g., hiring freezes, global pandemic), come up with a plan to continue working, and persist in any way possible, while waiting for the climate to change.

6. *Campus Club Administration & Management.* The planning and organizing for the club need to be worked on between semesters (summer and winter recess) otherwise students become overwhelmed with schoolwork and organization falls off throughout the semester. Student officers and faculty Advisors need to have planning and organization meetings during semester breaks and throughout the semester.

The current situation is in Quadrant IV with high student leadership, active faculty involvement, awaiting and actively pursuing more funding, and student/faculty ratio at a period low. Faculty and department support is good. The external factor looming is COVID19, but at the time of writing this paper, that is headed in the right direction as classes will be held on campus in fall 2021. Future work is to continue working to improve the gender gap in the CPIS program at FSC. Future activities will be assessed and reported on the influence of student experience, student success, and enrollment gender balance.

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Teaching SAP S/4 HANA Powered by ERP Simulation Games: A Pedagogy Study

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Abstract

The enterprise system is critical in today's business world. Many universities have recognized the demand and potentials, and incorporated it into their information systems, business intelligence, and STEM curriculums. Strong interest exists in using ERPsim games to help students learn the concepts of complex enterprise systems. The study presents the multiple pedagogical approaches to teach an enterprise system learning project using ERPsim games in the information system course in the business curriculum. In the SAP ERPsim game environment, students are able to navigate SAP ERP, explore business processes and data integration, execute the ERPsim game, model multi-dimensional data, perform enterprise data analytics on business transactional data in the ERPsim system, and make business strategic decisions based on the transactional data generated from ERPsim games. Eight learning approaches that have been applied to the case study are: 1) Interdisciplinary learning; 2) Game-based learning; 3) Experiential learning; 4) Flipped-classroom; 5) Interactive learning; 6) Collaborative learning; 7) Inquiry-based learning; and 8) Distributed learning. The study provides the comparison of multiple learning approaches and software tools to the case project during pre-and in-pandemic, and proposes the multiple learning approaches in post-pandemic. The project was utilized in the face-to-face class before the COVID-19 pandemic and was also taught online during the pandemic. The pandemic has motivated educators to adopt multiple pedagogical approaches to teach ERPsim games with advanced remote teaching technologies. As students are going back to traditional classrooms, educators need to seize these technological advances and make good use of them in the class effectively in the post-pandemic. The project design meets the global shortage of next-generation business leaders and enterprise system professionals in the digital business world. The project contents promote marketable knowledge and skills for students of information systems, enterprise analytics and STEM majors.

Keywords: ERP SAP, SAP Curriculum, Business Processes, ERPsim Games, Enterprise Systems, Pedagogy

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