

***IBS International Symposium on Computer  
Science, Computer Engineering and  
Educational Technology 2019***

Wolfram Hardt  
(Hrsg.)

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The International Symposium on Computer Science, Computer Engineering and Educational Technology (ISCSET) has a long history. This international event has been annually organized since 2012, and is now starting to attract many young researchers from different countries. It started as a cooperation between the TU Chemnitz in Germany and the Mongolian University of Science and Technology, and was later joined by the Novosibirsk State Technical University from Russia and the Harbin University of Science and Technology from China. These four universities are now successfully cooperating and organizing the annual ISCSET event.

This year, the International Symposium on Computer Science, Computer Engineering and Educational Technology has welcomed participants from Afghanistan, Bangladesh, China, Egypt, Germany, India, Mongolia, Morocco, Portugal, Russia and Syria.

This Symposium is partially supported by the project “DrIVE-MATH – Development of Innovative Mathematical Teaching Strategies in European Engineering Degrees” (Grant Agreement No. 2017-1-PT01-KA203-035866), which is funded by the Erasmus+ Program of the European Union.

Prof. Dr. Uranchimeg Tudevdaeva

Chairwoman of the ISCSET Symposium

July 2019



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# Analysis of Assessment Methodologies in Learning Management System for Scalable Mentoring Processes

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**Abstract**— Learning management system assists mentors in university education, to support a large group of students. Mentors have a vital role to train and to instruct the students. Online assessment methodology of learning management systems is a viable option to fulfill these tasks. It has the potential to curtail mentors' workload by reducing the complexity on the basis of scalable mentoring processes. This paper proposes concepts generated from the analysis of learning materials on existing online assessment tool named "ONYX". The analysis shows significant application areas in which "ONYX" can be used for estimating and identifying missing functionalities in the domain of computer engineering.

**Keywords**— Assessment, Learning Management System (LMS), automatic assessment, mentoring, scalable mentoring.

## I. INTRODUCTION

The dynamic relationship of mentoring is formed when a beginner is enlightened with greater perspective from an advanced career incumbent known as a mentor [1]. It is an effective instrument for the professional and personal development of young talents based on the informal experience and knowledge transfer. The mentor motivates the mentee in his professional self-discovery process, advises him on career planning and gives constructive feedback on his achievements and abilities [1].

Mentoring takes place outside of dependent relationships and is practiced in "public space". This has a program structure where the existence of promotional relations is visible and transparent [1]. In military service, it is the role of a mentor to advise, instruct, counsel and train the mentee [1]. On the contrary, the process of teaching and learning in higher education requires domain specific expertise that leads a mentor to take on different roles [1], which are defined as follows:

### A. Advice

A mentor listens and reflects the mentee's ideas and plans and shares his or her insights, practical experience and may recommend specific steps for the further course of action.

### B. Instructions

A mentor instructs or guides the mentee to acquire knowledge in the specific domain. As an expert he/ she may provide specific information and some "how to" guidance as a copy of pertinent sections of a manual or examples of completed work.

### C. Training

A mentor may go on the mentee's training and background, assessing the experience level and where

deficiencies are identified, teach the skills to the mentee. Then the mentor would let the mentee try out these new skills as well as assigning certain assignments for which the mentor provides feedback at various stages of the assignment.

### D. Activation / Mentoring

A mentor encourages the mentee to assume additional responsibilities in the required time. He encourages the mentee to set goals.

### E. Social-emotional support

A mentor supports the mentees in feelings, questions or problems that affect the learning process and the personal well-being of the mentee.

### F. Networking

A mentor proposes further literature to the mentee and refers to experts in the respective domain by creating the scope of peer mentoring. He also shows career prospects.

### G. Model

A mentor uses sample solutions and expert examples to show how the task could be successfully solved and how it is applied in practice.

Performing these roles while mentoring in 21<sup>st</sup> century has got a new dimension with the growing popularity of e-learning. The teaching learning process in e-learning is influenced by computer aided mentoring [7]. Computer-aided mentoring is also known as e-mentoring, tele mentoring, cyber mentoring, virtual mentoring, online mentoring, internet mentoring, computer-mediated mentoring, and email mentoring [5]. It is a process in which mentors help protégés via electronic channels of communication [5]. Technology-mediated communication allows the process to scale despite containing the same goals and outcome of a traditional mentoring.

In order to analyze the technical realization of scalable mentoring processes, the project "Personalized competence development through scalable mentoring processes-tech4comp" started in October 2018 [12]. Following the central question "How to design concepts that proves the quality of a scalable process of individual mentoring for the acquisition of competences?"- the project aims to digitally redesign classic, personalized mentoring using data analytics. Its purpose is to bring the benefits of a sustainable and privacy-compliant use of computer-aided mentoring systems in higher education of Germany. In this way, this project responds to changing the learning realities and access in the digital age by taking into account the diversity of the students and allow individual access to study through technology. As

a part of this project, automated assessment in the learning management system (LMS) will be implemented in order to provide scalable mentoring support addressing the mentoring role Instruction (B) and Training (C).

In this paper, the assessment methodologies have been analyzed with regard to the conceptual plan of mentoring process. The following sections of this paper form the fundamental basis of mentoring to analyze assessment methodologies.

## II. LITERATURE REVIEW

### A. Computer-aided mentoring

Learning management systems (LMS) provide computer-aided mentoring in order to improve student engagement and retention. As a reason, more students are joining online courses and e-learning is gaining more popularity [6]. Computer-aided mentoring is defined as “a computer mediated, mutually worthwhile between a mentor and a protégé that provides learning, advising, encouraging, promoting, and modeling, that is often boundary less, egalitarian, and qualitatively different from traditional face-to face mentoring [6].

Computer-aided mentoring or e-mentoring can also reward protégés by expanding their social and professional network, their knowledge base, access to resources, and job opportunities along with giving the mentors ample of time and flexibility for mentoring a large group of students in higher education [7]. It also provides a valuable tool for supporting the retention, progression, and completion of online courses to acquire the competences. The findings of some recent research indicate that virtual mentoring relationship quality was positively related to general and career based self-efficacy, which, in turn, was positively related to enhanced career aspirations and increased reflective skills (i.e., awareness of one's strengths and weaknesses) of the mentee [4].

### B. Available Technologies

Computer-aided mentoring in short, e-mentoring is a new context where the mentoring process between the mentor and protégé operates through online processes [2]. Depending on the variable of face to face interaction, blended or hybrid e-mentoring and virtual e-mentoring exist in current LMS [3]. With hybrid or blended mentoring, mentors and protégés use some combination of face-to-face interactions and online elements (e.g., email, discussion forum) with the possibility of both synchronous and asynchronous communication [3]. For example, a group of researcher put forth a hybrid model in which participants interact via face to face activities (e.g., lunch meetings, focus groups, inquiry based workshops, technology training courses) and virtual activities (e.g., avatar-to-avatar meetings in Second Life, wiki-based text exchanges, streaming video) in order to expand the knowledge, skills, and abilities of the learners [3]. Acknowledging that e-mentoring used electronic communications, the key feature of virtual e-mentoring lies in internet, using e-mail and list servers and non-face to face method of interactions [3].

Mostly the tools which are available in e-mentoring are either virtual pedagogical agent, discussion forms, FAQs or emails in online learning environment (OLE) [8]. There are a

number learning management systems (LMS) like Moodle or OPAL which has the possibilities to provide learning materials, options of self-testing for the mentees to provide scalable mentoring support. On the contrary, there is less evidence of using these learning technologies to advise, instruct, train, mentor, model along with providing the scope of networking all together [8]. The area of scalable computer-aided mentoring support is still under-researched [7].

In the next section, a conceptual plan is developed based on these state of art.

## III. CONCEPTUAL PLAN OF THE COMPUTER-AIDED MENTORING PROCESS

The department of Computer Engineering of Chemnitz University of Technology (TUC) is a part of the “tech4comp” project group. The process of computer-aided mentoring support will be provided through the central LMS of TUC. A conceptual plan is developed to analyze the scalable computer-aided mentoring process using this LMS. The plan to implement computer-aided mentoring includes five core parts. They are explained below.

### A. Material organization

The course in LMS will provide the lecture materials to the student. These materials will be responsible for the content knowledge of specific domain. The material organization also includes reference database and glossary. Therefore, this will cover the mentoring role of ‘Instructions’.

### B. Structural organization

The structural organization is the fundamental base of this mentoring process. It includes sending reminders to students to participate in the course. The organization of tasks and tests in each lesson are consisted in this plan. Moreover, the scope of peer-mentoring, provision of information (FAQs), list of contact persons and contact points for specific problems are other significant areas of this plan.

There is a plan to generate a list of possible topics and organizations of internship and theses depending on the competencies of the student. This list will provide them options for networking.

### C. Learning path

The planned preparatory course will have the option of creating individual learning path. This path will be created at the task level of the course. The system will adapt the learning path automatically based on the trial and error performed by the student. If the student cannot perform the tasks in the preparation stage, individual feedback will be provided. Furthermore, the automatic mentoring system will facilitate with the scope of more practice.

### D. Assessment

An assessment for each topic will be conducted in the LMS following the preparation of tasks. Both the task and test will be set with regard to the didactics of “Bloom’s Taxonomy”. The students are expected to gain higher order and lower order skills. It includes six levels of competencies shown below in Fig. 1.

The lower order skills are remembering basic knowledge, able to explain expected concept and applying the knowledge in a practical scenario. The higher order skills contain the

expertise of analyzing concepts, evaluating factors and producing original work. Based on this taxonomy, the items for task and test will be developed in an online assessment tool of the LMS.

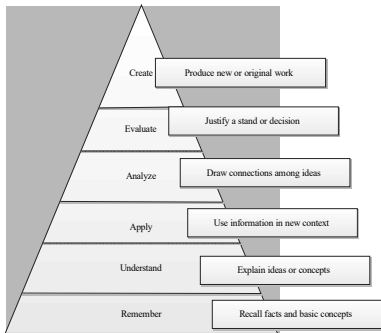


Fig. 1. Bloom's Taxonomy

### E. Diagnosis of the assessment

The diagnosis of the assessment is important for learning path adaption. It will be conducted through automated correction in the online assessment tool. After the evaluation of the task and test, individual feedback will be given. Accordingly, the automated learning path will be created and adapted according to learning need of the students.

The core parts (C), (D) and (E) are planned in this way to render support of instruction and scope of training to student. In this study, the analyses of probable concepts are conducted for automatic assessment in LMS. This is done to execute the plan of core part Assessment (D).

## IV. METHODOLOGY

### A. Instrument

The name of the central LMS of TUC is "Online platform for academic teaching and learning" (OPAL). "ONYX Test suite" (ONYX) is the provision to conduct automatic assessment in OPAL. Therefore, ONYX is the instrument for this study.

The probable concepts of the analyses are derived from the course material of the sample course. The course materials are drawn from the lecture slides of the course. The lecture slides of the sample course represent all the basic and important concepts and information for developing competencies. On that account, the lecture slides are another instrument in this study.

### B. Sample

For conducting the automatic assessment, two courses have been selected in the department of Computer Engineering at TUC. It has been done through purposive sampling. The purpose of selecting these courses are:

- It has been identified that the students have problems preparing for the labs at home. It results in bad marks and a high failure rate for the practical courses. Reasons can be to less motivation or overstrain during preparation. According to the plan, the preparation has to be done at home. As a result,

perfect preconditions for e-mentoring are set enabling a well-fitting test scenario.

- The preparation at home is not a direct part of the grading and can be done alone, leading to no negative influence for the students if the technology has bugs or is not accessible during the test phase. In consequence, no negative effect for the students are expected reasoned by technical misbehavior.
- The 2 courses are structured equally and facing the same problems, so the same concept can be used for both increasing the sample size.

A short overview of the students and content in the sample courses are shown in Table I,

TABLE I. OVERVIEW OF COURSES

Course	Number of students (Per Semester)	Groups	Course content (With number)
Course 1	120-150	6	4 Labs
Course 2	89-126	6	4 Labs

### C. Content analysis

Conducting the online assessment in the sample courses requires to test the compatibility of the course material with ONYX. For this reason, the content analysis has been conducted on the lecture slides from one of the sample courses.

The features of ONYX are also explored to find out the possible types of tasks. 3 types of task formats of ONYX are presented in Table II.

TABLE II. TASK TYPES AND FORMATS IN ONYX

Types	Task formats
Basic Types	Choice interaction
	Text entry interaction
	Extended text interaction
Advanced task types	Match interaction
	Matrix interaction
	Order interaction
	Hotspot interaction
	Hottext interaction
	Inline Choice
	Upload interaction
Specific task types	Numerical input interaction
	Calculation interaction
	Formula comparison
	Regular expression
	Programming interaction

The conceptual content analysis has been done from the lecture slides using the task formats of Table II. The lecture slides which contain only the name of the topics are excluded. The frequency of the concepts is derived to show descriptive statistics.

## V. RESULT

The analyses indicate that 81.65% content is possible to assess using the chosen online assessment tool ONYX. The findings of the content analysis show that there are in total 5

concepts in the lecture slides with regard to the task formats of ONYX.

In the following Table III the concepts along with the percentage of the frequency are presented. The features of the 5 concepts (a, b, c, d, e) highlighted in figure 2, distinguishes them from one another and are explained below.

#### A. Text Processing

Containing the highest percentage in the analysis, this concept includes the types of content which are text, text with figures and pictures. These can be tested with editorial field in ONYX using basic and advanced types of task format (Fig.2).

TABLE III. FINDINGS OF CONTENT ANALYSIS

Concepts	Implementability (in percentage)	Not Implementability (in percentage)	Missing feature
Text Processing	55.44%		
Graphical Processing	16.1%	17.98%	Generating Graphics
Table Formatting	4.12%	0.37%	Generating Graphics
Equation Calculation	4.12%		
Generating Algorithm	1.87%		
Summary	81.65%	18.35%	

#### B. Graphical Processing

The slides with labeled pictures are placed in this concept. This concept also includes different types structures, graphical arrow, mathematical graph and flow diagram shown in Fig.2. 16.1% concepts can be tested with the task format "Text entry interaction". The needed feature for the rest of the concepts to test these type of competences requires to generate different kinds of graphics which is missing in ONYX. As a result, 17.98% content cannot be tested using the chosen online assessment tool.

#### C. Table Formatting

This concept includes table to be filled with text, numbers. It is possible to test in ONYX using text entry interaction, numerical input and calculation interaction. On the contrary, 0.37% task is to generate mathematical graphs from tables. Because of the missing feature it is not possible in ONYX.

#### D. Equation Calculation

This concept has the features of simple calculation using formula, conducting calculation from graphics and doing calculation from the data of the tables. These are all possible to be assessed using the task format numerical input and calculation interaction in ONYX.

#### E. Generating Algorithm

The attributes of this concept are to write algorithm from given flow diagram, graphical structures and equations.

These features are possible to assess using programming and text entry interaction in ONYX.

## VI. DISCUSSION

The findings show that the features of assessment methodology are domain specific. It clearly indicates that it is not similar to other domain. It requires particular functionalities in the assessment tool of LMS to assess the learning outcomes.

In the domain of Computer Engineering, the learning material mostly deals with text based content. Because in this domain the student needs to know the exact definition of the technical term. The explanation of the code, formula and regular expression are the basis of content knowledge in the course material. Otherwise, they cannot learn to utilize the functionality of the terms and code during the implementation in the practical classes and projects. In ONYX, 10 types of task formats provide the option to assess text based content. This is why, assessing text based content is in ONYX has become the most viable option. Conducting mathematical calculation and developing algorithm are significant learning areas of this domain. Another important competency is to be able to do programming. The automatic assessment tool ONYX has the provision to test these types of competencies through the specific types of tasks. This is why, the findings represent the probability to set numerous similar tasks in ONYX.

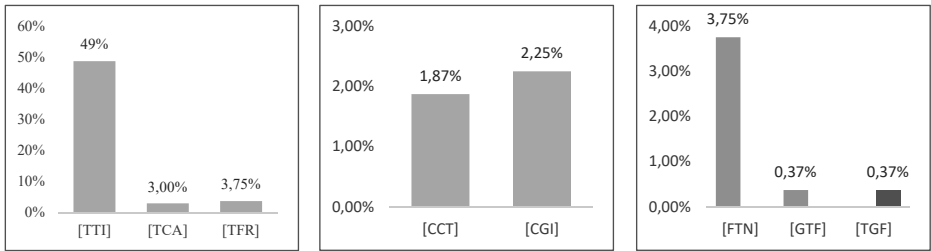
The findings furthermore show that a significant amount of the content knowledge depends on ability of producing new graphics. This is a higher order skill according to Bloom's Taxonomy. Moreover, generating and designing graphs, structure, table, models is a mandatory competency to be assessed in Computer Engineering. The findings specify that this competency cannot be assessed in ONYX. It is the missing feature of this automatic assessment tool.

Above all, a major part of the content can be tested using the assessment tool of OPAL except the tasks that involve graphical analysis. Therefore, another solution has to be found as a next step of the study.

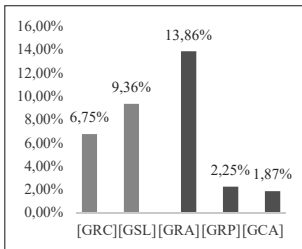
## VII. CONCLUSIONS

Learning management systems (LMS) can assist in mentoring a large group of students [3]. Scalable mentoring requires to execute all the roles of mentor which are advising, instructing, training, activating knowledge of mentee, giving social and emotional support, networking to show the career aspects of the mentee and modeling the best examples [11].

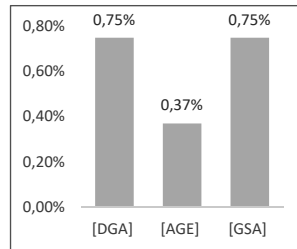
In higher education, students are most in need of mentoring to be prepared for their near future career. The teaching learning process in higher education relates to competence based knowledge that needs practicing [6]. Automatic assessment methodologies in LMS make it viable to mentor to instruct and train the large group students with less complicity [3]. In this paper, an attempt has been made to initiate automatic assessment by analyzing the content of the course. The findings show significant possibilities to assess the competencies using the tool ONYX. This study shows the exploratory findings of automatic assessment methodologies in the domain of computer engineering.



- (a) Text processing with**  
 [TTI] Test results contain Text and Text with images  
 [TCA] Test results contain Text and Algorithms  
 [TFR] Test results contain equations or regular expressions
- (b) Equation Calculation with**  
 [CCT] Test results contain calculation in text format and calculation in tables  
 [CGI] Test results contain calculation from diagram and image
- (c) Table formatting with**  
 [FTN] Test results contain features and numerical data in tables  
 [GTF] Test results contain the conversion of graphical data into table  
 [TGF] Test results contain the conversion of table to graphics



- (d) Graphical processing with**  
 [GRC] Test results contain graphics with or without table  
 [GSL] Test results contain structures  
 [GRA] Test results contain structures with arrow  
 [GRP] Test results contain graphs  
 [GCA] Test results contain the conversion of algorithm into diagram



- (e) Generating Algorithms with**  
 [DGA] Test results contain diagram and algorithm  
 [AGE] Test results contain algorithm and equation  
 [GSA] Test results contain structure and algorithm

Fig. 2. Detailed results of the subcategories from the conceptualization displaying the Implementability in % (light gray) and the non Implementable Functions in % (dark gray)

### VIII. FUTURE IMPLEMENTATION

As a part of the future implementation of this study, tasks need to be set in the online assessment tool "ONYX". A pilot testing is required by conducting the automatic testing on the students to find out the reliability and validity of the test for course 1.

Additional assessment tools are needed to be looked into. This will help testing the graphical analysis in OPAL. According to the findings of course 1, the same procedure can be directed with another sample "Course 2". Furthermore, the tests need to be conducted in sample courses to realize the generalizability of automatic assessment methodologies. These will initiate the implementation of the conceptual plan. Besides, the plans of the other core parts will be carried out in OPAL to provide scalable mentoring support.

### ACKNOWLEDGEMENT

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# Artificial Neural Network Image Recognition For Smart City Applications

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**Abstract-** There is a wide class of “Smart City” applications, which involve a task of intellectual video processing with the purpose of automatic recognition of distinct objects and automatic counting the objects of certain classes. In this paper this task is solved with the technique of deep learning neural networks using TensorFlow framework. The results of application of several neural network models for processing of complicated images are presented, and technical questions of the recognition procedure are discussed.

**Keywords** — smart city, neural, tensorflow, class, video

## I. INTRODUCTION

The "Smart City" applications often involve solving of problems associated with smart video processing from cameras and other sources. In particular, there is a task of automatic recognition of distinct objects and automatic counting the objects of certain classes. Examples of such applications are the following: counting the number of passengers in a vehicle, counting the number of people at bus stops, counting the number of cars that have been accumulated at the road intersection, counting the number of people entering and leaving the stores, cattle tracking, etc. We apply deep learning neural network technique for solving of this task. In particular, we use a set of pre-trained models designed for using with TensorFlow framework. These models permit to analyze complicated images containing multiple objects of different classes. The models differ in obtained precision of image recognition, and in time of processing of the images. In general, more precise results require larger time of image processing, so in each distinct application the compromise needs to be found to obtain the acceptable precision for reasonable time. We present some numerical results of testing of few pre-trained models in this paper.

## II. USED SOFTWARE

### A. Objects finding software

The objects finding task is solved by several software solutions and libraries. The list of software products that can solve this problem is given below:

- TensorFlow;
- DetectNet;
- Neural Network Objects (NNO);
- NEURObjets.

These software solutions allow you to solve the problem. However, among the products listed, TensorFlow is the best for several reasons.

### B. About TensorFlow

TensorFlow is an end-to-end open source platform for machine learning. It has a comprehensive, flexible ecosystem

of tools, libraries and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML powered applications. Some key features are decisive:

- Build and train ML models easily using intuitive high-level APIs like Keras with eager execution, which makes for immediate model iteration and easy debugging;
- Easily train and deploy models in the cloud, on-prem, in the browser, or on-device no matter what language you use;
- A simple and flexible architecture to take new ideas from concept to code, to state-of-the-art models, and to publication faster;

It's important, that TensorFlow provides stable Python (for version 3.7 across all platforms) and C APIs, and without API backwards compatibility guarantee: C++, Go, Java, JavaScript and Swift (early release). Third-party packages are available for C#, Haskell, Julia, R, Scala, Rust, OCaml, and Crystal.

Apache license version 2.0 makes sure that the user does not have to worry about infringing any patents by using the TensorFlow software.

## III. MODELS

The use of TensorFlow involves either creating your own model (neural network) or using a ready-made one. At the moment, a large number of models adapted to different tasks are distributed in the internet.

### A. TensorFlow official models

The TensorFlow official models are a collection of example models that use TensorFlow's high-level APIs. They are intended to be well-maintained, tested, and kept up to date with the latest TensorFlow API. They should also be reasonably optimized for fast performance while still being easy to read.

Available models

- `boosted_trees`: A Gradient Boosted Trees model to classify higgs boson process from HIGGS Data Set.
- `mnist`: A basic model to classify digits from the MNIST dataset.

- resnet: A deep residual network that can be used to classify both CIFAR-10 and ImageNet's dataset of 1000 classes.
- transformer: A transformer model to translate the WMT English to German dataset.
- wide\_deep: A model that combines a wide model and deep network to classify census income data.

### B. MNIST dataset

The MNIST database of handwritten digits, available from this page, has a training set of 60,000 examples, and a test set of 10,000 examples. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image.

In the Python language developer can use:

```
!rm $MODEL_FILE_NAME
!wget $MODEL_PATH
!tar xzf $MODEL_FILE_NAME
```

Where MODEL\_PATH - <http://yann.lecun.com/exdb/mnist/> in the case of MNIST models.

### C. RESNET dataset

Deeper neural networks are more difficult to train. RESNET present a residual learning framework to ease the training of networks that are substantially deeper than those used previously. We explicitly reformulate the layers as learning residual functions with reference to the layer inputs, instead of learning unreferenced functions. RESNET provide comprehensive empirical evidence showing that these residual networks are easier to optimize, and can gain accuracy from considerably increased depth. On the ImageNet dataset RESNET evaluate residual nets with a depth of up to 152 layers---8x deeper than VGG nets but still having lower complexity.

Resnet models path is a [http://download.tensorflow.org/models/object\\_detection/](http://download.tensorflow.org/models/object_detection/) in the case of TensorFlow due to easy library integration.

## IV. USED DATASETS

In their own software solution, the authors used two datasets to get the result. Below is information about their use.

### A. Using the RESNET 50 v1 FPN dataset

This dataset available by reference:

[http://download.tensorflow.org/models/object\\_detection/sd\\_resnet50\\_v1\\_fpn\\_shared\\_box\\_predictor\\_640x640\\_coco14\\_sync\\_2018\\_07\\_03.tar.gz](http://download.tensorflow.org/models/object_detection/sd_resnet50_v1_fpn_shared_box_predictor_640x640_coco14_sync_2018_07_03.tar.gz)

SSD with Resnet 50 v1 FPN feature extractor, shared box predictor and focal loss (a.k.a Retinanet). Trained on COCO, initialized from Imagenet classification checkpoint. Achieves 35.2 mAP on COCO14 minival dataset. Doubling the number of training steps to 50k gets 36.9 mAP.

Such characteristics allow to get not too accurate results at low time costs. The examples that will be listed below showed

that this model shows itself well in the case when objects do not intersect and are located on a contrasting background.

Resnet models path is a [http://download.tensorflow.org/models/object\\_detection/](http://download.tensorflow.org/models/object_detection/) in the case of TensorFlow due to easy library integration.

### B. Using Faster RCNN NAS Coco dataset

This dataset available by reference:

[https://github.com/tensorflow/models/blob/master/research/object\\_detection/samples/configs/faster\\_rcnn\\_nas\\_coco](https://github.com/tensorflow/models/blob/master/research/object_detection/samples/configs/faster_rcnn_nas_coco)

Faster R-CNN with NASNet-A featurization. Configured for MSCOCO Dataset.

This dataset allowed us to significantly increase the quality of recognition, but for each such operation it takes much more time. Examples and results are shown below.

Resnet models path is a [http://download.tensorflow.org/models/object\\_detection/](http://download.tensorflow.org/models/object_detection/) in the case of TensorFlow due to easy library integration.

## V. DETECTION RESULTS

Both considered models were used and tested on different images to search for different classes of objects.

### A. Finding classes via RESNET 50 v1 FPN model.

For simple cases of objects searching, for example, when the background and objects are clearly identified and separated, the first model was used (RESNET 50 v1 FPN).



Fig. 1. Detection of cat and dog objects classes in the simple case

Similarly, the model is able to recognize objects and other classes, however, in this case, the recognition accuracy may be lost. For example, a large number of overlapping people.

As already noted, this model requires more time to process the image, but it represents a much more accurate result. To confirm this, the authors processed complex cases using this model. Figure 4 shows the result of processing the first difficult image.

A significant increase in recognition quality is noticeable.

This is also confirmed by the processing of the second difficult image using the RCNN NAS Coco model. The result of processing is shown in Figure 5.





Fig. 2. Detection of many people in the difficult case

In Figure 2, a noticeable large number of errors and unrecognized objects are noted. The same effect is confirmed by Figure 3.



Fig. 3. Another difficult case

### B. Finding classes via RCNN NAS Coco model.

These examples fully confirm the information on the operation of these models, which was presented above.

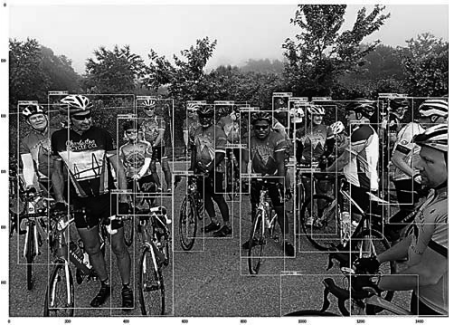


Fig. 4. Detection of many people via RCNN NAS Coco model



Fig. 5. Processing of difficult image case via RCNN NAS Coco model

## VI. CONCLUSIONS

In this paper, few pre-trained deep neural network modes were applied for recognition and counting of multiple objects on complicated images. The results obtained with two models: Resnet 50 v1 FPN and RCNN NAS Coco model have been presented. The RCNN NAS Coco model provides more precise results of objects recognition, but it requires about 18 seconds to process the image. Therefore, if the application requires real time processing, then more simple models should be used, even with less precision of recognition.

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# Challenges in the Adoption of Learning Analytics in Mongolian University

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**Abstract**— A learning analytical tool integrated dashboard based on a solution called quality in education system can improve education quality of the learning process. The emerging field of learning analytics involves the analysis of data about learners and their activities to inform the enhancement of teaching and learning practices and environments. Learning and academic analytics in higher education are used to predict student success by examining how and what students learn and how success is supported by academic programs and institutions

**Keywords**—learning analytics, educational data mining, students' tracking data.

## I. INTRODUCTION

In recent years, learning analytics has become an intense topic with many institutes deploying learning management systems and learning analytics tools. In this paper, we introduce adoption of learning analytics platforms in Mongolian universities. The aim of the research is to support education and learning through research into educational big data accumulated on these platforms. We also discuss the future trend of our research into learning analytics platforms.

Learning analytics is focusing on data that coming from Learning Management System (LMS). The data coming from LMS includes the number of times the student has logged into the page, the assessment of the student according to course prerequisites, the time spent by the student in reading the course materials and the time taken to complete the module assessments and attending discussions on forum.

Learning Management System is the most common tool for the teaching online. LMS has several features and services, like upload course materials, videos, links, quizzes online, various other activities, assignment submission, discussion forum, files upload/ download capacity, grading, online calendar and etc.

A learning analytical tool integrated dashboard based on a solution called quality in education system can improve education quality of the learning process. This learning system will assess and analyze the performance of students.

They support activities and other course materials. Teachers need to know the progress of students in the activities and give feedbacks to them. This teacher-student relationship should be effectively transposed from traditional system to online one. Furthermore, many analytical tools can be integrated in the numerical platform to enhance the quality of the teaching and reduce the time spent on administration. This learning system is developed as a platform which it will be possible to add a student, upload a file, and add a course and a subject. It will be also possible to generate reports based on learning analytics which play a

vital role in enhancing the students' performance and increase their successes.

The emerging field of learning analytics involves the analysis of data about learners and their activities to inform the enhancement of teaching and learning practices and environments. Online learning has several opportunities to exploit the use of technology. The technology will help to support the learning activities by gathering the data of the learning courses that may use in the assessments. While the students are using the system, the system can hold their involvements and gather the structures of problem solving, knowledge and planning in which used on it. This reflects and stores all information of each student in details who is visit, input, solve some activities and number of attempts that the students made on the course learning and number of the given feedbacks and amount of time they spend on the learning activities.

Any institution has its aim to improve its education and do the analytics that helps to increase the students' retention, enhance its service and to raise the grade of students.

Today, it is almost impossible to implement teaching processes without using information and communication technologies (ICT), especially in higher education. Education institutions often use learning management systems (LMS), such as Moodle, Edmodo, Canvas, Schoology, Blackboard Learn, and others. When accessing these systems with their personal account, each student's activity is recorded in a log file. Besides analyzing the raw data from log files directly, there is an option to use Moodle plugins that provide learning analytics and enable the faster analysis of students' behavior on LMS. In this paper, some of these plugins are presented.

Most Learning Management Systems (LMS), for example, Blackboard, can capture which students are doing homework questions and summarise the results.

Learning analytics puts a focus on predicting and improving student performance by looking at patterns in the learning data.

Learning analytics is the measurement, collection, analysis, and reporting of patterns from the data to understand and optimise learning (Moissa, Gasparini & Karczinski, 2015; ElAtia, Ipperciel & Hammad, 2011). The data is the evidence (Ubell, 2016).

Document goals for learning analytics are employed such as prediction of future learning, improving the subject domain model, optimising instructional methods, studying the impact on pedagogical approaches, and the advancement of the science of learning (AlShammari, Aldhafiri, and Al-Shammari, n.d.).

However, this paper is focused on analyzing the log files of a course implemented on the LMS Moodle at the Faculty of Organization and Informatics at the University of Zagreb. The results of the students' behavior, based on logs in Moodle, will be interpreted in terms of student success.

In Mongolia, several higher education institutions use LMS to support teaching process. The most used LMS in Mongolia Moodle, and specifically at the Mongolian University of Science and Technology, is UNIMIS.

When accessing an LMS with their personal account, students create a digital profile that is saved in LMS log files. The main idea of LA is to analyze the raw data in log files and generate new knowledge about students' behavior.

## II. LA AND EDM

Analytics is a method using supporting technologies to find hidden patterns in data. As more data becomes available from learning activities, educational stakeholders can experiment with data mining and analytic technologies to improve educational decisions. As educational organisations move resources online, systems capture increasing amounts of learning data. Most Learning Management Systems (LMS) can capture which students are doing homework questions and summarise the results. The LMS can also log how often a posted document such as lecture is accessed by students. Learning analytics puts a focus on predicting and improving student performance by looking at patterns in the learning data.

Prediction is a key goal of learning analytics. The system can predict student success rates and provide recommendations. The prediction model combined with data visualisations can help identify patterns, exceptions, and insights into teaching. All of this information is available before the final examination.

To measure and predict performance of higher education students is very challenging task for researchers. Many researches have proposed and going on in this field because it is a field where improvement is needed time by time, for this it is crucial to analyze previous performance of the students so that their performance can be predicted in future. For this purpose, researchers have utilized the student data from university database in their study based upon identified attributes/ factors that affect a student performance and by using different techniques of machine learning and data mining, they have predicted students' performance in upcoming year which may be useful and helpful for the students as well as faculties to improve student grades in academics.

We need to differentiate between LA (Learning Analytic), AA (Academic Analytics) And EDM (Educational Data Mining). Each of which has a different pattern in terms of process and purpose pointing out to the LA learning analytics it is the process of collecting measuring analysing and reporting data patterns with the purpose of optimizing the content according to the learner's experience learning analytics has its origins roots from business intelligence. Moreover, the idea behind the optimization of the content in the learning experience for the student is defined as adaptive learning system that to gather and analyse the information in an intelligent way, Educational Data Mining.

Two areas that are specific to the use of big data in education are educational data mining and learning analytics. Although there is no hard and fast distinction between these two fields, they have had somewhat different research histories and are developing as distinct research areas.

Generally, educational data mining looks for new patterns in data and develops new algorithms and/or new models, while learning analytics applies known predictive models in instructional systems. [1]

Educational data mining focuses on developing and implementing methods with a goal of promoting discoveries from data in educational settings. It examines patterns in a large data set related to students' actions.

As a definition of educational data mining that uses data mining algorithms with the objective of solving certain educational issues. The methods may be utilized to form a better understanding of the educational settings and learners defined educational data mining as data analysis. Techniques which when applied extract hidden knowledge consisting of tasks consisting of pattern discovery as well as predictive modelling.

Educational data mining is emerging as a research area with a number of computational and psychological methods and research approaches for understanding how students learn. New computer-supported interactive learning methods and tools—intelligent tutoring systems, simulations, games—have opened up opportunities to collect and analyse student data, to discover patterns and trends in those data, and to make new discoveries and test hypotheses about how students learn. Data collected from online learning systems can be aggregated over large numbers of students and can contain many variables that data mining algorithms can explore for model building. EDM develops methods and applies techniques from statistics, machine learning, and data mining to analyse data collected during teaching and learning. EDM tests learning theories and informs educational practice

Academic analytics refers to an application of the principles and tools of business intelligence to academia with the goal of improving educational institutions' decision-making and performance Academic analytics combines "large data sets, statistical techniques, and predictive modelling".

Learning Analytics and Educational data mining have risen as two independent research communities because of the increasing interest in the application of analytics in education, and the large amount of available data and software platforms and tools as well. Learning analytics uses predictive models that provide actionable information.

Learning analytics applies techniques from information science, sociology, psychology, statistics, machine learning, and data mining to analyse data collected during education administration and services, teaching, and learning.

Learning analytics creates applications that directly influence educational practice. The purpose of LA is to tailor educational opportunities to the individual learner's need and ability through actions such as intervening with students at risk or providing feedback and instructional content.

Conversely, educational data mining tries to generate systematic and automated responses to learners. While LA focuses on the application of known methods and models to address issues affecting student learning and the organizational learning system, educational data mining focuses on the development of new computational data analysis methods. One of the main applications of learning analytics is tracking and predicting learners' performance as well as identifying potential problematic issues and students at risk. Some universities have already used LA in various courses to improve learning.

These are some examples of pioneer higher education institutions that applied LA. When discussing learning analytics methods in education, it is important to provide a background regarding the flow of analytical information. The flow of analytical information can be traced from the students to the stakeholders within the framework of a hierarchy. When provided the opportunity to offer input and make recommendations, stakeholders can help enrich the learning experiences of students.

Large data sets are present from students' interactions with educational software. online learning - among other sources - with public data repositories helping the researchers in the field because capturing the data would be difficult to handle in the normal way to show the student final performance.

### III. DATA USE IN LEARNING ANALYTICS

Data - driven approach had been introduced by analytics in a way in terms that individuals and organizations conduct business and make decisions. Education, and in particular higher education became proof against the effect of analytics. Many universities around the world have started to apply analytics to gain new insights on a variety of business and educational issues aiming for improvement. Online learning systems—learning management systems, learning platforms, and learning software—have the ability to capture streams of behaviours of learners are analysed in details can operate on the data providing a number of stakeholders with feedback to improve teaching, learning, and educational decision making.

To clarify how such adaptive systems, operate, using the predictive models created by educational data mining and from the perspective of the system in terms of learning analytics.

Determining student-at Risk through Predictive Modelling

Tracking the student participation online and offline, student progression as well as highlighting any possible issues with teachers or the administration become one of the major tasks being adopted by learning analytics system in the universities nowadays.

For many institutions predictive modelling is the most usable method that enable them get have an access for the use of their historical data of their students and identifying

the student at risk giving them instant support that they need for the course progression. Access to LMS use logs for their courses and the data use became a driver for many scholar to develop coping software applications and by the use of those applications that the entire faculty would easily identify at risk students and give the needed support in some cases early intervention. Not to mention one of the most important uses for the LMS which is reporting to improve student achievement, which depends on the entire faculty and learner responses.

Students categorized by classifying their features extracted from logged data in a web - based system as a first step and their second step was prediction for their final grades using a genetic algorithms for the purpose of accuracy in their prediction through combining more than one classifier together and weighted feature vector as well.

Learning and academic analytics in higher education are used to predict student success by examining how and what students learn and how success is supported by academic programs and institutions.

Additionally, If only we focused on individual learners, these applications do not help us to evaluate if a course activity or overall design can be improved for all learners in a course, which has a much larger potential impact to improve student achievement.

Student tracking data are readily accessible, scalable and non-intrusive and provide lead indicators of final student performance or failure.

Instructors should be able to determine the meaning and effect of the measures of the indicators on the students as well. Here are some of the learning analytics sources that are made available for the data.

- Content/announcement views relative within students of a course
- Activity/resource views, reads, relative to number of possible views.
- Interacting with the tutors.
- Interacting with the students and the actual content through online discussion.
- Mid-year and final academic performance.
- Assessment Feedback views.
- Content/announcement.

Capturing data from VLE is a first step that happens when the user/learner interacts with the announcement or the digital content providing that LMS provides restricted data about the whole process or requires even more complicated procedure for capturing purposes. Gathering involves the selection and capture of data; processing involves the aggregation of information; displaying involves the sharing of the information; and dissemination involves decision-making based on that information. The process of capturing itself includes (a) recording the activity by capturing the interaction of the learner with the actual learning content (b) and detailed activity which could be used for further purposes such as measuring the student engagement degree with the learning content.

Combining the data with the statistical techniques after the process of capturing comes a second step identifying the technologies and describing the methods been used, then analysing and assessing the effect of the activities and plan which will lead eventually to predict the student engagement features that are important in the business process.

Summarizing the collection phase:

- (1) Collect the information about learners from their learning profiles on the virtual learning environment.
- (2) Filter the information and data gathered from student.
- (3) Select the information needed according to the information to be built and the purpose for this model .

#### IV. REFINING THE DEVELOPED MODEL

Data Use in Adaptive Learning-Online learning systems—learning management systems, learning platforms, and learning software—have the ability to capture streams of learner behaviours, and the tools and techniques described above can operate on the data to provide a variety of stakeholders with feedback to improve teaching, learning, and educational decision making.

To demonstrate how such adaptive systems, operate, using the predictive models created by educational data mining and the system-level view of learning analytics, this section describes a prototypical learning system with six components.

A content management, maintenance, and delivery component interacts with students to customized subject content and assessments to support student learning.

- A student learning database (or other big data repository) stores real time student input and behaviours captured as students interacts within the system.
- A predictive model combines demographic data (from an external student information system) and learning/behaviour data from the student learning database to track a student's progress and make predictions about his or her future behaviours or performance
- A reporting server uses the output of the predictive model to produce indicative dashboards that provide visible feedback for many users (tutors/students).
- An adaption engine customizes actual content based on the output of the predictive model to deliver material according to a student's performance level in a being improved continuously.
- An intervention engine allows teachers, administrators, or system developers to intervene and override the automated system to better serve a student's learning.

Additionally, the idea behind the optimization of the content in the learning experience for the student is featured as adaptive learning system for the purpose of gathering and analysing the information in an intelligent way to better shape learning pedagogy.

The adaptive learning is to be considered as an artificial intelligent tutor as the new technology learns the way people

learn and adapt its material according to how do each one gets the information in which accordingly they adjust the learning content presented to learner

#### V. REFINING THE DEVELOPED MODEL

The most important of learning analytics is data mining in the learning management system. Based on the analysis of the learning environment by factor analysis, the decision to improve the quality of the study is a relative concept. The data collection system and student data will be used for the analysis of factors affecting the learning achievement and the effectiveness of the results will vary. Most of these factors are student data personalities and it is difficult to take action to improve student achievement. The researchers calculate the accuracy of predictive modeling of student learning achievement and defines the relationship between factors. We have been analyzing factors that affect our learning achievement for six years by collecting data in a system of learning. The findings of the study were based on the level of knowledge of the students and the knowledge gained from the subject matter, however, in order to obtain an appropriate evaluation of the problem.

When there are about 90 universities in Mongolia and the number of enrollments in universities is declining, the quality of preparing quality specialists is a major issue in universities. It is difficult to secure the quality of the university's Qualitative Assessment. The majority of schools using LMS are collecting limited data in the learning environment, which makes it difficult to develop EDM research directions.

In addition to technical challenges in data and system integration, several studies have identified challenges related to strategic planning and policy.

Several challenges have been identified:

- LMS will extract the data needed for the analysis of training activities
- Installation plugins of LMS learning analytic tools
- Development of learning analytics tool in university own LMS like UNIMIS
- Learning data is used for students performance depends on mining data from LMS

Data type is very important for Learning environments' decision-making by implementing Learning Analytics.

Making decision by predicting the student's performance, using data such as high school and family information, enrollment scores, age, sex, etc., as well as midterm exams and previous semester's result, is not very appropriate for us.

The learning track in the learning process represents the students' learning style and the data such as forum attendance, quizzes, assignment grades and any log data comes from learning system using learning tools were an important tool for improving student learning achievement. The learning tools in the LMS such as lectures, forum, quizzes, assignments, sample of the assignments, database of student's assignment is best resources for learning data and learning process result of every 2 weeks is very important for students motivation.

## VI. CONCLUSION

Most of the policies also lack guidance for the development of data literacy among end- users and for evaluation of the impact and effectiveness of learning analytics. Nevertheless, the existing learning analytics policies have established some examples that are of value for reference, particularly for institutions that are planning to develop their own institutional policies for learning analytics. The review also confirms that one of the biggest challenges in the adoption of learning analytics is the lack of institutional policies that are developed specifically to guide the practice of learning analytics with considerations of an individual institution's own cultural, economic, political and technical context as posited in policy development approaches.

To develop learning analytics in own institution we should collect important data at first and install learning analytic tool in LMS. If we can analyse learning data 2, 3 times during semester and make a important decision using result of these analysis we can improve learning achievements. The most important decision is during learning process, not the future prediction in end of the semester.

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# Computer-Aided Population of Knowledge Base for Automotive Software Engineering

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**Abstract**—To support the development in the automotive software engineering, the system architecture AUTOSAR was designed. The aim of AUTOSAR is to reuse the software functionalities decoupled from the hardware. This architecture is very complex because of a large number of parameters. These parameters need to be set individually for each application. A huge amount of information about the configuration can be found in the official specification documents. To use the information of different AUTOSAR versions in a third-party tool, like testing- or E-Learning tools, a structured data store is required. This data store needs to be filled automatically. Our parsers provide structured data from two different sources. With this information new applications are conceivable.

**Keywords**—Automotive Software Engineering, AUTOSAR, Database, Parser

## I. MOTIVATION

For testing of AUTOSAR (Automotive Open System Architecture) [1] Projects, a prototype called ASTAS (Application Specific Test of AUTOSAR Systems) [2][5] was developed by the Professorship CE of TU-Chemnitz. In this Context the AUTOSAR knowledge base was designed [3][4]. ASTAS supports the development process by static analysis of source code and configuration as well as by dynamic test. These tests are generated in a semi-automated manner. The knowledge base contains data about AUTOSAR versions, platforms, modules of the BSW (basic software), function headers of the BSW-Modules and dependencies between these modules [6]. The database is used for multiple tests of AUTOSAR ECUs by ASTAS (see [12]) and for an AUTOSAR E-Learning tool [10]. Moreover, this database is used to generate automated tests for education in software engineering [11].

To fill the database with AUTOSAR knowledge there was already an application [3] implemented for parsing the required data from the tresos installation files. Tresos [7] is a tool from Elektrobit for configuring the AUTOSAR BSW. The database can be maintained manually to add more knowledge. To automate the parsing of the data to get information from other AUTOSAR versions, the existing parser has to be extended or a new parser based on the project data is needed.

## II. CONCEPT

The required data corresponding to the structure of the knowledge base can be discovered in the tresos installation files and the AUTOSAR project.

### A. Tresos installation parser

Elektrobit published a Version of tresos for each AUTOSAR version. The tresos installation files contains structured information about the official AUTOSAR specifications of all tresos configurable AUTOSAR modules.

There was already developed a tool, to parse the tresos installation files of AUOSAR version 3 and fill information into the AUTOSAR knowledge base [3]. To extend the existing tresos installation file parser, the application should be able to parse the data from all existing tresos versions and insert the data into the knowledge base. (see Fig. 1) Instead of overwriting already existing items they should be updated.

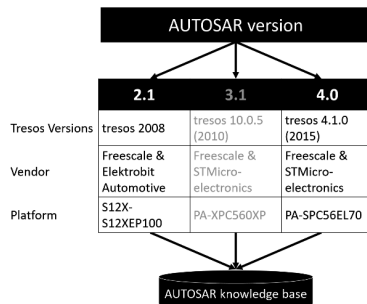


Fig. 1. Parsing of information from different AUTOSAR versions

Tresos is based on Eclipse and for every AUTOSAR BSW module there is an Eclipse plugin. The plugins can be found in the “plugins” folder under the installation path. In this folder each plugin has its own subfolder with a “plugin.xml” file in it. The function headers can be parsed from the header files. The source and the header files from the basic software module are located in the folders “include”, “src”, “lib\_include” and “lib\_src”. The “config” folder includes configuration files in the Elektrobit specific “xdm” format. In addition to the parsing of multiple AUTOSAR versions the dependencies of the BSW modules can be also parsed from the installation data. To save this data a new table has to be added to the knowledge base.

### B. Project parser

The other way to get knowledge of the basic software is to parse an AUTOSAR project. Such a project realizes functionalities of ECUs (Electronic Control Unit) with the AUTOSAR architecture. The project contains a subset of information from the tresos installation files. The entry point for parsing the data is the “preferences.xdm” in the “prefs” folder under the project root path. This file contains the relative paths to the configuration files from all BSW modules included by the project. The “preferences.xdm” also includes information about the target ECU. In the configuration files from modules are information of each BSW module and the configuration data.

### III. IMPLEMENTATION

ASTAS was developed with the .NET-Framework and the programming language C#. To keep to the development from the existing projects as near as possible both parsers should be written in C# with the .NET-Framework.

To parse the configuration XML (Extensible Markup Language) files from the installation folder of tresos and the configuration files from an AUTOSAR project, the inbuilt LINQ to XML [8] functionalities from .NET are used. LINQ (Language Integrated Query) [9] is a generic query language introduced by Microsoft. With LINQ it is possible to query data of various formats.

#### A. Tresos installation parser

The existing parser needs to be adapted to the tresos installation files of the AUTOSAR Versions 2 and 4. For these small adjustments of the xml parser, the namespaces and the function parser were made. To discover the BSW module dependencies, the header and source files for each module has to be parsed for includes. If an include points to a different BSW module, the module under consideration depends on the included module.

To save the parsed data in the database the scheme needs to be updated. A new table for the dependencies of the BSW Modules must be added to the database. In addition, a new table for the AUTOSAR BSW module identifier, which is defined in the official AUTOSAR specification, was added. This table refers each BSW module from different AUTOSAR versions to the type and task of the module.

After parsing, the data must be inserted into the extended knowledge base. Already existing records must not be overwritten. Records with dependencies have to be inserted first. If the table already contains the record, the identifier of the existing record was used to reference this record to the dependent record. For example, if an AUTOSAR version should be added but already exists in the knowledge base, the ID of the existing version is used to reference the BSW modules added in the following.

#### B. Project parser

A new data structure based on the structure of the AUTOSAR knowledge base was designed for saving the parsed data from AUTOSAR projects.

In the "preferences.xdm" file, the ECU information has to be stored under the XML tags with the attribute "ECUCNature". In addition to the name of the target ECU, "target" and "derivatives" are also included. These are known in the knowledge base as "Type" and "Revision" in the "Platform" table. The modules are located under the tags with the attribute "ModuleConfigurations". In addition to the name of the module, the path to the respective configuration file can also be found here. With this knowledge the platform and partly the BSW module classes of the data structure can be filled. To parse the configuration files of the modules, the paths of the module configurations must be followed. The paths are seen relative from the project root directory. In these configuration files are the remaining attributes of the BSW modules. These can be found under the tag with the attribute "CommonPublishedInformation". After the data is completely parsed, the data structure is temporarily displayed in a .NET PropertyGrid.

### IV. CONCLUSION

In conclusion, two parsers have been developed which can read and structure the data from AUTOSAR projects and the tresos installation files.

With the tresos installation file parser it is possible to fill the knowledge base automatically. Thus, the AUTOSAR knowledge base was extended by the AUTOSAR versions 2 and 4. In Table 1, the current inserted data of the knowledge base is counted.

Table 1. Current dataset of AUTOSAR knowledge base

<i>AUTOSAR Version</i>	<i>Modules</i>	<i>Functions of modules</i>	<i>Dependencies between modules</i>
AUTOSAR 2	35	934	25
AUTOSAR 3	48	1063	38
AUTOSAR 4	45	1523	57

The project parser makes it possible to analyse an AUTOSAR project and retrieve structured information. This simplifies the development of new ASTAS test modules. The ASTAS test module can include the parser and use the data as support to analyse the basic software.

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# Current Research on Integrated Scheduling Problem

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**Abstract**—Scheduling problem has always been a hot topic in the field of production and combinatorial optimization. And integrated scheduling problem, which consider the processing and the assembling at the same time, has enriched this field. In recent years, the research of integrated scheduling has been greatly developed by many scholars. Under this situation, the article introduces the integrated scheduling problem, then summarize the present research status of the current integrated scheduling problem. Several representative integrated scheduling algorithms are analyzed and their shortcomings are pointed out. Finally, several research directions of the future integrated scheduling problems are also pointed out.

**Keywords**—integrated scheduling problem, integrated scheduling algorithm, multi-workshops.

## I. INTRODUCTION

As one of the key factors affecting the production efficiency of manufacturing industry, an effective scheduling optimization algorithm can maximize the production efficiency under the limitation of the enterprise orders, equipment and other hardware resources. At present, scholars have done a lot of research on job shop scheduling problems [1-5]. These algorithms are mainly aimed at optimizing the scheduling problem which machining the work piece first [1-2], and then assembling each work piece into a product [3-5]. However, with the continuous transformation of social demand for products to individualization and diversification, the production and manufacturing industry will face more and more orders for multi-variety and small batches products. In such a situation, the production efficiency is reduced if the production mode is still carried out according to the traditional production mode of first-processing and post-assembling which causes the parallel relationship between the internal processing and the assembly of the product separated. For that reason, the integrated scheduling that consider the processing and assembly of products at the same time was proposed. Then a series of scheduling optimization algorithms are generated, and many new research fields are expanded.

## II. INTEGRATED SCHEDULING PROBLEM

In the traditional job shop scheduling problem, because the work pieces are independent and unconstrained, the processing is pure machining or pure assembly scheduling problems. In the complex product integrated scheduling problem, there are constraints between work pieces, so it deals with the processing consider the machining and assembly at the same time. This constraint relationship is shown as Fig.1. And this process graph is called as process tree. Each node represents a process, and it consists of process name, processing equipment and processing time as process name/processing equipment/ processing time. The arrow direction of the edge represents the partial order relationship between the processes. A leaf node has no penetration, and the root node has no dissolution. The product is finished when the root process is finished.

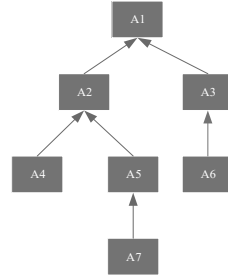


Fig. 1. A process tree

The integrated scheduling problem of complex products can be briefly described as follows: There are  $n$  processes to be processed or assembled assigned to  $m$  equipment. Meanwhile, the following constraints must be met: each process can only be assigned to one equipment for processing or assembly; At a certain time, an equipment can only process or assemble a process, and the processing or assembly process of the equipment cannot be interrupted; The processing or assembly of each process must meet the process constraints conditions, that is, it must be processed or assembled before its immediate successor can be processed or assembled.

## III. RESEARCH STATUS OF INTEGRATED SCHEDULING PROBLEM

By the end of the 20th century, because of the demand of the individual production, the production efficiency and the competitiveness of the enterprise cannot be better improved by using the production scheduling mode of the pure processing and the pure assembly. At this time, a large number of scholars began to focus on the research of the integrated scheduling method combined with processing and assembly. The research is not limited to the general integrated scheduling problem, and meanwhile, the integrated scheduling problem is expanded so as to be more suitable for products with special equipment and special production requirements. And with the improvement of the production capacity of the enterprises and aiming at the enterprises with the cooperative production environment, a great research results of the integrated scheduling problem not only for a single workshop but also for the multi-workshop has been obtained.

### A. Research status of the General Integrated scheduling problem

The general integrated scheduling problem is oriented to the dynamic and static manufacturing of a single complex product and multiple different small batch products. There are only priority constraints among the processes of each product and there is only one equipment for each function in

the workshop. The optimization scheduling goal is to minimize the maximum completion time of the product.

For general single complex product, the ACPM (allied critical path method) is proposed in [6], this algorithm determines the scheduling order of the processes by the path length according to the process tree structure, the process on the longest path is operated first, and the order of the process on other path is adjusted according to its priority constraint with the process on the longest path. However, since the algorithm determines the pre-scheduling sequence of processes, it ignores the problem that the actual occupation time of the equipment is different due to the different processing time of the same equipment processes. Therefore, there may be a lot of idle time of the equipment. Subsequently, in order to improve this disadvantage in [6-8], the compact method of key equipment, the dynamic priority scheduling method, the dynamic critical path method and the vertical and horizontal bidirectional scheduling method are derived on the basis of ACPM. These algorithms comprehensively analyze the influence of the longest path and the processing time of processes on the total completion time of the product. However, because it is based on the number of layers and sets the priority in advance. It neglects that the priority processing of low-priority leaf nodes may reduce the idle time of the equipment and improve the utilization rate of the equipment. Then, in [9], an integrated scheduling algorithm based on idle equipment driver is proposed, and a maximum parallel strategy is proposed to make the process as parallel as possible, and the integrated scheduling problem is solved from the point of view of signal system. Furthermore, an integrated scheduling algorithm with backward preemption is proposed in [10]. Based on the idea of event driven, an integrated scheduling algorithm for adjusting the idle time period of equipment is proposed in [11]. On the basis of the idle driver of the equipment, the event driver of the unscheduled process in the idle time period of the equipment is added. The idle time of the equipment is further shortened. In [12-14], considering the deficiency of the above-mentioned algorithm, a time-selecting algorithm is proposed. From the perspective of all available machinable time points of the process, the integrated scheduling problem is solved by an enumeration method, but the complexity of the algorithm is obviously higher than that of other algorithms. And [15-16] uses genetic algorithm to solve the problem of integrated scheduling. For general multi-complex products, in [17], the root alignment method is used for the first time to transform the products with multiple tree structures into a virtual process tree, which simplifies the multi-products scheduling problem to a single product scheduling problem. The transformed process tree is shown in Fig.2, where the root node VR is a virtual node.

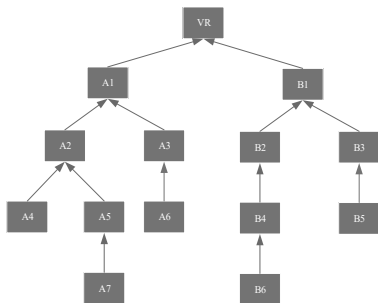


Fig. 2. A virtual process tree of two products

### B. Research status of the extended integrated scheduling problem

In order to make the integrated scheduling problem closer to the actual production and processing problem, the internal resource allocation of the production enterprise and the processing characteristics of the product itself are fully considered. The processing structure of the product is not completely dependent on the product processing tree, so the integrated scheduling problem is extended. The special problems solved are divided into three categories: special equipment, special process and mixing problem. Table 1 gives the literature on the special equipment problems that have been studied at present. Table 2 gives the literature on the special process problems that have been studied at present, and Table 3 lists the literature on the mixed problems. Through Table 1-3, we can find that the research on extended integrated scheduling problem is not deep enough at present. In order to use the process tree structure to study these extended integrated problem, researches proposed the extended process trees. For instant, a kind of extended process tree is shown in Fig.3, which is used to solve the problem in [18]. And the virtual node V2 denote the waiting time between the processes C10 and C3.

TABLE I. SCHEMES ON SPECIAL PROCESS

Special Process				
Process of Multi-equipment cooperative processing	Processes with no waiting	Processes with fixed waiting time	processes require same completion time	The product consider the due time
_____	[22], [19]	[18]	[23], [21]	[20]

TABLE II. SCHEMES ON SPECIAL EQUIPMENT

Special Equipment			
Batch processing equipment	Flexible equipment	Same equipment	Adjustment time generated by multifunctional equipment
[27], [28], [29], [30]	[26],[24],[18]	[25]	_____

TABLE III. SCHEMES ON MIX PROBLEM

Special Process Special Equipment	The process of Multi-equipment Cooperative processing	Processes with no waiting	Processes with fixed waiting time	processes require same completion time	The product consider the due time
Batch processing equipment	_____	_____	_____	_____	_____
Flexible equipment	_____	_____	[18]	_____	_____
Same equipment	_____	_____	_____	_____	_____
Adjustment time generated by multifunctional equipment	_____	_____	_____	_____	_____

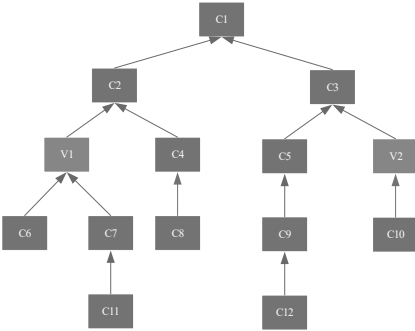


Fig. 3. A virtual extended process tree

### C. Research status of the integrated Scheduling for multi-workshop

At present, the research on integrated scheduling problem has gradually changed from the traditional single-workshop integrated scheduling problem to the multi-workshop, that is, distributed integrated scheduling problem and some research results have been made.

In [31], allied critical path algorithm and load balancing algorithm are used to solve the scheduling problem for the two workshops for the first time, but the parallelism between the processes is ignored, and the problem that the load balancing of the workshop is not its scheduling goal. In [32], workshop allocation is carried out by means of process grouping, which reduces the transfer times between workshops and realizes the scheduling optimization of the two workshops, but it pays too much attention to parallelism and ignores the compactness between processes. On the basis of the two, the horizontal and vertical effects are taken into account, and the strategy of evenly distributing the longest static overlapping time is put forward, which improves the parallelism of the process. The neighborhood rendering strategy and the selection strategy of the same equipment workshop are proposed to determine the equipment workshop, but the problems of process preemption and redundant migration may occur. In [33], a two-shop

integrated scheduling algorithm based on timing strategy is proposed, which avoids the problem of decreasing serial compactness and insufficient parallelism, and no longer adopts workshop equilibrium strategy to further optimize the product completion time. Literature [34] for asymmetric two workshops, a minimum migration process end time strategy is designed to determine the processing workshop. In [35], the device-driven integrated scheduling algorithm is extended to two workshops. Furthermore, in [36], the batch equilibrium strategy is used to solve the integrated scheduling problem of the three workshops. In [23], the integrated scheduling problem of three workshops is extended to multiple workshops, and a special process that needs to be completed at the same time is added, and the reverse sequence batch scheduling strategy is used to solve the problem. In the above, the integrated scheduling problem is gradually extended from single workshop to two workshops, and finally to multiple workshops, and the integrated scheduling problem is gradually generalized. There are still many aspects to be further discussed and studied on the integrated scheduling problem of multi-workshop.

## IV. RESEARCH PROSPECT

So far, although a lot of research has been done on the integrated scheduling problem, we can still expand the research on the integrated scheduling problem from the following aspects in the future:

1) *Optimization objective*: At present, the integrated scheduling algorithm is mainly aimed at the single objective problem which is minimizing the maximum of the completion time of the product. We can take many other factors into account, such as the processing and transportation costs, minimum delay, warehouse capacity, equipment load, equipment failure. Then establish the multi-objective problem.

2) *Multi-workshop integrated scheduling problem with special equipment and special process*: Currently, the study on multi-workshop is only for the general single product, but, in fact, the situation of the practical machining is more complicated, it is necessary to consider the many special equipment and special process.

3) *Integrated scheduling problem of Network equipment*: With the growth of the strength of the enterprise, the processing equipment is no longer limited to the workshop, but to establish a huge equipment network. So we can study the integrated scheduling problem with networked devices, that means the connective of the networked devices should be considered.

## V. CONCLUSION

In this paper, the integrated scheduling problem is briefly introduced, and the algorithms of extended integrated scheduling problem and multi-workshop integrated scheduling problem for general integrated scheduling problem are briefly introduced and their shortcomings are pointed out. It is beneficial to further optimize it. Finally, the future research of integrated scheduling is prospected, which is beneficial to the further study of the related problems of integrated scheduling. It is hoped that this paper can provide a favorable reference for those engaged in scheduling problems.

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# Design of a tool set for automated feedback on scientific writing

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**Abstract**—Automated assessment in the context of education has a need for processing and assessment of scientific writing without human supervision. This paper aims to demonstrate a way to integrate a text processing and analysis component into a running Learning Management System for individual and automated feedback generation. It combines the field of distributed systems and web engineering with text analysis technologies. The resulting proof of concept enables rapid roll-out of this tool into test beds for further research.

**Index Terms**—automated feedback generation, learning management system, scientific writing assessment, text analysis, virtual mentoring

## I. INTRODUCTION

Assessment of scientific writing may consume significant amounts of time given the amount of text to be read and principles of good feedback to be followed [1, pp. 2-3]. This leads to delayed feedback or feedback without in-depth assessment for the students. However, feedback in time or with more depth would be important to help students to improve their performance. Supervised feedback may only be given with fewer delays or more depth if it can be scheduled more efficiently. There is a limit of how much optimization is possible, since staff member count and available time is limited. Alternatively peer assessment might be used [2]. Further optimization would be possible if fewer or no supervision would be required.

This can be part of a general virtual mentoring strategy, where the roles of virtual mentor agents resemble the roles of human mentors. Mentoring generally includes the role of knowledge and skill support [3], which can be called a training role. Automation can help to analyze the texts and give feedback so that the need for supervision can be reduced. This can reduce workload for mentors and supervisors as well as allow individuals in large groups of students to receive feedback in time and possibly in more depth. It also allows such individuals to receive additional feedback, that would otherwise require more mentoring resources, that are usually not available in conventional mentoring settings due to financial, human or organizational constraints.

Approaches in the educational field have been made with the Text-Model Inspection Trace of Concepts and Relations

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(T-MITOCAR) software package [4]. It allows teachers to visualize association graphs of the work of students. These association graphs can be used to detect the coverage of knowledge. As an extension for the context of scientific work at universities this paper proposes the use of text analysis by T-MITOCAR not only for the scientific work itself but also for the used references so that coverage of these references can be analyzed.

T-MITOCAR expects plain text as input, therefore format conversion is required beforehand. Additionally, scientific work is different to school work in the way that it may use multiple columns or complex layouts, which requires transformation into running text. Conversion and transformation can be consolidated into one processing task. With further unification of upload, processing and assessment it is possible to avoid media disruptions and to present a seamless platform. Integration into running Learning Management Systems is a missing piece in existing implementations.

### A. Contributions

Our vision is, that automated feedback for scientific writing can be generated by sophisticated text analysis. In order to achieve this, two requirements must be met: technical feasibility of a unified platform and fitness of T-MITOCAR for relevant feedback generation. While the fitness of T-MITOCAR for the purpose of automated assessment shall be evaluated in future work, this paper concentrates on the technical feasibility of a unified platform and contributes to the following objectives in this context:

- Definition of an interface for text transformation of journal layouts to running texts
- Definition of an interface for the utilization of T-MITOCAR for text analysis and assessment
- Unification of upload, processing and assessment to a seamless platform
- Integration into running Learning Management System

These contributions will be demonstrated through a proof-of-concept implementation.

The paper will continue with a presentation of related work about T-MITOCAR and then show the concept and the

description of the prototype implementation for the new tool design. In the conclusion, all achievements will be stated and limitations as well as the future outlook discussed.

### B. Related work

Before the concept and the implementation is described, related work is discussed. Pirnay-Dummer and Ifenthaler already recognized the important role of writing in “institutionalized learning environments” and developed a tool set to “produce instant feedback on semantic and structural aspects of the text” [5, pp. 217-218]. They developed the T-MITOCAR tool set, which originally gave graphical feedback, as well as web- and text-based prototypes like TASA [5, pp. 218] or AKOVIA [6] based on parts of the tool set.

They point out that limitations exist regarding the target language, for which currently only German or English is supported. Also, the algorithms might produce skewed results if improper grammar or unrecognized synonyms are used [6, pp. 245].

As T-MITOCAR only accepts plain text as input, text conversion and transformation tools are required. Existing tools in this field, that might support this task, include the GeneRation Of Bibliographic Data (GROBID) library for producing structured documents out of raw documents [7]. Such structured documents can be used to produce running plain text with the relevant parts and in the correct order.

In addition to pure knowledge assessment, T-MITOCAR and AKOVIA was also suggested for grading purposes, for which significant correlations were present for certain subjects [8].

For our use case parts of the T-MITOCAR tool set are planned to be used for the purposes of virtual mentoring in the sense of a training role. That use case will be described in the following chapter in more detail along with a concept for the whole system design before the paper will move on to the proof-of-concept implementation.

## II. CONCEPT

This section shows the use case and the tool design. Our use case is centered around a student, who uploads a self-authored scientific report along with references and receives feedback for further improvement. This is a usual part of seminar courses, which train the student how to do scientific work.

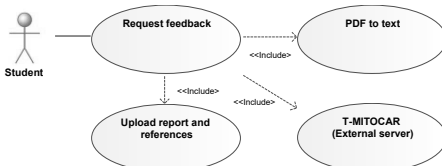


Fig. 1. Use case diagram.

The use case diagram in Fig. 1 shows that the only human actor involved is the student, thus no human supervision will be required. When the student requests feedback, the system must handle three activities: upload of the scientific report and associated references, the conversion of provided documents from the widely-used portable document format (PDF) to raw text and finally the utilization of T-MITOCAR running on an external server to acquire the feedback, which will be composed based on the result by T-MITOCAR.

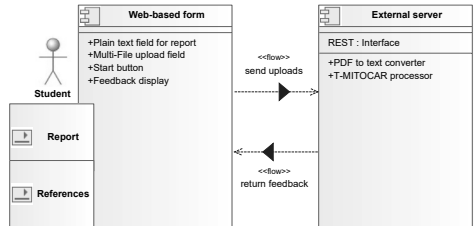


Fig. 2. System overview.

Fig. 2 shows the system which is composed of two components. First component is a web-based form shown to the student of our use case. It takes the report and references as input and will eventually show the feedback to the student.

Learning Management Systems like the Online Platform for Academic Teaching and Learning (OPAL) provide integration interfaces for which the standardized Learning Tools Interoperability (LTI) standard was established [9]. This interface makes it possible to run custom web-based software and have it available as course elements.

An external server is considered as second component and responsible for processing and feedback generation.

The whole process handled by this system can be divided into five steps: upload of documents, conversion of PDF to text, assessment by T-MITOCAR, and finally the feedback generation and display. No media disruptions will be caused as upload and feedback display will be all in digital form. After upload, the web based form will send the input data to a thin controller with the only responsibility to forward the data to the processing controller residing on an external server from which it will receive the answer. This processing controller will therefore be solely responsible for processing, assessment and feedback generation. Feedback display will be executed by the web based form as soon as the answer is received. PDF to text conversion transforms documents from PDF to raw text and converts the layout to a running text only previously divided into meaningful paragraphs. Based on this transformed text, T-MITOCAR can create association graphs for evaluation of the coverage of scientific fields and the used references. It would also be possible to apply further measures on the text. Feedback will be constructed and selected in the final step using the assessment results. While T-MITOCAR

will not generate text-based feedback by itself, the result of T-MITOCAR will be used to generate such feedback.

In the next chapter, a prototype implementation of this concept is described in more detail. The prototype will have integration into a running Learning Management System and interfaces prepared for interaction with the future implementation of the external server.

### III. IMPLEMENTATION

In order to demonstrate the achievement of the defined objectives, it is required to proof the concept of a seamless automated platform by a prototype implementation. It is required to demonstrate, that the resulting tool has working interfaces for future connection to the processing server, that will handle transformation of the text and utilization of T-MITOCAR, and that the tool can be integrated into a running Learning Management System, which will be shown in the following.

The implementation follows the components and steps of the concept. The first step of the concept is realized as a web-based form. It allows the user to submit the report in plain text form and the references as PDF. The user should have access to the plain text of his work so that there is no need to do a transformation of the text for his own work. Only the references must be transformed into running text. The thin controller, which is the server running the web-based form, for accepting the user upload is realized in the script language PHP. An important part of the thin controller is the role as a tool provider with LTI interface. It will handle the LTI authentication and save the user data into a session, while also a database is required to save some information during authentication.

Provide scientific report

Abstract... Automated assessment in the context of education has a need for processing and assessment of scientific writing without human supervision. This paper aims to demonstrate a way to integrate a text processing and analysis component into a running Learning Management System for individual but automated feedback generation. It combines the field of distributed systems and web engineering with text analysis technologies. The resulting proof of concept enables rapid roll-out of this tool into test beds for further research.

Upload references  
 11 files

Feedback

Overall good performance, but you should focus more on lorem ipsum.

Fig 3. Web-based form

Fig. 3 shows the web-based form with the input and upload fields as well as the start button. As soon as the student clicks on the button the data will be submitted and the thin controller will prepare a request encoded as JavaScript Object Notation (JSON) with the report encoded as string and the files encoded as Base64 to be binary safe. The request is sent to an external controller which will execute the other steps and generate the feedback. Execution of processing, assessment and feedback generation is done sequentially with the proper tools. T-MITOCAR is not integrated yet, but the interface is working and will serve a static but similar feedback to that expected from T-MITOCAR for demonstration purposes. This is sufficient to demonstrate technical feasibility. Finally, the feedback is sent back to a callback Uniform Resource Identifier (URI) which will have the feedback attached in the query string. The web-based form will display the attached feedback to the user.

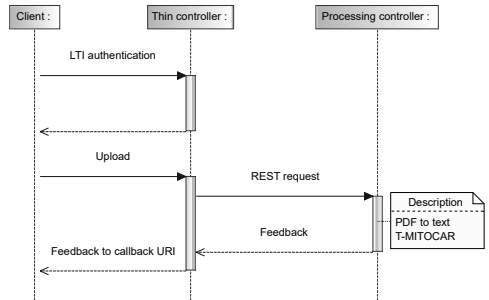


Fig. 4. Communication flow.

The diagram in Fig. 4 shows the flow between the user end-point, the thin controller and the processing controller. Interaction with the database has been neglected for simplification. The Representational State Transfer (REST) request looks as follows. It has been defined as a JSON-based structure:

```

1: {
2:   "action": "generate_feedback",
3:   "payload": {
4:     "user": "...",
5:     "report": "...",
6:     "references": [...],
7:   }
8: }
    
```

Fig. 5. REST request.

It follows the Remote Procedure Call (RPC) pattern for JSON where an action or method is defined and several parameters are attached. The parameters shown in Fig. 5 in this case are the user (ID), the report in plain text and the Base64 encoded references as an array of strings. This allows for

future compatibility with emerging JSON-based web service protocols or standards like JSON-WSP [10] or JSON Hyper Schema [11].

With the information provided, an external server could process the report and references, generate feedback and send it back. Having achieved this proof-of-concept implementation with an actual user interface shown in Fig. 3 and a working back end implemented as described above, it is now possible to discuss the result and the future outlook.

#### IV. RESULTS

We defined four objectives in the introduction which are required to show technical feasibility of a unified platform that itself is a requirement to achieve our vision of automated feedback for scientific writing by sophisticated text analysis.

All objectives defined in the introduction have been achieved and demonstrated through the proof-of-concept implementation. Our first objective was to define an interface for text transformation. This was defined in the concept and evaluated in the prototype. A user can pass uploads to an external processing controller, which could be running the transformation. The second objective was also to define an interface, but for the utilization of T-MITOCAR. Again, this was defined in the concept and evaluated in the prototype. After text transformation, any upload can be passed to T-MITOCAR on the external processing controller for analysis. With the developed prototype, all defined process steps are unified to a seamless platform, which was the third objective. Integration into OPAL via LTI was successful, so that it can be demonstrated, that integration into running Learning Management Systems works, which fulfills the fourth and last objective. This shows the technical feasibility of a unified platform for automated feedback for scientific writing and allows proceeding with our vision.

#### V. FUTURE WORK

Future work is planned to prove that T-MITOCAR can provide useful results for automated feedback generation. In relation to this, it is planned to research application of this tool for computer science courses in test beds with real students. This highlights another open question: compliance with data protection law must be evaluated before use on real subjects to ensure lawfulness of the tool. This includes the identification of transmitted data as well as mechanics to gather consent of subjects if needed.

There are possible limitations that might affect future use of this tool. Apparent limitations will be the already pointed out limitations by T-MITOCAR and additionally the problem, that quality of references is not checked. An additional check should be implemented in the future to improve the result. This could be assisted by a white or black list of publishers, by patterns for the use of different types of references or similar metrics. Other metrics, including those acquired through machine learning technologies, might be applied as well in the future in addition to the results acquired through T-MITOCAR. The processing server should provide interfaces or hooks to

enable plugins for further application of metrics. Also, the suitability of T-MITOCAR for different scientific areas should be evaluated.

#### VI. CONCLUSION

Despite the future work in mind, the current resulting work is ready to be used for rapid roll-out of this tool base into test beds. It provides the basis to spawn several tool sets with integration into running Learning Management Systems. With this basis, further research is possible and will be more efficient.

#### ACKNOWLEDGMENT

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# Development of a device for photodynamic therapy

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**Abstract**—The paper presents the design of a new experimental veterinary device for photodynamic therapy. The main objective of the work was the development of a compact and inexpensive device capable of working with several types of photosensitizers, in conditions of livestock buildings. To achieve this goal, the developed device has LED emitters with wavelengths of 660, 620, 430, 395 nm and a power of 55 mW / cm<sup>2</sup>. The developed device was manufactured and tested on the strain *Staphylococcus aureus*. When using the methylene blue dye as a photosensitizer, it was found that the effectiveness of its bactericidal action is comparable with antibiotics.

**Keywords** — antibiotic resistance, photodynamic therapy, methylene blue dye, optical radiation, veterinary medicine.

## I. INTRODUCTION

The spread of multiple antibiotic resistance among pathogenic microorganisms forces research in the field of new methods of treating infectious diseases. One of such methods is photodynamic therapy, based on the use of photosensitive substances (photosensitizers) and optical radiation (1). Photosensitizers are substances capable of dissociating upon absorption of optical radiation with a specific wavelength, thus forming free radicals with a cytotoxic effect; this property is used in the treatment of cancer and certain infectious diseases (2,3). This promising treatment method is currently used in veterinary practice in isolated cases or only for experimental purposes, which is largely due to the low distribution and high cost of specialized equipment for conducting irradiation based on laser sources. The closest devices for veterinary use are Thor Photomedicine inc., However, they use radiation with a wavelength of 660 nm, 810 nm and 850 nm, which is not enough for photodynamic therapy (4).

The solution to this problem can be the development of a simple and inexpensive device for photodynamic therapy using LED as a radiation source with a different wavelength.

## II. DESIGNING A NEW DEVICE

The aim of this work is to develop a prototype veterinary device for photodynamic therapy. As a result of this work, a prototype device was manufactured. The block diagram of the device for photodynamic therapy is presented in Fig. 1.

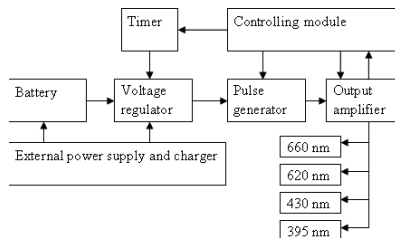


Fig.1 The block diagram of a new device

The device is designed for photodynamic therapy using photosensitizers, as well as phototherapy without them. The device is designed to work with various types of photosensitizers, which is ensured by the presence of irradiators with the necessary wavelengths: 660 nm, 620 nm, 430 nm, 395 nm, built on the basis of LEDs. The most suitable for the device photosensitizers will be the following: Phenothiazines (absorption spectrum 620-660 nm): methylene blue, toluidine blue.

- Chlorine-containing (absorption spectrum 620-660 nm): chlorin e6, "Photoditazine", "Photolon".
- Acridines (absorption spectrum 400-500 nm): proflavine, ethacridine, aminoacridine, acridine orange.
- Preparations based on chlorophyll (absorption spectrum 390-465 nm and 650-690 nm): chlorophyllipt, galenofillipt)

The device is built using CMOS-digital logic circuits. Provided for the modulation of optical radiation with frequencies from 0 to 25 000 Hz. To limit the duration of work in the design provides a digital timer. The power supply of the device is from an alternating current network of 220 volts, as well as from an autonomous source - a built-in lithium battery. Climatic version - for cold and temperate climate, allows operation in conditions of polluted rooms with high humidity. The assembled device is presented in figure 2.



Fig.2 The block diagram of a new device

To determine the effectiveness of the manufactured device, we have done laboratory tests.

### III. MATERIALS AND METHODS

We used a 0.1% solution of methylene blue dye in distilled water, which has an absorption spectrum of optical radiation in the range of 618-668 nm.

Bacteriological studies used a LED irradiator with a wavelength of 620 nm and an output power of 1500 mW., a field strain of *Staphylococcus aureus*, a set of disks with antibiotics to determine antibiotic resistance. Also used similar disks with methylene blue, made independently.

In the course of the experiment, continuous sowing of the strain *Staphylococcus aureus* was carried out, then disks were placed on the surface of the nutrient medium: in the first experimental group — disks with antibiotics, in the second — disks with methylene blue without subsequent irradiation, in the control group — disks with methylene blue and subsequent irradiation for 10 minutes. After incubation period, then the diameter of the zone of growth inhibition of microorganisms was measured, the results were statistically processed.

### IV. RESULTS

In this experiment, an increase in the diameter of the zone of growth inhibition of *Staphylococcus aureus* was found in the control group after exposure to optical radiation with a wavelength of 620 nm. The results are presented in table 1.

TABLE I. DIAMETER OF THE ZONES OF GROWHT INHIBITION

Group	Diameter of the zone of growth inhibition		
	Type of drug	M±m (n=5)	Difference with control, %
Control	Methylene blue with radiation	3.4±0.36	-
first experimental	Streptomycin	3.12±0.23	8.24
	Ampicillin	2.76±0.49	18.82
	Amoxicillin	3.36±0.51	1.2
	Gentamicin	4.46±0.41	-36.47
	Levomyectin	4.24±0.24	-24.7
	Tylosin	3.28	-3.53
second experimental	Methylene blue without radiation	2.34±0.09*	31.17

\*p<0.05

From the above data it follows that the solution of methylene blue dye, even without irradiation, has a slight antimicrobial effect. Irradiation of the solution significantly

increases its antimicrobial properties, in this case 31.17%. The antimicrobial effect of irradiated methylene blue discs is 8.24% higher than streptomycin, 18.82% ampicillin and 1.2% amoxicillin, but significantly less than gentamicin, levomyectin and tylosin. The fig. 3 presents the result of the action of methylene blue dye as a photosensitizer.



Fig.3 Result of the photosensitizer action

Fig. 3 shows the absence of the growth of *Staphylococcus aureus* colonies in the left Petri dish after exposure of the methylene blue dye to optical radiation with a wavelength of 620 nm is noticeable. In the right Petri dish, which was not irradiated, the growth of *Staphylococcus aureus* colonies is visible.

### V. CONCLUSION

Designed for veterinary use, the device showed high efficiency in laboratory conditions. Thus, the developed device can be used together with methylene blue dye as a photosensitizer, in photodynamic therapy of diseases caused by *Staphylococcus aureus*.

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# Effect of Teachers Beliefs about Using OER on Their Teaching Practices

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**Abstract**—Mongolia is the country with least density in the world (1.92 persons per kilometer) and hence the role of Open Educational Resources (OER) is very important. In this research we summarize the results of our survey taken from about six hundred teachers of Mongolia on their usage of OER. In the result of this research we found several important observations: teachers use OER in their teaching activities independent from their location of living, teachers use many popular sources to find useful information in Mongolian language.

**Keywords**—level of usage for sources, level of engagement with OER, using OER, adoption of open licensing for OER, teacher beliefs about using OER, work related advantages, student related advantages

## I. INTRODUCTION

Mongolia is a country with the least population density in the world of 1.92 persons per each kilometer square. Moreover there is a larger portion of young generation under 35 years old in total population.

The country is divided administratively into 21 provinces (aimags) and the capital city Ulaanbaatar. Each aimag divided into subprovinces or districts which is called soums in Mongolian. Ulaanbaatar city is divided into 9 districts. Total number of soums is 329.

The education system of the country is composed into preschool, primary school, secondary school, high school and university education. Totally, there are 729 elementary, secondary and high schools in the country while 96 higher education institutions. The school enrolment rates are high in all level of education with low illiterate rate. However, there are not enough sources of evidence to conclude the quality of education system of the country.

The education system of the country is centrally planned and the Ministry of Education, Culture and Science together with supporting agencies are responsible for developing, implementing and assuring the quality of all pre-university level of education, and professional development of teachers. One of these supporting agencies is the Institute of Teachers Professional Development (ITPD) which provides various teacher professional support services for teachers of all level of education in the country.

A new school curriculum was developed and introduced for the primary level in 2014, and for the lower secondary and preschool levels the new curricula were prepared in 2014 and piloted in 2015. Upper secondary curricula were developed in 2015 and piloted from 2016. However new curricula adopted for preschool, primary and secondary level educations do not yet define through policies, programs or instructions, how OER can be integrated into teaching. But having infrastructures for OER at certain levels and the

accumulation of OER in Mongolia is advantageous and gives some hope for the future. Moreover, teaching instructions and textbooks for each subject at each level are openly available for students, teachers and parents. These resources will support the implementation of the approved curriculum. Open lessons and resources provided by ITPD and Moodle based online training for preschool and school teachers working at the 1st, 5th, 10th and 15th years are very important tools for teachers to develop continuously in their workplace, understand changes and challenges of curricula, and implement the curricula.

On the other hand, the Ministry of Education publishes and prints textbooks for all grades and subjects and owns the copyright (econtent.edu.mn). Currently 168 textbooks are available online for students, teachers, parents, schools and other stakeholders. Moreover during the 2013-2014 school year the Ministry of Education financed complete lesson packages for Mathematics and Natural Science for each grade of secondary and high school levels. All these materials were developed jointly by school teachers and some private companies. Currently open educational resources on more than 140 interactive packages of Math, Physics, Chemistry and Biology for grade 8-12 students are available in the Mongolian language on the website. The website also contains numerous video lesson packages and handbooks for elementary school teachers. Preparation of these video lessons and teacher handbooks was financed by the JICA project.

In this research we will present some brief results of the survey which conducted in the beginning of the school year 2018-2019. We studied teacher's beliefs and attitudes toward following two points:

- Use of OER for improvement of Curriculum and teaching methodologies,
- The advantages in using OER.

The survey covered 598 teachers of various subjects.

## II. LITERATURE REVIEW IN BRIEF

A common theme in the open educational resource literature was that educators were still at early stages of awareness and adoption of these resources [1], [2], [3]. Many educators were described in the study as unknowingly using open resources (such as images, Wiki articles, and other openly licensed Internet resources) without necessarily labelling them OER [4]. The skills of teacher to find useful resources and use of these materials for their needs are fundamental for integration of OER in teaching.

Many studies have been done on how ICT-based learning affects student learning approaches and attitudes. First, we cite some results of these studies.

Some researchers investigated differences between students' self-regulated learning strategies which are cognitive learning strategies (rehearsal, organization, elaboration, critical thinking), metacognitive learning strategies, time-resource management strategies (time and study environment strategies, peer learning strategies, help seeking strategies) in traditional and non-traditional mathematics classrooms [5]. The research was done in 2014 and 131 students participated in this study. The results of the study implied that students who participated in an ICT-based Mathematics course had more effective use of various learning strategies including organization, elaboration and critical thinking. Students in both traditional and non-traditional classrooms used rehearsal strategies more frequently, but there was no significant difference. Also, this research found that students who participated in the ICT-based course used more desirable metacognitive learning strategies and more effectively managed the learning environment and created study schedules, and sought help more often than students who participated in the traditional classroom. This research implied that if teachers effectively manage their teaching strategies in the ICT based Mathematics course then students may use more powerful cognitive, metacognitive learning strategies, and more appropriate time and resource management strategies.

An empirical study was conducted with more than 500 primary school teachers from diverse locations across the country and looked at two aspects of education practices, teacher training activities and practical ICT experiences at school level, and investigated their relationships to three domains of perceived self-efficacy, confidence, competency, and satisfaction, within the primary school teachers in Mongolia [6]. The study found that school-based training is associated with higher self-efficacy among different levels of teacher training activities. The study also found that positive institutional attitude toward ICT integrated education is important for teachers' high self-efficacy. Two points are suggested as implications of the study. First, planning ICT related trainings at school level, especially employing peer-learning, should be a priority. Second, including training sessions for school managements to provide them with a broad understanding of the pedagogical value of ICT is a critical strategy. Few studies have been conducted about OER in Mongolian context.

### III. METHODOLOGY

#### A. Sample

An empirical study was conducted with more than 500 primary school teachers from diverse locations across the country and looked at two aspects of education practices, teacher training activities. For this reason, in the beginning of the school year 2018-2019 we studied opportunities for teachers to find OER in their mother language and how they might use the OER. The survey covered 598 teachers of various subjects.

If we look at the locations of teachers:

- 45.8% were rural teachers,
- 29.2% were teachers from centers of provinces
- 25.0% were from Ulaanbaatar.

Age of respondents was:

- 11.2% (67) younger than 25 years old,
- 25.1% (150) between 25-29,
- 34.3% (205) between 30-39,
- 20.4% (122) between 40-49,
- 8.2% (49) older than 50.

#### B. Measurement

Respondents assessed possibilities to find useful OER from following sources with scores between 1-5 (1 = Impossible, 2 = Less, 3 = Neutral, 4 = possible, 5 = very possible). The sources are: Facebook, Google, Slide Share and Prezi, Blogs, YouTube, Web site of ITPD, Web site of MIE, MECS site [econtent.edu.mn](http://econtent.edu.mn), Web site of EEC.

In order to measure the level of use of OER in teaching practices we used 6 questions with 5 responses where 1 = Don't use, 2 = Less, 3 = Neutral, 4 = Good, 5 = Very good. Questions are following: To improve theoretical knowledge (TU1), to improve teaching methodology (TU2), to understand change in curriculum (TU3), to assess students (TU4), to prepare lesson resources (TU5), to use resources directly in the lessons (TU6).

Level of OER engagement measured by a question "How often do you use OER for classes?" with 5 responses where 1 = once a week, 2 = once two weeks, 3 = once a month, 4 = once a period, 5 = never. And, teachers' beliefs about the work-related advantages and student-related advantages in using OER measured by corresponding 5 and 4 questions with 5-likert scale.

#### C. Data analysis

Descriptive statistics were used to provide a general picture. The Kruskal-Wallis test was used to clarify differences due to age, living places and engagement levels. The SPSS 19 statistical program was used for analysis.

## IV. RESEARCH RESULTS

#### A. Use of OER for Improvement of Curriculum and Teaching Methodologies

First we tested what OERs are most used by Mongolian teachers and for what purpose they are using.

Respondents assessed possibilities to find useful OER from following sources with scores between 1-5 (1 = Impossible, 2 = Less, 3 = Neutral, 4 = possible, 5 = very possible). The sources are:

- 1) Facebook (R1),
- 2) Google (R2),
- 3) Slide Share, Prezi (R3)
- 4) Blogs (R4)
- 5) YouTube (R5)
- 6) Web site of ITPD, [itpd.mn](http://itpd.mn) (R6)
- 7) Web site of MIE (R7),
- 8) MECS site, [econtent.edu.mn](http://econtent.edu.mn) (R8)
- 9) Web site of EEC, (R9).

Here we coded Facebook, Google, Slide Share or Prezi, Blogs, YouTube, Web site of ITPD, Web site of MIE,

MECS site econtent.edu.mn and Web site of EEC as R1, R2, R3, R4, R5, R6, R7, R8 and R9, respectively.

Looking at the average usage ranking of each sources, the ranking of teachers under the age of 35 is the highest. So, we tested the difference in the average rank of usage of the source based on the age of the teacher. In order to clarify these differences, we used Kruskal-Wallis test and the following tables show results of this analysis.

As results of Kruskal-Wallis test, the average rank of use for Slide share, blog, websites of ITPD and MECS the differences are statistically significantly depending on the age of the teacher. However, the mean rank of use for Facebook, Google, YouTube, web sites of EEC and MIE is still high for younger teachers, but there is no significant difference. Thus, although the average ranking used for some sources varies with age, there is the advantage that the teachers use many popular sources to find useful information in the Mongolian language.

TABLE I. ANALYSIS OF AGE DIFFERENCES FOR USING SOURCES

	R1	R2	R3	R1	R2	R3	R1	R2	R3
Chi-square	3.8	8.9	24.2	16.6	7.3	16.3	7.6	14.8	7.8
Df <sup>a</sup>	4	4	4	4	4	4	4	4	4
Asymp. Sig. <sup>b</sup>	.43	.06	.00	.00	.12	.00	.11	.01	.10

<sup>a</sup> degrees of freedom

<sup>b</sup> Asymptotic significance

As results of Kruskal-Wallis test, the average rank of use for Slide share, blog, websites of ITPD and MECS the differences are statistically significantly depending on the age of the teacher. However, the mean rank of use for Facebook, Google, YouTube, web sites of EEC and MIE is still high for younger teachers, but there is no significant difference. Thus, although the average ranking used for some sources varies with age, there is the advantage that the teachers use many popular sources to find useful information in the Mongolian language.

Previous studies concluded that the lack of educational resources is often problematic in locations and along some groups. Rural communities generally have poorer physical infrastructure and internet connectivity. Teachers in urban areas have more opportunities for teacher professional development and are thus better placed to develop new pedagogical knowledge and skills. They also more likely to have access to personal digital devices and computer labs in which to practice technologically enabled educational innovation.

We compared the average usage rankings to identify spatial differences in teacher usage rankings for each source. As results of comparative studies, Slideshare, Blogs, and YouTube will have a higher rank for UB and province center teachers. For other sources, rank of use is not different depending on location. It is important for teachers to use the most popular information sources to obtain information in their own language regardless of location.

We also asked whether teachers search and use OER in foreign languages. The average ranking of use OER in foreign languages depends on the location, which is high for teachers from UB and lowest for rural teachers.

Few studies focused on teachers' usage of OER in teaching and learning. In order to check the level of use of OER in teaching practices we used several questions with 5 responses where 1 = Don't use, 2 = Less, 3 = Neutral, 4 = Good, 5 = Very good. Questions are following:

To improve theoretical knowledge (TU1), to improve teaching methodology (TU2), to understand change in curriculum (TU3), to assess students (TU4), to prepare lesson resources (TU5), to use resources directly in the lessons (TU6).

We provide a general picture of how teachers use OER in their lessons in the following table.

TABLE II.WAYS THAT OER IS INTEGRATED INTO TEACHING PRACTICES

Code	Statement	Rate 1	Rate 2	Rate 3	Rate 4	Rate 5
TU1	To improve theoretical knowledge	2.7% (16)	18.7% (112)	33.4% (200)	36.5% (218)	8.4% (50)
TU2	To improve teaching methodology	2.7% (16)	14% (84)	29.8% (178)	42.8% (256)	10.5% (63)
TU3	To understand curriculum change	3.0% (18)	17.1% (102)	29.4% (176)	39.3% (235)	11% (66)
TU4	To assess students	4.7% (28)	17.2% (103)	33.1% (198)	35.5% (212)	9.4% (56)
TU5	To prepare lesson resources	1.7% (10)	11.7% (70)	25.4% (152)	42.6% (255)	18.4% (110)
TU6	To use resources directly to lessons	5.4% (32)	20.2% (121)	32.8% (196)	31.1% (186)	10.4% (62)

From this table, we can see that percentage of responses 1 (don't use) is very low or less than 6%. On the other hand, total percentage of responses 4 and 5 is more than 40%. The percentage of teachers who use OER in less or medium level is in between 37.3%-53.2%.

Analysing the result of Kruskal-Wallis test, we are able to say that teachers use OER in their teaching activities independent from their location of living and this is also advantageous from the point of view of geography and population density of Mongolia.

### B. The advantages in using OER

There was a lack of evidence of the effectiveness of OER. Educators considering a shift in their practice were interested in evidence about whether or not OER resulted in improved learner and teacher outcomes. The advantages of the usage of OER are manifold.

To check the level of OER engagement we used a question "How often do you use OER for classes?" with 5 responses where 1= once a week, 2 = once two weeks, 3 = once a month, 4 = once a period, 5 = never. One of the 598 teachers who participated in the survey did not respond and the survey results are shown in the following table. Here we coded the responses as given in the table.

TABLE III. LEVEL OF ENGAGEMENT WITH OER

Code	Responses	Percent
E1	Once a week	1.5 % (9)
E2	Once two week	12.4% (74)
E3	Once a month	31.8 % (190)
E4	Once a period	33.2% (198)
E5	Never	20.9 % (125)

From this table, we conclude that teachers' frequency of OER use is low. Teachers' goals have a significant impact on their motivation and engagement. The low frequency may depend on the purpose of the teachers. For examples, there may be goals such as only career advancement and taking part in a competition or contest. On the other hand, there may be little support from management and school. There are currently no studies on factors affecting the optimal use of OER and OER adoption. Therefore, further research is needed to implement policies and programs to improve public interest, attitudes, knowledge and understanding about OER.

What advantages do you see in using OER for you and your students?

To clarify teachers' beliefs about the work-related advantages in using OER we used 5 questions with 5-likert scale. The result of the response is shown in the following diagram.

In order to get picture on teachers' beliefs about work related advantages in using OER in their lessons, here we compared percentage of responses 1 (strongly disagree) and 2 (disagree) against the percentage of responses 4 (agree) and 5 (strongly agree). Table 4 shows the percentage of teachers who rated 1 and 2; 3; also 4 and 5. The used statements are abbreviated as WRB1, WRB2, WRB3, WRB4, and WRB5.

TABLE IV. TEACHERS' BELIEFS ABOUT WORK RELATED ADVANTAGES

Code	Statement	Percent (n) (1 and 2)	Percent (n) (3)	Percent (n) (4 and 5)
WRB1	It makes lessons interesting	14.5% (87)	30.1% (180)	55.4% (331)
WRB2	Saves time for preparation	14.2% (85)	31.5% (188)	54.3% (325)
WRB3	Gives possibilities to scope with each students pace	23.9% (143)	38.1% (228)	38.0% (227)
WRB4	Using OER allows the class to be accessible to students	15.1% (90)	34.6% (207)	50.3% (301)
WRB5	Using OER is beneficial to the teacher's work.	13.04% (78)	31.94% (191)	55.02% (329)

In order to clarify teachers' beliefs about the student related advantages in using OER we used 4 questions with 5-

likert scale. The result of the response is shown in the following diagram. Table 5 shows the percentage of teachers who rated 1 and 2; 3; also 4 and 5. The used statements are abbreviated as SRB1, SRB2, SRB3 and SRB4.

TABLE V. TEACHERS' BELIEFS ABOUT STUDENTS LEARNING AND MOTIVATION

Code	Statement	Percent (n) (1 and 2)	Percent (n) (3)	Percent (n) (4 and 5)
SRB1	Student participation increases	15.9 % (95)	32.1 % (192)	52.0% (311)
SRB2	Improve student's learning strategies	15.7% (94)	34.3% (205)	50.0% (299)
SRB3	OER helps students to do their homework more creatively	18.6% (111)	37.1% (222)	44.3% (265)
SRB4	I believe that OER have positive effects on student achievement.	10.0% (60)	35.1% (210)	54.9% (328)

If we look at the mean rank of OER integrating into teaching practices, teacher beliefs regarding the use of OER by engagement levels, the ranking for teachers with high engagement is highest (See Appendix 3, 4 and 5). So we studied the average ranking differences which are OER integrating into teaching practices and the teachers' beliefs about using OER at the teachers' engagement levels. In order to clarify these differences, we used Kruskal-Wallis test and the following tables show results of these analyzes.

TABLE VI. ANALYSIS OF MEAN RANK DIFFERENCES FOR OER INTEGRATED INTO TEACHING PRACTICES

	TU1	TU2	TU3	TU4	TU5	TU6
Chi-Square	80.4	119.2	81.3	84.3	116.2	76.9
Df	4	4	4	4	4	4
Asymp. Sig.	.000	.000	.000	.000	.000	.000

TABLE VII. ANALYSIS OF MEAN RANK DIFFERENCES FOR TEACHERS' BELIEFS ABOUT USING OER

	WRB1	WRB2	WRB3	WRB4	WRB5
Chi-Square	113.4	105.6	79.7	112.6	136.2
Df	4	4	4	4	4
Asymp. Sig.	.000	.000	.000	.000	.000

	SRB1	SRB2	SRB3	SRB4
Chi-Square	131.1	133.7	116.6	134.1
Df	4	4	4	4
Asymp. Sig.	.000	.000	.000	.000

As results of Kruskal-Wallis tests, the average rank of all the characteristics that are integrated into teacher training and the teacher's beliefs regarding the use OER are statistically significantly depending on the engagement level of the teacher. In other words, all the characteristics of the teacher are higher with the higher involved teachers. Therefore, it is important to provide comprehensive OER teaching materials to the teacher and to focus on improving attitudes and awareness towards all levels of the OER community.

At the international level, much research has been done on the relationship between OER integrated teaching methodology and student characteristics (student's attitude towards learning, motivation, learning strategy). However, in Mongolia, this type of research is not enough. In the future, studies on attitudes, beliefs, awareness of the students on OER, factors affecting student characteristics, and relationships among these variables are necessary.

## V. DISCUSSION AND CONCLUSION

We give our conclusions and proposal for future work for each of the factors.

### A. Use of OER for improvement of Curriculum and teaching methodologies

The use of OER in order to integrate curriculum and teaching methodologies has several opportunities, advantages and disadvantages.

#### Opportunities and advantages

- Lower density of population and sparsely distributed in a large land area
- Younger average age of population implies also younger average age of teachers (about 73% percent of teachers are working less than 15 years)
- Infrastructure of OER is set for a specific level and the country is still continuing the policy to develop the infrastructure.
- Most parts of the population are using smartphones and connecting to the Internet via smartphones.
- Accumulation of OER is the result of government, institutional and private initiatives to date.
- Teachers tend to use OER from various sources in specific education levels.
- Teachers tend to use OER in their teaching activities at specific levels.

#### Disadvantages

- Uneven, disorganized supply
- Incompatible policies and lack of incentives (OER and curriculum, teaching and learning)
- Lack of OER standards
- Use of OER in foreign languages is low
- Limited proof of effectiveness
- Less attractiveness of public interest, awareness, and understanding

- Sufficiency of technology, equipment's and the Internet is still in question especially in rural communities.

Looking into opportunities, advantages and disadvantages the MECSS need to emphasize on the following issues.

- To organize activities in order to provide complete OER for basic subjects in preschools, schools and basic courses in universities.
- Supportive policies that remove restrictions on OER funding and implementation and that provide incentives for OER adoption
- OER sustainably integrated into education
- Adoption of OER that improve teaching and learning
- OER adapts to new transformations in technology (e.g., mobile phones, tablets, etc.)
- See OER as one strong tool to defeat poverty in the country.

### B. The advantages in using OER

Based on our survey results we conclude that it is important to initiate an ambitious national project which will supply comprehensive OER teaching materials for pre-university school teachers and implement policy on improving positive attitudes and awareness towards OER in the wider communities in the country.

At the international level, much research has been done on the relationship between OER integrated teaching methodology and student characteristics (student's attitude towards learning, motivation, learning strategy). However, for the case of Mongolia, this type of research is not enough. In the future, studies on attitudes, beliefs, awareness of the students on OER, factors affecting student characteristics, and relationships among these variables are crucial.

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# Influence of Using Information and Communication Technology (ICT) on Grade VIII Students' Science Learning at Junior Secondary Level in Dhaka City

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**Abstract**—At present, Information and Communication Technology (ICT) has evolved a new era in education sector of Bangladesh. It is hoped that ICT will assist for effective learning of students and change the teaching approach from teachers centered to students-centered learning. This study aims at determining ICT influences on grade VIII students' science learning. To find this answer, a convergent parallel mixed method design has been followed. In this design, students' view towards ICT use in classroom was explained using a quantitative survey instrument. Qualitative tools for example, observation schedule and focus group discussion were used to explore how ICT influences their learning.

For this study, four schools have been selected by purposive sampling technique as the purpose was ICT-supported schools. One hundred and two students have been selected from four schools by simple random sampling technique. For focus group discussion (FGD), 26 students have been selected from grade VIII by purposive sampling technique. To analyze quantitative data, descriptive statistical analysis has been done and qualitative data were analyzed thematically. The analysis showed that students have positive views towards ICT use in classroom. It has been revealed in this study that students get motivated through ICT and they learn better when they see moving pictures and videos by ICT. It is also found that teachers' lacking in pedagogy skills affects students' learning. However, ICT helps students to learn quickly, but the students want ICT along with hands-on activity and books also.

**Keywords**—Information and communication technology, Science learning and students' attitude.

## I. INTRODUCTION

Education is the prerequisite for the success of a country. However, many least developed countries remain far beyond the reach of quality education compared to other countries because of poor economic condition. In present world, Information and Communication Technology (ICT) is considered as one of the most effective components for the development of a nation. Different ICTs are now set to expand access to education, strengthen the application of education to the vast digital workplace, and raise educational quality by, among others, making teaching and learning into an engagement, learning process connected to real life [1]. The government of Bangladesh has taken initiatives to implement ICT to revolutionize the education system. With the successful implementation of ICT in the education system, the government can look at a greater participation of the country in the global information society. It is expected that ICT will have impact on the access, cost-effectiveness, and quality of

the education system too. The increasing digital device needs to be addressed by the informed and well administered implementation of ICT. ICT has been introduced in education with a belief that it can contribute to make learning attractive & interesting, encourage student-centered learning, & transform traditional classroom-based education into an innovative way of learning [2]. So, in this regard a question has arisen whether ICT-use in science classroom influences students' learning.

## II. PROBLEM STATEMENT

In Bangladesh, not all the teachers are comfortable with using ICT in classroom. Though they know how to use the device, but they have deficiency in pedagogy for using it which affects students' learning. According to [3], some teachers of Bangladesh do not feel comfortable in using ICT in classroom because of some technical problem with ICT; it hampers the lesson and it may affect students' learning. As ICT is a new tool to the students, sometimes they are more interested in ICT devices than the learning content. Reference [3] has also asserted that students' attraction to the ICT device interrupts teaching-learning activities. As a result, it can't be presumed that the use of ICT in classroom will assist students to learn science better. It is therefore, matter of concern that ICT can't be simply added to teaching and learning activities, just because the goals and the way of the teaching and learning science will change when ICT is used in education. It needs to make sure that ICT has a positive impact on students' learning.

## III. PURPOSE OF THE STUDY AND RESEARCH QUESTIONS

The purpose of this study was to find out what the students' views are on the use of ICT in science classroom & how ICT influences grade VIII students' science learning. In order to find out the answer the following research questions have been set:

1. What are the students' views on the use of ICT in science classroom?
2. How does ICT use influence students' science learning?

## IV. THEORETICAL FRAMEWORK

ICT stands for Information and Communication Technology and are defined as all e-technologies used in creating, storing, processing, communicating and disseminating information of



all kinds [4]. ICT includes Internet, wireless networks, telecommunications equipment and medium, information technology equipment and services, documentation centers, commercial information providers, and other related information and communication activities.

The integration of ICT into education has been assumed as the possibility of the new technological tools to change the traditional educational system [5]. Many researchers believe that ICT use can turn teaching learning activity from a teacher-centered into a learner-centered style and provides opportunities to improve information-reasoning skills, communication skills, higher thinking skills, creativity, and problem solving [6], [7].

Bangladesh has taken a vision-2021 to create a prosperous and digital Bangladesh within 2021. The objectives of National ICT policy 2009 [4] is to spread the quality of education all over the world, promote computer literacy at all levels of education and adopt ICTs through research and development. With this vision, Bangladesh has introduced ICT tools in every schools of the country.

In science teaching and learning, ICT tools can enhance its' both the practical and theoretical aspect [8]. Reference [9] asserted in a research report that ICT provide fast and accurate feedback to students, and speed up computations and graphing, freeing students to focus on strategies and interpretation. Reference [10] in a study found that teachers who have good access to computers, help students with a meaningful learning.

The tools that are usually being used in science class have the contribution to motivate students. For example, the visual & interactive features of ICT motivate students for learning by gaining their attention [11]. It is argued that students who use technologies, such as multimedia to present their own work show higher engagement in learning [2].

There are number of factors related to ICT that can influence students' learning. Reference [12], [13], [14] have developed a model to explain two kinds of factors. The first one is Non-Manipulative. These factors are not influenced by the schools, such as- Ages of students, Lack of & unreliability of equipment, Equity access to equipment, up-to-date hardware & software, etc. The second one is Manipulative factors. These factors are human ones that are manageable & changeable, such as-Students' view towards use of ICT. In this study, I have found out students' attitude towards ICT.

There are several studies stated that students' views has an impact on students' learning science. Reference [15] reported that negative attitude was a hurdle towards integrating ICT in teaching and learning. On the other hand, [16] found that positive attitude is prerequisite of effective use of ICT. It, therefore, appears that views of students towards using ICT in classroom may influence students' science learning and to get broader view of ICT-impact, it is necessary to consider students' perception.

## V. METHODOLOGY

Mixed method design has been followed in this study. There are six types of mixed method design. Among them this study

followed convergent parallel design considering the research purpose (See fig. 1). The purpose of a convergent parallel mixed method design is to simultaneously collect both quantitative and qualitative data, merge the data and use the results to understand a research problem [17]. In this study, quantitative data along with qualitative data has been collected and found the result after merging the data.

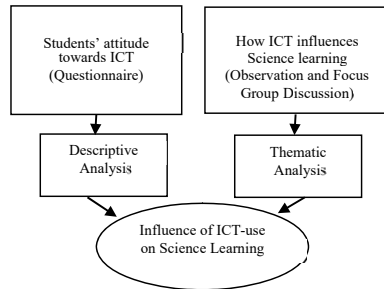


Fig 1. Research design of this study

The sample of this study was 102 students of grade VIII of four ICT-supported secondary schools in Dhaka city. These students have been selected by Simple Random Sampling from four schools. The four schools have been selected by using Purposive Sampling. The four science classes of Grade VIII of four secondary schools' science teachers have been chosen through convenience sampling to observe. 26 students have been selected through purposive sampling technique for focus group discussion. Each group has consisted 6-8 students.

A questionnaire has been designed for collecting quantitative data. This tool has been used for students to identify what the students' views are about using ICT in science classroom. A five point Likert scale has been designed for determining the answer. Here, scale 5= strongly agree (SA), 4= agree (A), 3=neutral (N), 2= disagree (D) and 1= strongly disagree (SD). In this questionnaire, there were two factors: Perceived usefulness of ICT and students' attitude towards ICT.

To explore how ICT use influences students' science learning, observation schedule has been prepared. The focus was to observe how students learn through ICT and how ICT influences their science learning. In this study, focus group discussion has been arranged for students to find out how ICT use influences students' science learning.

A descriptive statistical analysis has been conducted to analyze quantitative data. Microsoft excel was used to calculate the percentage of the number of respondents according to the statement. A thematic analysis technique has been followed to analyze qualitative data.

## VI. RESULT AND DISCUSSION

In this study, the first aim was to determine the view of students towards use of ICT in classroom. Here, I have used

Technology acceptance model to determine students' views. There are two factors under this model that I have analyzed as follows:

1. Perceived usefulness of ICT (12 items) and

2. Students' attitude towards ICT (5 items).

From perceived usefulness factor (See table. I), it has been found that a large portion of students (61% Strongly Agree and 36% Agree) believe that ICT motivate them to learn science; it also engage them in science concept. It is also found from this study that ICT helps to conduct experiment (52% Strongly Agree and 43% Agree) (See table. 1) and it saves time to learn. From the past literature, it is also found that ICT can enhance science learning. ICT improves motivation and engagement among students, support experimentation and saves the time [8]. It is seen from the findings of this research that most of the students think that ICT can improve their achievement of learning and other study has the same findings. Therefore, from above discussion of perceived usefulness of ICT, it is clear that the students believe that ICT is useful for learning science.

TABLE I. Students' response to perceived usefulness of ICT

Statement	Scale	Percentage %
1. The use of ICT encourages students to learn science.	SA	61
	A	36
	N	2
	D	1
	SD	0
2. Direct interaction with science concept is possible through ICT.	SA	14
	A	20
	N	22
	D	32
	SD	12
3. Using ICT in science class helps to get clear concept of science.	SA	5
	A	1
	N	6
	D	44
	SD	44
4. By using ICT in science class, science concept can be understood quickly.	SA	10
	A	11
	N	29
	D	35
	SD	15
5. Learning science becomes complicated	SA	36
	A	38
	N	6
	D	18

because of using ICT.	SD	1
6. The use of ICT is not needed to learn science.	SA	6
	A	9
	N	7
	D	42
	SD	36
7. The use of ICT increases participation in learning.	SA	47
	A	46
	N	2
	D	3
	SD	2
8. ICT use creates problem to learn science.	SA	11
	A	14
	N	6
	D	33
	SD	36
9. To learn science, ICT is better than hands-on activity.	SA	27
	A	45
	N	12
	D	7
	SD	9
10. ICT helps to understand scientific experiment.	SA	52
	A	43
	N	3
	D	2
	SD	0
11. ICT do not help to conduct Scientific inquiry.	SA	4
	A	5
	N	6
	D	51
	SD	34
ICT does not improve the result of science subject.	SA	7
	A	7
	N	11
	D	36
	SD	39

The other factor of my research was students' attitude towards ICT. The majority of the students (61% Strongly Agree and 36% Agree) (See table. II) feel that learning is attractive to them when teacher use ICT in classroom; they want ICT along with book; they don't think ICT is time consuming. The students also think that they got chance to work with their peers in ICT class. The findings of this study reveal that the students

have positive attitudes towards ICT. Reference [18] and [19] has also had the similar findings that a majority of students maintained positive attitude toward using ICT and they accepted the use of ICT for learning.

Therefore, it can be concluded from the above discussion that the students want ICT in their classroom to learn science.

TABLE II. Students' response to attitude towards ICT

Statement	Scale	Percentage %
1. By using ICT, learning becomes attractive	SA	61
	A	36
	N	2
	D	1
	SD	0
2. Like to study without ICT	SA	14
	A	20
	N	22
	D	32
	SD	12
3. ICT using is Time Consuming	SA	5
	A	1
	N	6
	D	44
	SD	44
4. Learning book is better than ICT.	SA	10
	A	11
	N	29
	D	35
	SD	15
5. ICT creates opportunity to work with other classmates.	SA	36
	A	38
	N	6
	D	18
	SD	1

The second aim of this study was to explore how ICT use in class influences students' science learning. To find out the answer of this question, I have observed the class and conduct focus group discussion with students. I have compiled the findings in six themes:

1. Motivation through ICT
2. Better understanding through ICT
3. Ways of learning through ICT
4. Learning quickly through ICT
5. ICT vs. Book
6. Issues related to use of ICT

#### A. Motivation through ICT

One of the students said in focus group discussion: *"I can clearly understand the topic through images. So I feel motivated."* So this study reveals that students get motivated in class when they see colorful pictures and videos. There is enough considerable research evidence which indicates that students are highly motivated when they learn by ICT tools. For example, [20] has mentioned in their study that the use of ICT in science class motivates students. Some of the participant students of this study have mentioned that they feel bored when they read book. ICT can hold their attention. On this point, [20] said that when teacher use ICT tools correctly, students' interest and attention increase.

It is also found from focus group discussion with students that they get to know real life events and can apply it in real life; that is why they feel curious in ICT class. . Some students said the following:

*"I get involved in ICT class. Because I get to know real life events and can apply it in real life also."*

Other researchers have also got the similar findings. They asserted that ICT helps to motivate and engage students as it helps to relate school experiences with the real world [21], [22], cited by [23].

Therefore, it is revealed from this study that ICT is motivating students and thus enhancing their learning.

#### B. Better understanding through ICT

This study has disclosed that the students understand the topic better when they see the topic through ICT. They can also remember the topic longer that they have seen. Two of them have stated the following:

*"I understand science more in ICT class."* *"Basic concept is more understandable in ICT and it is easy to understand."*

It is found from other study that ICT tools are essentials to promote better knowledge and understanding science (for example, [24]). ICT will help students to achieve something that they cannot be achieved without it and it will allow students to learn something more effectively. That indicates ICT helps pupil to learn effectively that cannot be happened in other ways.

On the other hand, in this study, some students mentioned that they were unable to comprehend because of teachers' lack of pedagogy skills. The evidence shows that when teachers use their knowledge both the subject and also how students understand the subject with their use of ICT have more direct effect on students' achievement [24]. However, the scenario is opposite in this study. All the teachers taught whole chapter in one class, though only one topic should have been teaching in one class. For this reason, they cannot explain every terms of the content. Reference [25] has mentioned in their project that ICTs can amplify science learning if teachers can use specific pedagogical strategies to unpack the scientific ideas. Therefore, the present situation of our classroom tells that the teachers have lack of pedagogy skills and it affects students' learning.

### C. Ways of learning

The participants of this study asserted in discussion that they can learn better when they see pictures and videos; because sometimes they cannot understand what their teacher says or they cannot comprehend what is written on board. One of them has said:

*"Sometimes I cannot understand what sir is saying. But by watching the video or pictures I can easily understand the matter."*

Also some dangerous experiment can be done through ICT. Reference [25] has showed in their project that digital tools that supported visual meaning-making in science supported science learning. Here, digital tools indicate videos, animations, images, maps and models from the internet etc. In a practical user's guide named ICT in Support of Science Education, published by [26], it has been mentioned that the multi-media resources like images and moving pictures enhance understanding of scientific ideas. So, it is quite evident that students can learn better when they see visual meaning tools.

On the contrary, some of the students of this study have urged for hands-on activity along with ICT as they think they will learn better if teacher applies both way in classroom. There are several studies that have mentioned the same. Reference [27] has written in their technical report that students' understanding of science knowledge and understanding of scientific approach can be achieved when using ICT or hands-on activities. That means, it doesn't need to use only ICT. By using both, ICT and hands-on activity, students can learn science.

### D. Learning quickly through ICT

It has been explored from this study that ICT saves students' time to learn science as they can see the concept by ICT. According to the participants of this study, it takes time to realize the concept when they read the book only. They can grasp the idea soon when they see colorful pictures and videos. Another student has mentioned that as he has seen the video of refraction, he got the concept fast.

*"When sir showed us that if we put a pencil in a glass of water, it seems broken. It helps me to understand that it's happening because of refraction. If sir just told us about it, I could not get it, but as I saw it, I got it soon."*

Reference [28] has pointed out this advantage of ICT. They said that the students who use ICT will learn faster than others who are unfamiliar to technology.

ICT also helps to conduct experiment quickly as teacher and students don't have to collect the apparatus, they can find it in internet. According to [8], among several advantages, one of the important advantages of ICT is it provides quicker and accurate data and save lesson time.

Therefore, it is evident that ICT use is not time consuming, rather it helps to learn and conduct experiment within time.

### E. ICT vs. Book

This study reveals that most of the students want ICT along with book in classroom as ICT helps them to understand the

basic concept and difficult terms of the book. One student has pointed out a chapter that was difficult to her:

*"The cell division of living organisms is very difficult chapter. In text book, it is written in tough language. So we cannot understand it. When I saw it as a video and picture, I easily understood it."*

According to [24], students who use ICT gain deeper understanding of complex topics and concepts. The students also think language of ICT is easier than book. Moreover, they need to write language of book in exam paper. Therefore, both are necessary to them.

So, it can be concluded that students need ICT to understand the basic idea of the topic that is written on book. They also need to read book to know the terminology. So ICT and book both are important to learn science.

### F. Issues related to use of ICT

In this study, many students have said that ICT has no negative side, but some of them have opposed them. They said when they look at the monitor or screen for a long time, they feel irritation in their eyes and some of them have headache. In a student's word:

*"There is only one bad side that is health problem. If I watch video on the screen for a long time, I face problem in my eyes and many students have headache."*

There is no enough information on whether the radiations emitted by ICT technologies do not have harmful health effects for students and teachers [29]. Therefore, it is a vital issue for using ICT that should be acknowledged in further research.

The findings of this study also revealed that there are some technical problems related to ICT in classroom. Sometimes electricity goes down. Laptop's battery goes down, jack problem, connection problem are the common problem that students have mentioned. Reference [30] has also acknowledged this problem. He said that the lack of technical support was reported to be one of the factors inhibiting the use of ICT in classroom.

Another finding that has been found in this study is some students think students-teacher interaction is absent in ICT class. They can contact with teacher more in non-ICT class. According to [31], ICT will exploit whole class interactive teaching and encourage students to share ideas and findings. But this environment is missing in present classroom.

Students don't participate in teaching- learning activities. They hesitate to ask teacher any questions and teachers don't encourage them to talk. Reference [28] has also mentioned in their study that ICT may affect the connection process between teacher and student, as ICT becomes a communication tool instead of face to face communication, so the distance of the transaction will increase. Therefore, students' concern is highly justified.

## VII. CONCLUSION

This research revealed that students have a positive view towards use of ICT in science classroom and the influence of

ICT on students' science learning is quite strong. Despite all, some areas have been found where some changes are needed. Teachers should change their teaching practice while using ICT. They need to have idea about how students can learn better, what type of ICT resources they should use, their content knowledge and the commitment to serve the students. To achieve pedagogy skills, teachers can form professional learning community, which will help them to compare their position, improve their practice and they will be accountable with their job. Teachers' training programs and authorities of schools should emphasis ICT pedagogy in their training session for teachers. The curriculum committee should address teachers' pedagogy in curriculum and textbook. Reference [8] have also asserted that training for teachers in using ICT in the classroom appears to have had more success that teachers are beginning to develop and try new strategies that can overcome this situation. The digital content should be monitored by educators or education specialists for maintaining standards. The school and policy makers should consider issues related to ICT for integrating it in classroom.

#### ACKNOWLEDGMENT

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# InMotion Project Results in Russia

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**Abstract**—An international educational project entitled InMotion co-funded by the Erasmus+ program of the European Union is briefly described. The project results in Russia are presented. The usage of virtual laboratories in e-learning modules is shown.

**Keywords**—e-learning, blended learning, computer modeling and simulation, engineering education

## I. INTRODUCTION

Innovative teaching and learning strategies in open modeling and simulation environment for student-centered engineering education (InMotion) is an international educational project co-financed by the Erasmus+ program, Key Action 2, Capacity building in the field of higher education, of the European Union.

The project is devoted to continuing the reform of the system of higher education in engineering in Malaysia and the Russian Federation to improve the quality of education and teaching according to the priorities established in the Bucharest and Yerevan Communiqués and to meet the demands of the Strategic Framework for European Cooperation in Education and Training (ET 2020). Nowadays, modeling and simulation is rather crucial part of an engineer's work. Big manufacturers are supplied with parts along with their models, which allows constructing a model of the product under development. The model can be simulated in order to avoid major part of time-consuming, expensive and sometimes dangerous or even impossible nature experimenting. Fifty years ago, usually only a mathematician could mathematically model a system of interest. It used to be done manually and often symbolically, whereas today an average engineer can easily and conveniently create a model of the system in a modeling and simulation environment avoiding the issues of, for instance, manipulating differential-algebraic systems of equations [1], choosing an appropriate numerical integration method [2], setting it up and so on. Although, such knowledge definitely can help in case of an error during simulation. Therefore, the project deals with teaching this important field of engineering, namely computer modeling and simulation of complex dynamical systems.

The project started on October 15th, 2016, and is to last for three years. Fig. 1 depicts the organizational structure of the project team, which consists of 3 European universities, namely Universität Bremen (Bremen, Germany), Universidad Nacional de Educación a Distancia (Madrid, Spain) and University of Ljubljana (Ljubljana, Slovenia), 3 Russian universities, Peter the Great Saint Petersburg Polytechnic University (Saint Petersburg, Russia),

Saint Petersburg State Marine Technical University (Saint Petersburg, Russia), Novosibirsk State Technical University (Novosibirsk, Russia), 3 Malaysian universities, which are Universiti Teknologi PETRONAS (Perak, Malaysia), Universiti Kuala Lumpur (Kuala Lumpur, Malaysia), Universiti Teknologi Malaysia (Johor Bahru, Malaysia), and Saint Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences (Saint Petersburg, Russia). These are abbreviated as UniHB, UNED, UL, SPbPU, SPbSMTU, NSTU, UTP, UniKL, UTM, SPIRAS respectively. There are three coordinators: the overall project coordinator, UniHB, UNED, for the Russian partners, SMTU, and coordinator for the Malaysian partners, which is UniKL. The European universities report to the project coordinator, whereas SPIRAS, in particular, evaluates the project outcomes.

The project is managed in and most of the e-learning materials are implemented in an open-source learning management system called SAKAI [3].

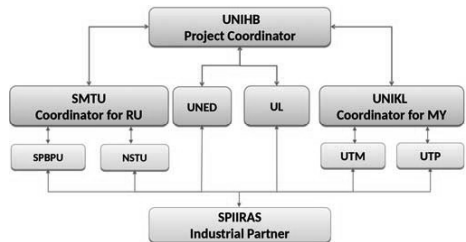


Fig. 1. Organizational structure

First of all, the project team performed analysis of computer modeling and simulation end-user needs. The results are that there is a huge need in computer modeling and simulation engineers on the market, many of Russian and Malaysian young engineers do not meet the demand of stakeholders. After reviewing computer modeling and simulation educational programs taught in and methods used by the partner universities and some other European universities, 14 syllabi for undergraduate and graduate students were either developed from scratch or improved, taking into account the modern concepts of blended learning, project-based learning, and student-centered learning [4, 5], by the partner universities.

## II. PRINTED MATERIALS

Six textbooks were written for the aforementioned courses during the project by the European and Russian partners.

UNED wrote a textbook called Modeling and Simulation in Engineering using Modelica. The authors introduce the reader to modeling in the object-oriented modeling language Modelica, basics of DAE simulation and handling events in hybrid systems, and two Modelica modeling and simulation environments, OpenModelica and Dymola [1]. The materials are illustrated with numerous examples. The textbook was translated into Russian by SPbPU.

UL presented a textbook named Control-Oriented Modeling and Simulation: Methods and Tools. The book is devoted to basic concepts of control engineering, modeling and simulation of control systems, including identification issues and discrete-event simulation. The textbook was translated into Russian by NSTU.

SPbPU prepared two textbooks entitled Mathematical modeling of complex dynamic systems and Component modeling of complex dynamical systems. The former solely deals with mathematical modeling of systems of the mentioned kind. Since there are numerous modeling and simulation environments on the market, learning fundamental mathematical modeling has benefits over learning specific computer modeling environment and its features at the beginning of one's path. Although, the textbook contains examples of modeling and simulation in the RMD environment. The latter textbook is devoted to the modern approach of object-oriented modeling in RMD.

SPbSMTU developed a textbook introducing the reader to computer modeling and simulation of dynamical systems in Wolfram SystemModeler. The examples are from the mechanical domain in general.

Fundamentals of event-continuous system simulation theory is a textbook written by NSTU under the InMotion project. The book contains materials on hybrid dynamical systems, mathematical concepts behind them, numerical methods for integrating generally stiff modes of hybrid systems, algorithms for controlling the step size with regard to the accuracy, stability and behavior of the event functions [2].

## III. E-LEARNING MATERIALS

The courses developed under the InMotion project use the advantage of blended learning [4], that is part of them is implemented in the form of an e-learning module in the SAKAI environment. The student can access the syllabus, textual and media materials, communicate with other students and the instructor and so on. The system allows employing automatic tests and assignments checked by the instructor.

On May 13<sup>th</sup>, 2019, a massive open online course (MOOC) entitled Computer-Aided Modeling and Simulation of Event-Continuous Systems (Fig. 2) was started on NSTU's SAKAI. The MOOC is intended to learning the basics of mathematical and computer modeling and simulation (M&S). Dynamical models can be built for systems of different physical nature: mechanical objects, electrical networks, chemical reactions, biological systems, etc. That is why one of the course goals is to show students

the universality of mathematical and computer M&S and to teach them how to use modern computer M&S environments. Students learn how to develop mathematical and computer models applying their knowledge in the previously learned disciplines, such as physics, electrical engineering, mathematics, etc, in order to mathematically describe and simulate the behavior of a system of interest.

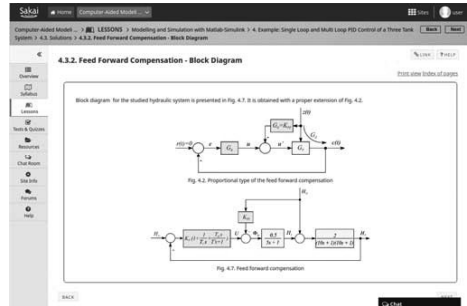


Fig. 2. Computer-Aided Modeling and Simulation of Event-Continuous Systems MOOC

The MOOC is divided into three parts.

The first part of the course is dedicated to M&S with Modelica. It is structured into two parts: an introduction to the Modelica language and a project. The M&S environments used during this part of the course are DYMOLA and OpenModelica.

The second part of the course introduces control-oriented M&S with Matlab/Simulink. Apart from the basic M&S in the Simulink environment, students learn how to perform parametrization, optimization, and linearization. Different types of control are illustrated by a three tank system.

The third part is devoted to a M&S environment called ISMA. This software tool supports a general-purpose modeling language named LISMA, which allows describing hybrid or event-continuous systems exhibiting both continuous and discrete behaviors.

Apart from contents traditional for e-learning modules, SAKAI can employ virtual laboratories, which improve learning by visualizing modeling and simulation. Such a laboratory is shown in Fig. 3. The student can adjust the model parameters, model structure, visually assess important characteristics of the simulated system.

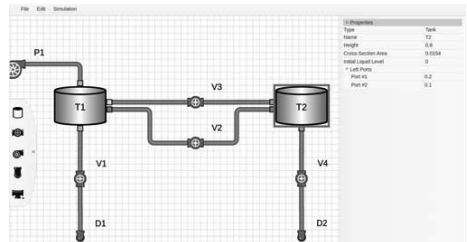


Fig. 3. Virtual laboratory



Moreover, visualization makes learning more interesting compared to reading static text or watching a video, since the student can control what is happening and immediately see the results of his or her actions.

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# Interpreting Student’s Knowledge in Mathshop Program Implementation of Bayesian Knowledge Tracing

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**Abstract**— Bayesian Knowledge Tracing (BKT) is one of the most popular knowledge inference models due to its predictive accuracy, interpretability and ability to infer student knowledge. In this paper, we present results from our ongoing research which uses BKT tool to evaluate and model the knowledge of students who use our Mathshop program. The Mathshop program gives opportunity to pre and school age children to learn mathematics in an engaging and interesting way based on new mathematics educational standards, trends and curriculum of mathematical competence. By using the application, children will develop the capacity to know and practice basic concepts of mathematics by themselves, while also being provided with the full opportunity to improve their learning techniques, confidence, ability to express themselves and develop their intelligence and thinking skills.

For this work, we have used skill score data of primary school students of two schools, a public school and a private school. The dataset consists of Mathshop program’s test results of 63300 transactions belonging to 765 students’ work on 275 different skills. We have developed student model using BKT for each primary school class. The preliminary result show possibility of using BKT in interpretation of math skills earned with Mathshop program.

**Keywords**— Knowledge tracing, knowledge component, student model.

## I. INTRODUCTION

In an environment of information, communication and technological development, the sustained promotion of equilibrium in globalization and localization is a fundamental factor in determining the trends of new-century society and human development.

Within the field of Intelligent Tutoring Systems (ITSs), student modeling is important because it can help guide interaction between a student and a ITS [1]. Student modeling allows researchers and developers to understand how students learn and improve content of learning system based on their findings. Knowledge tracing algorithms which track the skillset students have attained are used to establish student modeling Bayesian Knowledge Tracing (BKT) is one of the most popular knowledge inference models due do its predictive accuracy, interpretability and ability to infer student knowledge. We incorporated the Bayesian Knowledge tracing

to Mathshop 1.0 dataset to yield a learning system with increased efficiency and to improve content.

## II. STUDENT MODELING LITERATURE REVIEW

The basic goal of a learning model is to estimate the current knowledge and future performance of a learner based on data about their past performance. This can be seen as a typical machine learning task of estimating a hidden state based on noisy observations. A specific feature of learner modeling is the presence of learning and forgetting processes that lead to changes in the hidden knowledge state. The choice of the basic approach to modeling learning and forgetting is thus the key decision in learner modeling. Figure 1 provides a schematic overview of basic approaches.

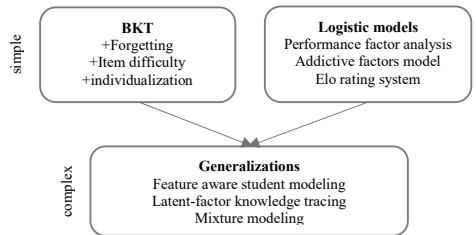


Fig. 1. Overview of basic approaches for modeling learning

The most commonly used approach is the Bayesian knowledge tracing model described in the previous section. From the perspective of learning dynamics, the key assumption of this model is the discrete transition from an unknown to a known state. The basic version of the model presented here has many extensions and variants including forgetting [2], item difficulty [3], individualization [4][5], and time between attempts [6].

The second major approach to modeling learning is a class of logistic models. In this case skill is modeled by a continuous variable and learning is modeled by a gradual change. In the case of learner modeling a typical logistic model is the Performance factor analysis [7] described in the previous

section. Other similar models are the Additive factors model [8], Instructional factors analysis [9], and the Elo rating system [10]. Logistic models are used particularly often in the case of declarative knowledge and the modeling of forgetting [11], [10], [12].

The choice between BKT and logistic models is currently not fully resolved. Although some researchers have compared the two approaches [13], the results are not conclusive and probably do not generalize – an appropriate choice of a modeling approach depends on a particular domain and on the purpose of a model. However, in many cases researchers pick one of the two modeling approaches without providing any rationale for the choice. Recently, researchers proposed several generalizations and combinations of logistic models and knowledge tracing [14], [15].

### III. BAYESIAN KNOWLEDGE TRACING

Bayesian knowledge tracing is an algorithm used in ITS and evaluate the learning ability of each student. This method is first introduced by Atkinson and Corbett in Intelligent tutoring field in 1995 [16]. BKT is a two state Hidden Markov Model where the student knows a given skill (referred to as knowledge component) where they don't know it. Those components are illustrated

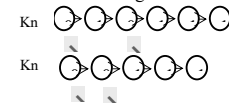


Fig. 2. Knowledge components

Knowledge tracing assumes that each skill has four parameters: two knowledge parameters and two performance parameters. [17] Bayesian Knowledge tracing has also four parameters:

- p(L<sub>0</sub>) Probability of initial knowledge
- p(T) Probability of learning

$$p(L_1)_u^k = p(L_0)^k \quad (1a)$$

$$p(L_{t+1}|obs = wrong)_u^k = \frac{p(L_t)_u^k * (1 - p(S)^k)}{p(L_t)_u^k * (1 - p(S)^k) + (1 - p(L_t)_u^k) * p(G)^k} \quad (1b)$$

$$p(L_{t+1}|obs = wrong)_u^k = \frac{p(L_t)_u^k * p(S)^k}{p(L_t)_u^k * p(S)^k + (1 - p(L_t)_u^k) * (1 - p(G)^k)} \quad (1c)$$

$$p(L_{t+1})_u^k = p(L_{t+1}|obs)_u^k + (1 - p(L_{t+1}|obs)_u^k) * p(T)^k \quad (1d)$$

$$p(C_{t+1})_u^k = p(L_t)_u^k * (1 - p(S)^k) + (1 - p(L_t)_u^k) * p(G)^k \quad (1e)$$

The EM method is commonly used in the implementation of Bayesian Knowledge Tracing, and it was also applied in the tool written in C/C++ programming language that is used in our experiment.

- p(G) Probability of guess
- p(S) Probability of slip.

BKT assumes that student knowledge is represented as an asset of binary variables-one per skill. The BTK parameters are calculated using following equations:

- (1a) - The initial probability of student  $u$  mastering skill  $k$
- (1b) - The correct probability of student  $u$  applied skill  $k$
- (1c) - The incorrect probability of student  $u$  applied skill  $k$
- (1d) - The conditional probability is used to update the probability of skill mastery
- (1e) - the probability of student  $u$  applying the skill  $k$  correctly on an upcoming practice opportunity

### IV. METHOD

There are two popular fitting methods in the literature.

1. Brute – force grid [18] It is simple brute force algorithm where a grid of possible values is set so that for each combination of parameters, a RSS value is obtained. Brute-force is very expensive in computational cost.
2. Expectation – maximization [19] (EM) algorithm is a way to find maximum-likelihood estimates for model parameters when your data is incomplete, has missing data points, or has unobserved (hidden) latent variables. It is an iterative way to approximate the maximum likelihood function. While maximum likelihood estimation can find the best fit model for a set of data, it doesn't work particularly well for incomplete data sets

The Hidden Markov model is a statistical tool for modeling sequential processes. This model consists of a Markov chain of hidden variables that generate continuous observed

variables. The likelihood of a correlation between variables in the circuit is governed by a set of model parameters.

Traditionally, HMMs have been defined by the following quintuple

$$\Lambda = (N, M, A, B, \pi) \quad (2)$$

Where:

N is the number of states for the model

M is the number of distinct observations symbols per state

A is the N x N state transition probability distribution given in the form of matrix  $A = \{a_{ij}\}$

B is the N x M observation symbol probability distribution,  $B = \{b_i(m)\}$ ,  $j \in [1, N]$ ,  $i \in [1, M]$ ,

$\pi$  is the initial state distribution vector  $\pi = \{\pi_i\}$ ,  $i \in [1, N]$

The first level of knowledge should be matched to the state matrix, and this matrix has two states: the knowledge is acquired or not acquired.

(2a) A priori probability of mastery p (L0) belongs in priors

(2b) Learning probability will be related to the state transition matrix of Markov and once acquired it is assumed that a skill is never forgotten.

(2c) Slipping and guessing probabilities are related to the observation matrix

We have two observation states that are correct or incorrect, so the observation matrix has 2 x 2 dimensions.

The values of transition and observation matrices' row are equal to 1.

$$\pi = [p(L_0) \quad 1 - p(L_0)] \quad (2a)$$

$$A = \begin{bmatrix} 1 & 0 \\ p(T) & 1 - p(T) \end{bmatrix} \quad (2b)$$

$$B = \begin{bmatrix} 1 - p(S) & p(S) \\ p(G) & 1 - p(G) \end{bmatrix} \quad (2c)$$

## V. EXPERIMENT

Students of two primary schools in UB were involved in the Mathshop programming test.

A database of 53540 solved math problems was created; 4,070 solved by 127 first graders, 8860 by 90 second graders, 15230 by 147 third graders, 12240 by 145 fourth graders, and 13140 problems solved by 162 fifth graders.

In our experiment, we analyzed student's knowledge parameters in different curriculum assignments using standard BKT tools written in C/C++ [20].

The data has the following characteristics:

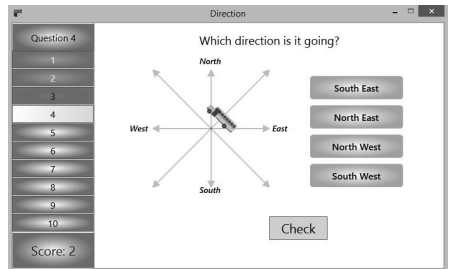


Fig. 3. An example task of Mathshop software.

- The Mathshop learning software has three different levels with simple, medium and advanced level problems for all grades. Each section covers units and topics that meet the standard of secondary school curriculum.
- The Mathshop e-learning software unit is considered as a knowledge component.
- Each topic (the knowledge component) consists of 10 tasks.
- It is impossible to skip any task on the same topic, you have to solve all of the problems in given order.
- Track of the tasks is a sequence of  $\{0,1\}$ . When a student leaves any of the tasks, it is considered to be an incorrect answer
- There tasks are multiple choice.

The figure 3 shows an example task of knowledge component in the Mathshop. In this task students are asked to select correct direction from a given set of directions.

The table 1 shows summary of the data for training which uses the BKT tool. The root mean square error (RMSE) is used to measure differences between the values of a predicted model and the values actually observed. Accuracy is rate of number of correct predictions on total of all cases to be predicted.

TABLE I. SUMMARY OF THE TRAINING OF THE DATA FOR TRAINING THE MODEL

Model	Number of Rows	RMSE	Accuracy
Class01A	2470	0.351916	0.843320
Class01B	960	0.386457	0.785417
Class01C	600	0.383071	0.795000
Class02A	6040	0.356172	0.831126
Class02B	1710	0.350951	0.830409
Class02C	1090	0.388684	0.784404
Class03A	9350	0.309066	0.885561
Class03B	4080	0.353069	0.828676
Class03C	1650	0.357539	0.830303
Class04A	9970	0.322438	0.866700

Class04B	1630	0.305653	0.884049
Class04C	580	0.298566	0.862069
Class05A	13140	0.246912	0.926332
Class05B	2320	0.360068	0.817316
Class05C	7460	0.359890	0.822252

## VI. RESULT

We have developed a tool for interpreting the knowledge that has been measured in C# language for Mathshop, where the following are the results of how difficult the assignments are and how the students are improving while they are doing the assignments to compare and contrast groups and schools. Figure 4, Table 2 illustrate how the students' knowledge in the 4<sup>th</sup> grade elementary level assignments on "Fractions and Decimals" are interpreted by using BKT. Score records of 86 students were recorded in this chapter assignments. Here, the problems on "What Fractions is Shaded", "Shading Equivalent Fractions", "Comparing Fractions 1" and "Nearest Whole Number" were easy for students, so they completed the assignments with relative ease. In chapters "Decimals from Words to Digits 1" and "Unit Fractions", students performed only a few assignments and skipped most of them. This led to low initial knowledge and learning ability parameters.

As students already possessed an initial understanding regarding the shading equivalent fractions and comparing

TABLE II. A ESTIMATED KNOWLEDGE PARAMETERS IN THE 4TH

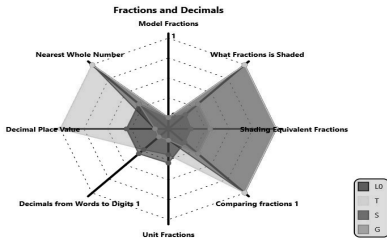


Fig. 4. A students' knowledge in the 4<sup>th</sup> grade simple level tasks on "Fractions and Decimals"

GRADE SIMPLE LEVEL TASKS ON "FRACTIONS AND DECIMALS"

Task Name	P(L0)	P(T)	P(S)	P(G)
What fractions is shaded	0.9987	0.9981	0.1111	0.3
Shading equivalent fractions	0.9988	0.9982	0.094	0.3
Comparing fractions 1	0.9988	0.9982	0.0976	0.3
Unit fractions	0	0.1828	0.288	0.0006
Decimals from words to digit 1	0	0.2266	0.3	0.0006
Decimal place value	0.0018	1	0.3	0
Nearest whole number	0.9986	0.9978	0.3	0.3

fractions 1, they were able to complete those tasks with minimal obstacles. Although students were not familiar with decimal place value, they were able to develop an understanding in the course of the tasks which led to a 100% probability to apply the skill. 30% of observed mistakes in the decimals from words to digit 1, decimal place value, nearest whole number sections resulted from the inattentiveness of students.

In examining the difficulty of assignments Figure 6 demonstrates that third grade students who participated in the experiment had a good level of knowledge about comparing whole numbers. However, the assignment proved to be too hard for them. This model is based on the data that 142 students solved math problems.

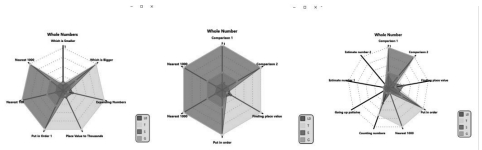


Fig. 5. Comparison of different tasks in the 4<sup>th</sup> grade

In the "Decimal Place Value" chapter, students completed simple assignments well, but they had difficulty completing assignments of medium difficulty, learning it while fulfilling the assignments. It is evident that the advanced assignments on the same topic were not easy to understand/difficult for the students so they left them unfinished.

To visualize the effectiveness of Bayesian Knowledge Tracing Algorithm, the fact that learners are doing simple assignments well proves they obtained good knowledge on it at mathematics class.

Figure 7 shows how the 5<sup>th</sup> grade private school students performed advanced level assignment on "Whole Numbers" chapter. Here the data of 27 students' calculations were taken into consideration. The guess parameter is greater than the other parameters on "Fractions to Decimals" chapter. This demonstrates the fact that the first attempts on this topic were done incorrectly by some students, but in the end the guessing answers turned out to be correct.

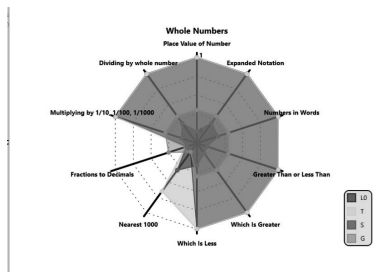


Fig. 6. A students' knowledge in the 5<sup>th</sup> grade advanced level tasks on "Whole Numbers"

## VII. CONCLUSION

The aim of this research was to show the advantages of learners' knowledge modeling using BKT and therefore develop an automatic skill development recommendation to bridge the knowledge gap for the users of the Mathshop program. If the learner's initial knowledge and the transition parameters are less than the slip and the guess parameters in knowledge model, Mathshop recommends returning to the task for later. For example, this was the case in the task "Fractions and Decimals" shown in figure 5.

In the first test, we have used the Brute-force algorithm. It takes about 15 minutes to estimate knowledge parameters of 13200 records. It was established that Brute force algorithm is expensive in computational cost. Therefore, we have used standard BKT tool by EM method to avoid these costs. In this case BKT tool's processing time was 0.203 seconds for the same data.

Results of the tests show that Bayesian Knowledge Tracing is an effective way to evaluate the students' knowledge in Mathshop program. A student model can represent a wide range of students' characteristics.

Visualization of student learning processes with the BKT tool creates the following advantages:

1. Visual results of BKT based knowledge model could be used to improve base curriculum of the subject and they also could help teachers to assess student knowledge.
2. Gathering the knowledge track of each student helps parents to see their child's actual level of knowledge and find out what subject they need to focus on.
3. By collecting the statistics of student's knowledge, the Mathshop designers and advisors can continuously improve the program contents and its way of presentation and other tactics.

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# Latest Trends In Continuous Integration for Highly Autonomous Driving

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**Abstract**—In highly autonomous driving, most of the vehicle's advanced functionalities are controlled by digital platforms. The increased use of complex software-based implementations has raised various challenges for the automotive industry, where high performance and network throughput, continuous integration, etc. are just some abstracted examples. To fulfill the complicated requirements and fast-changing market needs, the industry is in a transition from the traditional V-Model to the adoption of agile development process, where continuous integration of software foundation is a must for rapid prototyping and faster time to market.

**Index Terms**—ARA, Continuous Integration, Agile, Automotive, Software Development Methods

## I. INTRODUCTION

Cars or vehicles which were pure mechanical elements have partly transformed into complex electric and electronic systems. The reliability, efficiency, and overall performance of the cars have raised exponentially with these changes. The automotive domain is experiencing a shift in paradigm as digital processing, perceiving and communication technologies are emerging stronger. The highly autonomous driving is demanding complexity management and high-performance clusters [1].

The AUTOSAR Classic Platform is the standard for deeply embedded ECUs [3], and it has been very successful at standardization. It provides full specifications for hard real-time ECU in body, comfort, and chassis domains. However, this architecture suffers many limitations when it comes to supporting hardware with high-end embedded computing power, dynamic deployment of applications, updates-over-the-air, as well as reliability for autonomous vehicles [4] and the classic version cannot cope up with these requirements. Hence, AUTOSAR consortium has released a new architecture [5] [6] to deal with the increasing needs of modern applications. The standard also focuses on defining a complete methodology for software development process and use of different data artifacts that are generated at intermediate stages. Adaptive AUTOSAR [7] aims at leveraging the advanced technologies

to deliver a robust, dynamic and scalable platform for future high-performance automotive software.

### A. Traditional development process and agile

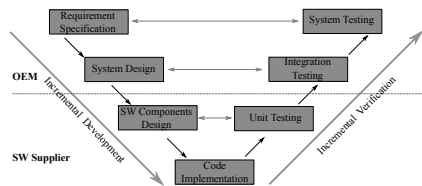


Fig. 1. V-Model Development Process [2]

The traditional methodology for software development involves the use of V-Model where the process is based on sequential phases of development as shown in figure 1. The time to get the software model working and deployed with the V model is significantly high as the product can't be released until all phases have been completed. Also, the testing cycle of the development is at the end of the process, which makes it a make-or-break situation. With the fast arising demands, the automotive industry needs to deliver products within a shorter time scale, and the current development methodology has limited capabilities in solving these challenges. Therefore, change in working methodologies is needed; it requires an incremental deployment approach that provides rapid response to changes and allows a continuous software development through iterative cycles [7].

The agile development process has been successfully adopted in many domains and yielded expected results. It uses iterative and incremental deployment focuses on the division of the requirements into multiple builds or iterations as shown in figure 2.

With the aforementioned development process, managing the iterations or build becomes easier and allows superior

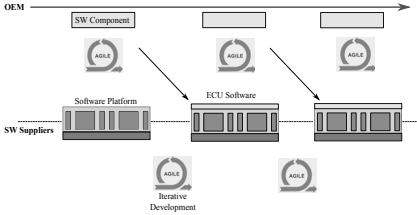


Fig. 2. Agile Development Process [2]

control on the process. The target is to produce a working build in the first iteration and subsequently improve the modules in the further ones, to serve end requirement. It is based on the idea of delivering working software frequently, and therefore, it requires the adoption of continuous integration [8]. However, the orientation of the software delivery and integration of the ECU software may vary since it usually depends on agreements and the type of contract between OEMs and SW Suppliers, where safety requirements also mentioned. To maintain safety, after each iteration safety analysis (SA) can be done. "we can use meta-data with high integrity to fulfill the safety requirements from design time to run time" [9].

## II. STATE OF THE ART

Various methodologies have been adopted to avail seamless integration methods over time. One such example is mentioned in [10], where a rapid prototyping concept for ADAS applications using classic AUTOSAR. In [11], it has been shown how OTA using the GENIVI platform was achieved.

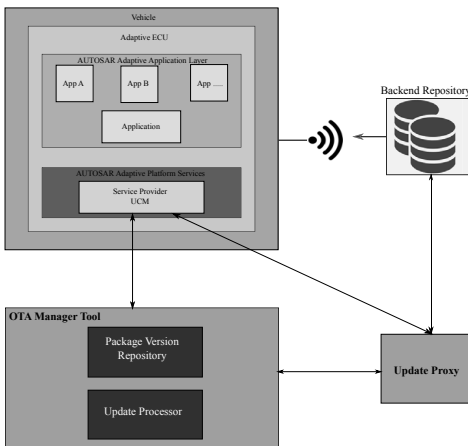


Fig. 3. Current State of Adaptive AUTOSAR [1]

The adaptive AUTOSAR update mechanism has shown in figure 3 [1]. Dynamic management of the system resources and the underlying communication. The development team should find the right balance among flexibility and safety for the system. A dedicated team of developers looks after update and configuration management.

## III. CONCEPT

Continuous Integration(CI) is a software development method where developers regularly integrate their work during the work-day in the central source repository. Besides, the CI workflow needs a complete build of the system and execution of unit tests at every code integration step to verify that the latest changes do not cause disruptions in the overall system [12] [9]. Also, building and testing should be automated to enable developers to continue their work without waiting for building and testing time [13] [14] [15]. Following are the main advantages of CI: [16]:

- Easy detection and removal of bugs
- Faster and automated integration
- Test execution and report collection on target platform
- Enables frequent release of new software updates

A standard continuous integration flow is shown in figure 4.

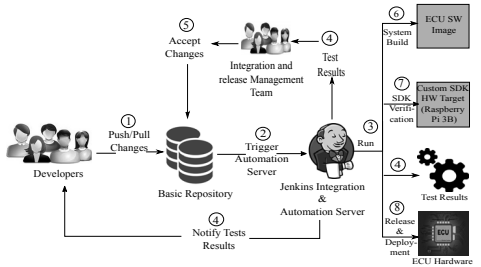


Fig. 4. Concept

As shown in the concept, developers will be able to retrieve (check-out) the recent version of the code from source control and add new code from that version. They can bring new source code into the shared source repository several times a day. The server checks the new additions at each code integration. Then, a fully automated build of the system is performed to detect build issues at each commit and maintain a working version of the system. In case of a build failure, the developers get notified, and they can take necessary actions to resolve the errors. It follows the phase of automated testing, SA which is an essential part of the CI chain. Automated testing assures that the software meets the mandatory requirements and executes with the desired performance. Finally, the test results and a report is submitted to the developers [2].

## IV. IMPLEMENTATION

A continuous integration workflow of a sample project was implemented. The objective of the project was the develop-



ment of an ECU that executes a sample Adaptive AUTOSAR Application on Raspberry Pi 3B.

#### A. Source Code Management

GitLab is used for the projects as source code management, and Jenkins tool has been adopted for the integration. All software modules and the part of the software were stored in a distinct GitLab repository. Using various repositories was a key consideration for better modularity, and each release of the software has better version control.

#### B. Build Environment

The build environment was based on the Yocto Project, which uses OpenEmbedded [17], an automation framework for building cross-compilation based on Linux. The Yocto meta layers have been cloned from open source repositories into the project directory. These also include the meta layers needed to build the selected target hardware. However, proprietary meta layers would have been required for advanced hardware. Using the open source tool Jenkins [18], the build system was automated; it permitted a fully configurable environment, including pre-and post-build functions. The build was done on a physical machine consisting of 4 CPUs and 8 GB RAM, which stored all cached documents as well.

#### C. Workflow

To build the ECU image, developer clones the current working repository on a local machine. Add new code or modify the existing code and commit the changes to the respective repository. Once the changes have been made, a system build is triggered automatically. It builds the ECU software image, generates the test results, and sends those results to integration and release management team for the review. After the changes have been approved and added to the repository, the whole system build was triggered. It was then possible to perform system level testing on the single physical hardware by deploying the image into the ECU and running tests. For testing of applications locally on the system, application specific simulation environment was generated. Later, the results of the testing activities were sent to the integration and release management team for the acceptance [2]. And after approval, software application was integrated then deployed on target using shell script.

## V. RESULTS AND CONCLUSION

In this paper, the benefits of agile over the traditional development process were explained. CI pipeline for incremental deployment of application has been successfully implemented and tested. Where In the first cycle, sample adaptive application was deployed on the target hardware. In the next cycle, over the air application update was done.

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# Short Review of Online Math Courses as MOOCs

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**Abstract**—This paper gives an overview of the online mathematics courses offered as Massive Open Online Courses (MOOCs). MOOCs are one of the fastest developing educational markets in the world. The aim of this short review is to estimate the scope of work and to identify a tendency for massive open online math courses among universities. The target of this review is not to establish a ranking comparison or a quality evaluation. The number of online available free and commercial courses are increasing dramatically. Learners are almost lost within the vast offer of online courses with various subjects. There is an increasing need for review work about massive open online courses based on defined subjects. This paper aims to fill the gap for MOOCs in the subject of mathematics. It could help educational institutions and professors to recognize missing contents for math courses and on the other hand could also be useful for learners to get some impressions about online mathematics courses provided as MOOCs.

**Keywords**—Online course, self-study, free courses, math course, massive open online course.

## I. INTRODUCTION

The technological development has enabled dramatic changes in all aspects of the education sector. Knowledge transfer techniques changed tremendously, when compared to the past several decades. Mobile Learning, Augmented Reality, Virtual Learning, Abstract Environment, Online Courses, Massive Online Open Courses (MOOCs), Personalized Learning and Life Long Learning are all terms that were not commonly understood only a few years ago. Nowadays, such terms are among the regular vocabulary within the educational sectors.

The boom of online available learning content started with the announcement of the Web 2.0 technology [1]. Since that time, lots of different content within online courses was published. MOOCs of the early stage consisted of a long video and few multiple choice questions as a quiz for the learners at the end of the video [2]. Top universities like the Massachusetts Institute of Technology (MIT) or Stanford University studied and analyzed the learning interactions in order to develop the new technologies for MOOCs.

The Global Massive Open Online Course Market was worth 3.38 Billion USD in 2017 and is estimated to reach 21.41 Billion USD by 2023 with a CAGR of 36.02% between 2017 and 2023 [3]. These facts prove that the need of online courses is massive and that it will increase in the future as well.

According to a statistical survey from Class Central, there are 11,400,000 courses available as MOOCs and more than 101 million learners are enrolled into different MOOCs. The massive open online courses are produced by more than 900 universities from all over the world [4].

Modern learners have a personalized way to learn and receive information. The traditional type of classroom, where the teacher is the core of the knowledge has dramatically changed. Nowadays, learners can receive their knowledge and information from different sources besides the teacher in the classroom. Therefore, educators and universities are supporting these changes and started to produce a huge amount of electronic contents for learners.

Nevertheless, there are many other reasons to develop and offer online courses for learners. The above listed aspects are in fact the most basic cases for online courses. The easy access to fast internet, the cheap mobile devices and the personalized learning attitude are all facts that are ensuring the distribution of online courses around the world and are facilitating the access from any place at any time.

The review of math courses for engineering and computer science students is partially needed within the ongoing project: DrIVE-MATH, where four universities from Portugal, Germany, France and Slovakia are involved. The main goal of the DrIVE-MATH project is to apply active learning methods such as EduScrum, Jigsaw, Problem-Based Learning (PBL), Team-Based Learning (TBL), Think-Pair-Share or Brainstorming on existing math lectures. The active learning elements shall be a benefit for teaching math courses for engineering students. Electronic materials would then be produced as an outcome of this project. Therefore, the project team needed to do a math-course oriented review of the available online courses.

## II. THE REVIEW METHODOLOGY

The review is focusing on the relevant MOOCs for math with learners enrolled from all over the world. A systematic course search was performed on a set of defined criteria. First, platforms for MOOCs were identified by the number of active enrolled learners. Here, a high number of counted enrolled students is interpreted as a well-established and well-known platform. Concerning the review of online courses for mathematics, the number was defined by more than 10 million enrolled students. Moreover, the freely available content and participation was considered as an issue for the review. However, it is good to mention that these platforms commonly offer free auditing of the courses, with a possibility of receiving a certificate at end, which the student needs to pay for. Lastly, the definition and usage of the specific keyword *math* was set as basic review criteria. Data for the review was collected from the Internet and was verified by the project partners from the other three countries: Portugal, France and Slovakia. This allowed for the generation of a summarized review, where the repeated courses that were overlapping within the gathered result data were excluded.

The scope of the review is limited by the first defined criterion: the most famous well-established platforms for

MOOCs. Based on this criterion, nine platforms for the mathematics oriented MOOCs were selected for a review. All the chosen platforms meet the aspect of free content; also called audit, and are free of charge for participation. For the search of relevant courses by a main keyword, the MOOC platforms are providing different strategies. In fact, some of the platforms directly provide a number of already offered math courses. For other platforms, a search engine needs to be used with a specified keyword—in this case the keyword *math*. However, every platform offers an enormous amount of math or math related courses. A defined review methodology is already introduced in [5]. A similar approach was used to identify e-tools for tutors of distance learning.

### III. THE REVIEW OF MOOCs

The results of the reviewed data are structured by an introductory information, the number of offered courses within the subject of math and a list with few random selected math courses. Most of the analyzed platforms provide some statistical and additional information about the MOOC. For more detailed information, it is necessary to check the official website of the particular MOOC.

#### 1) *The Study.com*

Adrian Ridner and Ben Wilson founded Study.com together in 2002 [6]. Since that time, more than 25,000 video lessons attracted more than 15 million learners per month. Learners can earn credits from partner colleges while learning through this platform.

At a first glance, the number of offered courses is visible on the platform's website, in a classified manner. 427 courses are listed under the math category.

The topics are ranging from Math 101, Math 102, Math for Kids, High School Algebra I to College Mathematics for Teachers: Professional Development.

#### 2) *The Open Culture*

Open Culture was founded in 2006 by Dan Colman [7]. It is a collection of free and open educational resources. Within this collection, around 1,300 free online courses from top universities and 1,000 free audio books and MOOCs from high ranked universities with certificates are available. Moreover, this platform supports 46 languages, for example English, Spanish and many more.

By searching with the keyword *math*, 64 courses on Open Culture could be found. These courses are from different universities such as the Harvard University, the University of California in Berkeley, the Massachusetts Institute of Technology (MIT) and others.

The topics ranged from Abstract Algebra, Calculus, Differential Equations to Statistics over Vector Calculus.

#### 3) *The Open Education Database (OEDb)*

This open platform was established in October 2006 [8]. Since January 2007, OEDb started to rank annually among distinguished online colleges.

The Chronicle of Higher Education's Wired Campus officially recognized OEDb in its ranking list starting from January 2009. Since March 2013, OEDb offers more than 10,000 free and open resources to its learners.

The search with the keyword *math* shows a result of 231 courses on the OEDb platform. This collection of courses is

from different universities such as the Duke University, the MIT, the Open University of Hong Kong and many others. Moreover, the list provides courses from other platforms with MOOCs such as the Khan Academy, the Math Planet and the UdeMy platforms.

The topics ranged from advanced algebraic concepts and applications in mathematics, advanced mathematics and algebra to statistics and undergraduate seminars in discrete mathematics.

#### 4) *The Khan Academy*

The Khan Academy was founded by Salman Khan in 2008 [9]. One main aspect of the Khan Academy, which is different to the other platforms, is that all the listed courses are free. Additionally, the team of Khan Academy tries to measure their effort using periodical surveys for learners. The question "Have you found Khan Academy meaningful to your education?" was sent to learners. Among the replies, 65% students from Stanford University and 57% students from Harvard University, Princeton University, Yale University, University of Pennsylvania, University of California in Berkeley, California Institute of Technology and MIT answered "Yes". In total, 64% of first-generation college students responded.

This academy offers online courses in math not only for college students, but also for pre-school and elementary school pupils.

Each subject is divided into several paragraphs. For example, Algebra I consists of: Algebra foundations, solving equations, solving inequalities, working with units, linear equations and graphs, functions and sequences, among others.

#### 5) *The Academic Earth*

In 2008, Richard Ludlow, Chris Bruner and Liam Pisano founded the Academic Earth platform with the mission of providing everyone on earth the access to a world-class education [10].

40 courses are offered within the mathematical field. Each of the courses consists of lots of sub-lessons. For example, the Algebra course includes 70 video lessons and the Calculus course includes 135 video lessons.

#### 6) *The Class Central*

Dhawal Shah founded the Class Central in 2011 [11]. Since 2011, more than 20 million learners have attended the more than 12,000 online courses offered within the Class Central platform. Moreover, the platform has more than 1.2 million registered users.

There are 384 courses offered in the field of mathematics. The topics ranged from the Introduction of Mathematical Thinking, Matrix Algebra for Engineers, Fibonacci Numbers and the Golden Ratio to Technical Math for the Industry.

#### 7) *The Coursera*

The Coursera platform was founded by Daphne Koller and Andrew Ng in 2012 [12]. It offers more than 2,700 courses for more than 250 specializations. They are cooperating with around 150 universities and industry partners. The platform counts more than 35 million learners who attended the offered courses.

The search with keyword *math* yielded to 1,696 courses: Mathematics for economics, Mathematics for Machine

Learning: Linear Algebra, Introduction to Discrete Mathematics for Computer Science, Mathematical Thinking in Computer Science and so on.

The Introduction to Mathematical Thinking course from the Stanford University attracted more than 200,000 learners and was evaluated with an average of 4.8 out of five from its learners.

#### 8) The edX

The edX platform was created by the Massachusetts Institute of Technology and the Harvard University in 2012 [13]. It has more than 20 million enrolled learners. "... We are the only leading MOOC provider that is both non-profit and open source ..." is the notable difference of edX when compared to other educational platforms and is clearly announced on their official website [14].

The search with the keyword *math* showed 164 courses: Introduction to Differential Equations, Application of Linear Algebra Part 1, Calculus 1A, 1B, 1C and so on.

The Calculus 1A: Differentiation, Calculus 1B: Integration and Calculus 1C: Coordinate Systems & Infinite Series are courses from the MIT. The first part started on 19<sup>th</sup> August 2018, the middle one on 21<sup>st</sup> November 2018 and the last course on 6<sup>th</sup> March 2019. All of the courses are free for the audience but if the learners want to get a verified certificate after successfully passing the tests, they have to pay 100 USD for each course.

#### 9) The OnlineCourses.com

Since 2016, OnlineCourses.com collects the best courses with the target of supporting learners with a selection of exploited MOOCs [15]. The main difference of OnlineCourse.com is the focus on two areas: MOOCs and video lectures. According to the definition of OnlineCourse.com, these two kinds of knowledge transfer are the friendliest environment for distance learners. Videos are delivered in a more natural way and are open for accessibility to the learners.

By a search with the keyword *math*, 37 courses were found on the OnlineCourse.com platform. This collection of courses is from different universities such as the MIT, the University of California in Berkeley, the University of Illinois and other universities.

The topics ranged from Linear Partial Differential Equations, Discrete Mathematics for Computer Science, Geometry to the Practice of Mathematics.

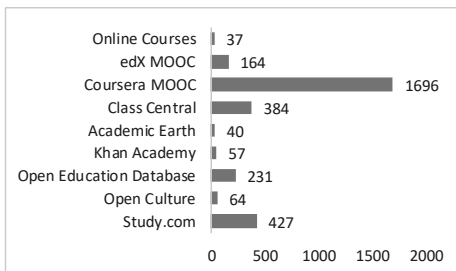


Fig. 1. The number of online MATH courses within the 9 selected platforms

Fig. 1 shows the results of the selected MOOCs math courses within the conducted review. According to the graphic, the Coursera platform has the biggest collection of MOOCs, namely 1,696. However, OnlineCourses.com, Academic Earth, Khan Academy and Open Culture are offering math massive open online courses as a complete program. For example, 57 courses from the Khan Academy are containing different lessons in one course. That means the figure cannot give a complete quantitative comparison view of the offered mathematics courses.

#### IV. SUMMARY OF REVIEW

In total, the nine biggest and most famous platforms for MOOCs were reviewed based on the selected subject: Mathematics. The oldest institution is Study.com. This platform started with publishing online video lessons. The evolution time of platforms for MOOCs can be divided into two main phases. During the first phase, the platforms functioned like a website that only collected and gathered the available online courses at one focal point. At that time, such platforms like Study.com, Open Culture and Open Education Database were providing centralized online courses data for learners. The next generation of platforms for MOOCs started with Coursera and edX. These platforms were established by university professors which had great experience with their own online courses. Besides Coursera and edX, other online open universities also emerged, such as Udacity and Udemu for instance. The main difference of these platforms is that they are not providing a collection of online courses only. They are independent educational institutions running fully online. Concerning the two biggest platforms for MOOCs, namely Coursera and edX, it can be concluded that the learners have widely accepted the online courses that have a self-oriented study aspect. More than 35 million plus some other 20 million learners have enrolled in the courses of these two MOOC platforms within the last 7 years.

Moreover, the most systematically completed courses were offered by the Khan Academy. The Khan Academy has special math courses and math groups, where the learners are able to find math courses with different levels: from the early math to the advanced college contents. Furthermore, the Khan Academy offers to the learners the opportunity to communicate and share their experience on mathematics with their teachers, as well as with their parents.

#### V. CONCLUSION

The authors conclude that there is a major blank for math online courses for engineering science, especially for computer science students. The review of MOOC platforms reported that only 3.3% of the online courses cover clear math subjects [16]. This proves that the universities should produce more online courses for math subjects, which could be useful for personalized learning. Moreover, online courses with math applications for engineering and computer science are still missing. 10% of online courses belong to science subjects and 7.1% cover engineering subjects. This shows that there is a need for cooperation between math and science professors to develop online courses with math applications for engineering and computer science students.

Last but not least, the conclusion out of the review is that universities and professors should focus more on using the already existing capacity of online courses for classroom as one of the active learning methods. Online courses for a specific subject can be offered to students as an additional source for self-study that could support learning at home. Using exercises and homework from high ranked universities can be of great benefit and is time-saving since preparing exercises with similar content would not be necessary anymore. Additionally, it will be helpful to the students to understand that science is the same everywhere and that the contents of top universities could be used even in their home country.

#### ACKNOWLEDGMENT

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# Traffic Light Sign Recognition for Situation Awareness using Monocular Camera

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**Abstract**—Traffic Light Sign Recognition plays a significant role in improving the intelligent transportation system. Recently, many techniques have been implemented to detect and recognize traffic sign lights. In this paper, a novel vision-based approach using image-processing algorithms for a specific hardware unit called the “CE-Box” is proposed. The aim is to recognize traffic light signs with high accuracy in semi-real time capability. The evaluation of the proposed approach has been done using a monocular camera. The recognition is highlighted via several CAN messages sent to an ECU via PiCan2, which is a part of the “CE-Box”. The goal of sending different CAN messages is to identify various surrounding situations of the vehicle. The output of the recognition of traffic light signs is provided as an input to the perception phase of Situation Awareness. The experiment demonstrates that the provided approach is able to achieve a desired traffic light signs recognition results with high quality, fast processing and robustness.

**Keywords**—traffic light signs, recognition, situation awareness, monocular camera, CEBox, PiCan2

## I. INTRODUCTION

The issue of accurate traffic light recognition plays an essential role in traffic control and collision avoidance. According to the U.S. Department of Transportation [1], the intersection accidents are the second most common reason for crashes of vehicles resulting from rear-end collisions. An accurate traffic light recognition system can notify drivers of any changes to oncoming traffic lights or even automatically induce the vehicle to react.

The traffic safety issues are becoming an attractive area for more researchers to collaborate with the automotive industry to develop safety solutions for a traffic environment. These solutions may differ according to the type of sensors used in the vehicles. One of these sensors is a monocular camera mounted in the vehicles, which allows the vehicles to recognize objects in various traffic environments in order to reduce the risk of traffic accidents. One of these approaches is the development of a robust traffic light recognition system, which is an important task in traffic environments and safe behaviour in a variety of traffic situations. One of the main drawbacks is the definition of a traffic light sign itself. The Vienna Convention specifies the traffic light means standard, but this convention does not define the body shapes colour and lamps colour as we can see in the fig 1,

there are various possible shapes for the traffic light object without even a standard specification.

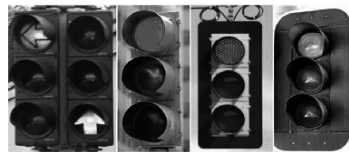


Fig 1: Different Specification of Traffic Light Sign [2]

Situation Awareness is the ability to perceive information from the environment, making a clear understanding of those perceived information and projection of future states based on the current state as situations. It is a widely used term in Aviation, made popular by Mica R. Endsley. Recently, the term Situation Awareness is gaining attention in autonomous driving. This paper focuses on traffic light recognition as one of the components of the perceived level of Situation Awareness in autonomous driving.

The perception of traffic lights is a very special problem due to the reason of not having a standard specification. Generalizing the recognition of traffic light signs without a standard specification becomes very difficult. However, it is possible to recognize traffic light signs using specific techniques and applying them in specific hardware.

Audi carried out many studies in 2008 to transmit traffic lights on the radio; however, this requires a significant improvement on broadcasting technology. At the same time, various sensors such as sonar, radar and camera are already available as components for driver assistance systems. Therefore, this study focused mainly on the visual assistance system by recognizing traffic lights in images and videos.

In this paper, an implementation of a combination of image processing algorithms to detect and recognize the traffic light sign for situation awareness using a monocular camera was done. It focuses on Hough Circle Transformation to detect the circles of traffic light signs. The implementation was tested on a specific hardware called the “CE-Box” from the department of computer engineering of TU Chemnitz.

A colour distribution technique is employed in order to recognize traffic lights by distinguishing them from other

objects achieved by using RGB and HSV colour space modelling techniques. The Hough transformation is also used to recognize the shape of the lights.

## II. LITERATURE REVIEW

### A. Situation Awareness

The term Situation Awareness is made widely popular by Mica R. Endsley. In her study [3] the three levels of situation awareness were introduced: perception, comprehension, and projection. Where the perception perceives information from the environment, comprehension makes sense of this information and projection projects an action based on the taken action. In this situation, traffic light recognition will be a useful case study in the perception level of Situation Awareness.

### B. Traffic Light Recognition

Plenty of techniques and approaches has been taken to detect traffic light in both real time and non-real time systems. In [4][5], real time traffic light signs detection was introduced using a spot light detection technique. Those approaches work very well when they are assumed that stoplight signs will have approximately the same position, size, and lighting, however, this is obviously not the situation when driving a vehicle. Another technique has been used for traffic light sign recognition is based on HSV (Hue, Saturation, and Value). Many studies [6][7] were segmented traffic light signs by employing a set of fuzzy rules based on the hue and saturation values of each pixel in the HSV colour space. The HSV colour space is suitable for colour segmentation traffic light task because the colour component of this space is invariant to varying light intensity.

Another popular technique in image processing and pattern recognition is Template Matching (TM) [8][9]. TM is a high-level machine vision method that identifies the portions of an image (or portions of images) that correspond to a particular image pattern. This method is also being used to detect traffic light by detecting different templates of red, green and yellow circular colours. There was another approach via Haar cascade classifiers [10], which employ pre trained data to recognize traffic lights. Recent Deep learning techniques are used widely in traffic light recognition and detection tasks, which are out of this study due the requirements and specified used hardware.

In this study, we focus on a combination of HSV colour transformation and Hough circle transform for recognizing traffic light signs.

## III. ENVIRONMENT SETUP

### A. Hardware

Department of Computer Engineering in TU Chemnitz has a variety of hardware demonstrators to display different applications. One of these hardware demonstrators is called the “BlackPearl”. The “CE-Box” highlighted in fig 2 is an integral part of this demonstrator. It is a hardware unit conceding of multiple racks which powers multiple Raspberry Pi 3B models. Each of the Raspberry Pi has a

PiCan2 unit mounted on it. Using the PiCan2, CAN messages can be sent and received. fig 3 illustrates the front panel of the “CE-Box” and its components.

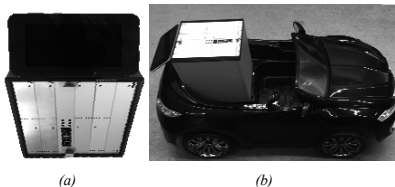


Fig 2: The “CE-Box”(a) & The “BlackPearl”(b)

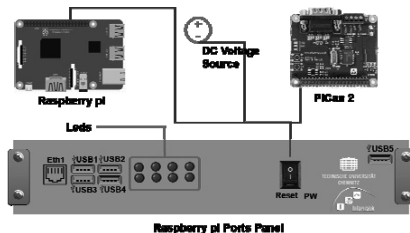


Fig 3: “CE-Box” front panel connections

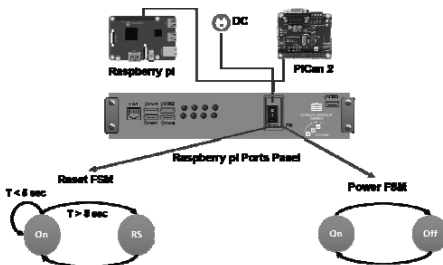


Fig 4: “CE-Box” front panel FSM's

The front panel of the “CE-Box” consists of 5 usb ports, one Ethernet port, 8 leds and 1 button dedicated for both reset and power options as shown in the figure 3.

The Ce-Box uses the Finite State Machine (FSM), highlighted in figure 5, in order to provide the reset and power functionality buttons, which are designed slightly differently. The user has to press and hold the button for more than 5 seconds in order to allow the Raspberry Pi to completely safety restart; on the other hand, the power button will directly disconnect and shut down the Raspberry Pi from the power source in a single press.

## B. Software

Each of the Raspberry Pi's utilized in the "CE-Box" is operated by "Raspbian Stretch" operating system. The CAN drivers for the pican2 are also installed. For performing image processing and computer vision applications, OpenCV 3.4.0 library [re] is installed on each of the Raspberry Pi with both Python 3.6.0 and C++ 11 dependencies.

## C. System Architecture

Images or videos are captured from a monocular camera is provided to the software architecture layer of the Raspberry Pi. This input data is received by an image processing application layer which running on the Raspbian stretch operating system. Based on the application layer different image processing algorithms can be done for detection and recognition purposes. In this case study, the traffic light sign is recognized based on a fusion of two imaging processing techniques (HSV Color Transformation and Hough Circle Transform). Once the object is detected and recognized, four CAN messages depending on the traffic light sign type can be sent to the ECU of a vehicle. This achieved with the help of PiCan2, which mounted on the Raspberry Pi. In this work, four CAN messages types are defining as following, three of them for different colored traffic light signs and one for not being able to recognize anything (failing model situation). These CAN messages are send using different message Id's. The system architecture and data flow control is shown in fig 5 and fig 6. The fig 5 shows the traffic light sign for Situation Awareness in the application layer.

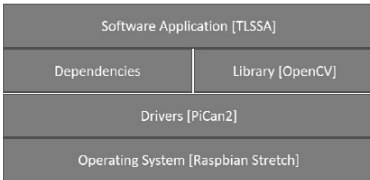


Fig 5: System Architecture Layer

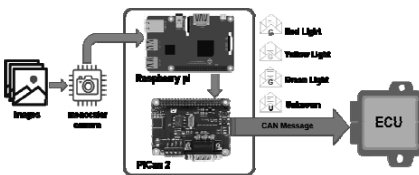


Fig 6: System Architecture

## IV. IMPLEMENTATION

This work focused on the recognition of traffic light signs from sequences of images captured from a monocular

camera mounted on the vehicle. Firstly, the Region of Interest (ROI) of traffic lights area is determined. Generally, traffic light signs are usually located on the upper part of an image. Furthermore, the light projected on the road by the automobiles can have an interference with the traffic light signs recognition. Therefore, the bottom half of the image is not taken into consideration, and thus, the image is then intercepted and only the upper 25% is taken into consideration for the image processing. Secondly, HSV colour transformation was done for red, green and yellow colour ranges, then the grey image filtration is applied to each image frame. After that, the Laplacian edge detector technique is implemented, the main drawback of this step is the Laplacian edge detector technique is extremely sensitive to noise. Therefore, the Gaussian blur method is used to reduce noise. Finally, the result was passed through Hough circle transform approach to recognize the traffic light signs in circular shapes.

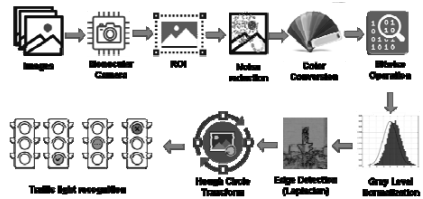


Fig 7: Implementation Algorithm

Fig 7 shows that the captured RGB image frames firstly, and after ROI is determined, different filters are applied for noise reduction such as Median Blur filter with kernel size 5 in order to minimize noise and also to remove salt and pepper noise. Then, RGB image frames converted to HSV colour map format. After that, a threshold is defined to estimate the ranges for red, green and yellow colours. Then the Hough Circle Transform technique is used for recognizing the red, green and yellow circle. Finally, if the detected circles are located in the given range, the coordinates  $(x, y)$  and radius  $r$  will be obtained. In order to determine the coordinates values, the edge values of neighbouring pixels will be checked and evaluated, if it is located in the range of  $(-3,3)$ . Finally, the result of recognizing traffic light signs will be provided as a text format, which will be sent as a message to ECU via a CAN bus as Red light for red traffic light sign, Green light for green traffic light sign, Yellow light for yellow traffic light sign, and Unknown in case of failing in recognizing traffic light sign.

## V. RESULTS & EVALUATION

### A. Results

The Implementation was tested on images from "The German Traffic Sign Detection Benchmark" [11], and results were successful in most of the cases. The results shown in the fig 8 below shows that the implementation worked as expected as it was able to detect red traffic light with a green circle around it and printing the result on the image.





Fig 8: Red traffic light sign recognition

Similar test was done from green traffic light recognition shown on fig 9 and fig 10.



Fig 9: Green traffic light sign recognition

The test results were successful on the input RGB images. Moreover, we decided to evaluate our algorithm on the offline video captured from the monocular camera. This video is part of Paris dataset [9]. The recognized traffic light signs are provided to the ECU as CAN messages via PiCan2 for individual detected colours. One extra message is provided in the case where no traffic light sign is detected.



Fig 10: Real world traffic light sign recognition

Although the algorithm was successful in the recognition of the traffic light signs, it also provided some false positive results in some use cases. We also found out that the results were better if a Median filter was applied instead of a Gaussian filter.

## VI. CONCLUSION AND FUTURE ASPECTS

In this paper, a new traffic light recognition algorithm was proposed using OpenCV library as a part of the perception level of situation awareness. Experimental results show that the algorithm is fast, robust and effective in the real world scenario. The test results were carried out in Raspberry Pi 3B model running Raspbian OS with a Pican2 mounted on it. This hardware unit is part of the hardware component called the “CE-Box” which is part of the hardware demonstrator called “BlackPearl” of department of computer science in TU Chemnitz.

As part of the future aspect of this study, for better accurate recognition of traffic light signs, the HSV ranges could be defined with much more precision. Furthermore, Machine learning and deep learning approaches for embedded hardware and could be studied in order to get more efficient development and use of hardware.

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