RECENT ADVANCES in EDUCATIONAL TECHNOLOGIES

Proceedings of the 2015 International Conference on Education and Modern Educational Technologies (EMET 2015)

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Applying algorithmic reasoning in education of children with hearing impairments

J. Zielińska, E. Brzdęk

This paper deals with the process of learning and memory development in children with repair impairments, relative to information processing and storage theories. The presented research clearly shows that applying algorithmic thinking by familiarizing this group of children with computers can help bridge educational gaps caused by hearing disorders. The paper covers the theoretical basis of the problem as well as the course and most important results of an empirical study devoted to analyzing the presented issues.

Algorithmic reasoning, deaf children, education, memory development

I. Introduction

INFORMATION storage and processing theory, which constitutes the theoretical (and – to a large extent – methodological) basis for the presented issues, relies in its cognitive and scientific aspects on scientific research in the area of experimental cognitive psychology and computer science [1]. These disciplines treat humans as users of symbol-based languages with a limited capacity for processing, and focus on analyzing the information flow when a human is presented with a specific task. Cognition can be divided into a number of basic processes, which occur in a specific time and order. These processes include: recognition, encoding, searching, sorting, classifying, linking and coordinating various types of information.

In the case of a deaf child, the presented processes are already impaired on the sensory level. The malfunctioning aural perception pathway has to be replaced with a different sensory mechanism – for instance, vision (which is where computers can be successfully exploited). Subsequently, actions have to be initiated which result in the handicapped child's working memory preserving the required information until such time as it is committed to permanent mnemonic storage. Devising functional problem-solving strategies for children with hearing impairments is a complicated and poorly developed process; hence the idea of creating an action plan which would consist of a sequence of well defined steps – a repeatable and learnable algorithm. Each task has to be formulated in a clear and unambiguous manner. As each problem is solved in a repetitive manner, an automation process takes hold, linking parallel events with one another. Tracking consistencies and inconsistencies in such an environment gives rise to subjective categorization and effects changes in one's perception.

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II. The Learning Process – Storage And Information Processing Theory

The information processing theory, when applied to the process of personality development, references Piaget's views where the child actively participates in trying to understand the world around it, basing its actions on two types of cognitive enhancement processes [3]. The first type of process is called assimilation, where new information is integrated into preexisting cognitive structures. The second type, accommodation, occurs when existing structures undergo changes in response to stimuli, and new, altered structures emerge to preserve internal balance.

Cognitive development methods which fit into the information processing schema are more specific to particular areas of development, easier to verify, more precise and more self-contained than those advanced by Piaget. Thus, they are also significantly less general in scope. In essence, they are based on two metaphors: the multi-store metaphor and the computer metaphor [2]. The multi-store metaphor relates sequential memory models. In such models, short-term (working) memory serves as the scene for a number of psychological processes which separate each external stimulus (treated as data input) from the associated reaction (i.e. output). Proponents of the information processing theory try to capture and describe coherent information flows passing through the human mind's entire cognitive system. In order to fully and precisely describe the events which occur between the reception of an external stimulus and the associated reaction. Therefore, an important factor influencing the cognitive field is the creation and development of cognitive process schemes and maximizing the influence exerted by control processes (both with regard to operation and assessment) on such schemes. In this context an important issue is the quantity, availability and structure of information.

Similarly to the computer metaphor. Both the human cognitive system and the computer process various types of input data into various types of output data in a systemic and intelligent manner. Such processing bases on information and rules stored internally. The computer metaphor is a useful point of reference at various stages of our analysis. The most general stage refers to the description of human cognition. Another stage involves treating computing technologies as a specific language in which to describe concepts and events.

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The most specific stage pertains to computerized simulation of human behavior. This research method is applied to better understand processes which enable humans to performs various types of tasks.

Both the concept of intelligence and the functioning of cognitive processes may be split into four distinct aspects, reflecting four levels of information processing [3]. The first aspect refers to the efficiency of the nervous system, expressed as the reliability and speed of neural signal transmission. The second involves formal properties of information processing (mental capacity). The third covers information processing strategies, i.e. selection of appropriate elements of the mental process and creating mental structures useful from the point of view of a given task. The final aspect is the capacity for self-assessment and control.

III. Conducted Research

The primary aim of the presented empirical research, aimed at demonstrating the usefulness of relating the information processing theory to cognitive studies, including the application of a custom-tailored algorithm for educating children with hearing impairments, is the assessment of formal properties of information processing in children with significant and severe hearing disorders [4] [5]. This research therefore fits within the second of the previously mentioned aspects. We have focused on intellectual processes associated with mental capacity, which is characterized by the speed of information processing (i.e. learning efficiency), working memory capacity and persistence of information storage (expressed as the so-called forgetting function).

The study group consisted of 88 children with significant or severe bipolar prelingual receptive aural impairment. All those children used hearing apparatuses and attended special primary school with facilities for educating deaf students. Their age was between 7 and 13 years. Hearing impairments prevented them from learning their national language by natural means and from acquiring knowledge from vocal cues. As a consequence, their linguistic and communicative abilities were also severely impacted, making it difficult for teachers to establish contact and sustain communication.

The presented study involved a special test, based on the deductive and autocreative learning model as well as on the assumption that the act of committing information to storage (or the lack thereof) can be expressed in probabilistic terms. The experimental procedure involved learning a series of stimuli pairs, where memorizing a given (though specific) element of the series enabled one to construct a simple stochastic learning model. Three independent events could therefore take place: committal of information to storage during a given attempt, lack of such committal or erasure of existing information.

Factors which described the mental capacity of the study group subjects were derived from mathematical formulae. For instance, the factor determining the probability of not remembering a given piece of information during a given attempt (interpreted as an inverse of the scope of the subject's working memory) was estimated as the average frequency of incorrect test results following the first attempt. If this factor was equal to 0, learning was fully effective during the first attempt, while a value equal to 1 indicated complete lack of learning. This in turn enabled us to calculate overall learning speed. Knowledge persistence was calculated directly as the difference between learning speed and an inverse of the capacity of the subject's working memory. Therefore, it was possible for the forgetting function to assume negative values whenever learning speed outpaced the capacity of the associated working memory capacity. In such cases the forgetting function, while devoid of its probabilistic meaning and inconsistent with the standard storage-based memory model, nevertheless retained empirical sense.

The learning process involves the execution of a well-defined, specific task. The specific act of learning, as a latent process, is not directly measurable – only the result of the task can be assessed. Hence it is possible for a person to commit information to memory even though such information is seemingly not consciously available to the subject. As a result of applying the proper experimental procedure, or otherwise during the course of information processing (both internal and external), such information may become expressed. This process is termed counterforgetting and is quite commonplace, similarly to information erasure or dismissal.

Taking into account the above facts, we have prepared a suitable test. Members of the study group had to memorize a series of fifteen geometrical shapes, selected from a pool of thirty. The structure of the task was well defined, the time was unlimited and the speed of learning was not regulated in any way. Attempts were repeated until the subjects could give two consecutive correct answers to test questions. The results gathered for aurally impaired children were subsequently compared with those achieved by children without any hearing defects.

The conducted empirical research clearly points to the fact that formal information processing qualities in aurally impaired children are identical to those possessed by children with no hearing defects, that their mental capacity is normal and is not affected by the existing hearing handicap. A similar conclusion was reached with respect to the variance of indicators, which was near identical in both groups. The smallest differences observed for each age group concerned the speed of learning; somewhat larger discrepancies characterized working memory capacity while the most significant differences involved the persistence of information storage.

An interesting and important conclusion, particularly from the point of view of educational practice, relates to the information storage persistence factor. During the learning process the value of this factor was often negative, which meant that the subject's working memory capacity was greater than estimates based on analysis and observation. This in turn implied greater intellectual potential, attributable to the possession of hidden information. In empirical research,

negatives values of the forgetting function were typically observed among older subjects. For sixth-grade children, such values were obtained in 37% of all cases. It follows that temporary, apparent lack of conscious information does not mean that such information is not present in memory and may not be expressed under different circumstances. For instance, by properly organizing a didactic process, with the aim of unlocking specific information processing strategies during learning. The use of computers looks particularly promising in this area, pointing to new areas of research, in relation to the ambivalence between creative and imitational activities, algorithmic and heuristic processing as well as selection of open-ended or limited-scope materials. The conclusions from this research can be applied to constructing new, computerized educational programs.

In the reference group, consisting of children with no hearing impairments, negative values of the forgetting function were observed in fewer subjects (statistically less than half of the cases present in the study group) and the distribution of these cases was also more even, with all age groups equally represented. It can therefore be concluded that the reference group was significantly different than the study group with respect to the subject of our research.

The results of the presented research enable us to surmise that current educational practice for children with hearing impairments is frequently misguided. Such mistakes are most likely the result of incorrect structuring of the didactic process and of incorrect evaluation criteria, which result from poor communication between teachers and handicapped students. Children with hearing disabilities form a diverse group which requires special "smart" educational processes, taking into accounts its capabilities and limitation, although it should be stressed that hearing impairment alone does not impact mental processes in the presented scope of study.

The conducted empirical research enables us to conclude which types of compensational mechanisms influence the learning process among children with hearing impairments. Such mechanisms typically act to offset low working memory capacity with increased persistence of information storage, while low persistence is in turn compensated by extended memory capacity, enabling learning through memorization. Our research also indicates that hearing impairments effect a strong link between the speed of learning and working memory capacity (relative to healthy children), although on the other hand the speed of learning becomes less dependent on information persistence. This state of affairs may be altered by applying computers as a didactic tool. It should be noted that information persistence is an important factor in increasing the learning curve among children who use computers in the learning process – a fact supported by modern research [4].

IV. Conclusions

Faced with the duties of teachers – particularly special education teachers – which involve creating rich learning environments to stimulate activities of their students, it is important to consider the role and impact of cognitive processes on learning and to model such processes. The most general aim here is to shorten the gap between cognitive processes and direct cognition by designing – or even enforcing, in the case of handicapped students – a suitable algorithm. Computers, treated as a tool shaping the dynamic evolution of students' cognitive abilities, can enhance both the quality and the effectiveness of learning [5], particularly among children with significant or severe hearing impairments, where ordinary vocal communication is difficult and frequently impossible. Scientific research, conducted on the basis of information storage and processing theories, can support this process, as proven by empirical studies. However, many such studies are either too narrow in scope or otherwise afflicted by the presence of artificial laboratory settings, disregarding the social context of the analyzed processes. This in turn forces us to reflect on the theoretical roots of the issue as well as to stress methodological aspects – perhaps by forming creative, interdisciplinary research teams which would be aware of the problems of people with hearing impairments and which would possess both the knowledge and the means to help such people.

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Management of processes of knowledge generation at universities

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***Abstract* —** The present paper compares the dynamics of research output of universities, which is expressed quantitatively, with the dynamics of transaction costs. Transaction costs are found to determine research performance of universities in terms of publishing research papers, obtaining patents, and participation in conferences and exhibitions. The paper empirically verifies the hypothesis that the transaction rate of knowledge generation expressed as participation in exhibitions in directly proportional to the number of economic units established at universities with the purpose of promoting the application of research achievements. The transaction rate of knowledge generation in the form of conference presentations is shown to be directly proportional to the university contractual work per capita.

***Keywords* —** Knowledge generation, Transaction costs, Research papers, Patents, Conference presentations.

I. INTRODUCTION

We are now a witness to boosting the role of knowledge in economic activity virtually at all levels of economy. This is primarily because the world is rapidly shifting to another development stage, the core of which is going to constitute the economy based on knowledge. A distinct feature of the latter is knowledge playing the crucial role, with its generation becoming an impetus for economic growth.

The analysis of world universities allows one to conclude that all sorts of funding there serve the primary function of any university – to distribute knowledge in society. Anything hampering its realization is considered unwelcome, and any commercial activity beyond knowledge transfer is seen as a principal cause of conflict of interests. That is why the need to scrutinize university research performance poses the challenge of great research relevance.

The objective of the present work is to estimate the correlation between the dynamics of university research output, which is measured quantitatively, and the dynamics of transaction costs.

The investigation is organized according to the following research logic: 1) examination of the preceding bulk of research, 2) drawing up work hypotheses, 3) discussion of the empirical investigation procedure, 4) obtaining empirical data, 5) verification of the work hypotheses.

II. RESEARCH BACKGROUND

B.R. Clark was the first to outline and elucidate three main perspectives of the university activity. The fundamental perspective of traditional universities suggests serving own academic ideals; the applied perspective, which is realized in commercially-oriented universities, is focused on realization of ideas having commercial potential; the research work of a socially-oriented university is aimed at objectives set by the society and the government [3].

The issues of evaluating performance of academic organizations have drawn the attention of many distinguished economic scholars. Thus, Bjørnåli E. S. and Gulbrandsen M. in 2010 addressed the ways of increasing profit of academic organizations by managerial stimulation of research performance [2]. Nilsson A. S., Rikne A. and Bengtsson L. looked at promoting and increasing the cost of academic activity outcome [4]. The issues of the cost of academic output transfer drew the attention of Zinkhan G. M., who saw the potential of reducing the costs of knowledge generation in its distribution through electronic media [11]. Visser Evert-Jan tried to assess the transaction costs of generation and distribution of academic output [7].

K. Arrow believed transaction costs to be those of exploitation in an economic system [1]. He compared the influence of transaction costs on economy with the phenomenon of friction in physics. Such ideas brought about a conclusion, that the closer an economy comes to the Walras's general equilibrium model the lower the level of transaction costs it demonstrates, with the opposite being as true.

On the other hand, D. North determined transaction costs as those consisting of 'the costs of assessment of useful properties of exchange goods and the costs of property rights security and enforcement on their execution'. These costs were assumed the source of social, economic and political institutions [5].

Taking the K. Arrow and D. North's beliefs for granted, we define the cost assessment of an economic institution as the transaction costs of establishing the norm of interaction between economic agents.

The need to consider transaction costs when investigating knowledge generation is clearly justified by the works of D. North, J. Wallis, and O. Williamson. The research of J. Wallis and D. North, devoted to transaction costs on macroeconomic level, showed the economic growth

of a country to cause the expansion of its transaction sector [8]. Therefore, the growth of knowledge, which is a factor of economic development, is determined by a change in the transaction cost rate. The development of innovation activity is often followed by transactions with highly specific assets. It was O. Williamson who first highlighted the problem of asset specificity [9]. This feature also indicates the need to elucidate the correlation between knowledge and transaction costs in an organization.

The previous research allowed to single out two types of transaction costs in academic organizations. In the academic sector of science, the vast majority of transaction costs of knowledge increase are the costs of information search and the costs of negotiations.

I earlier also showed that, in terms of production companies, the knowledge increase is determined by the dynamics of transaction costs. Similarly, in turn, the transaction costs change effects knowledge generation in research institutions. It should be mentioned here, that by transaction costs on research activity we understand the money allocated (and listed in accounting entries) to information search, travel expenses, representation, and other costs associated with research work. Salary and bonuses to the university's research and teaching staff are not included in transaction costs.

Given the above-mentioned, i introduced the transaction rate of knowledge generation – a quantitative parameter, which describes the increase of knowledge under the increase of transaction costs .

The transaction rate of knowledge generation can be calculated with the following equation:

$$v_{ij} = \frac{dk_j}{dTC_i} \qquad (1)$$

v_{ij} –rate of increase in j-IR (results of intellectual activity) under the change in i-transaction cost; dk_j – increase of j- type of knowledge; dTC_i - increase of i-transaction cost.

The parameter v_{ij} allows one to estimate the degree of effect of a transaction cost on knowledge generation.

It should be noted at this step, that by knowledge we understand structured and systematized information meant to meet certain objectives and to support the lives of human beings. In additon, I. Nonaka and H. Tacheuchi [18], as well as B.Landwall and S. Borras [16] pointed out that the process of generation and application of knowledge requires dynamic transformation of both tangible and intangible knowledge (or explicit and implicit knowledge), as well as the codified and non-codified relations between actors. P. Nightingale [17] was certain that if tangible knowledge can inevitably be transferred with some friction along time and distance, intangible knowledge is integrated within a human being in order to understand and utilise information.

In the present research, the indicators of tangible knowledge will include: the number of papers published in research journals, the number of patents, as well as participation in exhibitions (the number of exhibitions attended and the number of exhibits). Intangible knowledge involves conference presentations. It is assumed that conference meetings discuss premature ideas not yet complete and verified, so they can only be referred to as intangible knowledge.

III. WORKING HYPOTHESES

Hence, the analysis of the above-mentioned bulk of research and authors' contributions has allowed us to set out a number of working hypotheses for further investigation.

Hypothesis 1: The performance of research work at a university subdivision (tangible and intangible knowledge) is determined to a large extent by transaction costs on research activity.

Since education institutes are known to be different considering the number of researchers, the second hypothesis is formulated as follows.

Hypothesis 2: The transaction rate of knowledge generation, which is expressed as the number of papers published in research journals is proportional to the scientists having a degree and PhD students.

To the opinion of the authors, the number of research developments, which are put on display at exhibitions, must correspond to the number of innovation enterprises established at the institutes involved.

Hypothesis 3: The transaction rate of knowledge generation, which is expressed as exhibition participation, is proportional to the number of economic units established at the university with a purpose of promoting the application of research achievements.

It seems evident that there is a connection between the patents obtained and the number of innovation enterprises.

Hypothesis 4: The transaction rate of knowledge generation, which is expressed in the form of patents obtained, is proportional to the number of economic units established at the university in order to utilise research achievements.

Assessment of intangible knowledge in terms of conference presentations deserves a particular attention. It is a belief of the authors of the present paper that the intensity of conference presentations must correspond to the number of contracts an educational institution signs, or, specifically, to the number of commercial contracts signed per an employee. Therefore, the fifth hypothesis may look as follows.

Hypothesis 5: The transaction rate of knowledge generation, which is expressed as the number of conference presentations, is proportional to the university contractual output per capita.

These working hypotheses have been verified by an extensive empirical study.

IV. PROCEDURE OF EMPIRICAL STUDY

To provide the comparability of results, the representative sample included four large Institutes of the Ural Federal University named after B.N. Yeltsin specialized in sciences. For the sake of facilitation, the Institutes were assigned a serial number according to the number of faculty teaching staff: the first Institute - 297 persons, the second one – 254 persons, the third one – 193 persons, and the forth one – 126 persons, respectively.

When investigating the documentation of these Institutes, we filed the databases on the information effect and the output of research investigations in the years 2002 – 2011. It allowed us to obtain the empirical correlations of the tangible and intangible knowledge change under the change in transaction costs.

Fig.1 demonstrates the correlation between an increase in the number of research papers published and an increase in spending on research in the 1st Institution.

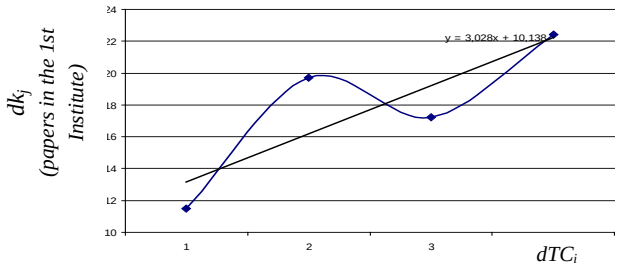

Fig 1.Dependence of an increase in the number of the papers published on an increase in the transaction costs on research

In the example given on Fig.1, v_{11} *is 3,03*. The indicator v_{ij} shows the share of the knowledge increase under 1% increase in the transaction costs. Similarly, the dependences of the transaction rates were drawn for all the knowledge types.

Data obtained and verification of hypotheses

The research carried out has proved the first working hypothesis about strong correlation between transaction costs and research performance at universities (Tab.1).

Table 1. Coefficients of correlation between transaction costs and research output

Indicators / Transaction costs of Institutes	Coefficients of dual correlation			
	Research Papers	Conference Presentations	Exhibits	Patents
1st Institute	0.8	0.79	0.79	0.88
2nd Institute	0.8	0.86	0.76	0.79
3rd Institute	0.88	0.82	0.83	0.87
4th Institute	0.98	0.81	0.79	0.94

Hence, the empirical investigation proved the research performance in a university's subdivision, which is given as knowledge generation in the form of papers published, patents drawn, participation in exhibitions and conferences, to be determined by the transaction costs on research activity.

To verify Hypothesis 2, we compared the number of researchers, including those having a degree, as well as PhD students, with the transaction rates of knowledge generation in the form of published papers (Tab.2)

Table 2. Transaction rates of knowledge generation in terms of the number of papers and the number of researchers

Institution	Rate of knowledge generation in the form of published papers	Number of researchers, persons
1st Institute	3.09	344
2nd Institute	0.41	253
3rd Institute	1.49	165
4th Institute	0.21	173

According to Table 2, Hypothesis 2 failed to be verified, because the transaction rate of knowledge generation tuned out to be disproportional to the number of researchers in an Institute. It seems likely that the transaction rate of knowledge generation in the form of papers published tends to be determined not by a total number of researchers but rather by their individual skills. This fact certainly requires further investigation.

Table 3 provides the results of empirical testing of Hypothesis 3 about the correlation between the knowledge generation rate in the form of participation in exhibitions and the number of economic units established at the university to utilise the research achievements, as well as the results of intellectual activity on the whole.

Table 3. Transaction rates of knowledge generation in terms of exhibit participation in exhibitions and the number of innovation economic units

Institution	Rate of knowledge generation in the form of exhibits	Number of economic innovation units
1st Institute	3.09	10
2nd Institute	1.70	7
3rd Institute	0.72	4
4th Institute	0.04	2

Table 3 undeniably proves the hypothesis that the transaction rate of knowledge generation in the form of exhibit participation in exhibitions is proportional to the number of economic units established at the university in order to utilise the research achievements.

It should be noted that the rate of a knowledge generation increase in the 1st Institute is 0.04. It seems likely that this type of knowledge has been created at the Institute, but the increase in the transaction costs in the

given period has exceeded the knowledge increase. Supposedly, such minimal rate is the result of the minimal number of economic units established to promote the research achievement transfer.

The tangible knowledge in the second Institute generated via exhibition participation corresponds to the minimal correlation (0.76) and the maximal rate of intellectual results increase (3.09). Such significant rate is likely to be the result of the large number of economic units established with the Institute's participation to utilise the research developments and the results of intellectual activity of the given subdivision.

Table 4 depicts the empirical verification of Hypothesis 4 concerning the correlation between the quantity patents and the number of economic units established at the university.

Table 4. Transaction rates of knowledge increase in terms of patents and the number of innovation economic units

Institute	Knowledge generation rate in the form of patents	Number of innovation economic units
4th Institution	1.43	7
3rd Institution	0.70	4
1st Institution	0.30	2
2nd Institution	0.29	10

Table 4 shows that Hypothesis 4 has not been verified, because the transaction rate of knowledge generation expressed as the number of patents is not proportional to the number of economic units established at universities to apply the research developments. As well as with Hypothesis 2, application for patents seems mainly to be determined by the individual innovative characteristics of a particular researcher.

Table 5 gives the empirical data verifying Hypothesis 5, which elucidates the correlation between the rate of knowledge generation during conference presentations and the total amount of contractual work done per one Institute's employee.

Table 5. Transaction rates of a knowledge increase in the form of conference presentations and the amount of contractual work per one employee a year

Institution	Knowledge generation rate in a form of conference presentations	Amount of contractual work per one employee a year, thousands of rub.
1st Institution	2.59	259,1
4th Institution	1.39	204,0
2nd Institution	0.30	202,2
3rd Institution	0.29	17,2

The data given in Table 5 provides convincing evidence for the validity of Hypothesis 5, which correlates the transaction rate of knowledge generation in the form of conference presentations and the amount of contractual work per one Institute's employee.

V. CONCLUSION

To summarize, the theoretical and empirical study undertaken to compare the dynamics of university research output, which is expressed quantitatively, with the dynamics of transaction funds spending has allowed us to reach the following conclusions.

First, the study has proved the hypothesis that transaction costs determine the university research performance in the form of papers published, patents obtained, and participation in exhibition and conferences.

Second, the study has empirically supported the hypothesis that the transaction rate of knowledge generation in the form of exhibit participation in exhibitions is proportional to the number of economic units established at Institutes to utilise the research developments.

Third, the empirically rejected hypotheses of correlation between the number of researchers and the transaction rate of research publication, as well as between the number of economic units and the transaction rate of patent registration, demonstrate the need to study these directions of intellectual activity in a greater detail.

Forth, it has been empirically proved that the transaction rate of knowledge generation in the form of conference presentations is proportional to the amount of contractual work per one institute's employee.

On the whole, the present study devoted to the transaction rates of knowledge generation in terms of various results of intellectual activity is of pilot character and might serve as a ground for researchers to draw attention to the potential of encouraging innovation by means of transaction costs.

The research has produced the results of a world level. The practical relevance of this study is the possibility to use this data in planning, stimulation and increasing the efficiency of new knowledge generation at universities. The theoretical significance is the introduction of a new notion, i.e. the transaction rate of knowledge generation, in the arsenal of tools of knowledge economy.

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Neuroeducation in the light of Embodied Cognition: an innovative perspective

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***Abstract*—**"Neuroeducation" and "Educational Neuroscience" are labels that refer to a branch of knowledge which is the subject of a rather heated debate amongst researchers. This new area, arising from an exchange between Neuroscience and Educational Sciences, is generally and mistakenly described as a context where educationally relevant evidences from neuroscientific field are "translated" into educational methodologies to directly foster pupils' learning performances in schools. Actually, as indicated above, it is a complicated matter since recent reviews [1][2] show that there is neither full agreement about the kinds of topics that should be included in the area of Educational Neuroscience nor a common lexicon that enables problems, issues and topics to be clearly defined. Therefore, this article would help to shed some light on this matter and to accomplish two main purposes: (1) to define the theoretical features of a new perspective, the Radical Embodied Cognition, which can clarify the relationship between Neuroscience and Education avoiding the most recurrent troublesome issues; (2) to define, within this framework, storytelling as an approach able to manage and measure continuous learning processes for students in different learning contexts.

***Keywords*—**Education, Neuroeducation, Neuroscience, Radical Embodied Cognition, Storytelling

I. Background

THE application of Neuroscience to educational problems is commonly depicted as "Neuroeducation" or "Educational Neuroscience". Illustrative of a strongly emerging trend, it highlights the need to bridge the gap between educators, psychologists and neuroscientists and to provide high quality information in the rush to apply so-called brain-based methods.

Incredible progress has been made in Neuroscience. The availability of non-invasive tools to image the human brain has allowed researchers to investigate how the brain changes over the course of development and learning and to investigate the brain circuits involved in key academic skills as well as more general cognitive skills. This unprecedented level of progress has spurred on efforts to forge greater links between neuroscientists and educators in an attempt to improve learning. Cognitive Neuroscience studies are making great strides forwards in enhancing our understanding of how the brain and cognition change as a function of learning.

Indeed, the idea was met with much excitement in the 1960s [3] when it was posited that neuropsychological approaches could be taken to deal with learning disorders. This was followed by a further wave of enthusiasm with Fuller and Glendening [4] proposing that so-called neuroeducators should serve both communities to apply knowledge about the brain to the learning process. Nevertheless, some 25 years later, and despite some very significant advances in understanding key neurocognitive processes [5], including those that underlie skills such as reading and mathematical abilities, this partnership has yet to reach its full potential [6].

While all the progress in research is positive, there are many challenges facing the emerging field of 'Neuroeducation'. There are some issues that people in the field of Neuroeducation should be aware of: interdisciplinary communication, the status of biological explanations of behaviour, managing expectations between disciplines and methodological limitations.

One of the greatest obstacles to real progress in Neuroeducation is represented by differences in levels of understanding possessed by educational researchers, teachers and neuroscientists about each other's disciplines and traditions, practices and methodological approaches. Lack of interdisciplinary training results from poor communication between educators and neuroscientists [7]. By taking advantage of such interdisciplinary training, neuroscientists would ask more educationally relevant questions and educators would be able to use knowledge gained through exposure to Neuroscience in their educational practice.

According to Ansari et Al. [7], there should be bi-directional and reciprocal interactions between both the disciplines of Neuroscience and Education, and research originating from each of these traditions is considered to be compelling in its own right. This will lead to greater communication between neuroscientists, educators and educational researchers, for all of whom the aim must be to achieve a common language to generate future research questions and translate research into concrete educational applications. The translation from research into practice will not be straightforward and will require many intervening steps as well as professionals capable of facilitating them.

Educators are turning increasingly to Neuroscience as an exciting new resource in their work helping children develop and learn. On the other perhaps more negative side, misconceptions about learning and the brain have proliferated. Influenced in part by popular but scientifically dubious "brain-based" educational programmes, neuromyths can inform teachers' instructional choices but promise no benefit for the children they teach [8].

There is frequent skepticism levelled at highly controlled experimental research by educational researchers, who are typically steeped in traditions that focus on rich natural environments including many variables that cannot be controlled for. On the other hand, these rich environments are

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the context in which classroom learning takes place and, therefore, it will be important to investigate how data obtained in highly controlled neuroimaging studies relate to classroom or laboratory learning.

Such lack of understanding can lead to fundamental misrepresentations on both sides. Neuromyths are commonly held and articulated assumptions about brain function that directly contradict themselves or are largely unsubstantiated by available evidence. There are many more such neuromyths that educators are being exposed to through books, newspapers and other resources (such as online materials). Without an adequate understanding of Neuroscience, educators cannot be expected to arbitrate between empirically proven evidence and neuromyths.

Therefore, in order to define topics and issues in which Educational Science and Neuroscience can profitably collaborate, it is necessary to put this relationship in a context of a model of mind able to validate the connection points as parts of a strong wider theoretical background [9].

Radical Embodied Cognition (REC) theory offers a new way to deal with problems and lacks arising from the relation between Neuroscience and Education. This perspective extends the concept of mind involving in it crucial items as body, action, perception and environment. Such an expansion entails some advantageous consequences about connections amongst cognitive elements and different analysis levels and methods. Identifying mind as a component emerging from the relation of a body that acts and perceives within an environment, REC absorbs the study of neural, physiological, behavioural, linguistic and social traits of human learning processes just into one framework.

Without such a model the relation between Neuroscience and Education is likely to remain at a superficial level.

II. Radical Embodied Cognition for bridging the gap

From our perspective, a model of mind capable of fulfilling this role is the Radical Embodied Cognition (REC) model. This point of view is a variation of Embodied Cognition (EC) and shares with it two basic assumptions.

The first one states that cognitive processes are subject to perception and motor processes. This assumption is opposed to conceiving cognition as separate from sensorimotor control and as a phenomenon completely independent from perception and action. It is in contrast with the "sandwich model of the mind" [10] that describes minds metaphorically as sandwiches in which the meat, the cognitive processes, represents the most important part and the bread, perception and motor processes, represents less important elements. This model throws bread away and preserves only the meat. EC, instead, strictly links these three elements in a circular relationship. In other words, from this perspective, cognition emerges from a co-action amongst cognitive processes, motor processes and perception [11].

The second assumption refuses a computational and representational model of the mind and a metaphor of it as a software that manipulates several symbols. It rejects an approach that links cognition exclusively to thoughts and explains this phenomenon as a set of rigid and fixed cognitive items. Cognition is not a set of mental contents (concepts) organized along different amodal (in a code unconnected to sensorial modalities) and static representations (temporal, spatial, causal, logical) [12][13] but rather, according to an EC perspective, a dynamic relation amongst cognitive processes, perception and motor processes [14].

Within the context of these two crucial assumptions, REC focuses on the role of motor processes and the body as crucial actors in structuring cognition in close connection with the world [15]. Thanks to this approach, the action and perception of a body in a world become key points of cognitive processes since the body is the first essential instrument for experiencing the world and its action is completely involved in the ways in which we come into contact with it [16]. Taking into account these elements redefines the concept of "cognition", including abilities in constructing behaviours that support goal management and achievement, social coordination and adaptability across different contexts.

Moreover, according to this approach, the brain, the main cognitive organ in the sandwich model of mind, becomes part of a social process that involves other extraneural components that are equally important and affect neural processes [17]. In contrast to the representational and neural view of mind and cognition, the REC perspective suggests that cognition as a part of social interaction can be described as a dynamic relationship between organisms, including brains and other extraneural components, that enables perception-action circles involving social and physical environments [18].

REC, giving a crucial role to the body, action and world (environments) relationships in a social dimension, also redefines the concept of "intelligence" as an element that emerges from complex interaction between social actors and environments within a developmental time course [19].

In addition, within this framework, redefining these concepts means redefining a concept that is closely connected to them, "cognitive development", and involving additional elements that in the past were not considered to be cognitive factors [12][13]. One of these is the temporal dimension.

Cognitive development arises from a permanent integration amongst elements that stand in different nested time scales. Some of them, e.g. perceptual input and real-time social interactions, stand in a fast time scale, guide cognitive processes in the moment and are repeatable and context sensitive. Others, e.g. learners' long term history, are realized in a slower time scale and are the background into which fast time scale factors flow, becoming part of them [20]

III. Storytelling as a learning methodology

At this stage, within such a perspective, it is essential to define an educational practice that involves all these different elements of cognition mentioned above and that enables multilevel analyses. Amongst different educational practices we decided to opt for storytelling since it is strictly connected to the embodied perspective due to its peculiar property to involve both the body and the mind, as a part of the body. In fact, storytelling is not reductionist and allows us to display cognitive functions united by the body and the environment at the same time. Moreover, storytelling allows us to overcome the issues related to the execution of those simple tasks that simply elicit neural activation. By means of storytelling

multisensory and multimodal sides of knowledge are legitimized. This methodology uses narratives as a mean to focus the events of reality and makes explanations congruent with logical sequences. It can be defined as an "interactive process" because the narrative discourse makes multiple interpretations possible for all those who come into contact with it. Moreover, storytelling actively contributes to increasing cognitive skills, since it is expressed in specific communicative contexts and facilitates the processes of meaning construction. [21] This methodology provides neuroscientific and educational analysis with several advantages in a REC perspective.

On the one hand, it enables the standard bottom up analyses of Neuroscience to be included, with regard to memory, attention, vocabulary, reading and writing skills, and visual skill [1] within research studies related to complex cognitive tasks involving the above mentioned indicators as mutual elements. Our aim is to exploit storytelling to carry out analyses at different levels of reductionism: from the most frequent reading comprehension, to the highest level of mathematical analysis of cognitive tasks, reinterpreting the relationship amongst the components of a reductionist approach.

As we mentioned above, the core of embodied cognition models of mind is that the body contributes to "higher" cognitive processes that are important to education, such as language comprehension, reading, mathematics, and scientific thinking. Storytelling, as a methodological practice, crucially enables the relationship amongst body, action and the world to be taken into account. It suggests a reinterpretation of the results of neuroscientific analyses, not only in terms of connections between a cognitive function and a specific cerebral area for a specific task, but in terms of connections amongst cognitive functions, cerebral areas and cognitive tasks that are strongly affected by the environmental-extraneural components mentioned above (goal management, goal achievement, social coordination, adaptability across different contexts).

On the other hand storytelling, as we outlined above, uses narratives as a means to focus the events of reality involving the body as the main "device" through which we experience the world [22]. Within this framework, the learner is physically immersed in a semiotic domain whose elements (words, images, symbols) have proper but related meanings [23] when he approaches storytelling practices. A semiotic domain represents a starting point from which learners construct meanings that are grounded in bodily experienced events and, for this reason, meanings that are at the same time sensory, linguistic, kinaestetic and affective [24].

A version of grounded and embodied meaning has important consequences in terms of education since it enhances critical thinking skills that allow theory (acquired contents) to be linked to practice (problem solving and comprehension processes) [25].

IV. Storytelling and Cogintive Measurements

The construction of educational practices to be experienced according to our approach is made possible by educational expertise that organizes the presentation of learning contents thanks to the embracement of the Educational Science area approaches. In particular, such approaches refer to the educational methodologies that can be contextualized in a learning process. As mentioned above, storytelling is an effective, educational methodology connectable to a learning process within a learning context.

From a psycholinguistic point of view, it enables classical linguistic relationships to be measured: lexicon-semantics, lexicon-syntax, semantics-syntax, lexicon-semantics-syntax. This can be carried out through the investigation of high frequency linguistic structures (syntactic patterns, regular and repeating phrasal constructions) occurring in interactions between learners and storytellers, and the examination of high frequency semantic frames in which different words and patterns are used in learner-storyteller conversational interactions. The analysis of these relationships entails several linguistic measurements that allow in depth examination of linguistic and cognitive markers (e.g. type/token ratio, word/utterances ratio, amount of speech, MLU - Mean Length of Utterances, IPSyn - Index of Productive Syntax, Narrative comprehension, Narrative production, Temporal and spatial categories development etc.).

Nevertheless, these measurements remain entrenched within a static and amodal model of mind if they are not linked to other components within the REC perspective. In order to fill this gap it is essential to link the study of these indicators to the study of the prosody of language.

Prosody is a sensory-motor phenomenon that, within the Radical Embodied model of mind, underpins the relationship between language, action and mind (body/brain) [26]. Examining the contribution of the tune and rhythm of speech to the meaning construction process, prosodic analyses of language enable research to be carried out regarding suprasegmental features that link language to behavioural and physiological traits.

When we examine fundamental frequency (vocal pitch), acoustic intensity (loudness), phoneme and syllable duration (rhythm) we are measuring sensory markers that are cognitive elements, some of which are different from language but related to it.

Prosody, for instance, interacts with emotion in speech [27] at linguistic, paralinguistic and non linguistic levels. Through an investigation at a prosody level, within a REC perspective and exploiting a storytelling process, the strictly psycholinguistic analyses mentioned above can be associated on the one hand to paralinguistic traits of speech that are not completely linguistic components but that affect the construction process of meaning as behavioural components. On the other hand they can be associated to non linguistic traits of speech that play a crucial role in offering essential information about speakers' (learners and storytellers) physiological aspects.

However, from a physiological point of view, storytelling is suitable to perform an assessment of students' neurofeedbacks during their execution of *ad hoc* learning tasks and a measurement of many electrophysiological signals on students, too, through wearable sensors. These signals are appropriate to identify and assess individuals' emotional engagement and interest while they are performing tasks, either consciously or unconsciously. In particular, the most relevant electrophysiological signals are those of EEG waves,

ECG trace and GSR trend. Behavioural evaluations would be enabled by ambient equipment such as video cameras, microphones and software that integrates the behavioural and the physiological signals acquired. All the data gathered would be useful to develop personalized educational strategies.

V. Conclusion

The proposed approach would materialize in physical contexts where measures (behavioural, physiological and psycholinguistic analyses of learners) could be performed. Such contexts may be conceived as structured spaces staged as multimedia and sensory environments, widely interactive and compliant to school students. Within this context, we envisage an approach that does not support the analyses of the structures rather the evolution (ontogeny) of cognitive functions during the execution of tasks designed *ad hoc*. Such activities would not be conceived as either merely pedagogical (didactic) strategies or tasks to elicit neural activation but rather as a halfway solution. That would represent strategies or tasks through which neural activation measurements would become part of a multilevel analysis by closely linking the lowest level reductionist evaluation in a continuum with the highest level social survey.

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The objectivization of the entry conditions of the pedagogical research

R. Drtina, J. Sedivy, M. Schlosser

***Abstract*—**In a technical concept the teaching process is the information transfer within the unidirectional or bidirectional Shannon-Weaver model of communication. The Lasswell model of communication is commonly used for the information transfer evaluation. For maximum effect, reflecting formal shape of both models, the demands for virtually lossless. The basic parameter for evaluating the quality of speech transmission is clarity

***Keywords*—** clarity, communication, information, quality transfer, speech transmission index, transfer

I. Introduction

DESPITE the escalating requirements for multimedia support teaching, improving the quality and effectiveness of education is the formation of the working environment in the context of the requirements of ISO 9001 [1], Art. 6.3 - Infrastructure and 6.4 - Working environment and decrees MMR 137/1998 Sb. [2] and MZ No.108/2001 Coll. [3] is essentially zero. In the case of educational research and are never objectively describe the input conditions. These can significantly affect the results (e.g. The evaluation of listening to language teaching) [4]. In the last years we randomly example. Gugová extensive research, the author [5], Dostal - Macháčková [6] or Polakova - Štefančíková [7].

Good working environment educational institutions, schools, workplaces and domestic (eg. In the use of e-learning courses) is subject to a number of hygiene and ergonomic requirements, it is necessary to ensure coherent optical and acoustic performance while achieving maximum possible transmission quality optical and acoustical information and minimize visual and auditory fatigue. In terms of research carried out must be ensured and necessary repeatability in terms of ISO 5725-1 [8] ISO 5725-2 [9] ISO 21748 [10] ISO 2602 [11] ISO 2854 [12]

II. Methodology and Information Technology

Likewise, vision and hearing (video and audio) receptors are still the dominant sense in mediating knowledge of the surrounding world. Although at this year's Consumer and Computing International Consumer Electronics Show head of the US subsidiary Bosch, Werner Struth, said that the "analog world as we know it ends" [14], our perception still remains analog as well as continue to persist transfer information analogue transmission channels which may interfere with, among others, restrictions resulting from digital technology [4].

Various educational research, studies on the quality and efficiency of the educational process should do so as objectively as possible and in connection with the implementation of quality management to take into account the requirements of ISO 9001 [1], which in Art. 6.4 - Working environment states: "The organization shall determine and manage the work environment needed to achieve compliance with the requirements for products. The term work environment relates to the conditions under which the work is done. These conditions include physical conditions, under-conditions and other environmental factors (such as noise, temperature, humidity, lighting or weather). "

Infrastructure states that "The organization shall determine, provide and maintain the infrastructure needed to achieve conformity to product requirements" [1]. Under the circumstances, then infrastructure includes:

- buildings, workspaces and related technical equipment,
- process equipment (both hardware and software), and
- support services (e.g. Communication or information systems).

If we identify, from a technical point of view, for acoustic information transmission didactic principles of clarity in the teaching process speech intelligibility, then we can, while respecting acceptable losing clarity of consonants at ZSS 5% derive requirements for acoustic transmission channel [15].

The primary prerequisite acoustic communication is very good logatomic cognizable and its derivative sentence intelligibility. Given that in professional courses is acoustic information transfer based on communication pupils primarily unfamiliar technical terms, we can rightly claim classrooms logatomic cognizable better than 97%. This can be easily verified using logatomic tests that are processed in tables for each language. Its verification and subsequent statistical evaluation is feasible without major problems means each

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school. Based on the results can then decide on the need and extent necessary acoustic treatment of the classroom and its technical equipment.

Consistent application of the golden rule didactics is for obvious reasons a source of higher demands on teachers. In practice this means that it is important not only to prepare acoustically provided information but also to adapt its communication process pupils with regard to their maturity, but also on the surrounding environment. The speed of speech must adapt perceptual abilities of students (normally recommended speech rate is approximately five syllables per second), to ensure proper articulation and speaking loud enough for all students to have a level playing field perception. Doing their own (ambient) noise classrooms, reverb and other disturbances significantly impair intelligibility. In this context, it is often underestimated disturbing noise in computer rooms [15].

Workers electrical engineering laboratories of the Department of Technical Subjects of Faculty of Education, University of Hradec Králové many years solves the problem of objectification measuring intelligibility in classrooms in collaboration with colleagues from acoustic laboratories FEL West Bohemia in Pilsen. The results of recent researches show often a stark difference between the Speech Transmission Index, measured by a standardized method of bite, insensitive to sources directivity and frequency characteristics of the transmission channel [16] [17] and the results obtained by logatomic tests. The aim of the research projects carried out in recent years, is to verify the measurement methods so as to ensure the correlation of the signal measurement method Stipe results of valid tests logatomic so ideally correlation coefficient ρCIS, LOG approached one, and that the measured values take into account the directionality of sources a bandwidth of.

III. Repeatability Tests and Security Conditions Research

In order for pedagogical research in the field of monitoring the effectiveness of training and evaluation of the quality and success of distance courses, in which an audio material, able to clearly define the input acoustic conditions of the working environment (this applies to both the spatial acoustics of lecture halls and classrooms, and home environment acoustics in the use of distance forms of teaching), and to be assured of technical reproducibility of the experiment in terms of standards [8-12], it is necessary to have a reference measurement signals.

Problems with the inconsistency of the results of different measurement procedures and methods are nothing new. Already researches conducted in the 50s and 60s of last century, a number of research organizations have shown different results of speech recognizability tests depending on the language. For example Borovičková - Maláč [18] reported that the differences between Czech and English, ceteris paribus, reaching up to 15% in favor of Czech, but not the Slavic languages are the results compared marketable. In the frequency range 600-2000 Hz is the difference between the recognizability of syllables Czech and Russian to 22%, again in favor of the Czech.

Both authors were well aware of the complexity of the issues and evaluate the clarity of their statements in that document that "if we emphasize the need for objective measurement methods in linguistics and especially in experimental phonetics, we also note that the very use of modern measuring equipment is unable to solve definitively any linguistic problem. We are fully aware that devices are only auxiliary equipment, the results of which must be individually processed and controlled by subjective methods. Although we expect in future not only with mechanization, but also automating highly complex measuring tasks and their evaluation, the final factor that will always remain one. It is due to the fact that the linguistic issues in terms of objective reality, which is always perceived subjectively by man "[18] is valid even after more than fifty years, in the era of digital technology and sophisticated measuring systems.

Also, previous research results evaluation method clarity, articulation index (speech intelligibility index - SII, ANSI S3.5 - 1997), which is used by university departments e.g. To evaluate the clarity in vehicles [19], which is implemented in the system of Czech technical standards, show that the method SII has considerable limitations, especially in cases where it is most disturbing noise below the reference areas of speech, articulation index is approaching 100% and above-the results are comparable with the results of standard listening tests.

Determining the articulation index is not according to the standard method [19] suitable for areas with a low level of self-noise and thus provided the results can not be considered fair. Therefore, introducing the concepts of "open articulation index" and "closed (Traditional) articulation index". Contributions to open speech articular index are not limited to the lower limit of the speech band. It is shifted to 0 dB and articulation index reaches values over 100%. Theoretically, the maximum attainable then approaching 225%.

IV. Logatomic Tests

The analysis of the results of measurements and signal spectra also demonstrated insensitivity standardized methods for frequency and directional characteristics of the emitters, which was at the beginning of the study rather negative findings highlighted the need for us to return to practice proven, time-consuming, but very sensitive method of detection achievable clarity - logatomic tests. We have unsuccessfully searched for the original recordings, which arose in the 60s and 70s for VÚZORT, AZD or Language Institute, Czech Academy. Most likely they are unique records irretrievably lost.

In cooperation with Czech Radio Hradec Králové (Radio HK) Therefore we have produced a new version logatomic tests for the detection of clarity (or more precisely - the

recognizability of the syllable) in classrooms and auditoriums. At this point, we consider it necessary to emphasize that the reference tests must be perfect from the technical and phonetic. It is therefore not possible to create in amateur conditions. The record shall be drawn up without corrective actions, without adjustment dynamics and must meet the requirement so. Voice format. This means that the signal from the reference monitor (in our case the reference emitter NTi Talk Box) must be the same as if at a given location within a particular speaker spoke.

Before the start of production, we measured the basic parameters of the study and transmission paths. Radio HK has anechoic space called. Plein air. Therefore, in the studio built ful damping panels (Fig.1). The average reverberation time of study is in the range of 270 ms of speech (Figure 2) and the radius of reverberation for omnidirectional radiation is 103 cm. Pro speaker is then the reverberation radius 162 cm distance and reverberation than 8 dB. Reverberation radius is so beyond the exterior wall panels and damping due to high distance is the dominant direct signal.

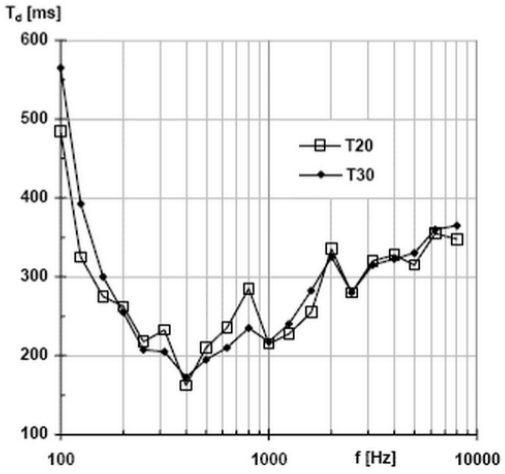

Fig. 1 The reverberation time of studios

With reference emitters NTi Talkbox test was conducted around the transmission channel. At the workplace moderators (Figure 2) was placed reference source and an alert has been measuring signals bite, white noise and pulses.

Neumann U87 microphone sensing is a professional studio standard. The recording was not called. Pop-filter with an omnidirectional polar pattern. The transfer characteristic is in the range of 100 Hz to 10 kHz (range NTi Talkbox) equals, speech transmission index Stipe gives the maximum possible value STI = 1.00 and A + quality, which is excellent speech, which can be in studio settings rightly expect.

For applications in educational research, we chose a compromise between the length logatomic test and achievable precision. Hundred syllables test has a resolution of 1%, and is divided into five groups of twenty syllables. When the cadence of 0,5/s i.e. One syllable in two seconds, with a break of 10 s between groups, one test takes less than 4 minutes. To listeners in repeated tests could remember the order of syllables are in various forms of tests swapped to the entire group, so each syllable.

The production tests involved a team of five employees of Czech Radio HK. Moderators Jakub Schmidt, Lada Klokočníková, Karel Sladký, sound engineer and director Leos Sedlacek Pavel Krejci. As we learned during manufacturing, currently director Tailor filmed in the seventies logatomic tests for AZD.

V. Variability of Logatomic Tests

Collaboration with professionals, particularly in the production of a key test of audio material, consider not only commonplace, but a necessary condition for objectification of input values pedagogical research whose content is aural component of the learning material. To get near the practice tests were filmed in three versions for voice, lower male voice, higher male voice and a female voice. Professional presenters under the leadership of literary director for us were the guarantee of a precise pronunciation of speech therapy without defects.

Equally important is a stable rate of speech, a constant cadence of logatoms and also neutral vocal performance without modulation or intonation changes. The structure and quality of the recorded material allows seamless combination of any 20 syllables groups of up to 120 tests for one vote. The combination 20 syllables groups from all three votes, then theoretically allows you to create over 360 thousand tests.

In addition to the basic transmission Kana testing and monitoring the impact of corrections, directivity emitters, transmission speed (bitrate) and associated digital signal degradation, we comparative method to determine the effect of imperfect articulation, speech defects, or improper technical processing of sound recording on the achievable intelligibility under otherwise identical conditions, transmission . Just to author learning material loaded the same logatomic test and comparing the results we get peace deterioration due to vocal intelligibility of speech, recording conditions, combination of both factors.

VI. Educational Experiment

In the framework of research project specific research we verified experimentally the influence of vocal expression and listening conditions. The task was to make students logatomic test in school environment cabinet or home office. To record the pillar was used electret microphone, commonly used for communication via Skype and a computer with standard configuration Win7. Very soon students know that record just one 20 syllables stretch in one sequence is not so simple.

Listening was the monitors RS-711H in the near field (60 cm, STI = 0.99) and built-in speakers Sony Vaio laptop (60 cm, STI = 0.93). The results are shown in Table 1.

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Table 1 The comparative test results

production of record		radio	home
listening device -	the source format	intelligibility	
monitor RS-711H	PCM 16 bit/44,1 kHz	100 %	89 %
Sony Vaio	PCM 16 bit/44,1 kHz	100 %	87 %
monitor RS-711H	MP3 56 kb/s	100 %	88 %
Sony Vaio	MP3 56 kb/s	98 %	87 %
monitor RS-711H	PCM 8 bit/16 kHz	94 %	87 %
Sony Vaio	PCM 8 bit/16 kHz	91 %	85 %
monitor RS-711H	PCM 8 bit/8 kHz	81 %	74 %
Sony Vaio	PCM 8 bit/8 kHz	78 %	73 %

The results in Table 1 show that the differences for high audio quality may reach tens of percent. It is quite logical that bad transmission and listening conditions contrary, differences partly blurred. The values shown are for illustration purposes only and benchmark results can not be generalized small data file. We just want to show that the production of audio materials for teaching, we should pay due attention. The fact remains that unlike logatomic the recognizability of the sentence intelligibility in adverse conditions is significantly higher because of the lack of conjecture out of context sentences.

VII. Conclusion

Based on the measurement results processed so far and part research surveys for the next period we can prioritize each task schedule component activities and verify the selected procedures of possible solutions. It is already clear that the assessment of achievable intelligibility (regardless of the type and destination area) in addition to previously evaluated parameters: reverberation time, frequency characteristics, in connection with a bandwidth of directionality emitters, we will have to consider the needs of educational research and eventual peace dynamic compression audio tracks audiovisual recordings.

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An Educational Tool for Analyzing and Synthesizing Linear Array Configurations

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***Abstract*—In spite of the large amount of available literature, to date, teachers do not have at their disposal numerical tools with which they can apply at will several analysis and synthesis methods prepared to aid in the design of linear arrays composed of non-isotropic elements. In this work we introduce a first version of a MATLAB-based Graphical User Interface (GUI) that can generate linear array configurations by using well-studied synthesis techniques. Such a GUI writes a file that can afterwards be read by a MATLAB tool -presented in previous works- that is capable of showing, on the one hand, the array geometrical configuration and, on the other hand, the power patterns generated by it.**

Keywords*—*MATLAB Tool, M-files, MATLAB Visualization, MATLAB Personalized Toolbox, Educational Numerical Tools, Electrical Engineering Computing, 3D Polar Power Pattern Visualization, Geometrical Arrangement, Three-dimensional Polar Radiation Diagram, Antennas, Linear Antenna Arrays, Antenna Radiation Patterns, Computer Graphics, Synthesis Techniques.

I. Introduction

Teachers that want to show in their classes some numerical results related to different aspects of the parameters of linear array antennas composed of, for example, dipoles or patches, usually have to resort to writing their own codes in any known programming language (such as C++, Fortran or MATLAB-based m-codes). Although all of those aspects can be covered by any commercial software tool that simulates electromagnetic radiating structures, most of those tools do not always represent the best choice available for such a purpose. On the one hand, those programs require additional efforts from the students in order to be manipulated with some minimum degree of profitability, and the time required to learn how to manage them depends greatly on their friendliness, which, for most programs, is not usually very high. On the other hand, and as far as the authors know, none of the commercial software tools that are currently available make use of any of the well established procedures that are presented as paradigm cases for synthesizing power patterns generated by linear arrays [1], [2], such as Chebyshev, Taylor [3] or Woodward-Lawson [4], [5] techniques. In this regard, some books related to antenna theory and design have at their disposal many customized codes that can be used to draw results related to some of the aforementioned subjects [1], [6], [7] but they are usually neither scalable nor general enough to be applicable to a variety of cases needed by different teachers.

As the popularity of MATLAB has increased markedly, teachers and designers have turned their attention to m-code programs, which have also the option of packaging the code in a Graphical User Interface (GUI) to make the built programs easier to handle. Two examples of MATLAB-based tools that can be used to analyse and design linear and planar arrays composed of isotropic elements are the works by Segvi et al. [8] and by Raj et al. [9], the former representing an easy-to-use GUI program very useful for teaching purposes. More sophisticated versions of software tools with which one is capable of dealing with planar arrays should include other types of elements different from isotropic, and this is done in [10], [11], [12], [13] and [14]. But there are also works that extend the idea and consider conformal arrays [15], [16] and [17], the last case nicely having acquired a high degree of sophistication, but, unfortunately, not freely available for the interested researchers.

In none of the aforementioned cases the user has at his/her disposal a way of selecting well-known synthesis procedures, or perhaps considering array configurations that are customarily presented in antennas books, such as, for example, linear arrays with uniformly spaced elements and having Gaussian amplitude excitation distributions. To fill this gap, in this paper we introduce a MATLAB-based Graphical User Interface (GUI) with a set of options with which the user is capable of designing a large variety of linear array configurations, considering both their excitation and spatial distributions. The tool is complementary to that presented in [16], that represents the spatial and electrical configuration of any type of array composed whether by dipoles, $\cos^2$-type patches or isotropic elements.

This paper is organized as follows. The tool is described in Section II, Section III is devoted to show some examples performed by the proposed tool, and some concluding remarks are made in Section IV.

II. Description of the Tool

The GUI, called LinArGen, is shown in Fig. 1. The different types of linear arrays that the user can generate with it are

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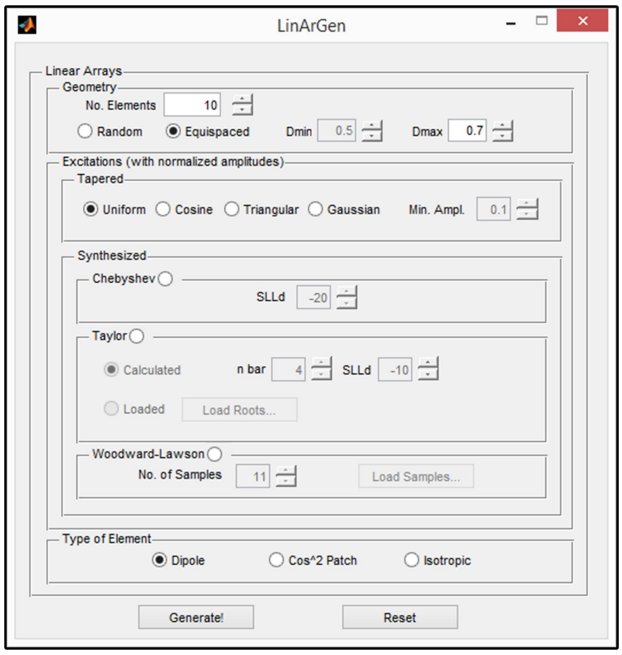

Fig. 1. The GUI for designing a variety of linear arrays.

given by the selected geometry, the excitation distribution and the type of element. The user can specify the number of elements N (set to $N = 10$ in the figure), and then if such elements are randomly or uniformly distributed along the x axis of a Global Cartesian Coordinate System (GCCS). In case the elements are randomly distributed, afterwards the user must specify the minimum and maximum inter-element distances (Dmin and Dmax, respectively, see Fig. 1), given in wavelength λ units, and once the spatial distribution is generated, the program will automatically place the array centred with respect to the GCCS.

The normalized excitation distribution can be whether selected through a synthesis method or generated with specific functions. For the first case, called "Tapered" distributions, the user can select one of the following options:

- Uniform: the amplitude is set to 1 for all the elements, whereas their phases are set to 0, i.e., $I_n = |I_n|\mathrm{e}^{\alpha_n} = 1$ (where, in general, I_n is the complex-valued excitation of the n-th element of the array).
- Cosine: the amplitudes of the elements have a cosine-type distribution, whose maximum value is 1 and its minimum is given by the one specified by the user in "Min. Ampl" in the text box on the right. The elements phases are set to 0.
- Triangular: the single central (for N odd) or the two central elements (N even) will have their amplitudes equal to 1, and the whole distribution will be linear, with amplitudes decaying toward the edges of the array up to the minimum value mentioned above.
- Gaussian: the amplitude distribution will follow a Gaussian bell pattern, with the maximum equal to 1 and the minimum specified by the user.

Now, if the user wants a "Synthesized" excitation distribution, there will be three options:

- Chebyshev: the amplitude excitation distribution will follow a configuration established by Chebyshev polynomials [1], in such a way that the power pattern generated by the array will have a uniform side lobe topology, whose overall maximum value will be given by that specified in the "SLLd" (desired Side Lobe Level, expressed in dB) text box.
- Taylor: in this case the tool will generate a (properly converted to the discrete domain) Taylor-like amplitude distribution [1], whether by specifying $\overline{n}$ ("n bar") - which indicates the number of side lobes controlled on both sides of the main lobe- and the corresponding overall SLLd, or loading a different set of $\overline{n}$ roots, which will be used in place of those generated by the program. In this last case, the user will even have the choice of specifying complex-valued roots (the file containing the roots must be composed of $\overline{n}$ rows -one for each root- and two columns -the real and imaginary parts of such roots-), thus generating a pattern with filled nulls [2].
- Woodward-Lawson: the user will have to specify the number of samples (number of points in the space where the power pattern will have a specified level [1]) and the level of such samples, obtained from a corresponding configuration file.

Next, it will be necessary to select the type of element to be used, and for this purpose the user will be able to choose between thin dipoles, patches or isotropic elements. For the first case, the program will specify a parameter corresponding to dipoles aligned along the z axis of the GCCS, and whose lengths will be, by default, set to $\lambda/2$. For the second case, the program will specify the parameter that corresponds to a $\cos^2$-type patch whose normal is parallel to the z axis of the GCCS. The third option does not require further explanation. In none of the cases the program will take into account the electromagnetic coupling between elements.

Finally, after the user hits the "Generate!" button, the program will prompt a "Save as" window, asking him/her to specify the name of the file that will store the generated configuration. Such a file will have the format required for the visualizer program that will represent the array and its corresponding generated patterns. Such a complementary program is extensively presented in a previous work [16].

III. Examples

In order to see the scopes of the tool, several examples are presented in this section.

A. Random Spatial Distribution and Uniform Excitation Amplitudes

We start by considering a linear array composed of 10 uniformly excited $\cos^2$-type patches. The elements are randomly distributed and their spacings range between 0.5λ and 0.7λ. Fig. 2 shows the array excitation configuration [16], together with the generated 3D main power pattern. The figure also shows a pattern cut taken at $\varphi = 0°$ and $-180° \leq \theta \leq 180°$, being θ and φ the usual spherical coordinate angles variables.

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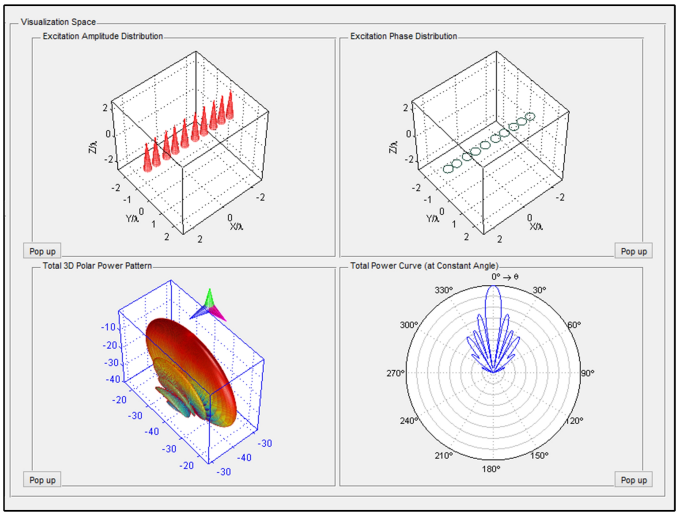

Fig. 2. Linear array of 10 $\cos^2$-type patches randomly distributed with uniform amplitude for the excitation of the elements.

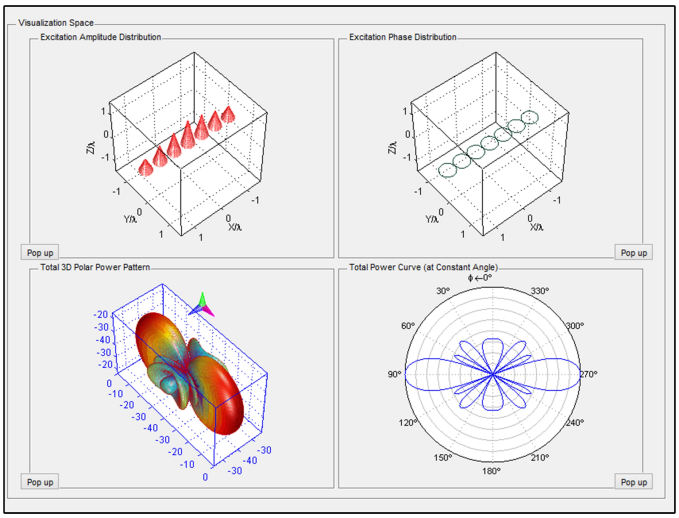

Fig. 3. Linear array of 7 dipoles uniformly separated along the x axis of the GCCS with triangular amplitude excitation distribution.

B. Equally Spaced Elements and Triangular Excitation Amplitude Distribution

As second example, we will consider a linear array composed of $N = 7$ half-wavelength dipoles, equally spaced $\lambda/2$ apart. The amplitude distribution is set as triangular, whose values range from 0.5 to 1. Both the array configuration and its generated main power pattern are shown in Fig. 3, where the pattern cut is obtained with $\theta = 90°$, and $0° \leq \varphi \leq 360°$.

C. Equally Spaced Elements and Taylor Excitation Distribution with $\overline{n} = 4, SLLd = -20dB$

Fig. 4 shows the spatial and electrical configuration of a linear array composed of $N = 11$ isotropic elements separated $\lambda/2$ apart, and whose excitation distribution is a Taylor-like

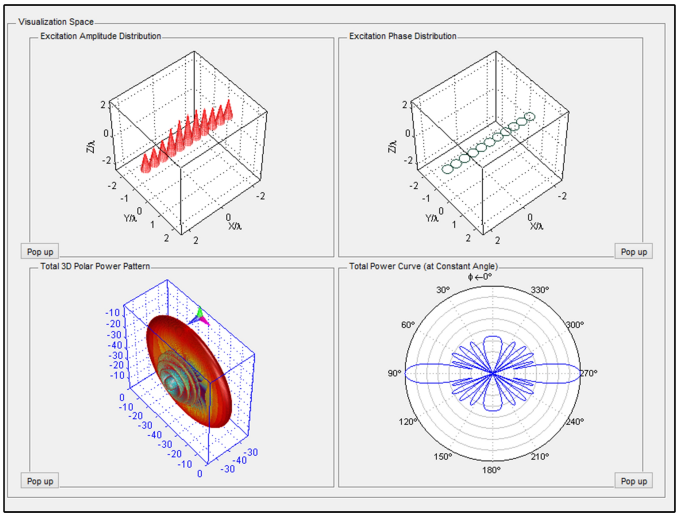

Fig. 4. Linear array of 11 isotropic elements uniformly separated along the x axis of the GCCS with $\overline{n} = 4$ Taylor-like amplitude excitation distribution. The generated pattern has an overall $SLL = -20$dB.

one, selected to radiate a pencil beam power pattern whose overall SLL equals -20 dB by controlling $\overline{n} = 4$ side lobes on both sides of the main lobe. The pattern cut is obtained with $\theta = 90°$, and $0° \leq \varphi \leq 360°$.

D. Equally Spaced Elements and 11-sample Woodward-Lawson Flat Top Beam

Finally, in Fig. 5 we present again an 11-element array whose isotropic elements are $\lambda/2$ equispaced. But this time the complex-valued excitation distribution corresponds to the one that synthesizes a 11-sample Woodward-Lawson (WL) [1] power pattern, being those samples uniformly distributed over $0° \leq \varphi \leq 180°$. Figs. 6 and 7 show larger plots of, respectively, the amplitude excitation distribution and the generated pattern cut of the described configuration.

IV. Conclusion

In this work we have shown how a tool developed by the authors that uses a MATLAB-based GUI can be satisfactorily employed by teachers for the configuration of linear antenna arrays, complementing other tools available in the literature designed for similar purposes. Some examples have also been shown to illustrate its proper operation.

The authors are currently preparing a version of this tool capable of being freely acquired on request.

Acknowledgment

The authors would like to thank Xunta de Galicia and Ministerio de Economa y Competitividad of Spain for their financial support under grants 2012/287, TEC2013-47141-C4-1-R, and R2014/037.

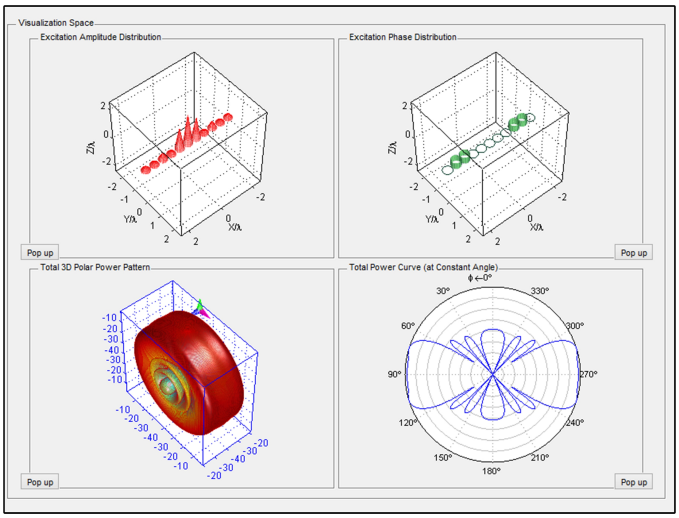

Fig. 5. Linear array of 11 isotropic elements uniformly separated $\lambda/2$ apart along the x axis of the GCCS with 11-sample WL-like amplitude excitation distribution. It can be seen that the generated pattern is a flat top beam with a wide coverage angle.

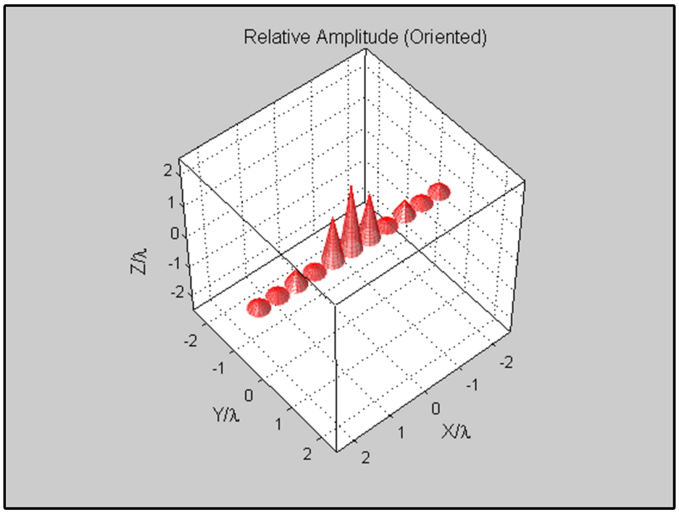

Fig. 6. Amplitude distribution of the array configuration given in Fig. 5

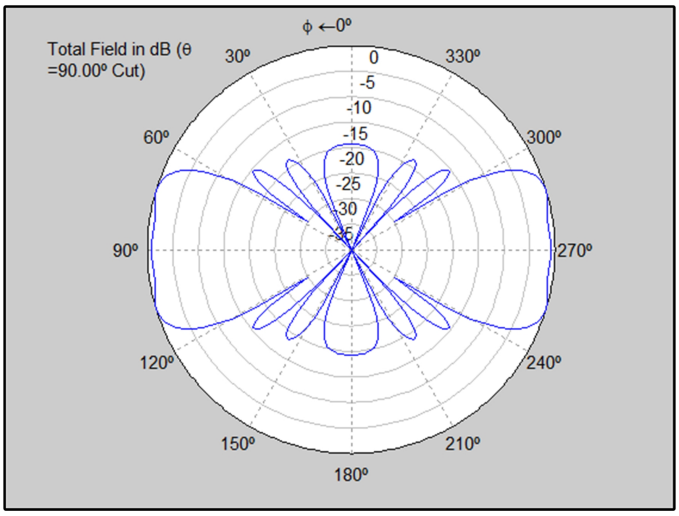

Fig. 7. Enlargement of the pattern cut of the WL-type configuration shown in Fig. 5

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Information Systems in Education

Ladislav Burita

***Abstract*—**The content and methodology of teaching the foundations of information systems (IS) development is described in the article. The structure of the course is presented, the applied motivational aspects are mentioned, and an illustrative example of a credit assignment – the result of student's work is included. The structured methodology as a theoretical approach is applied. The final IS is created in the MS Access environment. The experience gained from the two directions to teaching; the first case study is oriented to the ICT students and the second one pertains to the business oriented students.

Keywords—Information system; education; methodology; motivation; research; MS Access.

I. INTRODUCTION

The development of information systems (IS) for commercial goals is being executed through agile methodologies and object approaches. The web applications are being created, and working with IS by using mobile devices is being solved. The author should not condemn some historical approaches, such as structured methodology; it should use them appropriately with respect to the new conditions, bearing in mind what is important and how they can be useful in teaching.

The article presents the experience gained from teaching the course named 'Development and administration of IS' and 'Information management', based on a structured approach. It is specified in the study programmes as follows:

1) The introductory bachelor's degree course in the 'Information Systems' programme for future specialists in information technology (IT).
2) The course providing basic information about IS for master's degree of future specialists in business (economics, management, public services, etc.).

This work was supported in part by the U.S. Department of Commerce under Grant BS123456 (sponsor and financial support acknowledgment goes here). Paper titles should be written in uppercase and lowercase letters, not all uppercase. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., "Nd–Fe–B"). Do not write "(Invited)" in the title. Full names of authors are preferred in the author field, but are not required. Put a space between authors' initials.

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'***Development and administration of IS'*** is an obligatory bachelor's course of the CIS Department teaching programme, Faculty of Military Technology, University of Defence (UoD), Brno. The groups of students are usually small (about 8-16), so it is easy to apply an individual approach. The course has more than 10-year long tradition. The useful textbook is available for students [1]. An example of IS development represents the students work in the paper [3]. The similar approach is applied at the Academy of Armed Forces in Liptovský Mikuláš, Slovak [6].

'Information Management' is an optional master's course for students of the study program at the Department of Industrial Engineering and IS, Faculty of Management and Economics, Tomas Bata University (TBU) in Zlín. The education follows the course "Informatics for Economists and Managers" [8]. The subject was selected by 31 students, out of these, 15 (48%) study Management and Marketing and 16 (52%) Industrial Engineering. The course was planned for 15 hours, which were regularly divided into 3 consultations. At the first consultation, the students were asked about the reason for selecting the course. Out of 24 students attending, 22 responded to the question; see Table 1.

Table 1 Reasons for selecting the course [Source: author]

Ord.	Reason for selecting	Num.	%
1	Interest in IT/IS/enterprise IS	11	50
2	The only interesting elective course	4	18
3	To avoid econometrics	3	14
4	Continuity of subjects	1	5
5	Electronic enterprise	1	5
6	Relation to management	1	5
7	Merit for the field of study	1	5
	TOTAL	22	100

At the end of the course, a detailed survey (part of research work [2]) of the students' opinions on the content, importance and quality of the course was carried out.

II. ART OF INFORMATION SYSTEMS EDUCATION

There are numerous sources available on teaching IS. Several universities include IS in their portfolio, such as:

A) Centre for Knowledge Management, Faculty of Electrical Eng., Czech Technical University (CTU) in Prague [4].
B) Department of Computer Syst. and Communic., Faculty of

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Informatics, Masaryk University (MU) in Brno [7].

C) Department of IS, Faculty of Information Technology, University of Technology (UoT) in Brno [9].

D) Department of Informatics, Faculty of Business and Economics, MENDELU in Brno [5].

A. Centre for Knowledge Management

In the field of IS it deals with information, the way of storing and processing it in respect of the type of information, IS technology and its use depending on the area of application. Furthermore, the teaching includes business processes and the deployment of an IS through a project. The implementation methodologies, IS deployment. Legal aspects of IS and specifics associated with the state administration. A sample of an IS depending on the area of deployment and size of the customer.

B. Department of Computer Systems and Communications

The field of IS focuses on the knowledge and skills needed at all levels of the development, administration and modifications of IS. The emphasis is put on the knowledge necessary for analyzing and specifying demands, and for designing the system. Graduates will be able to work in different positions at IT departments which participate in the development and operation of IS and in using IT for organizations' activities.

The structure of courses in this field offers a large flexibility and enables students to graduate in this field through the completion of individually chosen courses which suit them and which comply with their previous knowledge of relevant areas of study. At the applied level, the courses familiarize the students with the 'classic' business IS, as well as geographic, environmental or public IS; or a view on IS with regard to network technologies, safety, or data mining.

C. Department of Information Systems

The Department is responsible for teaching the master's IS specialization, which covers such fields as programming, formal languages and compilers, database and information systems, computer networks, formal specifications, internet and distributed applications. The objective is to make students familiar with theory, technologies and procedures used in IS, and to teach them to develop such systems, applying advanced development tools and technologies. Besides, the Department is also in charge of conducting a number of courses in the bachelor's and Ph.D. programmes.

D. Department of Informatics

In the bachelor's study programme, there is the IS and technology course, which provides an overview of the IS enterprise relationship, discusses the application of methodologies and technologies of the IS creation.

In the master's study programme, the IS courses are structured in a way which provides students with necessary skills for the IS development issues in the enterprise. A systematic approach to solving problems is emphasized; the classic and modern methodology of systems from a life cycle perspective, architectures and procedures for creating SW are discussed, including the practical application of acquired knowledge, and problems of systems integration into synergistically functioning whole within the enterprise.

III. Structure and Content of the Course

The course begins with the analysis of IS issues. It includes the following topics: the concept of IS, its meaning and classification, data – information – knowledge, database system (DBS), data structures of database systems, the function of database management system (DBMS) and database (DB) properties.

Then follows the teaching of the IS modelling. It includes the topics of the IS model, general principles of modelling, IS life cycle, methodology – method – technique – tool.

After that a structured approach to IS development and a°conceptual level of modelling are introduced. This part can be described as the core for understanding the field and the proper basis for analytical thinking of an IS creator.

The structured methodology (levels and dimensions of modelling, application of general approaches to modelling, a°conceptual level model) are explained. The constructs and rules of the entity relational diagram (ERD), functional diagram (FD) and data dictionary (DD) are presented.

The course also includes the creation of IS by students themselves. The necessary information is conveyed through an°example, starting with the specifications and finding requirements for the IS, proceeding to various levels of modelling, creating the custom application and documenting the process and outcome. The theme for the creation of an IS is chosen by the students themselves. The procedure for the IS development and the outcome are given by detailed guidelines.

In the last part of the course, the logical and physical levels of IS modelling are introduced. They include the relational data model (RDM), the transformation of the ERD to RDM, RDM normalization, and relational operations. The development environment of the database management system (DBMS), MS Access and the description of the basic elements of the application (table, query, form and report) are presented.

The above mentioned structure of the course is suitable for teaching the IT specialists. In the case of the 'business' oriented students, some of the passages can be omitted or modified, and thus the learning objectives can be adapted to the students' needs.

It is not necessary to present the details of DBS, it is possible to replace the definition of the RDM by the 'table view of data', to omit normalization and relational operations. In addition, this group of students could become more familiar with the work in MS Access.

The lectures for the business oriented students were completed by themes of business oriented applications, project of implementation or update of IS, business intelligence, and cloud computing. The course requirements include a course credit and an examination. The credit is earned for developing and documenting an IS. Students use a textbook [1].

IV. Motivational Aspects of the Course

The basic motivational tool is continuous repetition of the teaching content and checking the students' skills and knowledge by testing them. Their test results are part of their final evaluation. In addition, the process of the IS creation is checked individually, the ERD design and its transformation into the RDM are discusses.

A well-proven motivational tool is the choice of the IS theme according to student's interest. It is easier to design and create an IS when the student is familiar with its environment and has a positive relationship with it. After several years of assigning this task, it can be summarized that the most popular topics for IS creations are:

- ICT (computers, software, media, security, signals).
- Trade and services (car, motorcycle, phones, food).
- Music (bands and singers, songs, DVD, instruments).
- Sports competition (soccer, athletics, shooting).
- Teaching (group of students, future praxis, eLearning).
- Machinery (cars, planes, weapons).

But the students also choose less frequent topics such as:

- Geography (cities, geocaching).
- Games (spacecraft).
- Lifestyle (nutrition, beer).
- Books and libraries.

The structure of instruction and the way the tasks are assigned and evaluated lead the students to independence. This is especially evident when they work on their course credit task. Brief orientation and the basic demands for the course credit work are given to students in the form of written instructions.

After the approval of the theme for their IS development and specification of the IS requirements, they proceed, if possible, on their own. The important progressive phases of work (conceptual and logical model) are discussed with the teacher, and the students continue only after submitting the outcomes and obtaining the teacher's approval.

The implementation environment is not presented in detail. It is up to the students to master work with MS Access; they themselves have to acquire the necessary aids. Students may even choose other development framework (Delphi, PHP, etc.). The submission of the course credit assignment is interactive; the students respond to the teacher's comments via electronic means of communication.

V. Example

The example presents an outcome of student's work in the academic year 2011-12. Its theme is 'Geocaching' [3]. Based on the documentation of this assignment, the following steps of the used methodology are presented:

1) The assignment for the IS development.
2) The Entity Relational Diagram (ERD) and the Data Dictionary (DD).
3) The Functional Diagram (FD).
4) The modified DD and Relational Data Model (RDM).
5) The Description of the final application.

1. The Assignment for the IS Development

Create an information system about cashes and their owners. The cache entity is characterized by the following attributes:

- The name of the cache and hint.
- The date of creation, and the date of the last visit.
- The cache coordinates.

The cache entity is further specified by the entities of type and size of the cache and the difficulty of the terrain where the cache is located. The person entity (the owner of the cache) is characterized by the following attributes:

- The owners name.
- The date of creation the account.
- The number of founded caches.

The IS should be prepared for the data saving, deleting, editing and searching and the creation of required reports.

2.The Entity Relational Diagram and the Data Dictionary

The ERD is shown at the Fig. 1 and the DD is described in the Table 2.

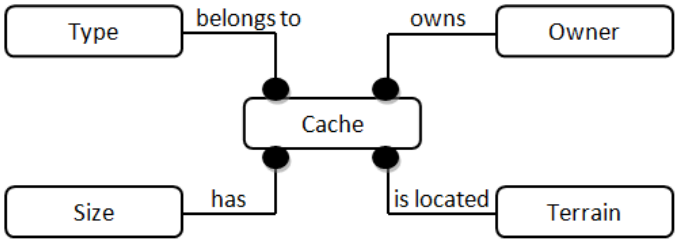

Fig.1 Entity Relational Diagram [Source: author]

Table 2 Data Dictionary [Source: author]

Entity	Attribute	Date Type	Primary Key
Cache	C_ID	Number	PK
	C_Title	Text	
	C_Hint	Text	
	C_DateCreate	Date	
	C_DateVisit	Date	
	C_Coordinates	Text	
Type	T_ID	Number	PK
	T_Title	Text	
Size	S_ID	Number	PK
	S_Size	Text	
Terrain	Ter_ID	Number	PK
	Ter_Terrain	Number	
Owner	O_ID	Number	PK
	O_Name	Text	
	O_DateCreate	Date	
	O_NumFound	Number	

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3.The Functional Diagram

The FD is a model of the future functions of the IS and is derived from the ERD, see Fig. 2.

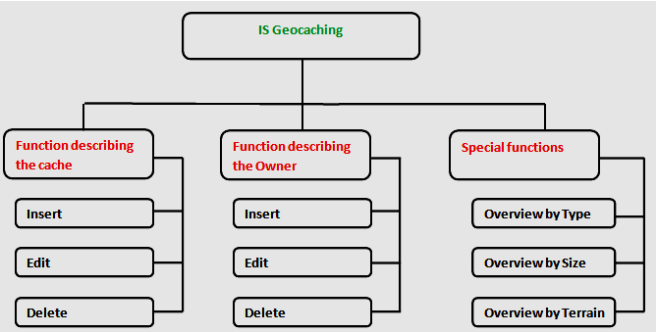

Fig. 2 Functional Diagram [Source: author]

4.The Modified DD and the Relational Data Model

The modified DD for the RDM is similar to DD for ERD; entities are transformed to the tables, attributes to the fields, and the relationships from the ERD of cardinality 1:N are replaced by foreign keys. The association of cardinality M:N is replace by relationship table, but it is not the case of the example. The RDM is shown at the Fig. 3.

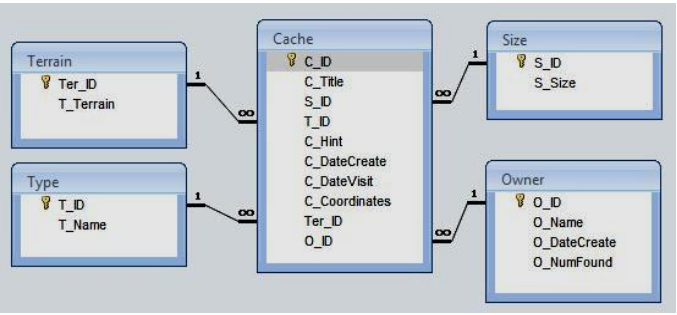

Fig. 3 Relational Data Model [Source: author]

5. The Description of the Final Application

The IS about caches and their owners was created in MS Access. The IS provides users with convenient and clear browsing through data about cashes and their owners.

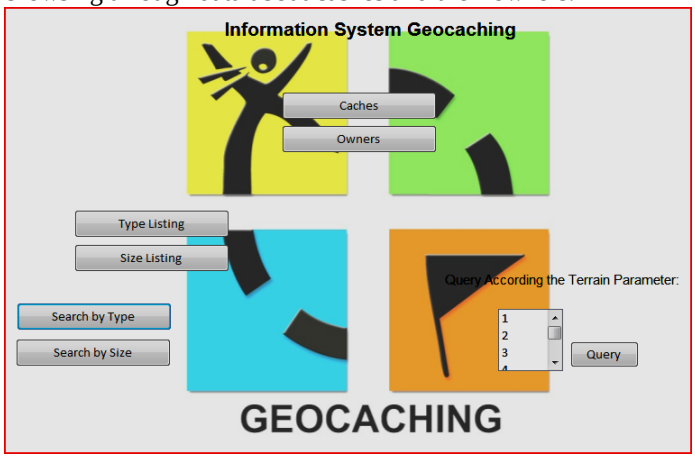

Fig. 4 Final application - the user interface [Source: author]

To manage the database, functions for adding, deleting and editing data are available. The program also allows the creation of reports according to selected criteria. The main menu offers seven function buttons (Fig. 4).

Clicking the '**Caches'** button enable the users to view data about cashes; it can be added, edited or deleted. Clicking the '**Owners'** button provides the users with similar functions concerning owners of the caches(Fig. 5).

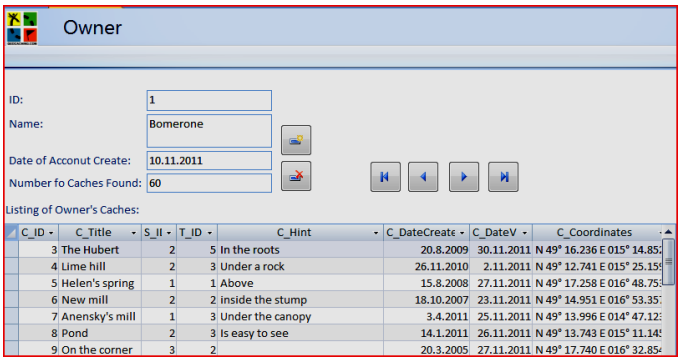

Fig. 5 Final application - data about the owners [Source: author]

By clicking the '**Type Listing'**, the users get a report in which caches are sorted by types, see Fig. 6.

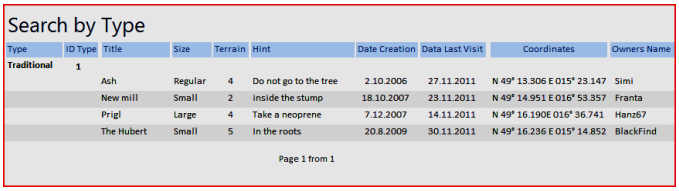

Fig. 6 Final application - report of cashes [Source: author]

The '**Size Listing'** button offers the same function; the set contains all caches sorted by size. By clicking the '**Search by Type'** button, the users get a form in which they can choose the type of cache that they want to be displayed. The '**Search by Size'** button has a similar function as the type of cache, but it is arranged by size.

The last function of the menu is a list, where the user can select the level of terrain difficulty. Clicking the '**Query'** button shows the table of caches selected according to the degree of terrain difficulty.

VI. Results of the Research

The pedagogical research was prepared in the academic year 2012/13. Here follows the research [2] evaluation based on the survey in the form at the Fig. 7. The survey was evaluated in the course Information management (KIMA), was anonymous, and in the paper-and-pencil form.

Some students were responding when taking their credit test. However, many students sent their credit assignments as well as their responses by e-mail, but these were not examined by the teacher immediately; they were printed and filed with the other ones. The students' responses follow the survey.

The result of the research was (by experiences in teaching)

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by the teacher expected. The responses were mostly positive. It was satisfaction of the methodology, structure, and practice of the course. It is very good teacher motivation for the future.

Survey on the KIMA course

1. Did the KIMA course meet your expectations?
☐ totally ☐ partly ☐ least
2. WHY did KIMA (not) meet your expectations?
3. The main content of KIMA – the creation of one's own IS is for the course:
☐ appropriate ☐ I don't know ☐ not appropriate
4. WHY is the creation of one's own IS (not) appropriate for the course?
5. Do you recommend maintaining this content in KIMA?
☐ yes ☐ I don't know ☐ no
6. Evaluation of the 'IS analysis – conceptual modelling' part of the course:
☐ easy ☐ moderately difficult ☐ difficult
7. Evaluation of the 'IS design – logical modelling':
☐ easy ☐ moderately difficult ☐ difficult
8. Evaluation of the 'IS creation – working with MS Access':
☐ easy ☐ moderately difficult ☐ difficult
9. Did you study something similar in the previous courses at UTB?
☐ yes ☐ approximately ☐ no
10. What are you taking away from the course for the completion of your study at UTB?
11. What are you taking away from the course for practice?
12. Evaluate your tutor:
☐ excellent ☐ average ☐ poor
13. Recommendation for your tutor.
14. Any other comment about the course?

fig. 7 Survey on the KIMA course [Source: author]

1. Did the KIMA course meet your expectations?
totally: 16 (74%) partly: 5 (22%) least: 1 (4%)

2a. WHY did KIMA meet your expectations?
Everything that was described in the curriculum was fulfilled.
I learnt something new.
Creation of one's own IS – 4x.
Working with MS Access – 2x.

2b. WHY did KIMA not meet your expectations?
To explain the procedure of the IS creation in a more detailed way.
The course required more independent work than I expected.
To devote more time to MS Access.
To use more sophisticated program than MS Access.
Not everybody owns MS Access – 2x.

3. The main content of KIMA – the creation of one's own IS is for the course:
appropriate: 21 (96 %) I don't know: 1 (4%) not appropriate

4. WHY is the creation of one's own IS appropriate for the course?
Practical work with databases, creating IS – 4x.
Course content reflects reality.
Deepening the knowledge of theory.
Developing analytical thinking.
Solving one's own example.

5. Do you recommend maintaining this content in KIMA?
yes: 16 (74%) I don't know: 3 (13%) no: 3 (13%)

6. Evaluation of the 'IS analysis – conceptual modelling':
easy: 6 (28%) moderately difficult: 13 (59%) difficult: 3 (13%)

7. Evaluation of the 'IS design – logical modelling':
easy: 5 (22%) moderately difficult: 14 (65%) difficult: 3 (13%)

8. Evaluation of the 'IS creation – working with MS Access':
easy: 10 (46%) moderately difficult: 11 (50%) difficult: 1 (4%)

9. Did you have something similar in the previous courses?
yes: 6 (28%) I don't know: 9 (41%) no: 7 (31%)

10. What are you taking away from the course for the completion of your study at TBU?
Working with MS Access – 9x.
Overview on the IS creation – 7x.
Improvement in MS Excel.
Course credit.
Revision for the final state exam.
Understanding data mining.
New information.

11. What are you taking away from the course for practice?
Working with MS Access – 7x.
Overview on the IS creation, specifications – 10x.

12. Evaluate your tutor:
excellent: 20 (92%) average: 2 (8%) poor

13. Recommendation for your tutor:
There is nothing to be changed in the course.
Keep going. Strong nerves.
I'd like to meet such teachers in other courses.
Beyond reproach, fast communication.
Satisfaction with the content of the course.
No objections.
More focus on practical work within the course.
Less independent work should be required.

14. Another comment on the course?
Satisfaction. Thank you.
Excellent organization, the willingness of the teacher.
A very useful course.
To add an introduction of a system
Even the looser form was suitable; yet I took away important pieces of knowledge.
It meets expectations; but I won't most likely use it in practice.

VII. Importance and Benefits

The importance of the course for 'business' oriented students lies in obtaining comprehensive theoretical information and practical experience in information systems and their development. Certainly, the subject contributes to the students' ability to document the results of their work and to work independently on an assignment.

The future IT specialists should benefit from the course by acquiring strong knowledge of basic concepts of information systems, which can be further developed in their further study and practice. The students do not need further expansion of the knowledge concerning the relational data model in the future. An important benefit of the course is the development of students' ability to work independently and to document the results of their work.

In both groups of students, the evaluation of the documentation is aimed encouraging students to work professionally with a text editor. It is truly surprising that most of the secondary schools graduates are not ready to create quality documents and are very poorly trained in the use of the office automation SW.

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VIII. Discussion

The article presents the experience of teaching IS to IT and business students. The same approaches and methods with slightly modified contents are applied. The resulting positive responses from students to the 'Information Management' course and near-unanimous recommendation to continue in the form described in the article have been an unequivocally positive surprise, even for the author.

A number of universities teach IS with different goals, such as a mere introduction, modeling and development, implementation and operation, integration, security, etc., at both general and professional levels.

Teaching IS is designed not only for computer science experts, but also for business students. IS is a topic where you can conveniently share different approaches and experiences and to use available information to carry out joint research projects.

Also, a targeted research on teaching IS would be beneficial; it would verify the applied methodologies, techniques and tools, forms of the teaching process, communication methods, the use of learning resources and other elements of teaching.

IX. Conclusion

The article summarizes the experience in teaching the foundations of IS. By stepwise refinement of the content and process of teaching, the course has reached the stage which guarantees its stability with the useful pieces of knowledge gained from methodological procedures applied, including the activation of students and their independent work development.

It is shown an illustrative example of student's work, which is presented without any corrections. The students' feedback on the course is positive; they appreciate the opportunity to become familiar with one of the approaches to IS development, and are grateful for the strong knowledge concerning the theory of IS modelling.

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Multiple Choice Question Tests – Advantages and Disadvantages

Jindřich Klůfa

***Abstract*—** In this paper we shall describe situations in which the multiple choice question tests are better than the standard tests. On the other hand, there are situations in which classical tests are more convenient. As an example we shall use tests in mathematics at the Faculty of Finance and Accounting at University of Economics in Prague. We shall consider the tests in mathematics in entrance examinations and the tests in the basic course of mathematics for the first year. For this analysis we shall use some probability methods.

***Keywords*—** Multiple choice question tests, tests in mathematics, probability methods.

I. Introduction

MULTIPLE QUESTION TESTS are widely used in testing knowledge of students. One of the advantages of such type of test is that the results can be evaluated quite easily even for large number of students. On the other hand, a student can obtain certain number of points in the test purely by guessing the right answers and this fact affects reliability of the test and should be considered in interpretation of test scores. This problem is addressed in education research – see Premadasa (1993), Klufa (2012).

An analysis of a multiple choice question test from probability point of view is provided in this paper. This test is for example used for entrance examinations at University of Economics – see Klufa (2011). Note that standard (no multiple choice questions) tests are used for checking knowledge of students in mathematics courses at University of Economics – for analysis of such test see (Otavova and Sykorova, 2014), but regarding entrance examination, multiple choice questions are preferred so that the results of tests can be obtained quickly and there is clearly no impact of any subjective factor in evaluation. Similar problems are in Moravec, Štěpánek and Valenta (2014), Brozova and Rydval (2013).

Entrance examinations at the Faculty of Finance and Accounting at University of Economics in Prague include mathematics and English. Test in mathematics has 10 questions for 5 points and 5 questions for 10 points (100 points total). Each question has 5 answers. Test in English has 50 questions for 2 points (100 points total). Each question has 4 answers. Questions are independent (one answer is correct), wrong answer is not penalized. We provide an answer to the following questions (under assumption of random choice of answers): what is probability that number of right answers exceeds given number, what is expected number of right answers, what is standard deviation, and finally what is a risk of success of students with lower performance levels.

II. Methods

Multiple choice question tests (the test has n questions, each question has m answers) are applied for the entrance examinations at the Faculty of Finance and Accounting at University of Economics in Prague. Therefore a model of binomial distribution can be used for the entrance examinations. From probability point of view a multiple choice question test means:

Let us consider n independent random trials having two possible outcomes, say "success" (right answer) and "failure" (wrong answer) with probabilities p and $(1-p)$ respectively. Probability of correctly answered question p (under assumption that each of m answers in particular question has the same probability and one answer just is correct) is $p=1/m$.

Let us denote X as number of successes (right answers) that occur in n independent random trials. X is random variable distributed according to the binomial law with parameters n and p. Probability that number of successes is k ($k=0, 1, 2, \ldots, n$) is (see e.g. Marek (2012))

$$P(X=k)=\binom{n}{k}p^k(1-p)^{n-k} \tag{1}$$

The expected value and the standard deviation of random variable X distributed according the binomial law with parameters n and p is

$$E(X)=np, \quad \sigma(X)=\sqrt{D(X)}=\sqrt{np(1-p)} \tag{2}$$

where $D(X)$ is dispersion of random variable X.

The distribution function of random variable X distributed according to the binomial law with parameters n and p is

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$$F(x) = 0, x < 0, \qquad F(x) = \sum_{k=0}^{[x]} \binom{n}{k} p^k (1-p)^{n-k}, x \geq 0 \qquad (3)$$

where *[x]* is integer part of *x*.

III. Entrance Examinations in Mathematics

Entrance examinations in mathematics have 10 questions for 5 points and 5 questions for 10 points (100 points total). Questions are independent. Each question has 5 answers; the wrong answer is not penalized. Under assumption that each answer has a same probability, probability of right answer is *p=1/5*.

Example 1. Under assumption of random choice of answers we shall find probability that number of points in the test in mathematics is 15.

Let us denote

Y = number of points in the test in mathematics
X_1 = number of right answers in the first 10 issues
X_2 = number of right answers in 10-points tasks

It holds

$$P(Y=15) = P[\ (X_1=1 \cap X_2=1)\ U\ (X_1=3 \cap X_2=0)\ ] =$$
$$= P[\ (X_1=1 \cap X_2=1)\ ] + P[\ (X_1=3 \cap X_2=0)\ ]$$

Random variables X_1, X_2 are independent, therefore we have - see e.g. Rényi (1972)

$$P(Y=15) = P\ (X_1=1)\ P(X_2=1) + P\ (X_1=3)\ P(X_2=0)$$

Random variable X_1 has binomial distribution with parameters *n=10* and *p=0,2*. Random variable X_2 has binomial distribution with parameters *n=5* and *p=0,2*. According to (1) we obtain

$$P(Y=15) = \binom{10}{1} 0{,}2\ 0{,}8^9 \binom{5}{1} 0{,}2\ 0{,}8^4 + \binom{10}{3} 0{,}2^3\ 0{,}8^7 \binom{5}{0} 0{,}8^5 = 0{,}175922$$

Analogously, we can calculate the probability *P(Y=k)* for other *k=0, 5, 10, 15, ..., 95, 100* (see Table 1 and Figure 1). For this calculation we used software Mathematica (Statistics 'Discrete Distributions') – see Wolfram (1996).

Points in the test	Probability	Points in the test	Probability
0	0,035184	55	0,002890
5	0,087961	60	0,000957
10	0,142937	65	0,000275
15	0,175922	70	0,000067
20	0,174547	75	0,000014
25	0,146098	80	0,000002
30	0,105227	85	3×10^{-7}
35	0,066057	90	2×10^{-8}
40	0,036467	95	1×10^{-9}
45	0,017761	100	3×10^{-11}
50	0,007634	Sum	1,000000

Tab. 1 Distribution of number of points in the test in mathematics

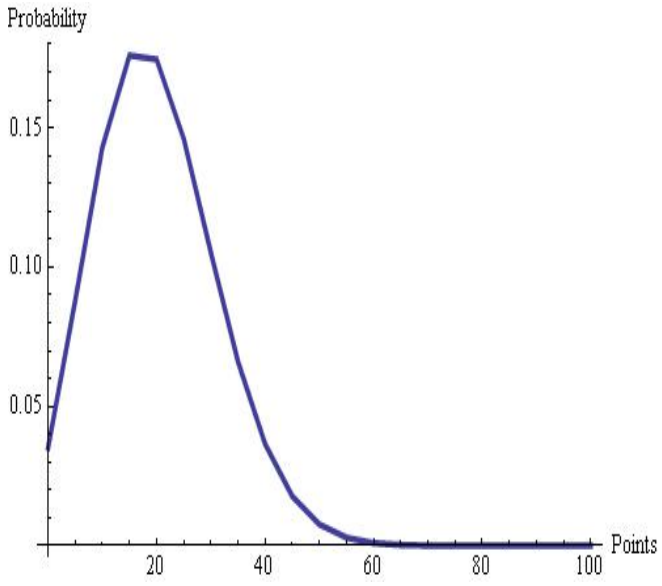

Fig. 1 Distribution of number of points in the test in mathematics (polygon)

Example 2. Under assumption of random choice of answers we shall find probability that number of points in the test in mathematics is

(a) 30 and more,
(b) 40 and more,
(c) 50 and more.

(a) Using notation from example 1 we have - see e.g. Rao (1973)

$$P(Y \geq 30) = 1 - P(Y<30) = 1 -$$

$$P[(Y=0) \cup (Y=5) \cup (Y=10) \cup (Y=15) \cup (Y=20) \cup (Y=25)] =$$

$$= 1 - [\, P(Y=0) + P(Y=5) + P(Y=10) + P(Y=15) + P(Y=20) + P(Y=25) \,]$$

Finally from Tab.1 we obtain

$$P(Y \geq 30) = 1 - 0{,}762649 = 0{,}237351.$$

Under assumption of random choice of answers almost a quarter of students get the test score 30 or more points.

(b) Analogously, we obtain

$$P(Y \geq 40) = 1 - P(Y<40) =$$

$$= 1 - [\, P(Y=0) + P(Y=5) + P(Y=10) + P(Y=15) + P(Y=20) + P(Y=25) + P(Y=30) + P(Y=35) \,]$$

Finally from Tab.1

$$P(Y \geq 40) = 1 - 0{,}933933 = 0{,}066067.$$

Under assumption of random choice of answers approximately 6,6% of students get the test score 40 or more points.

(c) Finally

$$P(Y \geq 50) = 1 - 0{,}988161 = 0{,}011839.$$

Under assumption of random choice of answers approximately 1,2% of students get the test score 50 or more points.

Example 3. Under assumption of random choice of answers we shall find expected number of points in the test in mathematics and mode.

Using notation from example 1 we have

$$Y = 5\,X_1 + 10\,X_2$$

Therefore - see e.g. Anděl (1978)

$$E(Y) = E(5X_1 + 10X_2) = 5\,E(X_1) + 10\,E(X_2)$$

According to (2) we obtain (e.g. $E(X_1) = 10 \,.\, 0{,}2 = 2$)

$$E(Y) = 5 \,.\, 2 + 10 \,.\, 1 = 20.$$

Expected number of points in the test is 20. The mode is the most probable number of points. From Tab.1 is

$$\hat{y} = 15.$$

I. IV. Conclusion

Entrance examinations at the Faculty of Finance and Accounting at University of Economics in Prague include mathematics and English. Probability that number of points from test in mathematics is 50 and more is 0,011839 (see example 2). Analogously, we can calculate this probability for test in English. We obtain 0,000122. That means (both tests are independent: 0,011839 x 0,000122 = 0,000001) that approximately one student from million (under assumption of random choice of answers and using 50 points as a cut-off value for successful completion in each test) successfully makes the entrance examinations at the Faculty of Finance and Accounting at University of Economics by pure guessing the answers.

Multiple choice question tests are optimal for entrance examinations at University of Economics. These tests are objective (there is clearly no impact of any subjective factor in evaluation). Moreover, results can be evaluated quite easily for large number of students. From results of this paper follows that risk of acceptance students with lower performance levels is negligible.

On the other hand, number of students in the basic course of mathematics is not large. In this case is better use the standard tests. These tests (the solution of concrete examples) examine the students' knowledge of mathematics better than the multiple choice question tests.

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The development of Buzan mind mapping self-instructional module for basic vocational education students

Tee, T. K., Madmor, M. A., Md Yunos, J., Yee, M. H., Mohamad, M. M., Che Rus, R., Hanapi, Z.

Abstract— Using Buzan Mind Mapping module could be an alternative approach and make significant contributions to teaching and learning especially for low achievement students. An attempt to develop a modular approach in Buzan Mind Mapping technique has been made in lower secondary school for basic vocational education students. This paper will discuss various components of the modular approach by referring to Meyer Model. Analysis on the qualities of Buzan Mind Mapping module revealed that four raters showed an agreement on satisfactory level and above for all 34 items. Meanwhile, 40 students gave positive feedbacks on the format and content of the module.

***Keywords*—** Buzan Mind Mapping, Self-Instructional Module, Vocational Education, Evaluation.

I. Introduction

A module is a specific type of learning resource. Modules are essentially self-contained, self-instructional packages, with learning paced by each student according to his or her individual needs and ability. A module covers either a single element of subject matter content or a group of content elements forming a discrete unit of subject matter or area of skill. A module also has clearly defined objectives [1]. Modules are not just "job sheets' or "old style work units" or "chapters of books" with questions added [2] [1]. Moreover, module is a planned series of learning activities designed carefully to assist the learners to accomplish certain specific objectives [3].

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II. Self-Instructional Module

The use of self-instructional modules can be an alternative approach and make an important contribution to teaching and learning [2] [4]. The module is a series of learning activities designed to help students to achieve certain specific objectives based on individual differences, interests and learning ability [4]. In addition, the self-instructional module approach is more effective than traditional methods on teaching and learning [5]. On the other hand, self-instructional module approach is able to help students to have better understanding in the learning process [6].

III. Buzan Mind Mapping Technique

Buzan mind map is among the famous thinking tools that has been used for centuries for the purpose of learning, brainstorming, memorizing, thinking, visualizing and problem solving by educators, engineers, psychologists and people in general [7]. Next, [8] argued that the old method of reading from left to right and from top to bottom in a linear fashion, while the human brain scan whole pages were read in a non-linear. Therefore, the laws of Buzan mind map is in line with the functioning of the human brain into thinking that it germinates and is not linear [7]. Plus, Buzan mind map's technique allows an individual to balance the left brain and right brain in learning process, in addition to endeavor recalls the memory effectively through emphasizing the concept of interconnectedness and imagination [9] [10] [11] [12].

Furthermore, [13] emphasized that the process of taking notes by using Buzan Mind Mapping technique allows the consciousness of a person [14] looks real, fun [15], describe, and draw up a systematic learning, through the translation of thought into the sheets of paper. During the learning process, the Buzan Mind Mapping technique is so effective especially in taking notes from reference books, textbooks, lectures, tutorials, course notes, study material and reading itself [10] [16] [17]. [12] states that Leonardo da Vinci, Galileo Galilei, Richard Feynman, Albert Einstein and Charles Darwin were

among the politicians who successfully practice this technique. In addition, Buzan mind map has been highlighted by several Fortune 500 companies such as IBM, Boieng, BP and Barclays who practice the use Buzan mind map [18].

IV. Problem Statement

Based on the Primary School Achievement Test 2014 results in Malaysia, it showed a sharp decline of 40 per cent which caused by the changes pattern of questions were set to assess the candidate's higher-order thinking skills (HOTS). This indicates that the students' HOTS level is low. According to the results, 14,433 students (3.11%) scored grade D and E, were likely to be dropout from the education system. The ministry of education was pro active to look into this critical dropout issue by launching the basic vocational education program to cater this target group. The program was started in 2012 with a total of 15 schools, 2013 of 50 schools and 2014 with a total of 16 schools. The duration for this program is 3 years and student who passes the assessments will receive the Malaysian Skills Certificate Level 1 and 2. Students are able to further their study at Vocational College, Civil Skills Training Institute and Private Training Institute. Due to the students' low achievement in study, an action must be taken to minimize the dropout rate. The researchers propose a new approach using Buzan Mind Mapping self-instructional module for basic vocational education students to improve their thinking skills and academic achivement.

V. Purpose of The Research

The purpose of this research is to develop and evaluate the qualities of Buzan Mind Mapping module for basic vocational education students.

Specifically, the research objectives are:

i. To develop the Buzan Mind Mapping module.
ii. To analyze the qualities of Buzan Mind Mapping module.

VI. Methodology

This is a quantitative approach research that started with the development of Buzan Mind Mapping module using Meyer Model (1988). The qualities of the Buzan Mind Mapping module were identified by four experts and 40 students using two sets of questionnaires.

VII. The Sample

Four experts and 40 students were selected to evaluate the qualities of the Buzan Mind Mapping module.

A. Reliability

The internal-consistency reliability value for the "What you thought of the module" instrument was $\alpha = .85$.

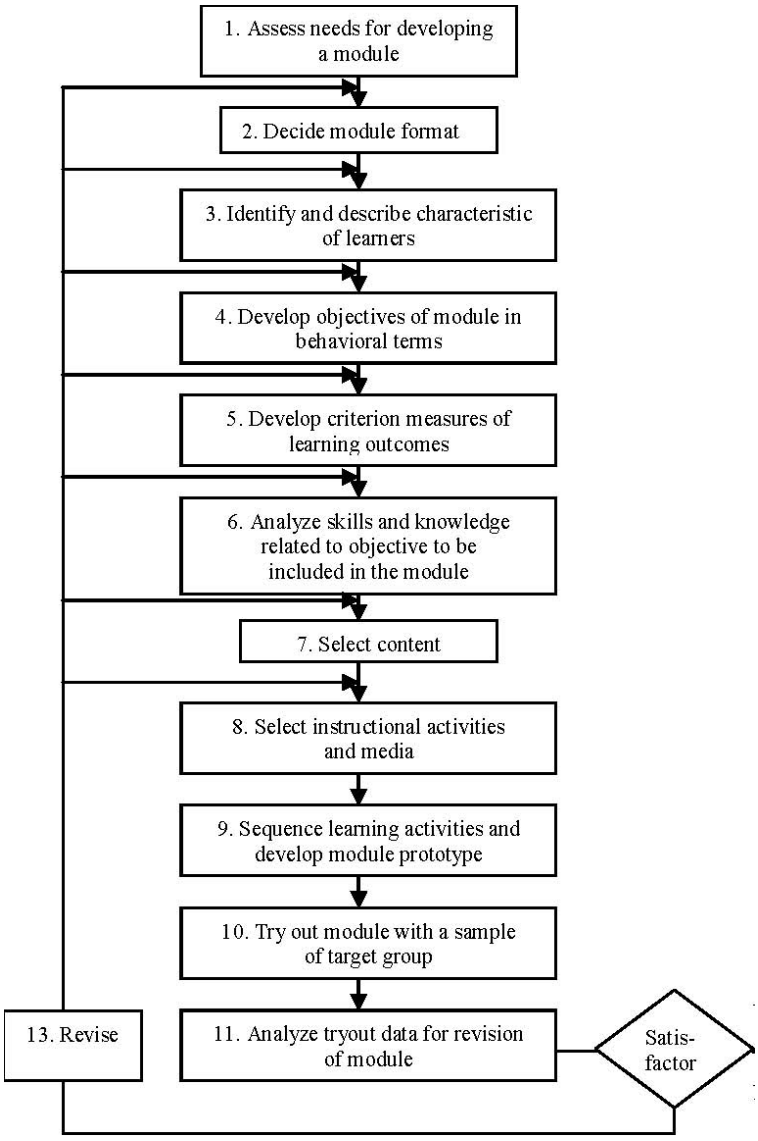
VIII. Development of Buzan Mind mapping Module

The development of Buzan Mind Mapping module was based on Meyer Model (Figure 1).

A. Steps in design and development of a module

Figure 1 shows the steps in design and development of a module. There are 11 main steps on developing a module based on the Meyer Model.

Figure 1: Steps in design and development of a module



IX. Findings and Discussions

Table 2 shows the checklist on the 60 steps for module production.

Table 2. 60 Steps for module production checklist

	Step/Element	Finalized	Not Applicable
1.	Title finalized	√	
2.	Cover designed and cover layout finalized	√	
3.	Title page completed	√	
4.	Contents page completed	√	
5.	Introduction and place of module in program me written	√	
6.	Statement of purpose written	√	
7.	Curriculum grid prepared		√
8.	Instructions on how to use the module written	√	
9.	List of aims written	√	
10.	Necessary background knowledge and skills listed	√	
11.	General objectives finalized and listed	√	
12.	Units defined	√	
13.	Specific objectives for each unit finalized and listed	√	
14.	Equipment and other resources needed for use with the module listed	√	
15.	Diagnostic pre-test prepared		√
16.	Answers to pre-test provided		√
17.	Answers to pre-test interpreted		√
18.	Post test written	√	
19.	Parallel forms of post test written		√
20.	All post test questions answered	√	
21.	All post test questions interpreted	√	
22.	Content selected	√	
23.	Content sequenced	√	
24.	Activities selected	√	
25.	All input phases completed	√	
26.	All process phases completed	√	
27.	All output phases completed	√	
28.	All consolidation passages written	√	
29.	All bridge passages written	√	
30.	Reinforcement statements included at all key points	√	
31.	Feedback information written for process phases	√	
32.	Feedback information written for output phases	√	
33.	All in-text questions written and placed in context		√
34.	All in-text questions requiring answers, answered		√
35.	Feedback quizzes included at all necessary points	√	
36.	All feedback quiz questions answered	√	
37.	All feedback quiz questions interpreted	√	
38.	All text revised in light of criteria set out in Chapter 10	√	
39.	All internal artwork completed	√	
40.	All page layouts completed	√	
41.	All units sequenced	√	
42.	Cover pages for all units prepared	√	
43.	Introduction written for each unit	√	
44.	Specifications completed for all audio-visuals		√
45.	All audio-visuals produced in prototype		√
46.	“Lead-in” to all audio-visuals clearly established		√
47.	“Follow-up” to all audio-visuals clearly expressed		√
48.	Alternatives written into the module to cater for resources which may-not be available to all students		√
49.	Section written giving final overview and consolidation	√	
50.	Annotated reading list prepared	√	
51.	Module evaluation instrument mocked-up	√	
52.	Module assemble in drat format	√	
53.	Boxed kit designed		√
54.	All typing completed	√	
55.	All elements checked	√	
56.	Proof-reading completed	√	
57.	Boxed kid produced as prototype		√
58.	Module assemble in final form	√	
59.	Final check on all components	√	
60.	Module reproduced in sufficient numbers for initial trial	-	

Four raters (content and design experts) used the instrument to rate the qualities of the Buzan Mind Mapping module. Analysis of the raters showed an agreement on the satisfactory level and above on all 34 items (Table 3). Based on the results, it shows that a good quality module could be produced by using Meyer Model. Anyway, time constraint is one of the main factors to be considered as the whole process of developing the draft module consists of 60 small steps. Besides that, there are three steps to be followed in the trialling procedure. Trialling with the small group and representative group using students as samples in the research could be difficult if it is not well planned [3]. Module developer also needs to assure that the time allocated for the samples to go through the module is sufficient.

Table 3. Rating scale for the evaluation of the qualities of Buzan Mind Mapping module (Experts)

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Title:	Buzan Mind Mapping module				
QUALITY		Rating			
3 = VS	= Very Satisfactory				
2 = S	= Satisfactory				
1 = U	= Unsatisfactory	VS	S	U	VU
0 = VU	= Very Unsatisfactory	(3)	(2)	(1)	(0)
1	Need				
2	Purpose	2	2		
3	Introduction	3	1		
4	Knowledge and skills required	3	1		
5	General aims	4			
6	General objectives	4			
7	Specific objectives	4			
8	Content is directly relevant	4			
9	Logical learning sequence	4			
10	Defined category	4			
11	Units	4			
12	Activities are appropriate	3	1		
13	Active participation and response				
14	Learning activity into small steps	2	2		
15	Input-process-output cycles	2	2		
16	Feedback questions and answer	2	2		
17	Feedback questions and answered clearly	3	1		
18	Feedback questions interpreted	4			
19	Feedback statements	4			
20	Reinforcement statements	2	2		
21	Visual elements	3	1		
22	Bridge passages	3	1		
23	Instructions	3	1		
24	Layout	2	2		
25	Humour	2	2		
26	Consolidation passages	3	1		
27	Overview of all main points	3	1		
28	Post test includes at least one item for each specific objective	3	1		
29	Form and wording	2	2		
30	Post test questions answered	2	2		
31	Results of the post test interpreted	3	1		
32	Motivate	2	2		
33	Length of time	3	1		
34	Well integrated	4			

After the experts have evaluated the draft module, corrections were made upon recommendations. Some input from the module was removed as the experts identified it is not suitable for the samples level. Meanwhile, typing errors and content ambiguity were also been changed. The trialling moved on to the second step after the experts evaluated and corrections had been made. 40 students (small group) were involved in this step. Responses on the module were collected using "Sheet I – comment on the general aspect" and "Sheet II – comment on the tasks" in the module. Generally, samples highlighted typo errors and minor content ambiguity in the module. Corrections and improvements were made based on.

X. Conclusion

Generally, self-instructional module is very useful to students, especially for those who are weak in learning. With this module, the students are able to learn the Buzan Mind Mapping technique and apply it directly on study especially for note taking and revision. Moreover, students could learn at their own pace by using this self-instructional module.

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Algorithmic thinking in paradigms of programming

Stepan Hubalovsky and Ondrej Korinek

***Abstract*—**Everyone faces the problems in everyday activities. They can be of various kinds - personal, business or other. To solve the problem, it is necessary to find a procedure, process that will solved it. It is necessary to establish the algorithm. Algorithms can be found not only in everyday routine activities, e.g. during crossing the street through the transition, cooking food etc., but also in subjects of programming. A number of courses of programming at different schools starts the teaching with algorithm development. The algorithm development is primarily related with structured paradigm of programming. On the other hand modern and most widely used is object-oriented paradigm in programming

Teaching methodology and election of paradigm of programming always depends on the particular school and taught subjects. The algorithm development is, for example bases of subjects like graph theory. The algorithm development has its place in teaching of programming. The proposal of procedures of problem solution is closely related to the way of thinking that beginning programmers are used.

The paper describes algorithmic thinking and analyzes the results of two teaching methodologies related to algorithm development - structured and object oriented paradigm versus object oriented paradigm with regard to algorithmic thinking of students of the Faculty of Science, University of Hradec Kralove.

***Keywords*—**Algorithm development, algorithm thinking, structured paradigm of programming, object oriented paradigm of programming.

I. Introduction

The development of new programming languages are often associated with new paradigms in programming. The languages of lower level, was replaced by the high-level languages [1]. The supporters and opponents of two most widely used paradigms - structured programming and object-oriented programming discussed the advantages and disadvantages of both paradigms. Recently, the most widely used is object-oriented paradigm, which is usually required by companies in the labor market. A candidate who can use the object libraries and creates the object program with under the rules of design patterns, interfaces and inheritance, has great advantage with comparison of candidate who cannot used it. Creation of extensive application using structured programming is not possible. In spite of this fact the object-oriented programming is taught in number of schools in later phase the programming or in optional subjects. Opponents of such a methodology (e.g. [2]), often point the fact that the student completely doesn't understand the object programming and often programmed by the previous ingrained habits. Despite the entirely legitimate objections against the structured oriented methodologies of teaching of programming, the introduction to structured oriented programming has their place. Other commonly used methods of teaching, is algorithm development and structured programming. At some schools algorithm development continues by object graph theory [3]. Structured programming is used e.g. in programming of robots in Lego Mindstorms.

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II. Algorithm Development and Programming

Algorithm can be represents in several ways - in the form of flowcharts, pseudocodes or structure-grams. It always depends on the teacher, which type of algorithm representation prefer [4]. Algorithm development is the basis of programming [5].

The first aspect that influences learning of algorithms and programming is influenced by the form of performed teaching:

- structured form, that teaching is divided into learning algorithms, structured programming and object-oriented programming in the end;
- object oriented form, i.e. from the beginning of the instruction focuses on object-oriented programming, with the principles of the algorithms are part of this instruction.

The paper analyzes the results of two teaching methodologies related to algorithm development based on structured programming with regard to algorithmic thinking, so let's described basic paradigm of structured programming first.

Structured programming is programming based on the structure of the program, which comes strictly from the algorithm flowchart. From the system approach point of view the algorithm as well as structured program (written in any structured language - Pascal, C++, VB Script) can be understood as system, because they have properties of the system – algorithm interacts with its environment through inputs and outputs, consists from elements that are affected by interactions. Another division algorithm to subsystems is

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possible, from a practical perspective, however unreasonable.

In this context it is necessary to mention what types of exercises are used for training the algorithm development and structured programming. The exercises reflect two facts. Firstly, in the past, early in the courses of programming (mainly structured programming - Pascal, Basic, etc.) has been teaching of programming realized by teachers who also taught mathematics, or had to mathematics very close. Second, math problems are basically the simplest tasks, can be clearly described, defined and then developed by algorithm and rewritten to the program structure. That, however, seems at first glance a logical and simple, brings disadvantages. Algorithm development and structured programming explained by the mathematical tasks usually focus on rewriting the mathematical equations and formulas to the algorithms regardless of their complex systems integration with the exercises from real life. Used tasks are often artificial and divorced from reality. System and multidisciplinary approach is missing. Students, who do not have sufficient mathematical skills, do not understand the task and it can result in resistance to the algorithm development and subsequently to programming.

Despite the different representation of algorithm and different paradigm of programming students should improve algorithmic thinking.

III. Algorithm Thinking

When designing the algorithm the various terms are used and combine. The terms are related to previous practical experience and theoretical knowledge of programmer. Algorithms that programmers solve, in most cases are also problematic. The algorithmic thinking is important for the proper design and construction of the algorithm, in which it is necessary to take into account the time and memory consumption [9]. The algorithm thinking is also used when analyzing e.g. the best sorting algorithm of the sequence of numbers or to verify that designed procedure satisfies all the properties of the algorithm. Algorithm thinking can be related to the basic terms that are used in algorithms development.

A. The Forms of Learning in Algorithm Thinking

Among the forms of learning that are related to algorithmic thinking, will include: deduction, induction, sorting, comparison, analysis and synthesis [10].

Deduction at algorithmic thinking used e.g. in the design of algorithms. The algorithm must meet certain rules that are universal and that has to be applied to build required algorithm.

Induction at the algorithmic thinking is used in reverse case than in the previous proposal, e.g. if in the design of a required algorithm is needed to check the general steps to prove the procedure is algorithm.

Sorting is in algorithmic thinking used for sorting algorithms. The sorting algorithm are the basis for teaching of algorithms. It is always necessary, with the given values in the sequence to determine, which sorting algorithm is most appropriate for a given sequence.

Comparing in algorithmic thinking can be understood as the most important form of algorithm learning. When teaching the algorithm development, the basis is to propose the most efficient algorithm that solves the problem. In proposal of the algorithm, the student has to use comparison thinking skills to select the most efficient algorithm from several proposed algorithms that solves the problem.

Analysis and *synthesis* are one of the most important intellectual operations that are related together [3]. At the beginning of the design of the algorithm the analysis of use of algorithmic structures and elements in the algorithm should be provided.

IV. Research of Methods of Teaching in the Subject of Programming

A. Methodology of the Research

Students at the Faculty of Science Univerzity of Hradec Králové in the study field Informatics in Education meet with programming in the first semester of the course Algorithms and Data Structures (hereinafter ALGDS). The course deals with basic algorithmic structures, one-dimensional array, matrixes and algorithms for sorting. The course of ALGDS is followed by three courses of programming in from the second up to fourth semesters. Programing language is C#.

The research investigation was carried out in the course of programming in the academic year 2013/2014. The main goal of the research was determined the comparison of two methods of teaching of programming - object-oriented programming and structured versus object-oriented programming with respect to algorithmic thinking. Students were randomly divided evenly into two groups according to the results in course ALGDS.

One group of students followed the algorithm development by structured programming in C # programming language with functions (methods) and based on algorithmic structures. The students designed structured C# programs based on similar algorithms, the already developed in course of ALGDS. The programs included conditions, loops, arrays, matrices. The structured programming was then followed by object-oriented programming, where the basic concepts of OOP were discussed.

The second group of students began immediately after the algorithm development (after the course ALGDS) with object oriented programming (without structured programming). In this group the concept of object oriented programming was more practiced. The concept of structured programming was omitted.

Both groups of students passed a midterm exam test with similar tasks, which consisted of theoretical and practical part. Practical (programming) part was divided into object and algorithmic part. To successfully pass the test, students had to reach in every part at least 60% of correct answer.

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B. Credit Test

The credit test consists form some different tasks. Students have to correctly designed class first. They initialize one dimensional array (sequence) by constructor. Algorithm constructions for one dimensional array create classes in methods. Methods for correct design of algorithm are focused to following areas:

- input data to the sequence;
- output data from the sequence;
- calculations and search of value in the sequence;
- shifts the values in the sequence,
- inserting / removing values in the sequence;
- work with multiple sequences.

Students has to fulfill one task from each area and create algorithm. Class definition, constructors and methods are separated from algorithmic structures in evaluation of the task.

Sample of credit test:

Create a new project in C # console application In Visual Studio based and fulfill following assignment.

Create class Sequence for sequences operation (one-dimensional array) with the following components:

Basic algorithms:

- *Constructor* - creates private data item of one-dimensional array type of integers of a given size.
- *N* - read-only property specifying the length of the sequence.
- *Fill* - filled array by numerical series in two different ways (overloads):
  - initial value will be set by input parameter (range will be from *X* to *N* + *X*).
  - input parameter is missing and a series will start from 1 (up to *N*).
- *WriteRow* - writes sequences to row of console (values are separated by commas).
- *Member* - returns values of sequence member in position specified by input parameter.

Algorithm for Calculations and Search:

- *Number* - determines the number of members whose value is equal to the value specified as input parameter and returns this number as output value

Algorithm for shift of values:

- *CycleShift* - cyclically moves to right the members of the sequence.

Algorithm for inserting the values:

- *Insert* - insert into the sequence the member whose value and position will be determined by input parameter.

Algorithm for work with multiple arrays

- *Division* – selects all the values of sequence members that are divisible by the value specified as input parameter and returns a value of sequence type as output.

In the main part of the program (method Main Class Program), create instance of the class Sequence and properly use all implemented methods.

C. The Result of the Research

The research investigated the influence of the different concepts on increase of algorithmic thinking.

The first credit test was the same for both groups of students. The test examines practical skills operate with one-dimensional array - calculations and searches, shifts the values in the sequence, inserting / removing values and work with multiple fields.

In the first group of the students (course of ALGDS followed by course of structured and object-oriented programming – *algorithmic group of student*) consist of 9 students participated in the test.

In the second group of the students (course of only OOP – *object oriented group of students*) consist of 8 students participated in the test.

Result of the algorithmic test

To determine whether the median of the result of student achieved in algorithmic part is the same for the first and second groups of students the nonparametric Mann-Whitney test was used.

Calculated P- value is P = 0.030384

with significance level $\alpha = 0.05$,

so we can reject the null hypothesis that the median of students results of the algorithmic part between the groups is the same. Between groups is statistically significant difference. Box plots diagram of both groups of students is in figure 1.

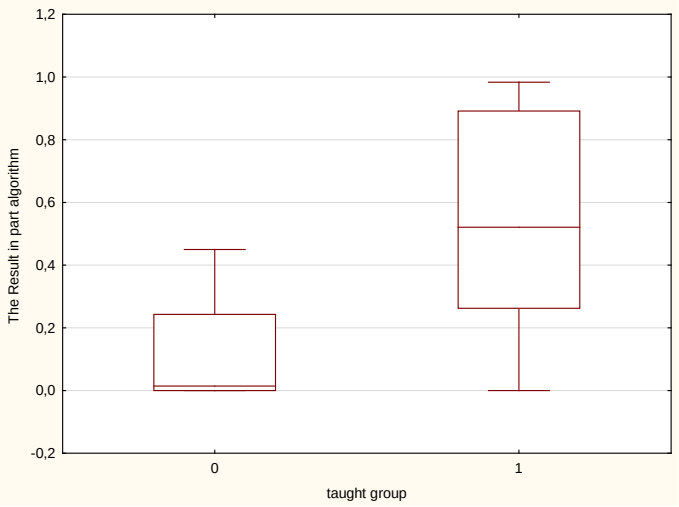

Fig. 1 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in algorithmic test.

The results show that the first algorithmic group of students reached far worse results than the second object oriented group of students.

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All student failed in the first algorithmic group.

Half of students (50%) succeeded in the second object oriented group of student.

Interesting results can be also reached from analysis of the code of programs (will be published later).

Algorithmic tasks of the test can be divided into two parts.

The *first part* contains tasks testing following terms: definition, input and output of the sequence in the form of one-dimensional array. These tasks was more trained in the algorithmic group of students.

The *second part* contains algorithmic construction for one-dimensional array: e.g. calculations and search, shifts of the values in the sequence etc. These task was practiced in both the courses – course ALGDS and programming.

Expected result should be as follows:

- first algorithmic group of students should have better results in the first part of the test
- the second part of the test should have the similar results

Result of the first part of algorithmic test

To determine whether the median of the results of the first part of the test (algorithmic part) (variable definition, input and output to the sequence) is the same for the both groups of students. It was again calculated by the nonparametric Mann-Whitney test.

Calculated P-value is P = 0.0237

with significance level $\alpha = 0.05$,

so we can reject the null hypothesis that the median of the results of the first algorithmic part of test algorithmic between both groups of student is the same. Between groups is statistically significant difference. Box plots chart of the two groups of students is shown on Figure 2.

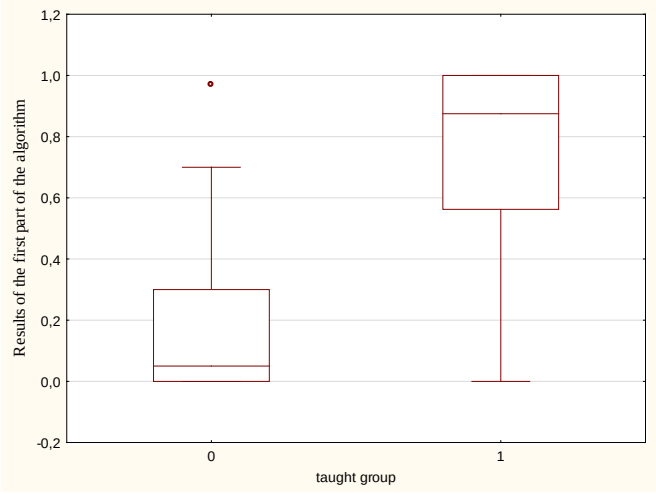

Fig. 2 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in the **first** part of algorithmic test.

The graph shows that the value of median of students from the second OOP group of students is greater than the maximum value of students from the first algorithmic group of students, excluding outliers.

Result of the second part of algorithmic test

To determine whether the median of the results of student of the second part of the test (concerning the sequences) is the same for the first and second group of students was again used the nonparametric Mann-Whitney test.

Calculated P-value is P = 0.075

with significance level $\alpha = 0.05$,

so we cannot reject the null hypothesis that the median of results of the students from the second algorithm part of the test is the same. Among groups there is not statistically significant difference.

Box plots graph of both groups of students is shown on Figure 3. From the graph it is clear that the second group of students gained better results than the first group.

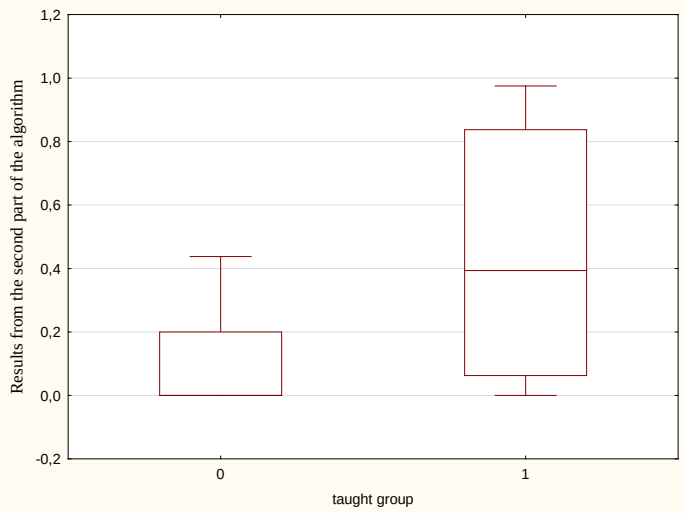

Fig. 3 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in the **second** part of algorithmic test.

D. Sample of Result of Tests

Students do not have problems with:

- algorithms for filling the sequence;
- output the value from sequence;
- algorithm for search of value in the sequence;
- algorithm for shifts value in the sequence;
- using of cycles;
- storing and writing the values to other variables;

Students have problems with:

- algorithm for inserting members to the sequence;
- algorithm for removing members from the sequence.

The problem is with changing the size of the field with determination or setting the size of the resulting sequence.

Example of task 1:

Create method that adds at the end of the sequence member

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whose value will be determined by input parameter.

The correct solution is shown in figure 4.

```
public void Pridej(int a)
{
    posloupnost.SetValue(a, posloupnost.Length + 1);
}
```

Fig. 4 Method – add member at the end of the sequence – correct solution.

Wrong student's solution is shown in figure 5 (wrong using of field sequence wrong assignment to the field).

```
public void Pridej()
{

    int a = Convert.ToInt32(Console.ReadLine());
    posloupnost.Array.Length = posloupnost.Length + 1;
    posloupnost[posloupnost.Length - 1] = x;
    for (int i = 0; i < k; i++)
    {
        Console.Write(posloupnost[i] + ", ");
    }
    Console.WriteLine();
    Console.WriteLine();

}
```

Fig. 5 Method – add member at the end of the sequence – wrong solution.

Students has also problems with design of algorithm development working with multiple sequences. They cannot verify the possibility of merge of two sequences and connect more sequences to different sequence.

Example of task 2:

Create method that merge the sequence at the end of the second one. The second sequence is specified as input parameter to the new third sequence. The result is returned as output value of type Sequence. The correct solution is shown in figure 6.

```
public Posloupnost PridejPole(Posloupnost Druha)
{
    int delka = posloupnost.Length + Druha.posloupnost.Length;
    Posloupnost Treti = new Posloupnost(delka);
    for (int i = 0; i < posloupnost.Length; i++)
    {
        Treti.posloupnost[i] = posloupnost[i];
        for (int j = N + 1; j <= delka; j++)
        {
            Treti.posloupnost[j] = Druha.posloupnost[i];
        }
    }
    return Treti;
}
```

Fig. 6 Method – merge the sequence at the end of the second one – correct solution.

Example of wrong student solution is shown in Figure 7.

```
public int PridejPole()
{
    int vysledek;
    for (int i = 0; i < posloupnost.Length - 1; i++)
        vysledek = (posloupnost[i] * posloupnost[i]) + vysledek;
    return vysledek;
}
```

Fig. 7 Method – merge the sequence at the end of the second one – wrong student's solution.

V. Conclusion

Paper describes algorithmic thinking and compared the two methodologies of teaching of programming in relation to the algorithmic and object oriented thinking.

Based on result of our research it is clear, that no student from the first group (first structured programming than object oriented programming) succeeded in the algorithmic part of the test.

On the other hand 50 % of students from the second group (only object oriented programming) succeeded the same test.

Detailed analysis of the results of two algorithmic parts test discovered that the results of the first group was far worse despite the fact that learning in the first group was more focused on algorithm development than in the second group.

The causes of failure may be several. One factor could be underestimation of the credit preliminary test. Another factor could be in the teacher's approach, because each group was taught by different teacher. To eliminate this factor, we will provide in this academic year the same research with the same teacher for both groups.

The results provide feedback based on which the learning of algorithm and programming will be modify.

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Object thinking in paradigms of programming

Stepan Hubalovsky and Ondrej Korinek

***Abstract*—**Thinking people use in their daily activities and thinking helps them to solve the situations, problems of everyday life. To solve the problem we are using the information we know. The information are stored in memory. When solving new situations we are used already known information. The already know information has to be combine to successfully solve a new problem.

The same situation programmers has to deal with during the design of new programs. Programmer has to combine various processes or parts of code that has ever used.

Programming is linked to several programming paradigms. Paradigms bring new programming options and replace the old one. A typical example is the replacement of a structured paradigm by object paradigm.

The paper analyzes two basic options for teaching of programming - object-oriented paradigm versus structured & object-oriented paradigm with respect to object-oriented thinking. The paper characterized object thinking as well as it shows types of examples for studying of thinking of two groups – object oriented and structured & object oriented.

The research was carried out in the Faculty of Science, University of Hradec Kralove.

***Keywords*—**Thinking, object thinking, object oriented programming, structured programming.

I. Introduction

MANY courses of programming for students – beginners begin with structured programming and after handling it the basic approach is followed by learning of object-oriented programming (OOP hereinafter). Learning by means of objects usually follows up at the very end of the course of programing. Difficulties of learning of this methods may be several.

One of the problems is that students do not have enough time to understand object-oriented thinking. Other problem is that the students understand object oriented programming only partly, they are still use and think in terms of structured programming and do not use benefit of object oriented programming [1]. It takes at least 6-18 months [2] then programmer of structured programming completely is reoriented towards OOP.

On the other hand the requirements of market are clear: programmer who does not handle the object oriented paradigm has on the labor market far less exercise than the one that handles it.

Why doesn't learning of programming focus entirely to object oriented paradigm? Structured programming has not so much use.

There may be several reasons:

- Teachers are experienced by a structured approach and do not like to change their ingrained habits.
- The problem is also when change the structured programming paradigm to object oriented programming. Some teachers start with object oriented paradigm after the third of course, others in the middle, others in the end of the course and some of them object oriented programming do not teach all.
- Some argue that structured programming uses algorithmic thinking which is used in everyday life.

Based on authors experience not only algorithm thinking, but also object thinking is important in everyday life.

II. Thinking

Definition thinking is difficult. There are several ways to define thinking.

"Thinking is based on the relationships between concepts" [3]. The concept we have stored in long-term memory. If we solve the problem, we use the information that we already know. We can then oriented in unfamiliar surroundings [3].

The thinking can be divided to the different forms [4]:

- deduction;
- induction;
- sorting;
- comparison;
- analysis;
- synthesis;
- generalization;
- abstraction.

A. Object Thinking

Although the definition of the thinking is difficult, the definition of object oriented thinking satisfies the above definition.

When programming the programmer is using a variety of combinations of terms related to previous practical experience and theoretical knowledge of programmer. Tasks that

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programmer solves, are also problematic in most cases. Among the forms of learning that are associated with the object of thinking, will include: deduction, induction, sorting, abstraction, analysis and synthesis.

III. Basic Concepts and Paradigm of the Programming

Algorithm can be represented in several ways - in the form of flowcharts, pseudocodes or structure-grams. It always depends on the teacher, which type of algorithm representation prefers. Algorithm development is the basis of programming [5].

The first aspect that influences learning of algorithms and programming is influenced by the form of performed teaching:

- structured form, that teaching is divided into learning algorithms, structured programming and object-oriented programming in the end;
- object oriented form, i.e. from the beginning of the instruction focuses on object-oriented programming, with the principles of the algorithms are part of this instruction.

The paper analyzes basic options for teaching of programming based on object-oriented programming with respect to object-oriented thinking, so let's describe basic paradigm of object oriented programming first.

The basic paradigm of object oriented programming (OOP) is to model on the computer the real-world situation – see e.g. [6], [7], [8].

The OOP applications are developed based on already created components. The basic terms of OOP are object, event abstraction, encapsulation, inheritance and polymorphism. From a system approach point of view the objects can be understood as open sub-system of whole application. Every object - the subsystem is a complete system - consisting of elements (a list of properties, event handlers), communicates with its environment through inputs (events, parameters) and outputs (methods and parameters).

Despite the different representation of algorithm and different paradigm of programming students should improve object thinking.

A. Concepts of Object-oriented Paradigm in Object Thinking

Object-oriented thinking is important for proper design of classes. The classes should contain methods with the appropriate parameters actually relate to the class.

Object-oriented thinking is used in connection with other basic concepts of Object oriented programming. The programmer has to analyze whose data or methods will be available for other outside objects and that data or methods will be hidden - the principle of encapsulation. Design of the program has to fulfill the principle that surrounding of the program knows as little about the object. Programmer has to consider about interface of the object [9], how it should be programmed and what should be implemented. According to [6] the term interface should precede inheritance.

The advantage in design of object-oriented program is the knowledge of formulas, such as in tasks in physics or mathematics. Using of correct formula, input of the relevant values, expressing of the resulting values is the basic mental operation for a successful solution of the problem. Physical or mathematical formulas have analogy in object-oriented programming in the form of design patterns. [10]

According to [10] the students should become acquainted with form of design pattern as soon as possible, because it is part of object oriented thinking.

IV. Research of Methodologies of Learning in the Subject Programming

A. Methodology of the Research

The course of Algorithms and Data Structures learned in the first semester at the Faculty of Science, University of Hradec Kralove is followed by three courses of Programming in the programming language C#.

The research investigation was carried out in the course of programming in the academic year 2013/2014. The main goal of the research was determined the comparison of two methods of teaching of programming - object-oriented programming and structured versus object-oriented programming with respect to algorithmic thinking. Students were randomly divided evenly into two groups according to the results in course of Algorithm and Data Structures.

One group of students (***structured group of student***) followed the algorithm development by structured programming in C# programming language with functions (methods) and based on algorithmic structures. The students designed structured C# programs based on similar algorithms, the already developed in course of Algorithm and Data Structures. The learning of structured programming was followed by learning of object-oriented programming. The basic terms of object oriented programming were introduced - design and definition of classes, abstract classes, methods, constructors, encapsulation, polymorphism, interfaces and inheritance.

The second group of students (***object group of student***) began immediately after the course Algorithm and Data Structure with object oriented programming (without structured programming). In this group the concept of object oriented programming was more practiced. The concept of structured programming was omitted.

Both groups of students passed a midterm exam test with similar tasks, which consisted of theoretical and practical part. Practical (programming) part was divided into object and algorithmic part. To successfully pass the test, students had to reach in every part at least 60% of correct answer.

The research investigated the influence of the different concepts on increase of objected thinking.

B. Credit Test

The credit test consists form some different tasks. Students

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have to correctly designed class first. They initialize one dimensional array (sequence) and private and public data items by constructor. Algorithm constructions for one dimensional array create classes in methods. Methods can or cannot return values. Return value can be in the form of primitive data type, array or class.

The OOP part (definition of class, constructor, and method) of the test is evaluated separately from algorithmic part.

Students have to define some method based on algorithmic areas. They have to fulfill one task from each algorithmic area.

Separated from algorithmic structures in evaluation of the task.

Sample of credit test:

Create class *Sequence* for sequence operation (one-dimensional array) with the following components:

- *Constructor* - creates private data item of type of one-dimensional array of integers of a given size.
- *N* - read-only property specifying the length of the sequence.

Filling the sequence:

- *FillFibonaccim* - using the method input the values of Fibonacci sequence to array values (1, 1, 2, 3, 5, 8, 13, 21 ...)

Output the sequence:

- *WriteRow* - using the method writes a sequence in the console line (values are separated by a comma).
- *Member* - using the method returns the value of element at the position specified as an input parameter.

Calculations and search in the sequence:

- *Average* - calculates and returns the average value of the terms of the sequence.

Shifting the values in the sequence:

- *Reversion* - reverses the order of the members in the sequence (e.g. from 1,2,3,4 to 4,3,2,1).

Inserting / removing values:

- *RemRand* - removes a randomly selected member of the sequence

Working with multiple sequences:

- *SumArray* - adds this sequence with the other sequences of the same length (has to be verified) specified as input parameter of the new third sequence, which returns as a return value of type Sequence.

In the main part of the program (method *Main* of class *Program*) create an instance of the class Sequence and properly use all the methods implemented.

C. The Result of the Research – Object Task

The first credit test was based on practical tasks. The algorithmic task was based on one-dimensional array. Students should propose algorithms of given problem.

The first algorithmic group of students consists of 9 students participated in the test.

The second object oriented group of students consists of 8 students participated in the test.

To determine whether the median of the result of student achieved in object part is the same for the first and second groups of students was used a nonparametric Mann-Whitney test.

Calculated P- value is P = 0.00127

with significance level $\alpha = 0.05$,

so we can reject the null hypothesis that the median of students results of the object part between the groups is the same. Between groups is statistically significant difference.

Box plots diagrams of both groups of students are in figure 1.

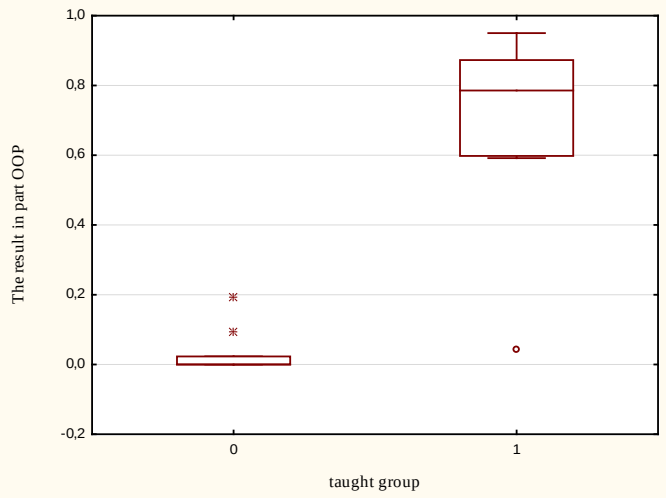

Fig. 1 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in algorithmic test.

The results show that the first algorithmic group of students completely failed in object oriented thinking, no student succeeds in the test.

In the second object oriented group 6 of 8 students succeeded.

Interesting results can be also reached from analysis of the code of programs (will be published later).

The basic object oriented skills include proper design classes, creating characterizing methods associated with the class, object calls and creating specific objects.

All these skills were in the student projects examined separately.

D. The Result of the Research – Object Oriented Task 1

In the first part of object oriented test was design classes, constructors, methods with primitive and object types examined.

To determine whether the median of the results correct initialization data elements using the constructor of the programs is the same for the first algorithmic group of student and second object oriented groups of students the nonparametric Mann-Whitney test was used.

Calculated P- value is P = 0.00064

with significance level $\alpha = 0.05$

Between both groups is statistically significant difference. We can reject the null hypothesis that the median of both

group of students is the same. Box plots of both groups of students are on Figure 2. The graph shows that the worst student of the second OOP group has higher score than the best student of the algorithmic group.

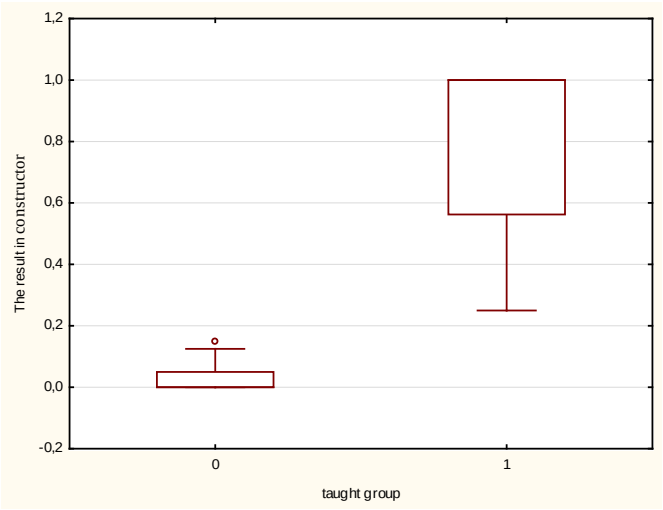

Fig. 2 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in object oriented test 1 - design classes, constructors, methods with primitive and object types.

E. The Result of the Research – Object Oriented Task 2

In the second part of object oriented test was create instance with specified values.

To determine whether the median of the results of the correct definition of methods with parameters of primitive and object types in the programs is the same for the first and second groups of students the nonparametric Mann-Whitney test was used.

Calculated P - value is P = 0.0033

With significance level $\alpha = 0.05$

Between both groups is statistically significant difference. We can reject the null hypothesis that the median of both group of students is the same. Box plots of both groups of students are on Figure 3.

From the graph it is clear that most student of the first algorithmic group of students didn't succeed the task. The student are not able defined methods in the class as well as defined object types.

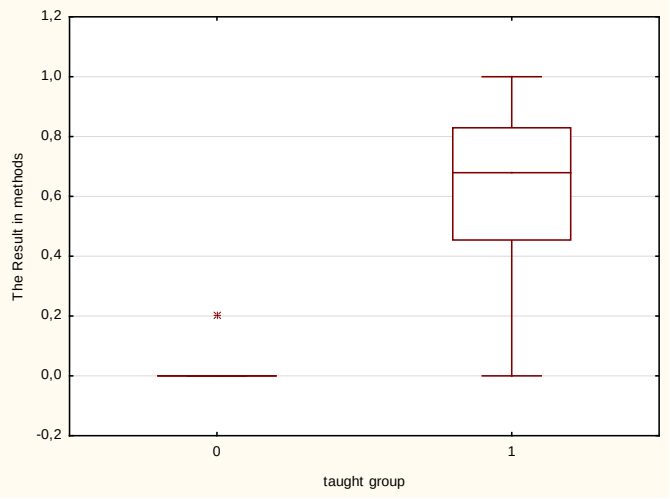

Fig. 3 Box plot diagram comparing result of algorithmic group of students with object oriented group of students in object oriented test 2 – creation of instance with specified values.

F. Sample of Result of Tests

Students OOP do not have problems with initialization data elements using the constructor. They can without any problems create instance of the class in the main part of the program. The student have the greatest problems with the return value in the method. Some of them cannot return even primitive data type or object type.

Students structured follow-up and object-oriented programming have problems with the whole object parts. They cannot properly create class, constructor or method.

Example of task:

Create method that determine the number of members whose value equals to the value specified as input parameter and the result value returns as output value.

Example the correct solution is shown in figure 4.

```
public int Pocet(int hodnota)
{
    int pocet = 0;
    for (int i = 0; i < N; i++)
    {
        if (posloupnost[i] == hodnota)
            pocet++;
    }
    return pocet;
}
```

Fig. 4 Method – determination of the number of members – correct solution.

Example of wrong student's solution is in figure 5 (wrong settings of input and return value of the methods. The value is not returned but the value is written).

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```
public void Pocet()
{
    int y = 0;
    int  x = Convert.ToInt32(Console.ReadLine());
    for (int i = 0; i < N; i++)
    {
        if (posloupnost[i] == x) y = y + 1;
    }
    Console.WriteLine(y);
    Console.WriteLine();
}
```

Fig. 5 Method – determination of the number of members – wrong student's solution.

V. Conclusion

The paper includes definition of object thinking and compared the two teaching methods of programming with respect to this thinking.

Based on result of our research it is clear, that no student from the first group (first structured programming than object oriented programming) succeeded in the object oriented part of the test.

On the other hand 75 % of students from the second group (only object oriented programming) succeeded the same test.

Detailed analysis of the results of the test discovered that the results of the first group was bad. The students had problems with the basic concepts of OOP in all parts of the proposal.

The causes of such failure can be several:

- shorter time spend by training of principles of object oriented programming
- different way of thinking that students understand.
- teacher's approach, because each group was taught by different teacher. To eliminate this factor, we will provide in this academic year the same research with the same teacher for both groups.

The results provide feedback based on which the learning of algorithm and programming will be modify.

Acknowledgment

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Influence of the Encryption Algorithms to Development of Algorithmic Thinking in Education of Programming

S. Hubalovsky and P. Hanzalova

***Abstract*—**The paper highlights the alternative learning of algorithm development and programming using cryptographic algorithms. The first section describes the different methods of teaching of programming. We focused primarily on those methods, which are used in our research. The next section described relationship between algorithmic thinking and cryptology. The set of examples demonstrated using of cryptology in algorithm development is part of the paper too. The last section shows the methodology and results of the pedagogical research, which takes place at the University of Hradec Kralove within specific research project, particularly we focus to the determination of the research group, methods, justification for the choice of programming language and existing research results.

***Keywords*—**Didactic of informatics, programming, algorithm development, algorithm thinking, cryptology.

I. Introduction

The interest of student on subjects focused on algorithm development and programming is no longer such as it was few years ago. At the same time, however, we can say that these subjects are taught beyond the technical or scientific subjects. Our research takes place at the Philosophical Faculty, University of Hradec Kralove in the humanities-oriented group of students. They have learning of algorithm development and programming as compulsory subject in its curriculum. It is study program computer-aided teaching archiving.

Based on previous experience within this subject, we noticed that content of the subject is for the humanities-oriented student quite difficult. This is mainly due to the high content of mathematics in algorithm tasks. Using of numeric exercises is the most common approach of learning of algorithm development and programming.

We therefore suggested and want to verify a new method that combines various existing approaches to teaching of algorithm development and programming. The main goal is to motivate students to mobilize, guide them to solve various examples. The new methodology emphasizes on clarity. At the same time we try to choose the least examples from numerical mathematics - most examples is built on cryptographic algorithms. These examples are easy to understand, can be clearly demonstrate and student can know only basic mathematical knowledge. At the same time there are a lot of such examples, we can demonstrate the basic algorithmic instructions, or even different algorithmic construction and functions.

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II. Approaches in Learning of Programming

A. Definition of the Approaches in Learning of Programming

There are different approaches in learning of beginners in programming. R. Pecinovsky [1] describes the following teaching programming techniques:

- *Hardware-first* = student has to first know the design of computers (hardware, machine code, and subsequently higher programming languages).
- *Algorithms-first* = student first uses a general representation of the algorithm (flowcharts, pseudo code) and subsequently writes program in the syntax of the language
- *Imperative-first* = student first learns classical structured programming instructions, and then passes the object oriented programming.
- *Functional-first* = student first learns function, which is usually not used in practice, so it discourages most of students
- *Objects-first* = student becomes from beginning familiar with object-oriented programming straight (there may student be information overloaded)
- *Breadth-first* = student has to understand first computer science in general; he has an overall view, which subsequently is applied to programming.

Most often used approach in learning of object-oriented programming is Object-first - see e.g. [2], [3], [4]. The second most common approach is Algorithms-first, often followed by learning of structured programming (see e.g. [5]).

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B. Structured Programming

Structured programming is programming based on the structure of the program, which comes strictly from the algorithm flowchart. From the system approach point of view the algorithm as well as structured program (written in any structured language - Pascal, C++, VB Script) can be understood as system, because they have properties of the system – algorithm interacts with its environment through inputs and outputs, consists from elements that are affected by interactions. Another division algorithm to subsystems is possible, from a practical perspective, however unreasonable.

In this context it is necessary to mention what types of exercises are used for training the algorithm development and structured programming. The exercises reflect two facts. Firstly, in the past, early in the courses of programming (mainly structured programming - Pascal, Basic, etc.) has been teaching of programming realized by teachers who also taught mathematics, or had to mathematics very close. Second, math problems are basically the simplest tasks, can be clearly described, defined and then developed by algorithm and rewritten to the program structure. That, however, seems at first glance a logical and simple, brings disadvantages. Algorithm development and structured programming explained by the mathematical tasks usually focus on rewriting the mathematical equations and formulas to the algorithms regardless of their complex systems integration with the exercises from real life. Used tasks are often artificial and divorced from reality. System and multidisciplinary approach is missing. Students, who do not have sufficient mathematical skills, do not understand the task and it can result in resistance to the algorithm development and subsequently to programming.

C. Object Oriented Programming

In contrast, the basic paradigm of Object oriented programming (OOP) is to model on the computer the real-world situation. The OOP applications are developed based on already created components. The basic terms of OOP are object, event abstraction, encapsulation, inheritance and polymorphism. From a system approach point of view the objects can be understood as open sub-system of whole application. Every object - the subsystem is a complete system - consisting of elements (a list of properties, event handlers), communicates with its environment through inputs (events, parameters) and outputs (methods and parameters).

D. Methods of Learning

The first method which respects the didactic principles is **constructivism**. The founder of constructivism is considered J. Piaget. The constructivist approach is based on cognitive methods and significantly is used individualization of teaching [6].

In constructivist teaching student itself creates new knowledge based on their previous knowledge, together with the information that can acquire during cognitive processes. The main feature of constructivism is the concept of learning as active, deliberate and social process of constructing meanings from submitted information and induced experience [7].

Constructivist method of teaching of programming is described by L. Salanci [8] or M. Ben-Ari [9]. When using constructivist teaching the student are able to solve various tasks, although they had never met them. The course consists of graded tasks and leading questions. Great emphasis is also placed on motivation, which is considered the most important factor in the learning process. The motivation is referred as the first phase of a simplified model of the cognitive process, next phase is collecting their own experiences, clarification of the rules and relationships, inference of the knowledge and training of the knowledge.

The findings of J. Piaget or J. Dewey's theory is based of experiential learning (described by D. Kolb). The different phases of experiential learning are shown in figure 1.

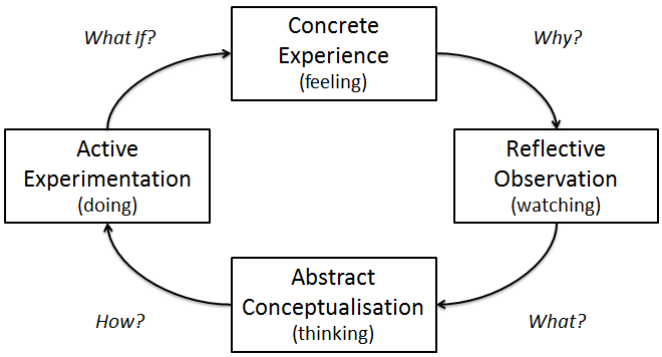


Fig. 1 Kolb's (Experiential) Learning Cycle.

Communicative approach is originally designed for teaching of foreign languages – language is not only understood as single structure (meaning the grammar and vocabulary), but language is also introduced and used in the sense of the executed functions. It was first introduced by G. H. Widdowson in 1978. One of the objectives of the communicative approach is to encourage the creativity of students. The communicative approach emphasizes on motivation and activity of students. Teacher is in position of guarantor of the methods and advisors. The motivational teaching methods like dialogical, problem or dramatic methods are used – see e.g. [10].

The Black Box method presents to students the task. Students investigated the relationship between cause (input) and the result (output). Student passes through three basic stages – see e.g. [11]:

- *abstraction* (student tries and watches what the is doing computer program and based on it derives general relationship);
- *encapsulation* (student considers how such a program could be written, composed its structure);

- *polymorphism* (based on previous experience student is able to describe in detail the connection between input and output).

These methods develop not only algorithmic thinking, but also a system approach, creativity and critical thinking of students. Block diagram of the Black Box Methods is shown on figure 2.

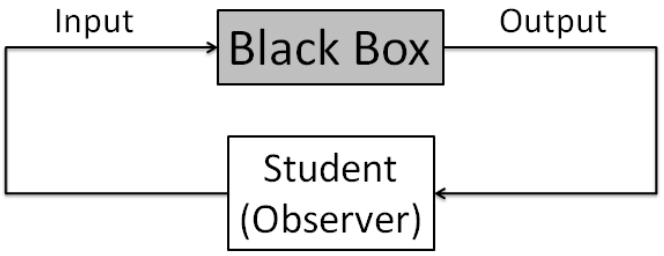


Fig. 2 Scheme of Black Box Method.

III. Algorithmic Thinking and Cryptology

Cryptology is the science that deals with the secrecy of messages.

We distinguish between three types of cryptology:

- *Cryptography* – creating form of ciphered messages that are understandable only to the addressee;
- *Cryptanalysis* - deciphering and breaking these ciphered messages;
- *Steganography* - creating of hide the message – the objective is to create the message that would not be found at all.

Some historical cryptosystems are known since antiquity (Caesar cipher or Hebrew ciphers). If we go through the history of cryptology, we observe how cryptology gradually improved and the procedures to encrypt and decrypt the text and techniques for solution of cryptograms are more.

However it is always necessary to use exactly specified sequence of steps to get the correct result. Therefore cryptology can be used for development of individual competencies of algorithmic thinking (which is nowadays considered to be one of the main key competencies of education from elementary school to high school).

A. Competencies of Cryptology in Algorithm Development

Within algorithmic thinking we can find these five competencies – see [12]:

- The ability to correctly apply the algorithm in a particular situation (student recognizes already known elements and applies known algorithm);
- Ability to create custom algorithms (analysis and re-synthesis of solutions to the sub-elements of the task);
- The ability to verify the accuracy and efficiency of the algorithm (to decide whether a given algorithm can be use in for given situation);
- The ability to recognize a problem that does not have algorithmic solution (they are tasks with no general algorithm of solution (e.g. Trisecting angle or square the circle), which is difficult to understand for many students)
- The ability to describe the algorithm in words.

B. Cryptology in Learning of Programming

Cryptology in learning of programming has been already presented in some publications.

Alternative learning of algorithm development using cryptology presents in his paper M. Capay [13]. He underlines mainly students' motivation and increasing of interest of student. These tasks are written in the form of mysteries that has to be detected. Algebraic riddles, puzzles and codes and ciphers are described on the principle of "black boxes". It is points out that the searched algorithm and programming solutions requires only basic knowledge of mathematical relationships. Ciphers are used for work with text strings. Only basic encryption techniques are used in the tasks. These tasks do not require explanation of its principle - namely mono-alphabetical substitution ciphers and transposition ciphers.

Another presented way of teaching of programming and algorithm development describes Š. Hubalovsky [14]. It is a systemic and multidisciplinary approach. Computer simulation of real systems based on knowledge of the situation in this field is created. The tasks are based on cryptanalysis - specifically cipher cryptanalysis mono-alphabetical cipher using bigrams [15] and trigrams [16] analysis of the reference text and the ciphertext. The solution is not without computer simulation hardly feasible.

The same approach is also engaged by M. Musílek. He describes case study of specific encryption method using Morse code – i.e. Morbit and Frationated Morse – see e.g. [17].

Encryption in the learning of algorithm development and programming has been used also by R. Morelli [18], which gives a detailed proposal for the project method in teaching of object-oriented programming. He describes particular task on historical encryption systems - Caesar cipher and simple transposition cipher.

IV. Case Study
Cryptology in Learning of Programming

A. Programming Language

Programming language Visual Basic for Application (VBA hereinafter), which is part of MS Excel (resp. MS Office) was selected in subject Programming in study program computer-aided teaching archiving. Advantage of programming in VBA in MS Excel is, that it allows work with MS Excel worksheets objects, mainly cells. The usage can be seen in deciphering using bigram [15] or trigrams analysis [16], where the process of storing the values into cells is very descriptive. Other advantage is possibility of creation of custom forms for easy control of the program. In addition, VBA programming

language based on Visual Basic (VB) is only adapted for MS Office products. The transition between these languages is due to the same syntax smooth.

B. Beginning Sample Lesson: the Exchange Values of Two Variables

Required knowledge: way of input of value and storage of value to variable (e.g. by using of InputBox ("the guiding text") and form of display the output (e.g. by using of MsgBox (X)).

Motivation:

Students have to solve the following situation: three containers are filled by different liquid. Two of them are filled by different liquids (or bulk materials). The task is to swap the contents of these containers. Props can be prepared for this activity – it depends on age of the students [10].

Example 1:

In the first practical tasks, students receive a new function in form of source code, which they have to describe verbally ("What happened when we used this source code?")

```
X = InputBox(„Input text including letter A“)
X = Replace(X, „a“, „u“)
X = Replace(X, „A“, „U“)
MsgBox(X)
```

The solution is the following description of the function:

```
Replace (expression, find, replace)
```

In the sequence of contiguous letters replace a certain substring with another substring.

The task may be accompanied by questions like:

- "What would happen if we missed a third line of code?";
- "What would be the output, if the letter “u” is replaced by other char in the second line of this code", etc.

Example 2:

In the next task students have to replace all the vowels by letter A (for example, when using language exercises, singing lessons). Students have to consider what letters are to be replaced and how the task can be simplified. Teacher can guide the students to use the function:

```
x = UCase (x).
```

This function replaces all letters to uppercase. This function is often used in encryption algorithms. The function can be also created by students using function:

```
Replace().
```

The task can be extended on removal all accents or punctuation.

The first task introduces the term function, the second task fixes the term function.

The next task develops algorithmic thinking of students (student can remember the motivational task which is help of solution).

Example 3:

Write program that exchanges the letters "A" and "E" in the text (i.e. if the input words is ABECEDA the output word will be EBACADE).

Students can use either the case-sensitive function (but at the end of the code all letters has to be changed to uppercase letters). Other and algorithmic better solution is based on using the third variable (another character), through which one of the specified letters is converted.

Example 4:

Write a program that will encrypt (or decrypt) text by Atbash cipher ("reverse alphabet" - the first letter is replaced with the last, the second is replaced with the second-last, etc.)

Example 5:

Write program that Morse code characters converted into the corresponding text.

This task is for some students quite difficult. Students have to order the commands Replace () from the longest to the shortest Morse alphabet letters. Example of bad sequence of commands:

```
…
X = Replace(X, "-/", "T")
X = Replace(X, "..-/", "U")
…
```

C. Final Project Lesson: Automatic Cryptoanalysis of the Cipher Text

Mastery of the principles algorithm development and programming is controlled by final project. Students use knowledge gained from previous lessons programming. Students are programmed in VBA.

The task of the project is to develop program for automatic cryptoanalysis of the monoalphabetical substitution cipher using frequency analysis of the bigrams of cipher text.

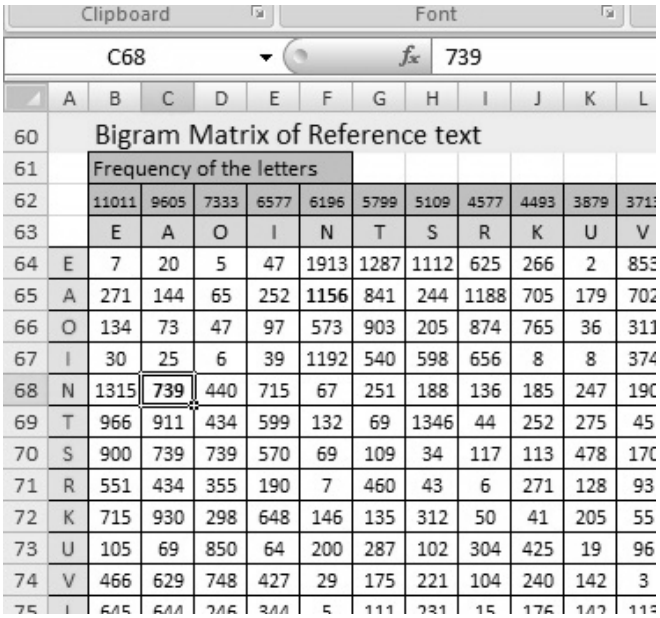
The solution of the above mentioned algorithmic task in MS Excel is subdivided into a number of more or less independent parts.

Detailed description of the automatic deciphering of monoalphabetical substitution cipher text can be found in [15].

1. Analysis of the reference text

The analysis of this reference text gives the first information about the frequency of individual letters, as well as the information of the frequency of bigrams of the selected language.

The final result of this step is creation of **bigram matrix *E* of reference text** – see figure 3.



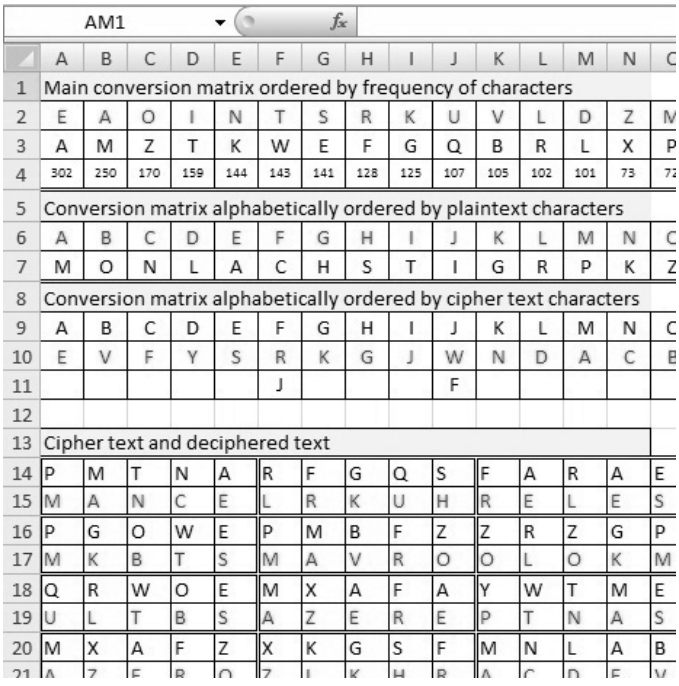
		A	B	C	D	E	F	G	H	I	J	K	L
60		Bigram Matrix of Reference text											
61		Frequency of the letters											
62		11011	9605	7333	6577	6196	5799	5109	4577	4493	3879	371	
63		E	A	O	I	N	T	S	R	K	U	V	
64	E	7	20	5	47	1913	1287	1112	625	266	2	853	
65	A	271	144	65	252	**1156**	841	244	1188	705	179	702	
66	O	134	73	47	97	573	903	205	874	765	36	311	
67	I	30	25	6	39	1192	540	598	656	8	8	374	
68	N	1315	**739**	440	715	67	251	188	136	185	247	190	
69	T	966	911	434	599	132	69	1346	44	252	275	45	
70	S	900	739	739	570	69	109	34	117	113	478	170	
71	R	551	434	355	190	7	460	43	6	271	128	93	
72	K	715	930	298	648	146	135	312	50	41	205	55	
73	U	105	69	850	64	200	287	102	304	425	19	96	
74	V	466	629	748	427	29	175	221	104	240	142	3	

Fig. 3 Bigram Matrix of Reference Text.

2. Downloading and analyzing of the cipher text

The next step is downloading and analyzing of the cipher text. In this step the cipher text has to be downloaded and corrected.

The final result of this step is creation of **frequency matrix of individual letters** (see figure 4) and creation of **bigram matrix *D* of cipher text**.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	C
1	Main conversion matrix ordered by frequency of characters														
2	E	A	O	I	N	T	S	R	K	U	V	L	D	Z	M
3	A	M	Z	T	K	W	E	F	G	Q	B	R	L	X	P
4	302	250	170	159	144	143	141	128	125	107	105	102	101	73	72
5	Conversion matrix alphabetically ordered by plaintext characters														
6	A	B	C	D	E	F	G	H	I	J	K	L	M	N	C
7	M	O	N	L	A	C	H	S	T	I	G	R	P	K	Z
8	Conversion matrix alphabetically ordered by cipher text characters														
9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	C
10	E	V	F	Y	S	R	K	G	J	W	N	D	A	C	B
11						J				F					
12															
13	Cipher text and deciphered text														
14	P	M	T	N	A	R	F	G	Q	S	F	A	R	A	E
15	M	A	N	C	E	L	R	K	U	H	R	E	L	E	S
16	P	G	O	W	E	P	M	B	F	Z	Z	R	Z	G	P
17	M	K	B	T	S	M	A	V	R	O	O	L	O	K	M
18	Q	R	W	O	E	M	X	A	F	A	Y	W	T	M	E
19	U	L	T	B	S	A	Z	E	R	E	P	T	N	A	S
20	M	X	A	F	Z	X	K	G	S	F	M	N	L	A	B

Fig. 4 Frequency Matrix of Individual Letters of Cipher Text.

In the end of this step the evaluation function *f* is calculated:

$$f = \sum_{i=1}^{26} \sum_{j=1}^{26} \left| D_{ij} - E_{ij} \right| \quad (1)$$

3. Analysis of bigrams of the cipher text and automatic deciphering

Analysis of bigrams of the cipher text and automatic deciphering of the cipher text is done in the final step.

The program analyses a text based on the frequency of the bigrams and create a new conversion matrix D' by a simultaneous substitution of two rows and two columns of the matrix *D*, calculates evaluation functions *f':*

$$f' = \sum_{i=1}^{26} \sum_{j=1}^{26} \left| D'_{ij} - E_{ij} \right| \quad (2)$$

and evaluates condition:

$$f' > f \quad (3)$$

If $f' > f$, the procedure continues with the next substitution of the letters in order. However, if $f' < f$, the procedure immediately stops and program suggest result of deciphering.

The process of automatic deciphering can be expressed by the flowchart shown in the figure 5.

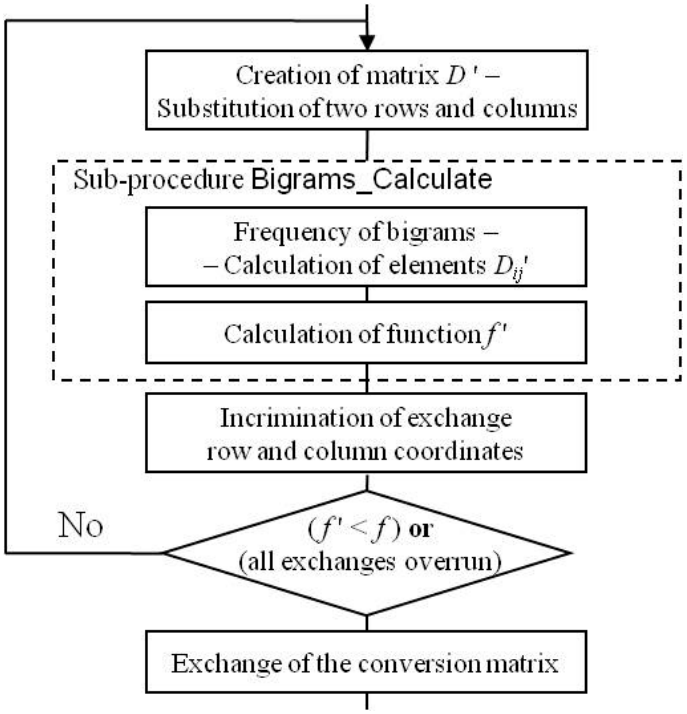


Fig. 5 Process of Automatic Deciphering.

V. RESEARCH

A. Research Methodology

The main research method is pedagogical experiment. The Dehnadi test for comparison of initial conditions in the experimental and control groups was used in the beginning of the research. The test investigates algorithmic thinking of the students and precondition of the students for the fulfillment the subject algorithm development and programming – see figure 6.

1. Read the following statements and tick the correct answer in the front column.	The new values of a and b are:

`int a = 10;`
`int b = 20;`
 	
`a = b;`
	☐ a = 30 b = 0
	☐ a = 30 b = 20
	☐ a = 20 b = 0
	☐ a = 20 b = 20
	☐ a = 10 b = 10
	☐ a = 10 b = 20
	☐ a = 20 b = 10
	☐ a = 0 b = 10
	☐ If none, give the correct values:
	a = b =

Fig. 6 Example of Dehnadi test.

B. Results of the Research

We found that there are several types of students in both experimental and control groups of student:

Type A: students handed blank test;

Type B: students to one question ticked more than one answer (the principle of the test is not understood);

Type C: students complete test correctly (60% of them already passed the course of programming in the previous study);

Type D: students complete test poorly;

Type E: students had some questions correct (in 90% they were the first three questions, which involve two variables, or even one question of three variables, when their value finally equal)

It is interesting that students who already attend course of algorithm development and programming belong to type C, D and E.

The distributions of students of experimental group are shown in figure 7 and distribution of student of control group is shown in figure 8.

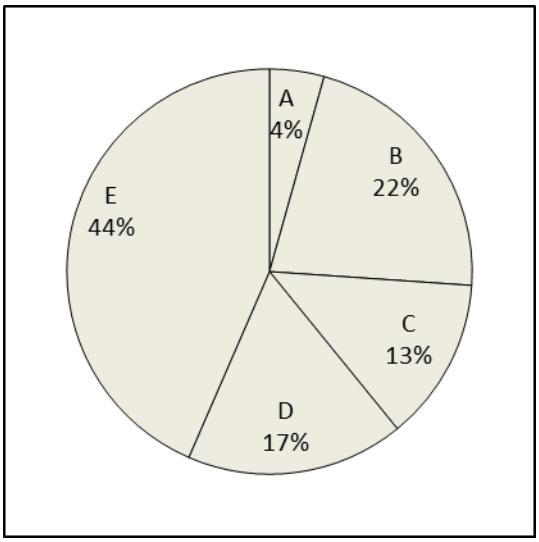


Fig. 7 Distributions of Students in Experimental Group.

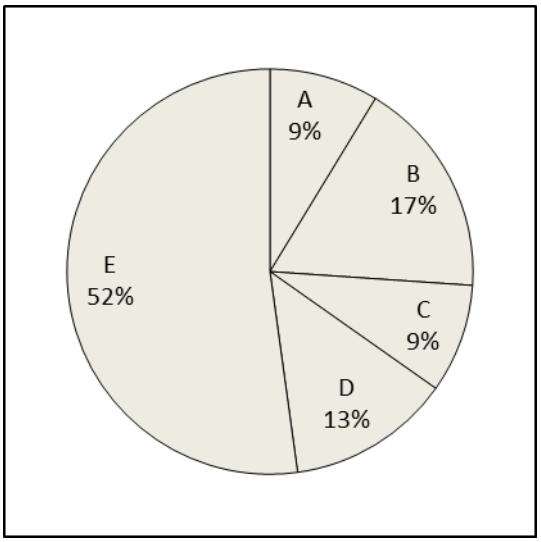


Fig. 8 Distributions of Students in Control Group.

The experimental group consist of 23% of girls, control group consist of 18% of girl.

The learning of algorithm development and programming in experimental group is carried out by proposed approach.

The learning in the control group is carried out by using classical, mostly math algorithms.

VI. Conclusion

Collection of exercises (tasks) for beginners of algorithm development and programming is created within the research. The tasks are focused on working with text - just basic knowledge of mathematics is required. The tasks are based motivational character of ciphers - it's something mysterious that is needed to be discovered. The ciphers and deciphering caused the development of computer technology, so the work with cipher and learning via cipher belongs to the field of information technology.

The methodology also uses various new approaches to teaching - constructivism, the principle of clarity, the technique of the Black Box or multidisciplinary approach.

The research described in the paper highlights the alternative learning of algorithm development and programming using cryptographic algorithms

The programming language Visual Basic for Application, which meets the requirements of modern programming language, were chosen in our research.

The final result of influence of using cryptology in learning of algorithm development and programming to development of algorithm thinking cannot be given without a final test. Based on observations and interviews with students in the experimental group, however, we can summarize these dependencies:

- Students who have input test without error, have no problems in seminars, they work independently and fulfilled given tasks.
- 80% of students who regularly attend seminars (75% of attendance) respond to the guiding questions and they are

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able to fulfill given tasks.

- Tasks related to text strings are for 50% of students more understandable than purely mathematical tasks (this group of students consists of 50% girls).
- Tasks related to historical cryptographic systems have motivational character. Students looked for various possible solutions and their programs were appropriately adjusted graphically and aesthetically. Their programs worked properly.

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Comparative Analysis of Applications Supporting Teaching Programming by Historical Encryption Algorithms

S. Hubalovsky and P. Hanzalova

***Abstract*—**The paper highlights the use of mobile applications in education. Specifically, it deals with the use of tablets. First, the paper focuses to utilization of tablets in learning - how this mobile technology can be used for educational needs. Then the paper presents case study of use the tablets and specifics requirements to tablet applications. Finally, the paper deals with applications that are focused on cryptology and present a comparative analysis of some selected applications.

***Keywords*—**Didactic of informatics, tablet, applications, cryptology.

I. Introduction

RECENTLY, the utilization of mobile technologies in education is quite often discussed – these are mainly tablets. The various projects are held in the Czech Republic now. The goal of the project is support this educational technology. Within these projects, schools are equipped by tablets for teachers, various trainings are organized and gradually this technology is included into learning. Generally one device is used for the whole class. In the secondary school, where is the research of influence of encryption algorithms to algorithmic thinking of pupils, the tablets are available for the whole class (one device per student). We decided to find out how these devices can be utilized in the lecture. We were searching for applications that could properly simulate and animate the principle of encryption algorithms. First, we focused on the applications available in the native language of pupils (Czech language). We found that there is a few of these application. Some of them did not comply with our requirements (e.g. the application contains only a few of ciphers). Applications that meet our requirements were mostly in English, although they were kept under the Czech name. Therefore, we decided to select from the available English applications.

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A. Mobile Technologies - Tablet

Handheld devices are increasingly available and affordable. "*Benefits identified in descriptive studies on such devices include accessibility, flexibility, and frequency of use, while concerns included small screen size, small size of keypad, and limited functions. Access in school tends to more fully engage students, and portability extends their learning beyond the school. Experts suggest that these personal devices can increase motivation, organizational skills, independent and active learning, and self-directed learning."* [1]

Tablet is a label for a laptop computer in the shape of plate with integrated touch screen, which is used as the main method of control. Tablets are highly portable hand-held computers. There is great choice of tablets on the market. At first we have to distinguish three basic categories due to operating system:

1. iOS
2. Android
3. Windows 8

Tablets are very fast growing branch of computer technology nowadays. It perfectly fit into today's modern lifestyle, when we need to maintain a connection to the virtual world. The display is usually 7-13" (7-8" tablets are highly mobile, 9-10" tablets are robust and suitable for working with text and 11-13" tablets are unique). It communicates via wireless (Wi-Fi). Applications are available in the store (Apple App Store, Google Play Store or Windows) and we can download it for free or buy it. The great advantage is built-in sensors (light sensor, compass, accelerometer, proximity sensor, etc. – depending on the type of tablet). Usually it has two cameras (one for selfie photo), microphone and speakers. This is consumer electronics, because technology is very fast-forward in this field and device already outdated in a few months. The biggest advantage is property that it may be ubiquitous – tablet is not bound to one fixed position. [2]

It is possible to buy a keyboard or special packaging (depends on the type of tablet due to jacks, camera and speakers).

B. Digital Literacy

Quite often we encounter with negative views on the digital learning technologies. Therefore, according to B. Brdicka, task of teachers is to know the pros and cons of digital technologies

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and their influence on the child in detail and to reinforce those positive effects during his lessons.

There are four formally described phase for students. Students using digital technology in the classroom should pass these stages:

Phase 1: The pupil understands the educational role of technology (uses, develops his own ideas and records the results of his work).

Phase 2: The pupil develops his own abilities (searches information and decides whether it is required).

Phase 3: The pupil evaluates founded information and uses them to presents his own ideas (supports his own development).

Phase 4: The pupil uses a broad repertoire of instruments in various subjects (reflects on the quality and meaningfulness). [3]

These phases have a lot in common with digital literacy. For comparing you can look at Figure 1 where we can see eight competencies of digital literacy by Futurelab [4].

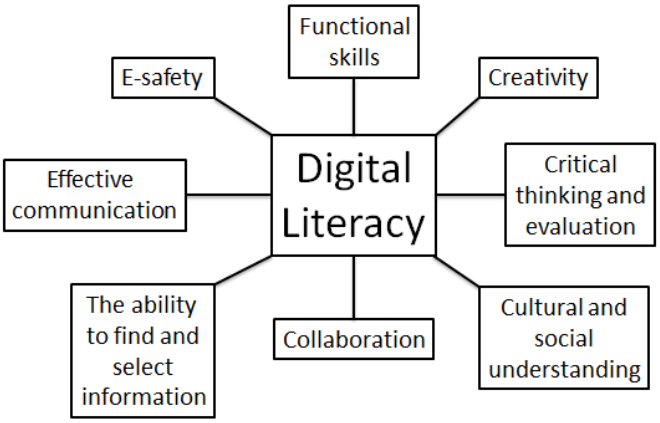

Fig. 1 The Components of Digital Literacy.

J. Utecht [5] deals with digital literacy in schools. He describes, how teachers teach today. He compared three basic literacies – print, digital and network. Network literacy is about understanding of how to find information, how to stay safe in social networks and about understanding connections.

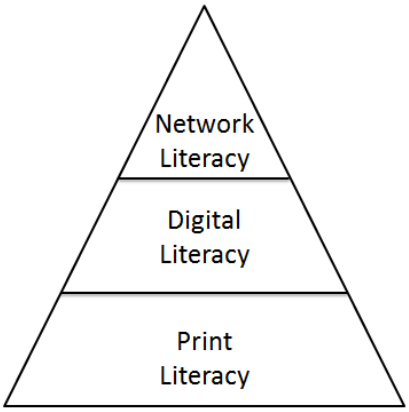

Fig. 2 Today's Model of Literacy Development.

"The pyramid represents the amount of time we spend teaching different types of literacy. Print Literacy is still the bases of our teaching in schools. Some of us and some schools are starting to bring digital literacy into the equation, but few of us are touching on or teaching Networked Literacy." [5]

Digital literacy is nowadays very important. Therefore, it is necessary to develop it.

C. Tablet in the Classroom

There are many ways to include tablet into teaching:

1:N (one tablet for more students)

The use of tablet in the classroom by the teacher is one of the latest trends. There is available only one tablet for whole class. It is mainly used for simulation or animations or to supplement the explanation. It is necessary to arrange the image transfer between the tablet and projector (Miracast software is used in our school).

Another possibility is to own more tablets for a class (students could work in the group with one device).

1:1 (one tablet for one student)

The tablet classroom is a special arranged class for working with tablets. It usually has different layout. In school there is often only one this class. It is designed for a working in groups therefore the distribution of equipment and seats is adapted to this. The classroom is available for all classes (mostly according to a predetermined schedule). It is often the kind of professional workroom, which can be equipped with a library. The alternative is a mobile tablet classroom. Tablets are portable and usable in any area (not only in school but also on the trip).

There are some problems associated with this situation – some pupils cannot control tablets for first's lessons (they need long period for getting accustomed). The preparation before the lesson is challenging too – a teacher has to check tablets. The charging must be provided directly in the school building.

The next possibility is **BYOD (Bring Your Own Device)**. The biggest problem that can occur is the diversity of operating systems. This could cause inoperable of some programs (all applications are not developed for all operating systems).

The solution is to purchase devices at the school and lend them to student home. We have already experiences with this system. But we have not so far positive feedback from parents in a large number of cases. We asked parents by questionnaire. The most frequent reasons are:

- financial responsibility for the device,
- distraction of attention from teaching,
- spending leisure time with tablet.

Only a few parents acknowledges that the tablet is similar to a digital device such as a smartphone (but it is big difference for teaching). And it is true that the majority of children already own smartphone [6].

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D. Utilization in Science Subjects

In addition to applications that can be downloaded from the store, tablet in the classroom can be used for:

- Quick access to information
- Writing notes
- Reading e-books and electronic text books
- Working at online courses
- Watch videos (e.g. Khan's Academy)
- Capturing photos and videos
- Making audio records
- Listening to music

In the science subject there is a great advantage of built-in sensors. Tablet is used as an experimental tool in teaching. Some tablets also allow the connection to external measuring device (especially used in physics or chemistry – see [7]). Recordings and results of fieldwork (favorite activity is to create your own herbarium or other variants of picture atlas) is easier with tablets.

II. The Case Study – Description of the Situation at our School

A. Initial Conditions

The school where the research of influence of cryptographic algorithms for the development of algorithmic thinking will take a place has 30 tablets. The teaching will be held within a subject Information and Computer Technology in grammar school. This will be a fourth year of high school. The devices have Android operating system. Therefore the second half of this article deals with applications from Google Play store.

The advantage is a great extension of this system, a wide range of available applications (there is the largest number of applications in comparison with other systems and many of them are free of charge), available are cloud services Google. Accounts can be connected with smartphone or computer. The weakness is the relatively large number of viruses that focus just on Android, appearance and layout varies by manufacturer graphical upgrades (we eliminate this because we have the same devices) and cheaper tablets are not reliable (we were selected from verified brands) [6].

B. A Sketch of the Teaching

Lessons will take a place at a grammar school in fourth grade during the course of Information and Computation Technologies in the field of algorithms and programming. The aim of research will be to determine whether the encryption algorithms have influence to the development of algorithmic thinking of students. Whether they are better than traditional algorithms (use mainly mathematics). We want to determine whether programming with the text string is feasible for students.

First, students must acquaint themselves with the historical encryption systems. These are fairly easy to understand. We want to use the available applications for tablets to simulate these encryptions systems. At the same time, these applications should serve as a control. After programming a cipher student can verify that the output is correct (identical with output in the application).

III. A Selection of Applications

We choose an application for OS Android (store Google Play). Applications should focus on cryptology and coding purely.

A. Application in the National Language

Initially we wanted to map out the available applications in student's native language (Czech).

Parameters for searching:

S1) Deals with cryptology
S2) Czech language
S3) Free of charge application

Parameters for a more detailed analysis:

A1) Rating of at least 50 users
A2) Rating of at least 4 stars
A3) Containing the classical encryption algorithms (overview)

After entering the "šifrování" (translation: encryption) we found five applications, that are comply with our parameters. Overview is in Table 1. It includes the name (title), author, logo, evaluation, date of updates and notes (language or content of application).

Tab. 1 Overview of Czech Cryptologic Applications.

Name ***Author***	**Logo**	**Rating (Users)**	**Upda-tes**	**Notes**
MCrypt - šifrování textu *Mirdinus*		5,0 (3)	17.09. 2014	
Šifrovací pomůcky Absolutno *Vašek Potoček*		4,5 (132)	21.01. 2014	
Sifrovaci pomucky *Jarda Kvapil*		4,4 (543)	15.03. 2012	
S.S.E. (Šifrovací software) *Paranoia Works*		4,3 (1281)	18.02. 2015	English Modern ciphers (strong algorithms – AES, RC6, etc.)
Šifrování věta *Sin-soft*		3,7 (83)	01.03. 2014	Foreign Language (English, Chinese) For the text messages encryption

From this list we selected two applications that comply with predetermined requirements (this it *Sifrovaci pomucky* and *Šifrovací pomůcky Absolutno*). Its detailed analysis is carried out in chapter IV.

B. Application in English

So we decided to extend the search to application in English as well. At first we have changed he parameters for search and selection for detailed analysis:

Parameters for searching:

S1) Deals with cryptology (historical encryption algorithms)
S2) Language: Czech and English
S3) Free of charge applications
S4) Rating of at least 4 stars

Parameters for a more detailed analysis:

A1) Rating of at least 50 users
A2) Interesting graphical design
A3) Containing the overview of classical encryption algorithms

Initially we entered the keyword "cryptology". The total number of founded applications was more than 350. All of them were free of charge. Therefore we chose those that gained four or more points in average rating. After this step we received at approximately 150 results. Some of them were in other languages than English.

Therefore these applications were also eliminated together with those which were in the form of games. Next we excluded unidirectional oriented applications (e.g. Caesar cipher only, ROT13, AES 256bit cipher, Enigma or Vigenere cipher) and applications related to modern encryption algorithms or steganography. It is interesting that there are over 50 applications in a few languages only for Caesar cipher. Some of total results contained extensive courses where cryptology was only one of many topics. These courses were also deleted from our list.

Essential information was gained from the description at Google Play store. We chose seven applications according to the criteria. We added another which has been found from different keywords (e.g. codes, ciphers, enciphering and geocaching).

Because the number of selected applications was relatively small, we added random other applications whose rating is only slightly below the four stars.

Tab. 2 Overview of English Cryptologic Applications.

Name ***Author***	**Logo**	**Rating (Users)**	**Upda-tes**
FunCrypt – Text Encrypter *Schakr*		5,0 (1)	28.06. 2013
Cryptaroo *Joey Wessel*		4,8 (6)	22.11. 2013
GCC – GeoCache Calculator *Eisbehr*		4,4 (2023)	03.05. 2014
Secret Coder Lite *Wolf Mountain Apps*		4,3 (78)	26.03. 2014
Cipherize, encryption tool *vm*		4,3 (54)	02.08. 2014
Cipher Cryptics *Soaryn*		4,2 (96)	16.10. 2013
Cipher Sender *High5!Apps*		4,2 (69)	13.05. 2012
MyCryptoApp *Banatas Sotiris – Gogoglou Vassilis*		4,2 (30)	16.09. 2014
Cryptoy *Government Communication Headquarters*		4,1 (215)	11.12. 2014
Universal Encoding Tool *zyclonite networx*		4,1 (102)	18.01. 2013

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Cryptography | Comp Sc Engg. *Faadooengineer. com*		4,1 (41)	19.02. 2015
Codes and Cyphers *Utopi Apps*		4,0 (1)	15.02. 2015
Hintdecoder for Geocaching *iBEAMi Technologies*		3,9 (99)	15.08. 2014
Decipher – Code and Cipher Kit *Disco Viking*		3,8 (34)	13.10. 2013
Scouts Codes Free *Applications PitachoKnoch*		3,7 (13)	27.07. 2012

We chose five other applications to the two previously selected. We paid attention to the overall average score and to number of users who evaluated it.

Two of these applications were directly labeled as an educational software (*Cryptoy* and *Cryparoo*). Because we have the same purpose in our case, we decided for a more detailed analysis of both of them. Application *Cryptography | Comp Sc Engg*. is teaching text elaborated in great details (although there are also chapters focused on historical ciphers the main themes are modern encryption algorithms). This application contains a relatively large amount of advertisings. Although it is very nicely processed we did not include it because there are no simulations of historical ciphers (it would be very difficult for some of our students). Some of applications focus on a certain group of ciphers (it is mostly about the substitution ciphers).

IV. Comparative Analysis

All subsequent applications have been tested on one of the tablets (Android version 4.2.1). We focused on clarity, layout, content (whether it is only the encryption program, or even educational, and how many different types of ciphers contains).

A. Cipher tools Absolutno (author: Vašek Potoček)

This application is available in the native language of our students and in English too (we can choose from these two languages in the settings). It is presented as Puzzlehunt Assistant. The graphical design is simple but pleasant. On the desktop there are 12 icons with labels (see Figure 3). We can find several types of ciphers under some of the icons (e.g. *Pigpen & Ciphers Grid*), because we can select various setting.

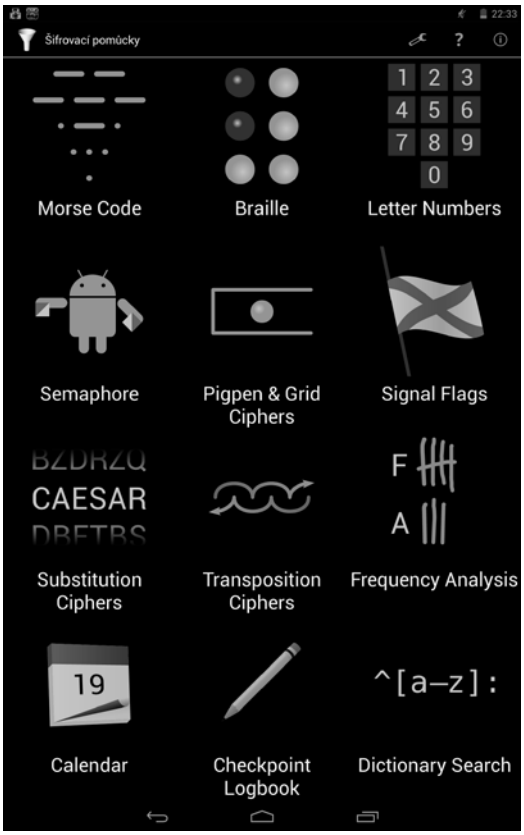

Fig. 3 Startup Screen (Screenshot).

B. Cipher tools (author: Jarda Kvapil)

This simple application gives a choice of available ciphers for users. Encrypt and decrypt are shown as two different ciphers. User enters a message or chooses more detailed information to the cipher. Program reacts immediately – equivalent occurs immediately after entering. There are the best known codes, monoalphabetic and polyalphabetic substitution ciphers, some of transposition ciphers and basic frequency analysis of letters.

C. Cryptoy (author: Government Communication Headquarters)

This application is included among educational software. Graphic design is precise and arranged. The application is adapted to touch device. The distribution is possible only in width. It acts as a suitable and useful simulation in teaching. The only disadvantage is the small number of topics:

- **Shift** – Caesar cipher with switch (rotate alphabet)
- **Substitution** – with your own key
- **Vigenere** – concrete example of polyalphabetic ciphers
- **Enigma** – wartime cipher by using machines

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There is always short description (About), the historical context (History) and mathematical relationships and attractions (Math) for each type. All of this is written in relatively simple English and text is adequately long. The application allows various settings of these ciphers. Here is used the touch screen. A didactic principle of clarity is respected here.

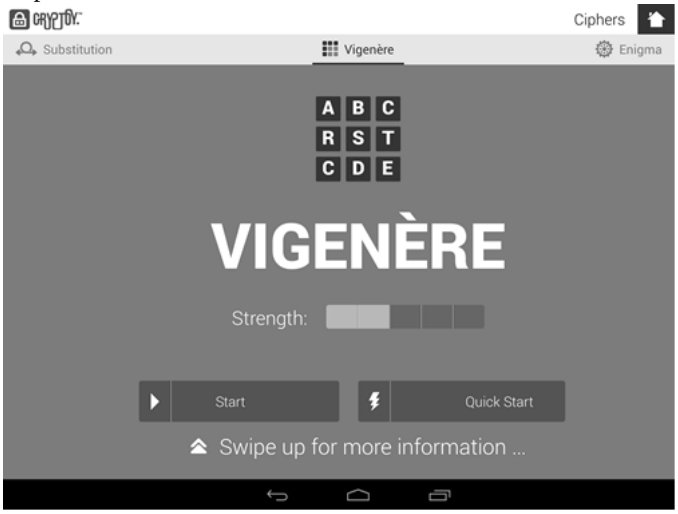

Fig. 4 Vigenere's Substitution Cipher (Screenshot).

D. Cryptaroo(author: Joey Wessel)

Fig. 5 Main Menu (Screenshot).

This is the second application that was included in the educational. Its layout is permitted only in height. Graphic design is very simple. Compared with the previous there is no description or animation. This is an application where it is possible to enter text in the input field. There are interesting tools for deciphering - it is unique compared to other applications. We find the classical frequency analysis of each letters (or characters), but also bigraph or trigraph analysis (see Figure 5).

E. GCC – GeoCache Calculator (author: Eisbehr)

During the first loading an application calls for donation but when you run it repeatedly this window dismiss. It consists of 63 icons. This application has very professional graphic design – you can choose from several variants of design (there is a dark and light version). The icons are described and accompanied by a simple picture (see Figure 6). They are in alphabetical order. Among them there is *Setting* and *About* (general information) that are intentionally included at the end. Some functions are suitable currently only for geocaching (Pi, Colors, Coordinates or Periodic system). But we can find a large number of ciphers there.

These are the most famous types of historical ciphers:

- Substitution – Atbash, Caesar, Bacon, Playfair, Polybius or Vigenere,…
- Transposition – Scytale, Rail Fence…
- Codes – ASCII, GC Code, Morse Code

Among others, there are also Enigma and RSA. We are interested of Scytale cipher which is one of the oldest transposition ciphers (we hardly ever meet with its simulation).

One missing thing in this application is the frequency analysis or other tools for deciphering the text.

Fig. 6 A Part of Startup Screen (Screenshot).

F. Secret Coder Lite (author: Wolf Mountain Apps)

At the first startup you have to click through several windows through which you confirm copyrights, etc. It is a simple application with a limited number of ciphers (see Figure 7). It consists of an input field, the window with a predefined selection of ciphers, the output fields and buttons *Encode* and *Clear*.

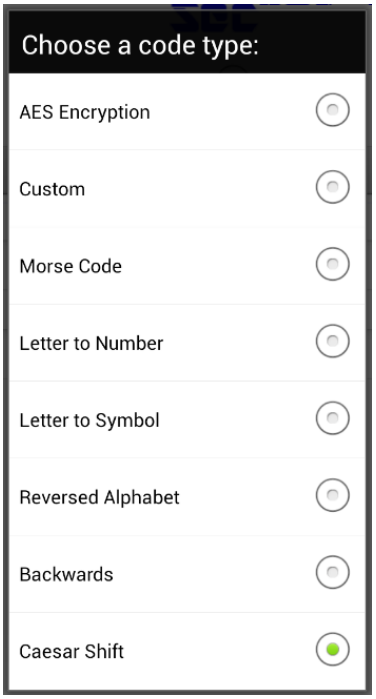

Fig. 7 The Offer of Encryption Algorithms (Screenshot).

G. Cipher Cryptics (author: Soaryn)

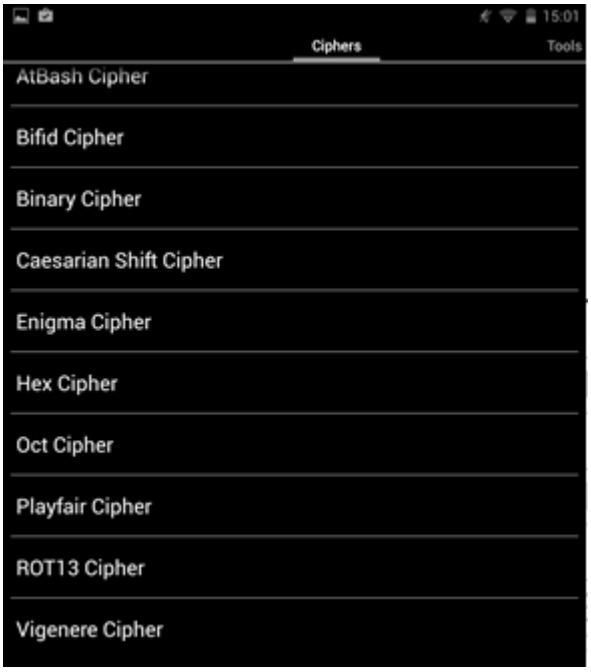

Fig. 8 A Part of Main Menu (Screenshot).

The application is solved easily. After starting there is a list of available ciphers (see Figure 8). After selection we have possibility to enter text (or keyword - it depends on the type) and to choose whether encrypt or decrypt. This option is missing for some cipher (the user has to know that the principle of encryption and decryption is the same, therefore, one program can be used). In the *Tools* tab does not work the *Tableau Tool*. When you enter different inputs it generates still the same table.

V. Conclusion

Table 3 gives brief assessment of the application in terms of content. In the rows there are individual applications (letter indicates the chapter where this application was launched). Columns indicate the types of ciphers (in the brackets there are the conditions for the minimum number of ciphers that we have set):

1. Monoalphabetic substitution ciphers (at least 5)
2. Polyalphabetic substitution ciphers (at least 1)
3. Transposition ciphers (at least 3)
4. Tools for deciphering (frequency analysis)
5. Codes (at least 3)
6. Other (Enigma or RSA)

If there is number one a table cell, it means that the application in the appropriate row fulfilled the conditions for the appropriate column. If there is zero cipher that type of cipher is missing or its number was small.

Tab. 3 Assessment of Selected Applications.

	1.	2.	3.	4.	5.	6.
A	1	1	1	1	1	0
B	0	1	0	1	1	0
C	1	1	0	0	0	1
D	1	1	0	1	0	0
E	1	1	1	0	1	1
F	1	0	0	0	0	0
G	1	1	0	0	1	1

Looking at the graph representation of the different types of encryption algorithms (Figure 9), we can see that either of type was not sufficiently represented in all applications. The above table shows that either of applications includes all types. The most common are substitution ciphers, on the contrary, the lack of transposition and tools for deciphering. However, we can use some mentioned applications for our purposes.

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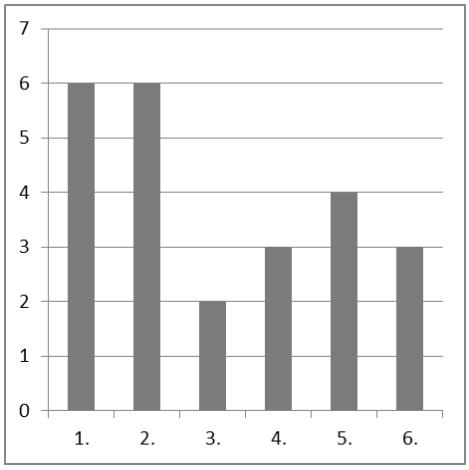

Fig. 9 Graph of the Number of Ciphers in Selected Applications.

We were surprised by the relatively small number of total applications. Those that deal with more types of ciphers are very little. We expected more applications focused on this direction because it is used in various encryption games, in geocaching or in other various leisure time activities.

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Implementation of E-learning at Primary School Education

Marie Hubalovska

***Abstract*—**The paper highlight possibility of implementation of the LMS (Learning Management System) Moodle to education in Primary School in Upice, Czech Republic.

The characteristic of education at primary school, specifics of e-learning at primary school and specifics of e-learning material for primary school are described in the theoretical background of the paper.

The paper presents the results of pilot quantitative research realized before implementation of LMS. The goal of the pilot research is to determine relationship between pupil's subjective assessment and pupil's mark from the subject and prove hypothesis that pupil's popularity of the subject is related to the pupil's grade.

Next step will be realized in June 2015, after half of year of using of e-learning materials in education of Primary School in Upice. This future step of the research should demonstrate whether the implementation and use of e-learning courses can affect a pupil's assessment to the subject as well as final evaluation grade of the subject.

***Keywords*—**E-learning, primary education, primary e-learning, Hot Potatoes.

I. Introduction

Fulfilment of the basic aims in process of primary education it is necessary to develop in **E-learning, primary education, socially disadvantaged pupils, Hot Potatoes.**upils competences, which give reliable base for lifelong education. The teacher must be able to react to changing ways of fulfilling the aims of education and adjust to it pedagogical and commutative style – see e.g. [1].

One of the not fully used possibilities till now how to approach new qualitatively directed pupil's development is sense full use of information and communication technology, namely at all levels of schools and in different educational or social personal context [2].

The current trends are focused to implementation of information and communication technologies to the conditions of teaching in primary educational system. We know that it is case of problem with rather extensive and branching by technical, technological and psycho didactic circumstances [3].

E-learning is one of the ways for effectively usage of information and communication technologies in education. The concept of e-learning in the Czech Republic is understood more broadly. The synonym for e-learning is technology-based learning (learning supported by technology). This concept covers a wide set of applications and processes, such as e.g. computer-based learning (learning supported by computer) and web-based learning (learning supported by web technologies) – see [4].

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II. Primary School and E-learning

A. Characteristic of Education at Primary School

Basic education builds on preschool education and education in the family. It is the only the stage of education, that all pupils have to. Basic education is divided to primary education and secondary education [5].

Primary education in its conception helps transition of pupils from early family and childhood education and to compulsory, regular and systematic education. It is based on learning, respecting and developing individual needs, capabilities and interests of each pupil (including pupils with special educational needs). Primary education by its activity and practical character, using appropriate methods motivate pupils to continuing learning, lead them to the learning activity and to the recognition that it is possible to search, discover, create and find suitable ways of solving problems.

During basic education, pupils gradually acquire such personal qualities that allow them to continue their studies, to innovate in the chosen profession and throughout their lives to further educate and according to their abilities to actively participate in society.

The primary education requires stimulating and creative environment that stimulates the brightest pupils, encourages the less talented pupils, protects and supports the weakest pupils. The primary education ensures that every child through learning develops optimally in accordance with him own assumptions for learning. The primary education also creates the conditions for teaching pupils with special educational needs. The primary education is characteristic by friendly and welcoming atmosphere encourages pupils to study, work and activities that suit their interests, and provides them space and time for active learning and full development of their personality. Evaluation of pupil's performance and pupil's achievements has to be based on the fulfillment of specific and practicable tasks, based on assessing of pupil's individual development and on positive motivation. Pupils has to feel success, do not be afraid of mistakes and work with it.

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During primary education, pupils gradually acquire such personal qualities that allow them to continue their studies.

B. Objectives of Primary Education

Primary education should help pupils form and gradually develop key competences and provide reliable basis of general education focused especially on everyday life situations and practical behavior. The primary education has following objectives [5]:

- enable pupils acquire learning strategies and motivate them for lifelong learning;
- encourage pupils to creative thinking, logical reasoning and problem solving;
- encourage pupils to versatile, effective and open communication;
- develop pupils' ability to cooperate and respect themselves and others work and successes
- help students discover and develop their own ability in accordance with real possibilities and apply these ability together with knowledge and skills for decisions.

C. E-learning

Components of e-learning are beginning to use at all universities, in increasing number of secondary schools and also exist primary schools that implement learning management systems. The aim is to increase the quality of the educational process. Information and communication technologies are used for supporting of cognitive processes as well as social and psychological aspects of education [6].

E-learning education through ICT has mainly a supporting character, it is alternative. Elementary schools use e-learning as supplement or extension of the classical "full-time" education. It is therefore better to use the term blended learning, which has not well-defined boundaries, is very flexible and offers the potential for future learning – see [7] or [8].

As it was already mentioned above, the content of the curriculum and the curriculum itself is processed in the form of multimedia courses, which represent the integration of text, images, sound and other multimedia elements. The educational model using the principles of e-learning is designed for guided self-study. The aim of e-learning support full-time course is to provide students the opportunity to work at their own pace, he can determine the method of "transfer", returning to the topic, choosing from more variant of explanation, more option of training and testing knowledge.

D. Educational System Development Phases of E-learning

System Design defines five stages of education development [9].

- *Analysis* – the main instructional problem is clarified, this stage is the base for educational program design.
- *Design* – the program goals are specified – activities, assessment instruments, performance conditions – from the objectives analysis to the specifications of the subject matter, activities and evaluation.
- *Development* – the educational program itself is developed with the use of varied developer's tools.
- *Implementation* – so called pilot run is launched during which the real efficiency of learning is tested and it is revealed if the program use leads to meeting the objectives.
- *Evaluation* – it is present in all five stages. Evaluation defines the program quality; it spots sources of problems and reveals potential faults. All this leads to improvements. Feedback function setting is analyzed. The focus is on efficiency and usefulness of individual teaching units.

All this stages of the education development has to be followed in e-learning education too.

E. Specifics of E-learning at Primary Education

Requirement on pupil at primary school are significantly different than in full-time study. They are also different in comparison with higher level of education.

Pupils have to have good time to plan given by their leader (teacher or parents).

The pupil has be motivate. Only motivation can "force" him to learn. In full time education are supporting factors e.g. classmates. In e-learning pupil has to be more active and responsible, his activity has to be supported again by teacher / parents.

In the higher level of the education the necessity is the ability of self-study, responsibility, ability of organization and planning of their own time, computer literacy at a certain level and availability of technology. These necessity has to be supported in primary education by teacher / leader / parent. Pupils should not be in e-learning problems alone.

The advantage of e-learning is that learners are during study a considerable degree of anonymity.

Discriminating factors such as appearance, clothing, race, gender are mostly irrelevant.

In the higher level of education the attention during e-learning focuses on the content of the discussions and the ability of participants to discuss and cooperate. The primary education is a bit different. Above mentioned is in beginning stage and it is developed.

Paradoxically, introverted pupils are in this communication in their area.

The higher level e-learning has negative phenomenon - the lack of physical contact with their classmates and with teacher. Uncovering his person in the course, creating a friendly atmosphere, dedication of forums for non-binding communication, can help to overcome feelings of aloneness. It is very important to do everything to make students feel not-isolated. Isolation can be overcome technical on-line resources, audio, video, chat. Student should have the opportunity to contribute their innovations, ideas, opinions of the subject. Students must realize that e-learning tutor is not the only source of information, students can learn a lot from their colleagues. Also important is the ability to compare the

level of acquired knowledge with other students.

The phenomenon of the lack of physical contact is in primary e-learning missing, because the e-learning form of the education has **only** supporting characters.

F. Different Role of Teacher in E-learning

Role of the teacher in e-learning is changing. Teacher successful in the present study may not have the skills to be successful as tutor of online learning. The teacher is a consultant, trainer, advisor and helper of learner, moderators of discussion, knowledge assessor, and evaluator. In this role the teacher has to be able to manage [9]:

- specific methods applicable in the e-learning course,
- replace the lack of physical presence so that he course environment contain tool for communication (tutor must create written form of communication, since he is basic element of communication during this type of education),
- openness to change, critical and self-critical thinking (sensitivity, openness and flexibility has to be essential for tutor),
- practical skills for creating of courses
- support of students during whole time of the learning.

Role of teacher at primary e-learning shifts to helper and leader.

G. Different Work with E-learning Materials

Working with e-materials has a character of individual work or guided independent work. Commonly is important prepare a thorough documentation for the course. The documentation has include goal of the work, the bases of the study and how to reach desired outcomes and based on what criteria will be evaluated.

In the higher level education the documentation is used directly by students. In the primary e-learning the documentation is intended to teacher or parents who are leader and helper of the pupil.

H. Specific of Primary E-learning Material

E-learning courses has to be created based on common as well as specific methodological and didactic approaches [9]:

- well balanced basic knowledge and activities (texts and explanations, experiments, questions, tasks, exercises, summaries) and additional information;
- interconnection of explanations and other e-learning parts;
- suitability and applicability of presented knowledge and activities in relation to the basic syllabus and target competences;
- motivational features representation;
- independent learners' activities support;
- implementation of cross-curricular relationships and topics;
- achieving educational goals;
- differentiated approach to learners with different levels of knowledge;

The primary e-learning has to focus to motivational and differentiated approach with regard to age and knowledge of the pupil.

The motivation character of the material has the most important role. The motivation of the primary school pupil can be supported mainly by [9]:

- choice of the topic, the topic of the material has to correspond of the age, knowledge, regional location;
- visualization and design, the e-learning material should be colored, interactive, should include pictures, etc.

One of the most appropriate program for creation of primary e-learning materials is Hot Potatoes. Hot Potatoes programs can be used for creating of interactive educational materials and exercises. Exercises created in Hot Potatoes provide to pupils rich feedback. In addition of direct evaluation in the form of message, whether the answer is right or wrong, the pupils learns how many percent of his work was successful. During exercise pupils has the opportunity use the help.

Example of the material created in Hot Potatoes is shown on figure 1.

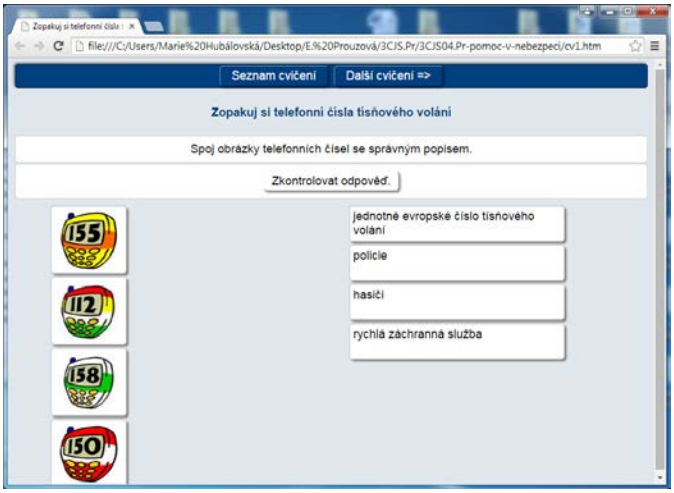

Fig. 1 Example of Hot Potatoes e-learning material.

III. RESEARCH PROJECT

Elementary School in Upice is solved European project named "Computer-aided learning of primary". The aim of the project is creation, implementation and evaluation primary e-learning materials and interactive exercises. The materials and exercises are created and implemented directly by teacher. The materials are created in web based programming tool Hot Potatoes. The material and exercises are entered into the school e-learning environment LMS Moodle. During this project will be created 6600 materials and exercises for pupils from 1st to 9th grade of elementary school in subject the Czech language, Mathematics, English language and Science. Involvement of such amount of e-learning materials in learning process represents a major shift toward the use of information

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technology at the elementary school.

The monograph describing creation and implementation of e-learning in primary education will be issued after finishing of the project (in 2015).

A. Objectives of the Project

The main objective of the project is to determine the effect of the implementation of e-learning to elementary school. In the pilot stage, we focused on mapping of input conditions - describe options of implementation of LMS Moodle to selected subjects and to determine the relationship of pupils to the researched subjects. It was discovered whether before the implementation of LMS Moodle there is correlation between the pupil's mark from the subject and subjective assessment of the subject by pupils.

In this paper we will describe the some results of pilot quantitative research realized before implementation of LMS. In the research we find out the correlation between **pupil's subjective assessment of the subject and pupil's evaluation grade**.

B. Methodology

To fulfill the defined objectives of the research project the implementation of LMS Moodle to education environment of elementary school will be generally described by case study of particular school. We therefore focused on the description of the start stage and the target stage. To determine the relationship between pupil's subjective assessment and pupil's mark from the subject, the correlation analysis, namely the determination of correlation coefficient has been used.

The hypothesis of our research is:

Pupil's popularity of the subject is related to the pupil's grade.

The research was carried out in:

- second class (40 pupils)
- third class (35 pupils)

of elementary school (e.g. the pupils are 7 – 10 year old).

C. Results of the Pilot Study

The results of the pilot study presented in this paper show correlation between:

- **pupil's subjective assessment** (independent variable)
- **pupil's evaluation grade** (dependent variable)

in the subjects:

- Czech language
- Mathematics
- Science
- English (only third class).

Sets of results are shown in the charts of figures 2 - 8. The charts represents graphical input for calculation of correlation coefficient – set of dependent and independent variables and its frequencies.

The horizontal axis represents independent variable – *pupil's subjective assessment* of given subject, 1 means the best assessment, 5 means the worst assessment.

Vertical axis represent dependent variable – pupil's *evaluation grade* from the subject, 1 means the best evaluation mark, 5 means the worst evaluation mark.

Diameter of the circle and numbers represents *frequencies* of the same set of dependent and independent variables.

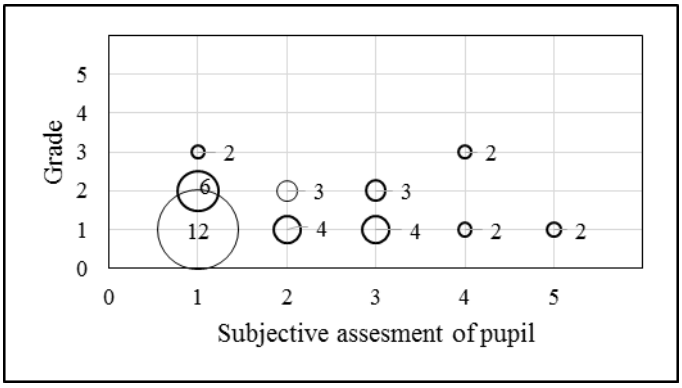

Fig. 2 Results of the research, class 2, subject Czech

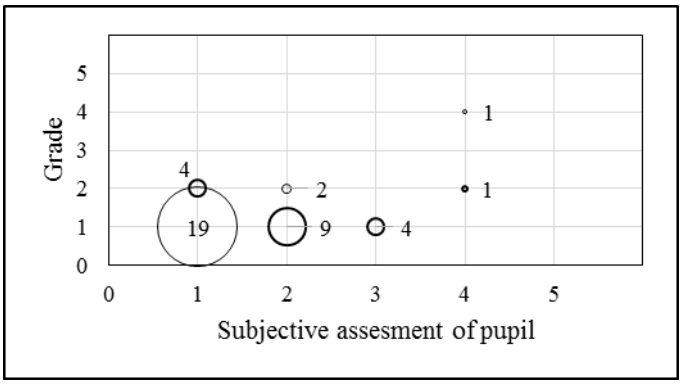

Fig. 3 Results of the research, class 2, subject Math

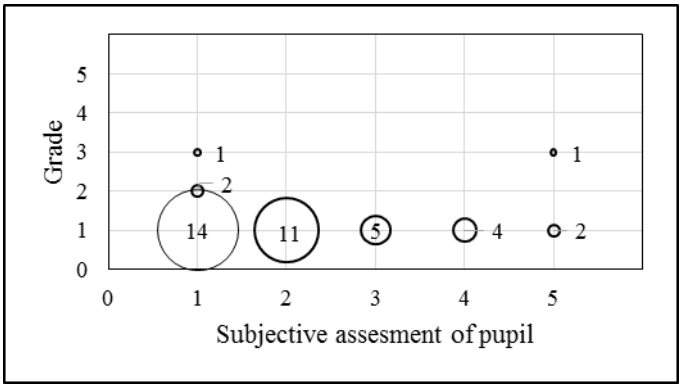

Fig. 4 Results of the research, class 2, subject Science

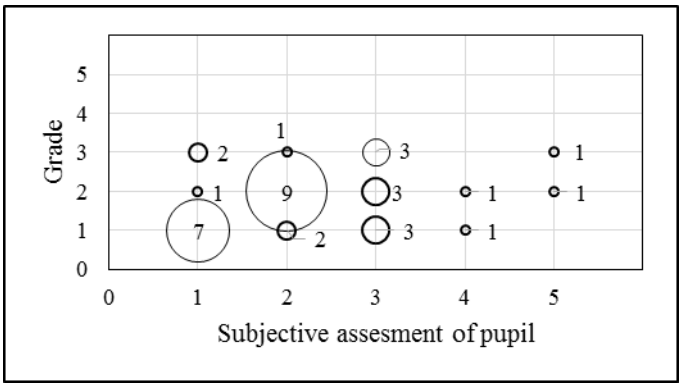

Fig. 5 Results of the research, class 3, subject Czech

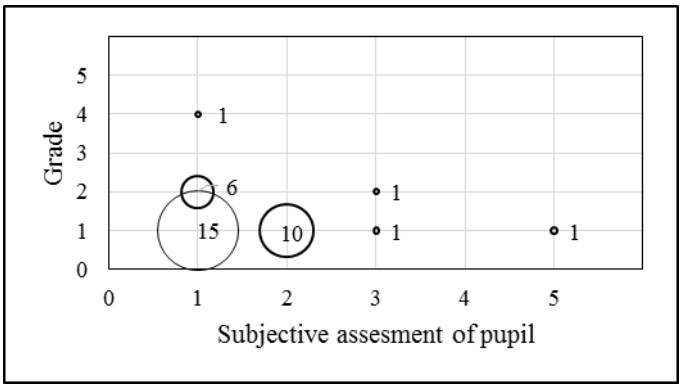

Fig. 6 Results of the research, class 3, subject Math

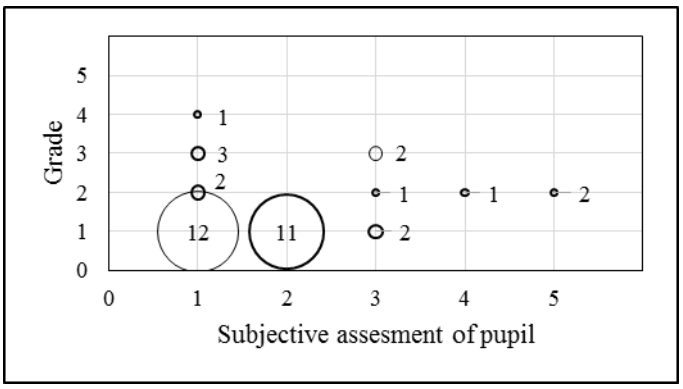

Fig. 7 Results of the research, class 3, subject Science

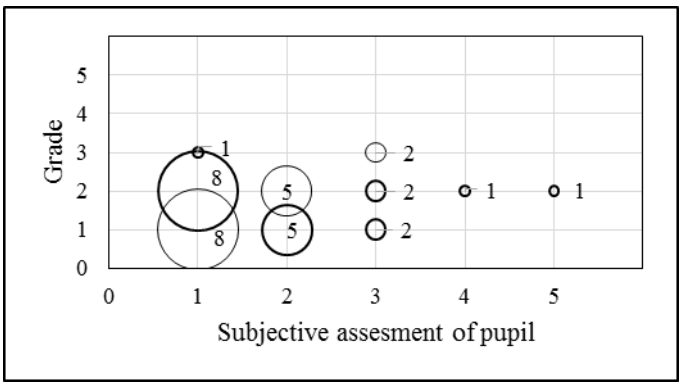

Fig. 8 Results of the research, class 3, subject English

Results of the correlation coefficient between pupil's subjective assessment and pupil's mark are shown in the table 1.

Table 1 Result of correlation coefficient

	Czech	Math	Science	English
Class 2	0.02	0.39	0.05	x
Class 3	0.27	− 0.17	0.15	0.22

D. Discussion of the Results

The results of the pilot study – above presented chart and table with calculated correlation coefficient (relation between *pupil's assessment of the subject* and the *pupil's grade from the subject*) shows following:

- The pupil's grade has motivating character in the first and the second class of the primary school. The grade 3, 4 and 5 are exceptional grades confirmed by result.
- The correlation coefficients mostly confirms the hypothesis that the popularity of the subject is related to the grade of the pupils.
- The exceptional result (negative correlation in Class 3, subject Mathematics) is probably caused by irresponsible filling of the questionnaire (see chart in figure 6).
- Near zero correlation in Class 2, subjects Czech and Science can caused by unpopularity of subject among pupils, maybe unpopularity of the teachers (see charts in figures 2 and 4).

IV. Conclusion

The main goal of the research is to determine whether the implementation and use of e-learning courses can affect a pupil's assessment to the subject as well as final evaluation grade of the subject.

To realize this main goal the pilot study described in the paper has been realized.

Next step will be realized in June 2015, after half of year of using of e-learning materials in education of Primary School in Upice.

Acknowledgment

This research has been supported by: Specific research project of University of Hradec Kralove, Faculty of Education in 2015.

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Marie Hubalovska was born in Trutnov, Czech Republic in 1972, she obtained master degree in Education of primary school in 1994 and master of degree in Education of special pedagogy and logopedy in 1995, both in Faculty of Pedagogics, Charles University in Prague, Czech Republic. She works in Primary School in Upice. She is is Ph.D. student at University of Hradec Kralove, Department of informatics, Faculty of Science, Hradec Kralove.
She is interested in using of ICT in primary education.

E-learning at Primary Education with Context of Socially Disadvantaged Pupils

Marie Hubalovska

***Abstract*—**The paper highlight possibility implementation of the LMS (Learning Management System) Moodle to education in Primary School in Upice, Czech Republic.

The characteristic of education at primary school, specifics of socially disadvantaged pupils in primary school education, specifics of e-learning at primary school and specifics of e-learning material for primary school are described in the theoretical background of the paper.

The paper presents Hot Potatoes program as suitable tool for creation of interactive e-learning materials. The Hot Potatoes materials are implemented to LMS Moodle of school which enables control, monitoring and evaluate of pupils' work.

The paper presents the results of research investigation. The main objective of the research investigation is find out how pupils of the Elementary School in Upice are using information and communication technologies in their learning. The research investigation also helps to identify the socially disadvantaged pupils, whose do not have computer or internet connection at home and cannot perform e-learning exercises at home. The paper offer the possible solution of the situation.

***Keywords*—**E-learning, primary education, socially disadvantaged pupils, Hot Potatoes.

I. Introduction

Fulfilment of the basic aims in process of primary education it is necessary to develop in pupils competences, which give reliable base for lifelong education. The teacher must be able to react to changing ways of fulfilling the aims of education and adjust to it pedagogical and commutative style – see e.g. [1].

One of the not fully used possibilities till now how to approach new qualitatively directed pupil's development is sense full use of information and communication technology, namely at all levels of schools and in different educational or social personal context [2].

The current trends are focused to implementation of information and communication technologies to the conditions of teaching in primary educational system. We know that it is case of problem with rather extensive and branching by technical, technological and psycho didactic circumstances [3].

The trends of implementation of information and communication technologies brings together significant problems concerning of socially disadvantaged pupils. The socially disabilities of the pupils is reflected usually in school unsuccess and given by different factors.

The paper presents pilot study provided before implementation of e-learning in primary school. The pilot study found out the quantity of socially disadvantaged pupils in the primary school and search the solution of removal of this phenomenon. The reason is that implementation of new technologies could bring together enlarge of social difference between pupils.

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II. Primary School Education

A. Characteristic of Education at Primary School

The process of learning is a complex system of interacting elements. Teachers and pupils are main actors of this process. It's a personality type of teacher, the pupil's personality, pupil's relationship to the subject, but also to teachers and their mutual communication. Of course in the teaching process has other elements and influences. They are essentially methods that a teacher uses, and environmental conditions in which the learning process takes place, forms of organization, content, teaching methods and resources [4].

Basic education builds on preschool education and education in the family. It is the only the stage of education, that all pupils have to. Basic education is divided to primary education and secondary education.

Primary education in its conception helps transition of pupils from early family and childhood education and to compulsory, regular and systematic education. It is based on learning, respecting and developing individual needs, capabilities and interests of each pupil (including pupils with special educational needs). Primary education by its activity and practical character, using appropriate methods motivate pupils to continuing learning, lead them to the learning activity and to the recognition that it is possible to search, discover, create and find suitable ways of solving problems.

During basic education, pupils gradually acquire such personal qualities that allow them to continue their studies, to innovate in the chosen profession and throughout their lives to further educate and according to their abilities to actively participate in society.

The primary education requires stimulating and creative environment that stimulates the brightest pupils, encourages

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the less talented pupils, protects and supports the weakest pupils. The primary education ensures that every child through learning develops optimally in accordance with him own assumptions for learning. The primary education also creates the conditions for teaching pupils with special educational needs. The primary education is characteristic by friendly and welcoming atmosphere encourages pupils to study, work and activities that suit their interests, and provides them space and time for active learning and full development of their personality. Evaluation of pupil's performance and pupil's achievements has to be based on the fulfillment of specific and practicable tasks, based on assessing of pupil's individual development and on positive motivation. Pupils has to feel success, do not be afraid of mistakes and work with it.

During primary education, pupils gradually acquire such personal qualities that allow them to continue their studies.

B. Objectives of Primary Education

Primary education should help pupils form and gradually develop key competences and provide reliable basis of general education focused especially on everyday life situations and practical behavior. The primary education has following objectives [4]:

- enable pupils acquire learning strategies and motivate them for lifelong learning;
- encourage pupils to creative thinking, logical reasoning and problem solving;
- encourage pupils to versatile, effective and open communication;
- develop pupils' ability to cooperate and respect themselves and others work and successes
- help students discover and develop their own ability in accordance with real possibilities and apply these ability together with knowledge and skills for decisions.

C. Socially Disadvantaged Pupils in Primary School Education

To group of socially disadvantaged pupils includes pupils, who come from a socially or culturally different environment (normal environment is environment where majority population lives). The socially disadvantaged pupils lives in minorities or come to major population in the context of migration. The number of such pupils in schools is increasing. Some of these pupils have no serious problems to integrate into regular schools. Some of the pupils have serious problems to integrate into regular schools. Pupils from families with low socio-cultural and economic status are more at risk of socio-pathological phenomena. Therefore, it is essential devote specific attention to these pupils and reflect their needs [4].

Socially disadvantaged pupils are understood pupils who do not have the same educational opportunities as the majority of the school population in the Czech Republic. The main reason are unfavorable socio-cultural conditions of their families or other environments in which they live.

Czech law defines integrating of socially disadvantaged children as entities with special educational needs.

The social disadvantage comes families with low socio-cultural status where is high risk of socio-pathological phenomena [5].

Social disadvantage is characterized by following criteria:

- low level of education of parents and other member of family;
- incomplete family;
- low income of family;
- low professional status of family members, including unemployment;
- low level of housing;
- minority background.

The aspects of social exclusion are different. Although the diagnosis of social disadvantage cannot be described by any generalized model (because the differences between families and their lifestyles and difficulties with individual children with social disabilities are high) some common can be socially excluded localities some common elements of lifestyle of socially excluded families can be found. It is given also by position of social disadvantaged localities. Social exclusion affects mostly the groups often identified as Roma in the Czech Republic [5].

We distinguish lot of types of social exclusion. For the purpose of this paper is important marginalization.

Marginalization is exclusion of individuals or social groups on the margins of society. Marginalized groups are often socially and economically weaker, they usually live in isolated areas (peripheries, specific town areas, etc.) They have corresponding effect on happening in majority.

Persons without education cannot find work for long-time. Their economic situation is bad. Their children are affected by this situation and belongs to socially excluded pupils.

Such pupils often do not have access to information and communication technologies and implementation of new technologies (e-learning) in school could enlarge of social difference between pupils and enlarge socially exclusion of the disadvantages pupils.

The long-term goal of the school must be the integration of pupils from different socially disadvantaged environment, protection of minority and the promotion of their success in major society. Therefore, it is essential that the school takes into account different socially disadvantage all such pupils and flexible respond to their social differences and to prepare for these pupils individual education plans that would suit their needs [4].

III. E-LEARNING

The modern trend of learning, which are currently implemented in teaching, is using of information and communication technologies in teaching. ICT can be used as school information system, as encyclopedic source of information, as operating resource for word processing, spreadsheets, photos, videos and more.

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In learning, the computers can be applies for the presentation of the subject, the teacher presents new information. The pupils use variety of training programs in which the pupil can be led by teacher or work independently. Working with educational programs allows the pupil individuality its personal rate. Computer aided learning may take place within the regular learning, where the pupil's work is by teacher directed.

Another form can be totally independent work of pupils. There is, however, important feedback not only for the pupil but also for teachers. This allows a number of environments, the most common is LMS Moodle. Totally independent work can be influenced by less possibilities of access of socially disadvantaged pupils to ICT outside school.

Moodle (Modular Object Oriented Dynamic Learning Environment) system is software support package for combined and distance learning using e-learning courses available through the Internet browsers [6]. Moodle is using the current web and server technology. Only normal user computer skills are required for working with Moodle. Moodle is Learning Management System - LMS Virtual Learning Environment - VLE and allows creation of educational content. Main assumption of using LMS is internet connection that is limiting factor for socially disadvantaged pupils.

According [7] e-learning can be used in this form:

- Education:
  - *at elementary schools* – only some elements are used, e.g. educational programs offering simulation, modelling, quizzes, services for learners with long-term absence, tools for weak and also gifted and diligent learners;
  - *at secondary schools* – besides the formats used at elementary schools, eLearning might serve as a source of information, as a collaboration tool and it can facilitate tasks completion;
  - *at universities* – full-time, distance and combined study programs – the entire above mentioned plus studies organization.
- Company training:
  - it enables staff training providing the same level and quality in all branches;
  - trainees can return to previous courses;
  - there is instant access to new data and procedures, e.g. new regulations;
  - connection to company information systems;
  - decreased costs of repeated trainings, trainers, travel allowances.
- Lifelong learning:
  - individual and personal access to educational sources, e.g. via educational servers.

A. Role of E-learning Education

Components of e-learning are beginning to use at all universities, in increasing number of secondary schools and also exist primary schools that implement learning management systems. The aim is to increase the quality of the educational process. Information and communication technologies are used for supporting of cognitive processes as well as social and psychological aspects of education [8].

E-learning education through ICT has mainly a supporting character, it is alternative. Elementary schools use e-learning as supplement or extension of the classical "full-time" education. It is therefore better to use the term blended learning, which has not well-defined boundaries, is very flexible and offers the potential for future learning – see [9] or [10].

As it was already mentioned above, the content of the curriculum and the curriculum itself is processed in the form of multimedia courses, which represent the integration of text, images, sound and other multimedia elements. The educational model using the principles of e-learning is designed for guided self-study. The aim of e-learning support full-time course is to provide students the opportunity to work at their own pace, he can determine the method of "transfer", returning to the topic, choosing from more variant of explanation, more option of training and testing knowledge.

B. Specifics of E-learning at Primary Education

Requirement on pupil at primary school are significantly different than in full-time study. They are also different in comparison with higher level of education.

Pupils have to be managed by their leader (teacher or parents). The leader of socially disadvantaged pupils is mainly teacher.

The pupil has be motivate. Only motivation can "force" him to learn. In full time education are supporting factors e.g. classmates. In e-learning pupil has to be more active and responsible, his activity has to be supported again by teacher / parents.

In the higher level of the education the necessity is the ability of self-study, responsibility, ability of organization and planning of their own time, computer literacy at a certain level and availability of technology. These necessity has to be supported in primary education by teacher / leader / parent. Pupils should not be in e-learning problems alone.

The advantage of e-learning is that learners are during study a considerable degree of anonymity.

Discriminating factors such as appearance, clothing, race, gender are mostly irrelevant.

The e-learning has negative phenomenon - the lack of physical contact. This problem is in primary school education missing, because the e-learning form of the education has **only** supporting characters.

C. Different role of teacher in e-learning

Role of the teacher in e-learning is changing. Teacher successful in the present study may not have the skills to be successful as tutor of online learning. The teacher is a consultant, trainer, advisor and helper of learner, moderators of discussion, knowledge assessor, and evaluator. In this role the teacher has to be able to manage [7]:

- specific methods applicable in the e-learning course,

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- replace the lack of physical presence so that he course environment contain tool for communication (tutor must create written form of communication, since he is basic element of communication during this type of education),
- openness to change, critical and self-critical thinking (sensitivity, openness and flexibility has to be essential for tutor),
- practical skills for creating of courses
- support of students during whole time of the learning.

Role of teacher at primary e-learning shifts to helper and leader. This role of teacher is absolutely unsubstitutable in the socially disadvantaged pupils.

D. Different work with e-learning materials

Working with e-materials has a character of individual work or guided independent work. Commonly is important prepare a thorough documentation for the course. The documentation has include goal of the work, the bases of the study and how to reach desired outcomes and based on what criteria will be evaluated.

In the primary e-learning the documentation is intended to teacher or parents who are leader and helper of the pupil.

E. Specific of Primary E-learning Material

E-learning courses has to be created based on common as well as specific methodological and didactic approaches [7]:

- well balanced basic knowledge and activities (texts and explanations, experiments, questions, tasks, exercises, summaries) and additional information;
- interconnection of explanations and other e-learning parts;
- suitability and applicability of presented knowledge and activities in relation to the basic syllabus and target competences;
- motivational features representation;
- independent learners' activities support;
- implementation of cross-curricular relationships and topics;
- achieving educational goals;
- differentiated approach to learners with different levels of knowledge;

The primary e-learning has to focus to motivational and differentiated approach with regard to age and knowledge of the pupil.

The motivation character of the material has the most important role. The motivation of the primary school pupil can be supported mainly by [7]:

- choice of the topic, the topic of the material has to correspond of the age, knowledge, regional location;
- visualization and design, the e-learning material should be colored, interactive, should include pictures, etc.

One of the most appropriate program for creation of primary e-learning materials is Hot Potatoes. Hot Potatoes programs can be used for creating of interactive educational materials and exercises. Exercises created in Hot Potatoes provide to pupils rich feedback. In addition of direct evaluation in the form of message, whether the answer is right or wrong, the pupils learns how many percent of his work was successful. During exercise pupils has the opportunity use the help.

IV. RESEARCH PROJECT

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Elementary School in Upice is specified by rather high percentage of socially disadvantaged pupils. There is about 12 % of such pupils. The situation is given by composition of the population and a lack of jobs.

The monograph describing creation and implementation of e-learning in primary education will be issued after finishing of the project (in 2015).

A. E-learning Materials Created in Hot Potatoes

Before the result of the pilot research investigation find out using of information and communication technologies by pupils will be presented, the e-learning material created in Hot Potatoes program by teacher of the school will be shown.

Web programming educational tool Hot Potatoes was created by a team of research and development at the University of Victoria under the leadership of dr. Stan Bogdanov. Hot Potatoes programs can be used for creating of interactive educational materials and exercises. Exercises created in Hot Potatoes provide to pupils rich feedback. In addition of direct evaluation in the form of message, whether the answer is right or wrong, the pupils learns how many percent of his work was successful. During exercise pupils has the opportunity use the help.

With regard to the possibility of continuous monitoring and evaluation of pupils' work, Hot potatoes exercises were implemented in school LMS Moodle. Linking such of two learning systems represents meanings shift that lets you take advantage of both systems simultaneously. LMS Moodle communicates very well with Hot Potatoes, which allows feedback for teacher. Results of completed exercises are transmitted to Moodle. The teacher can monitor the success of the performance of the exercises. In Moodle records more data, which are beneficial for teachers. It is the length of individual tasks, number of attempts, the success of the task in

percentage, frequency of access to Moodle etc.

Hot Potatoes has 5 modules (JQuiz, JCross, JCloze, JMatch, JMix - see figure 1), each of which is used to create a particular type of exercise that can be put in html format on the web site as interactive materials and exercises evaluated automatically by computer.

Fig. 1 Results of the research, class 3, subject Science

Modul *JQuiz* is intended for creating exercises allows the use of four types of input:

- Choose an answer
- Short answer yes / no
- Mixed response
- More correct answers

Modul *JCross* allows the creation of simple puzzles.

Modlu *JMatch* is suitable tool for creation of exercises based on pairs of concepts, which has to be paired according to specification.

Modul *JCloze* enables creation tests and refilling exercises.

Modul *JMix* enable creation of jumbled sentences, jumbled terms, series of numbers, series of multiples, etc. This tool enables create exercise, that allows sorting of the terms based on specification.

The exercises created in Hot Potatoes tool are very suitable especially for younger school age. Allows a large number of options for creation of interactive, interesting and attractive material and exercises. Hot Potatoes enables insert pictures and sounds. The different types of exercises can be very well adapted to the particularities of the age of the child. Therefore, this is the reason why the e-learning materials and exercises created in Hot Potatoes are suitable for primary education. The exercises can vary.

The exercises created in Hot Potatoes can be executed not only in the computers, but it can be used even in mobile technologies like tablets or smartphones etc.

The example of the exercises created in *JCloze* module is shown on figure 2. The exercise is intended for third class and subject Science.

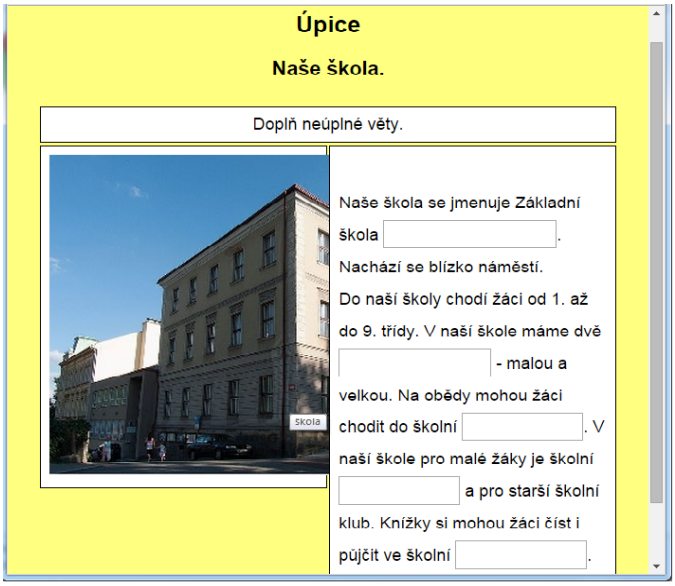

Fig. 2 Results of the research, class 3, subject Science

B. *Objective of Research Investigation*

The main objective of the research investigation is find out how pupils of the Elementary School in Upice are using information and communication technologies in their learning.

The research investigation helps to identify the socially disadvantaged pupils, whose do not have computer or internet connection at home and cannot perform e-learning exercises at home.

Since the school is obliged integrate the pupils from different socially disadvantaged environment and protect them, the solution of the situation is demonstrated in the paper too.

C. *Methodology of the Research Investigation*

The research investigation was created using non-standardized questionnaire, which covered the pupils from the second to fifth class.

The questionnaire was filled by 105 pupils.

D. *Results of Research Investigation*

Results of research investigation are shown in figures 3 – 9.

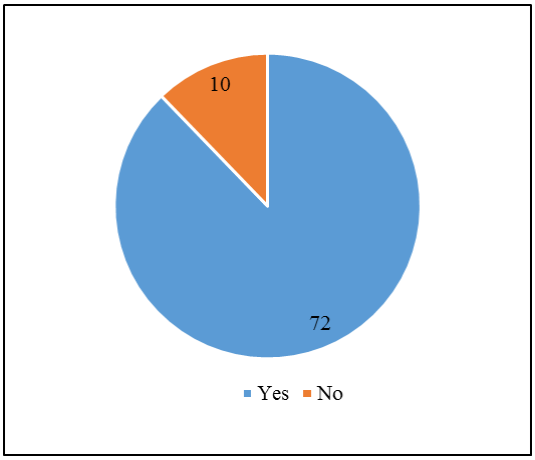

Fig. 3 Question 1 – Do you have a computer at home?

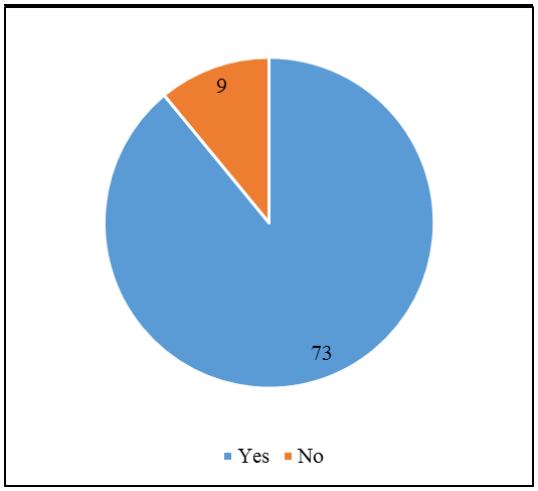

Fig. 4 Question 2 – Do you have internet connection at home?

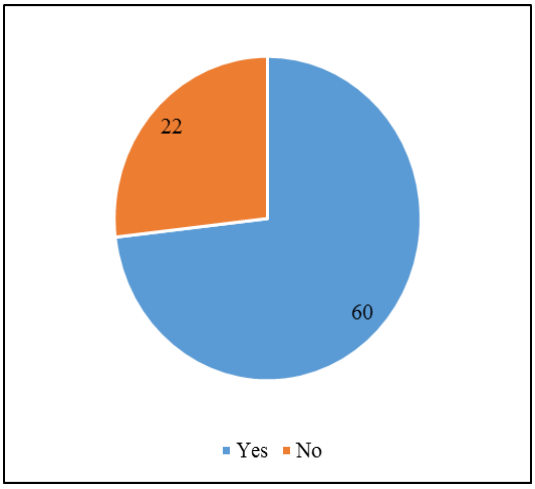

Fig. 7 Question 5 – Do you visit school websites?

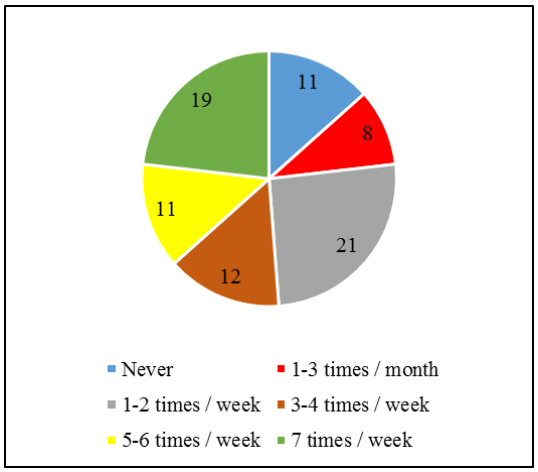

Fig. 5 Question 3 – How often do you work with PC?

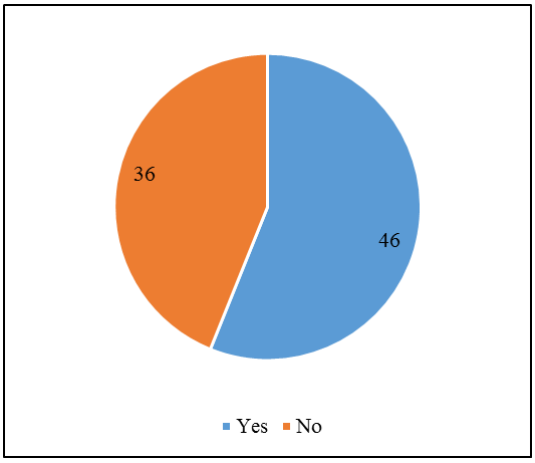

Fig. 8 Question 6 – Do you learn in school's Moodle?

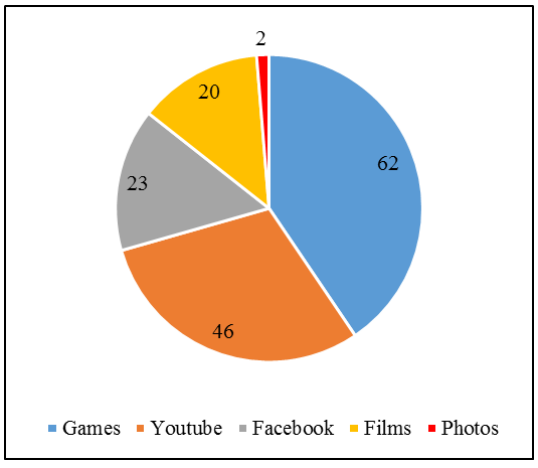

Fig. 6 Question 4 – What activities do you do on computer usually?

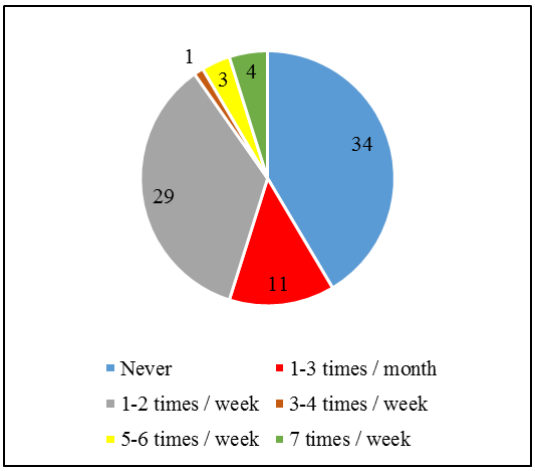

Fig. 9 Question 7 – How often do you learn via Moodle?

E. Discussion of the Results

The main result is that 12 % of the pupils have **no computer** at home. These pupils belongs between the socially disadvantaged pupils. The result corresponds to

percentage of the socially disadvantaged pupils in whole schools.

The interesting is comparing the results of question 1 and question 2. One pupil answer that they have no computer, but they have internet connection. The explanation of this discrepancy is that they are using internet in mobile phone.

The results of question 6 and 7 confirm our theory, that pupil at primary school has to be managed by their leader, teacher or parents. The parent's leadership is very often missing. E-learning task are more difficult than play computer games, watch films or listen Youtube – see comparison of results, questions 3 and 7.

V. Conclusion

The paper describes role and specifics of e-learning at primary school education. The attention is focused to socially disadvantaged pupils. The results of the research discover that 12 % of pupils of Primary school in Upice has no computer at home. Their possibilities of training via school e-learning system Moodle are limited.

Since the school is obliged integrate the pupils from different socially disadvantaged environment and protect them, there was build the ICT classroom for these pupils and school provides pedagogical supervision. The socially disadvantaged (not only) pupils use this benefit.

Acknowledgment

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The research on stress factors in athletes and the proposal of application for independent testing

Věra Strnadová, Petr Voborník and Kateřina Provazníková

***Abstract*—**The paper deals with stress factors in top-level athletes and in people doing a sport as a common leisure activity. The method of the research is a subjective questioning, statistical processing and eventually classifying respondents into the zones of stress potential with regard to frustration tolerance, handling stress and psychosomatic symptoms. The research has revealed that in the area of frustration tolerance half of the top-level sportsmen group range between the second and third zone of stress potential (18-29%), where the third stress zone is understood to be the optimal one. In the leisure sport activity group half of these people are also included in the second and third zones (18-41%). In terms of handling stress it has been found out that 68% of people from the top-level athletes group fall into the third stress zone and in the common population group 72% of its members again fall into the healthiest third zone. In the area of psychosomatic symptoms the group of top-level athletes show in the first place the feelings of tiredness and energy shortage (47%). Similarly in the group of recreational sportsmen the feelings of tiredness and energy shortage are also shown in the highest rate (37%). The electronic application for subjective questioning and the possibility of classification into stress potential zones was created on the address http://qol.alltest.eu/stress.

***Keywords*—**Anti-stress effects of sport, quality of life, frustration tolerance, handling stress, psychosomatic symptoms.

I. Introduction

An important element in reducing stress factors is physical fitness. People who regularly do *aerobic exercises*, that is any kind of endurance activity which increases heart rate and oxygen consumption – e.g. running, swimming, cycling or cross-country skiing – have significantly lower heart rate and blood pressure in a stress situation than other untrained people.

Physically fit individuals tend to fall ill as a result of stress events less often than people who are not in a good condition. In relation to these facts the programmes for coping with increased stress load are currently focused on *physical fitness*. The study on patients suffering from chronic chest pain has revealed that the combination of stress management techniques and regular exercise resulted in less frequent occurrence of angina pectoris than the actual stress management training. [1]

II. Theoretical basis

A. Anti-stress effects of sport

By its nature sport as a physical activity has *anti-stress effects*. Their physiological basis lies in the exertion character of sport activity. The result of GAS (General Adaptation Syndrome) is neurohumoral adaptation, i.e. increased readiness of an organism for washing out hormonal substances which primarily prepare the organism for muscle strain. This preparatory reaction of the organism probably evolutionarily developed in accordance with the instinctive reaction to a stressor represented by an animal fight or flight. In both cases there is a necessity of mobilization readiness and energy output which are ensured just by this neurohumoral response to stress. [2]

Health harmful consequences of stress consist in accumulation of unused metabolites of stress responses in the organism. In nature a stressed animal which is attacking or running away instinctively needs stress metabolites for muscle work. Modern humans usually do not accompany their social stress with increased physical activity, the metabolites stay in their blood and in the course of time they can contribute to a development of so called *lifestyle diseases* (hypertension, diabetes, cardiovascular disorders). Sport exertion after a hypokinetic stressful day can help by *consuming the accumulated metabolites in the organism* and thus act as health prevention of lifestyle diseases development. There is a practical psychological problem in the fact that the tiredness from a working day, though mental, has global effects and a person has to force himself/herself into an after-work sport activity more than into a morning, pre-work sport activity, which has rather warm-up character. Therefore after-work sport must have more enjoyable and attractive form. [3]

Anti-stress influence of sport consists in distracting a person from a serious existential work level and transferring him/her to an enjoyable level of play. This is a mechanism of *emotional retuning* with good psycho-hygienic effects. The experience of joyful absorption, so called *flow* has harmonizing effect and is

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an expression of quality of life improvement. The occupation and everyday duties lead to accumulation of tension, which is felt as worries. This unpleasant tension decreases in sport. We speak about the mechanism of *relaxation or taking our mind off things* – other emotional reactions overlay and relieve previous emotional tension and stress is reduced. [4]

In relation to anti-stress influence of sport the mechanism of *compensation* can be mentioned. It is balancing or substituting a certain activity. For example, a sedentary occupation in technical professions often leads to a psychological tension. It can be compensated by a sport activity that has within a mental hygiene anti-stress and positive effects. *The effect of active relaxation* is confirmed. Thus a physical activity does not intensify mental tiredness but it tends to reduce it.

There is a special importance of sport as a compensation for school children, not only in biological sense but also psychological and social. Sufficient physical activity is important for the child's growth as early as in the pre-school age. "Rollicking" often underestimated by adults has clearly positive *psychosocial and psycho-hygienic importance*. In addition to stimuli for physical development, it is also a source of compensation emotiveness. Current children are often deprived of this active motion component of emotiveness development and they seek compensation in imaginary and virtual emotiveness. Unfortunately, they sometimes also provoke this emotiveness chemically, which leads to a drug addiction. Sport as a substitution of emotional vacuum – boredom – has a primary importance for young people.

Top sport has a rather serious nature of work activity under a contract. It can be a source of overtraining and then it is necessary to proceed to a specific measure within the psychological preparation which is based on routine measures, the reduction of intensity and monotony of training, the increase of preparation diversity. Primarily regeneration and relaxation are necessary. *Relaxation and compensation exercises*, alternatively *compensation sports* belong to this area.

Sports preparation can be understood as increasing resistance to specific loads including frustration tolerance. A sports approach means perceiving even difficult life circumstances with grace and a decisive attitude that these situations need to be managed and endured. The general basis of resistance is *human fitness*. [3]

B. Sport and quality of life

The quality of life is a multi-dimensional term, World Health Organization (WHOQOL Group, 1998) determined six quality of life areas which are important both for clinical and non-clinical population: *physical health, mental condition, amount of independence, social relationships, environment and spirituality, religious belief and personal confidence.* [5]

Sport represents an enjoyable physical activity and has considerable *euphorigenic potencial*. Already in ancient times performance and its improvement were emphasized, which still applies to top sport. However, in recreational sport nowadays there is a shift from the performance concept towards the enjoyment concept, the change *from fitness to wellness*. The fitness concept stressed as a main goal primarily physical condition and its biological parameters. It was to be achieved through exercises, frequently of monotonous nature. Now the psychological circumstances of exercises and overall personal *well-being* are more prioritized. Sports with a varied content, rich emotional dynamics, often associated with a risk factor and technical equipment control are getting to the forefront of interest. *Adrenalin* enjoyment sports are beginning to be increasingly discussed.

In the last decades the subject of *quality of life* [1] has been following the philosophical issues of human happiness and meaning of life. As crucial for the quality of life are usually considered: somatic condition and motoric functions (self-sufficiency), mental normality, survival attributes (abilities and habits), healthy lifestyle, developmental care (preferably functional family and anchoring in relationships), adequate material conditions and vitalizing environment. These are followed by the diversity of lifestyles and interests. Sport is one of the manifestations of quality of life and the level of life standard. At the same time it is the expression of *internal vitality and joy*. A person doing a sport has extra physical and mental energy in comparison with common population. The *somatic* area is modified by sport to a healthy level – physical activity is natural strengthening of muscles, bones, cardiovascular and respiratory systems. The benefit is also apparent in the area of appearance, aesthetics and thus a healthy self-esteem is increased. The *mental* area is affected by sport primarily in the field of amusement which supports a positive mind set. [6]

In spite of the competitive environment and certain egoism of some individuals, sport is the opportunity for regular interpersonal communication, filling *affiliative needs*, it enables rich group dynamics in a team. Thus the social function of sport can significantly contribute to the quality of life improvement. [7] When performing sport activities a modern man/woman has the possibility of close contact with natural forces (sun, water, wind, snow, weather changes, mountains, rocks) and in this way also the *environmental dimension* of life is developed, which is very important for current predominantly technical civilization, mainly from the point of view of regular mental hygiene.

C. Research issues

Mental and physical heath

The belief of connection between physical exercise and mental health is known from the history of ancient times. It is reflected in the message *mens sana in corpore sano – there is a healthy mind in a healthy body.* The science started to be interested in this relation much later and it has not brought a closer understanding of the relation between physical exercise and mental health until the recent years [8], [9]. In 2004 the representative of the British Ministry of Health came up with the thought that *it is necessary to think about physical activities not only with respect to their therapeutic effect on mental illnesses but also due to their impact on mental health.* (Ministry of Health, DH, 2004: 58-59).

With the growth of intensity of physical activity the positive mood decreases and the negative mood increases even though the reaction to the load is not the same with all people. After

finishing exercise the *back-reflection effect* occurs during which the mood improves. Although further research needs to be conducted, it is possible to say that people doing regular exercises are less likely to be depressed. Moreover, exercises are recommended as a suitable therapy of mild to medium depression, in combination with other interventions (pharmacotherapy or psychotherapy) and under the control of a qualified mental health specialist. Research confirms the British Ministry of Health statement that active people have fewer symptoms of anxiety than inactive people. After all, physical activity significantly affects people with bad physical condition and high level of anxiety. It turned out that exercise is a feasible intervention for cancer patients, even those who are undergoing chemotherapy and suffering from an acute stage of the disease – here a number of benefits were recorded, such as the quality of life improvement and a depression decline. Qualitative studies revealed the importance of group cohesion and the identity within the group doing exercises as well as the fact that exercise helps patients change self-reflection and set goals for their physical functioning in everyday life. Teenage and adult diabetics that are physically active show higher levels of quality of life than those who are not engaged in any physical activity. Exercise also helps patients with heart diseases improve their mental health. Qualitative research has shown that as in the case of patients suffering from various immobilizing chronic conditions, exercise also helps cardiacs regain confidence in themselves which might have been lost as a result of the disease. [10]

Frustration tolerance

Frustration is defined as a state threatening the integrity of organism when a person must engage all abilities to protect himself/herself. The effort based on the natural necessity of satisfying a person's needs is blocked. In a narrower sense, frustration is the result of dissatisfying biologically primary, instinctive claims or the failure in achieving a goal, which is accompanied by feelings of destruction. As one of the determinants of human behaviour frustration is sometimes incorrectly mistaken for deprivation or the phenomenon of unfinished activity, which has similar symptoms as frustration.

Manifestations of frustration fall into the area of perception and behaviour disorders and often acquire the character of neuro vegetative or psychosomatic symptoms. They depend not only on the intensity and length of duration of frustration but also on a *person's resistance to frustration – so called frustration tolerance*.

The ability of frustration tolerance is connected with inborn properties of an individual (temperament, emotional stability versus instability) and further with influences of social environment (family influence and acquired experience). [11]

Although frustration can cause aggression, anxiety as well as neurovegetative disorders [4], it is an inseparable part of human life. Gradual and bearable frustration loading of organism even leads to increased psycho-physiological resistance of an individual.

Dealing with stress

Stress is generally understood as exertion, load, as an adaptation stimulus, as a demanding situation that must be managed by an athlete – physical load (training) and mental load (competition). The following degrees of load can be distinguished: extreme, excess, boundary, increased, adequate, optimal, negligible. In fact, load is any energetic demand on the organism. [12] There is a known concept of organism as a balanced system (homeostasis) which is deflected by a load and tends to regain the balance again. According to the adaptation theory [13] every other analogous load causes a smaller deflection, the organism gradually adapts to loads. The essence of training programmes for athletes is based on this fact.

In the 20th century the *theory of stress* brought a new approach to the issue of load. Its author is Hans Selye [2] who found out through experiments that all loading stimuli (stressors) from a certain intensity lead to triggering a unspecific reaction in the organism (i.e. always the same regardless of the initiator of stress), called general adaptation syndrome (GAS). It progresses in three phases: 1st – alarm (alarm reaction), typical for mobilization, inefficiency, 2nd – resistance, defence by drawing from energy storage, 3rd – exhaustion, spreading the reaction onto the whole organism, collapse. The criterion of GAS progress is production of hormones preparing the organism for physical exertion.

In fact stress is intensive emotion with all the activating consequences. The asthenic emotion is called distress, the sthenic emotion is eustress. Depending on the place affected by a stressor we speak about physical stress when it affects periphery (most often pain), and mental stress which is cerebral, brain, mental. For example, the ankle distortion means the physical stress for an athlete and the disqualification from the race is the mental stress. The response of the organism to both stress types is the same, unspecific, global. It differs only in intensity. The main criterion is the amount and kind of hormones identifiable in blood, saliva etc. (corticoids, adrenalin, noradrenalin, cortisol, hydrocortisol). [14]

The most frequent stressors in sport are expectation based tension (see pre-start condition, fear when taking a risk), demands of the programme, defeat, injury, loss of physical condition or disqualification.

Intensive and long-term distresses mean quality of life worsening and they can have an unpleasant impact on health – today this issue is dealt with by a modern field of *psychosomatic medicine*.

Psychosomatic symptoms

Psychosomatic symptoms in a stress situation during sport activities can be classified into three groups:

Organic – palpitation (the heart beat is too strong, fast and irregular in relation to the current exertion), losing breath and sweating without an exertion cause, chest pain, cramps and pain in the bottom part of stomach, metabolic disorders – loss of appetite, enormous muscle tension, especially in the area of cervical and lumbar spine, migraines that spread from the neck to the top of the head and forehead.

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Emotional – sharp mood fluctuation, hypochondria, dreaming, autistic thinking, lack of concentration, neurotic symptoms, inadequate tiredness, fear from social contact, loss of empathy, impulsiveness.

Behavioural – decline in performance, loss of physical condition, worsened quality of training preparation, taking anaesthetics, disorders of life rhythm (insufficient sleep, chronic tiredness), excesses in behaviour, tendency towards isolation. [6]

As it can be concluded from the previous enumeration, the difficulty in diagnostics results from variety and also contradiction of symptoms which are sovereignly individual. Unlike a physical illness, which manifests itself e.g. by a fever, the situation in psychosomatic symptoms is unclear and the affected person often refuses to admit the seriousness of his/her condition. A frequent danger in sport is overtraining, which has stress effects. Psychological dangerousness lays in the fact that it is the result of good intentions, increased motivation and big effort to assert oneself. The cause are big training dozes and underestimating the regeneration of performance disposition. A lot of coaches of top-level athletes still see regeneration as a luxury. It results in protracted stress conditions. Therefore it is absolutely essential not to underestimate psychosomatic symptoms in a stress situation, regard them as a warning signal and adopt routine measures to eliminate them.

III. Methodology

A. Method of research and a group of respondents

The method of a questionnaire survey was used in the research on the basis of subjective evaluation according to the questionnaire by Micková. [15], [16]

The research was focused on finding out stress factors in three sectors:

1) frustration tolerance – the form of YES/NO questions was used here
2) handling stress , i.e. behaviour in a stress situation – the form of questioning by means of assessing scale was used and two aspects of the research were followed here – the amount of emotional reaction to stress and the amount of using malcoping (harming) strategies
3) psychosomatic symptoms - the form of questioning by means of assessing scale was used here

B. Group of respondents

50 athletes in total were included in the research set. Most of the athletes were secondary school or university students.

Top-level athletes – cross-country skiers, men; n = 25; age 19 – 25 years, average 21 years

The athletes were selected into this set according to the criterion of sport performance efficiency. At the time of the survey they belonged to the 1st class of performance efficiency and they regularly took part in the races of Czech Cup or a higher category (at least 5 races). At the same time 15 athletes from this set were or still are the members of the representation team. However this was not the condition for inclusion into the research. For none of the athletes sport was the source of livelihood. With regard to various training methods it can be assumed that at the time of racing period, during which the research was carried out, the average weekly sport activity occupied between 10 and 15 hours. It should be noted that the athletes of this group belonged mostly to the Czech performance top level.

Common population doing sport as a leisure activity - men; n = 25; age 21 – 25 years, average 22.5 years

The athletes selected into this set do a sport regularly in various sport activities, maximum of 8 hours a week (the average of a weekly sport activity was 5 hours in this set), at the same time they were not included in any representation team and currently did not have their performance efficiency certified in any sport. On the basis of the collected data it can be said that this group represents common population doing sport as a leisure activity which mostly does not interfere with the life of the athletes.

C. Procedure of conducting the research

Modern technologies were used for doing the research. It was carried out with the help of the company Google Inc., thanks to which the questionnaire was converted into electronic form and the company Facebook Inc. enabled direct communication with the respondents – each of them was approached individually on the basis of pre-prepared list of names. Thus obtaining proper answers only from the selected people was guaranteed. The research was conducted and gradually statistically processed in the years 2013-2014. 88 questionnaires in total were sent off, out of these 64 (73%) completed questionnaires were used.

Set 1 – Top-level athletes – cross-country skiers: Sent off 40 questionnaires, returned completed 30 (75%).

Set 2 – Common population doing sport as a leisure activity: Sent off 48 questionnaires, returned completed 34 (71%).

Consequently the number of respondents was reduced to 50 (25 in each of the two sets) due to meeting assigned criteria.

Individual components of the questionnaire were evaluated in points. The statistical significance of differences was owing to a small number of subsets (n=25) calculated by means of Mann-Whiteny U-test. For statistical processing a complement for Microsoft Excel, Trial version of the program SigmaXL was used.

D. Characteristics of stress potential zones

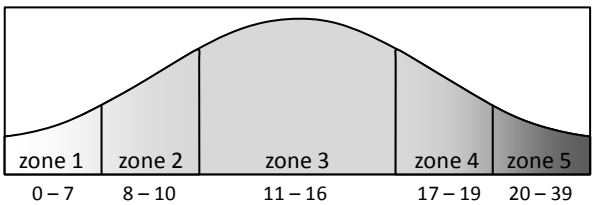


Fig. 1 – Zones of stress potential

Zone 1: The stress level is *very low*. The personality needs to be encouraged and motivated in his/her life so that they could use their abilities better. Here it is necessary to realize the existence of so called positive stress – eustress which enables

to manage the demands of modern life, strengthens and develops a human personality.

Zone 2: The stress level is *low*. It can be connected with introvert orientation of the personality and a stabilized way of life progressing without changes and excitement. The personality is in a rather balanced life situation and does not have to be afraid of stress-related diseases. However he/she does not use all their abilities. It is necessary to place bigger demands on themselves, set more ambitious goals and overcome passivity.

Zone 3: The stress level is *average*. It is an *optimal zone* of stress potential. Most of the population find themselves in this zone. In the personality's life the periods of increased load alternate with the periods of peace and relaxation. For achieving goals the certain stress level is necessary but it must not be permanent and long-term. Increased load-peaceful condition rhythm enables a person to live a balanced and satisfying life.

Zone 4: The stress level is *high* and it means a warning signal. The personality should explore individual areas of his/her life and consequently decide which problems need a quick solution. This way mental problems as well as threatening physical problems can be turned away. It is time to change the lifestyle and prevent complications. It is necessary to seek advice from close friends and relatives or ask for a professional help. It is also advisable to get to know strategies of coping with excessive stress.

Zone 5: The stress level is *dangerously high.* The personality is currently experiencing abnormally high stress. He/she has serious problems requiring an urgent solution. The personality is no longer capable of helping himself/herself a so it is necessary to seek professional help of a psychologist or a psychiatrist.

IV. Results

A. Zones of stress potential

The limit values of individual stress potential zones were converted into their percentage in the scale 0 (0%) up to 39 (100%; see Fig. 2). Also the point results of each respondent from individual questionnaires were converted into percentage.

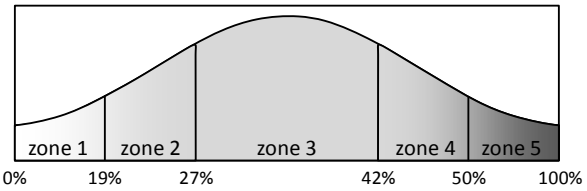
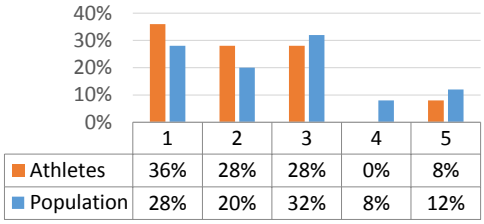


Fig. 2 – Zones of stress potential converted into percentage

B. Frustration tolerance

First of all numbers of inclusion in stress potential zones were compared for frustration tolerance of the group of top-level athletes – cross-country skiers and of common population sportsmen (see Fig. 3).



	1	2	3	4	5
Athletes	36%	28%	28%	0%	8%
Population	28%	20%	32%	8%	12%

Fig. 3 – Comparison of numbers of inclusion in zones for frustration tolerance of groups of top-level athletes and common population sportsmen

Half of the group of **athletes** (approx. 12 people) range on the border of zones 2 and 3 (18-29%). Other members (other approx. 12 people) diverge from the average of the group by their inclusion in zones – they are more divergent.

Half of the **population** group (approx. 12 people) is included in zones 2 and 3 (18-41%). The group does not contain too different/divergent individuals. Other members (approx. Other 12 people) do not diverge from the group average by their inclusion in zones as in the athletes group. Further a boxplot representation of the amount of frustration tolerance in athletes and population groups was created for a more detailed comparison. (Fig. 4)

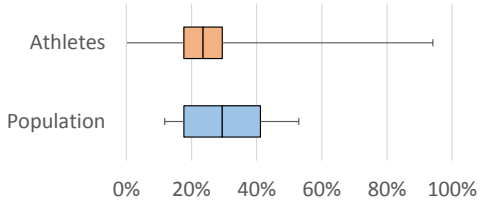
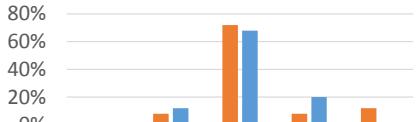


Fig. 4 – Boxplot representation of amount of frustration tolerance in top-level athletes and common population sportsmen

C. Handling stress

First of all we compared numbers of inclusions in zones for optimal handling stress of the top-level athletes group and the group of common population sportsmen (Fig. 5) a then for a more detailed comparison a boxplot representation of the amount of stress handling by top-level athletes and common population sportsmen was created. (Fig. 6)



	1	2	3	4	5
Athletes	0%	8%	72%	8%	12%
Population	0%	12%	68%	20%	0%

Fig. 5 – Comparison of numbers of zone inclusions for optimal handling stress by groups of top-level athletes and common population sportsmen

68% of group members of **athletes** fall into stress zone 3 which is the healthiest one with respect to handling stress. 72% of group members of **population** again fall into stress zone 3 which is the healthiest one with respect to handling stress.

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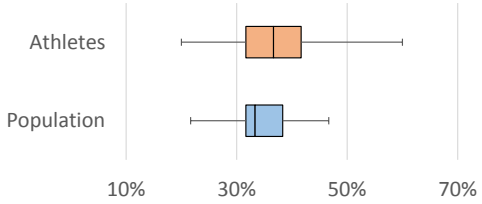

Fig. 6 – Boxplot representation of amount of stress handling by top-level athletes and common population sportsmen

D. Psychosomatic symptoms

Further the research focused on the comparison of the numbers of inclusions in stress potential zones for psychosomatic symptoms in the groups of top-level athletes – cross-country skiers and common population sportsmen. (Fig. 7)

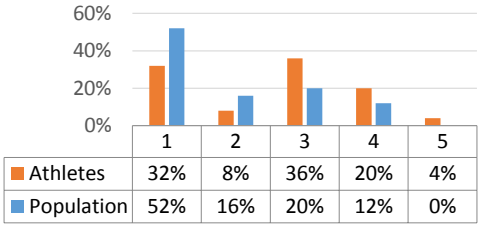

Fig. 7 – Comparison of numbers of inclusions in zones for psychosomatic symptoms in groups of top-level athletes and common population sportsmen

Approximately the same number – one third – of group members of **athletes** occur both in stress zone 1 and zone 3. More than a half of group members of **population** are from the point of view of psychosomatic symptoms included in stress zone 1.

Consequently, for a more detailed comparison a boxplot representation of amount of psychosomatic symptoms occurrence in top-level athletes and common population sportsmen was created. (Fig. 8)

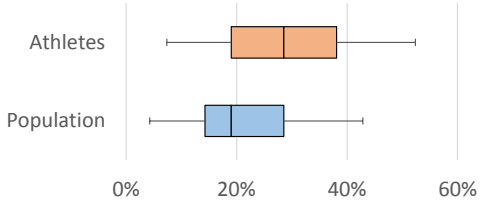

Fig. 8 – Boxplot representation of amount of psychosomatic symptoms occurrence in top-level athletes and common population sportsmen

Further we focused on the comparison of amount of individual psychosomatic symptoms in the groups of top-level athletes and common population sportsmen (Fig. 9)

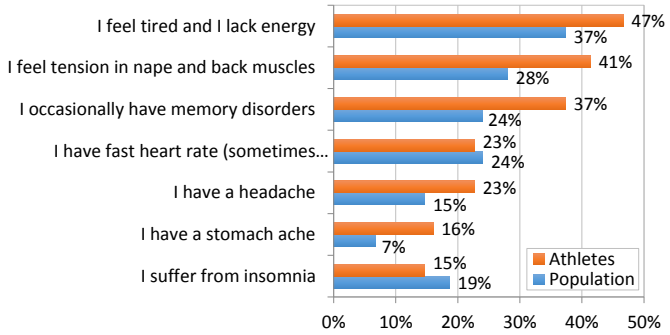

Fig. 9 – Comparison of amount of individual psychosomatic symptoms in groups of top-level athletes and common population sportsmen

Consequently, the number of psychosomatic symptoms was found out in the groups of top-level athletes and common population sportsmen. (Tab. I, Fig. 10)

Table I – Number of psychosomatic symptoms in groups of top-level athletes and common population sportsmen

	Population	
1	I feel tired and I lack energy	37%
2	I feel tension in nape and back muscles	28%
3	I have fast heart rate (sometimes connected with excessive heart beat)	24%
4	I occasionally have memory disorders	24%
5	I suffer from insomnia	19%
6	I have a headache	15%
7	I have a stomach ache	7%
	Athletes	
1	I feel tired and I lack energy	47%
2	I feel tension in nape and back muscles	41%
3	I occasionally have memory disorders	37%
4	I have a headache	23%
5	I have fast heart rate (sometimes connected with excessive heart beat)	23%
6	I have a stomach ache	16%
7	I suffer from insomnia	15%

From the above mentioned symptoms the group of top-level athletes show feelings of tiredness and lack of energy most often (47%). In the group of common population sportsmen the situation is similar, the feelings of tiredness and lack of energy are shown also in the highest rate (37%).

The second position in the table is held by feelings of tension in nape and back muscles in the group of athletes (41%) and also in the group of common population sportsmen (28%).

In the third place top-level athletes show memory disorders (37%) and common population sportsmen fast heart rate sometimes connected with excessive heart beat (24%).

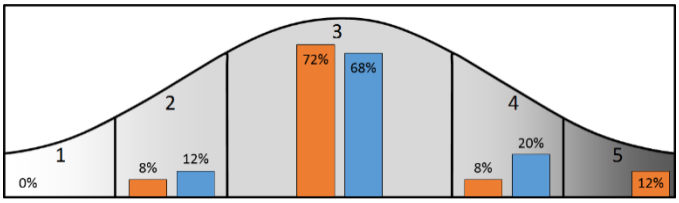

Fig. 10 – Number of psychosomatic symptoms in groups of top-level athletes and common population sportsmen

V. Application for Independent Testing

The data for this research was obtained by individual respondents filling in printed paper questionnaires. That brought a few difficulties such as the distribution of questionnaires, time and space limitation for filling them in, insufficient anonymity, collection of completed questionnaires, conversion of data into a digital form and its statistical processing.

In order to eliminate these problems in future or at least reduce them considerably, an on-line application was created which facilitates the whole process significantly. Users then do not fill the data in the paper forms but on-line in web forms, which is more preferred [17]. Thanks to that it is also possible to reach far larger sample of respondents because apart from those directly involved in the project other „anonymous" volunteers can participate in the research. All the recorded data is available immediately after it is entered and thus it can be automatically continuously evaluated.

This application is freely available on the address http://qol.alltest.eu/stress. Here we can find a signpost to all three questionnaires relating to stress: Frustration tolerance, handling stress and Symptoms of stress. The first one includes yes/no question type and for better user comfort the answer is selected only by clicking (with a mouse or a finger on the touch device) on the icon which gradually switches over from the original state of a question mark (answer not selected) to the option yes (for the approval of a statement on a given line) and consequently no (for the disapproval of the appropriate statement; see Fig. 11)

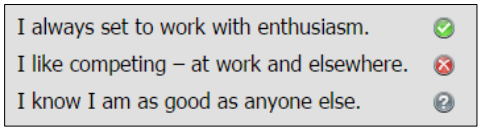

Fig. 11 – Illustration of filling answers in Frustration tolerance questionnaire

In other two forms answers are given on a scale 0-3, which was simplified here by the selection of number of stars. It expresses a degree of agreement with a given item (1 star – total disagreement, 4 stars – total agreement; see Fig. 12)

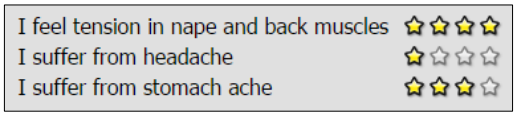

Fig. 12 – Illustration of filling answers in questionnaire Symptoms of stress

After filling in all the items in the questionnaire the user clicks on the push button *Evaluate* and immediately a graphic evaluation is displayed and in percentage put in the appropriate stress zone (see Fig. 13).

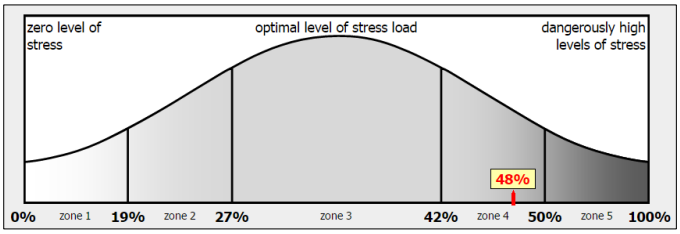

Fig. 13 – Illustration of questionnaire evaluation – putting user in stress zone

A constituent part of the questionnaire is also the data for categorization of respondents (see Fig. 14): year of birth (for putting in the age group), sex, occupation (student of secondary school, university student, worker, senior) and determination of intensity of doing sport activities (regularly, sometimes, never). Name and e-mail are optional but in case of filling them in they can serve for the evaluation of the development of individual stress level in time.

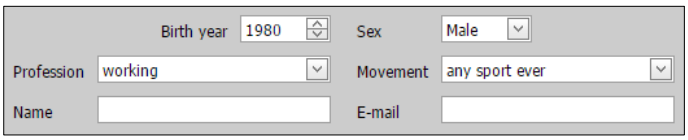

Fig. 14 – Illustration of filling in categorization data about user

The complete data of the questionnaire is during the evaluation simultaneously saved in a database on the server for later anonymous, collective, statistical processing. This gives us a possibility to continue in the research all the time with the growing sample of respondents and thus with more relevant results.

For the future we also plan to extend the evaluation of each questionnaire by the comparison of individual figures with average results of the other respondents. This way users will also get information on what their figures are in relation to the whole population, the same age group, the same sex etc.

VI. Conclusion

Physical activities can represent an effective prevention of the development of both physical and mental illnesses.

Our research was comparing two groups, the group of top-level athletes and the group of common population doing sport on a recreational basis. In the area of *frustration tolerance* it has been found out that a half of the top-level athletes group (approx. 12 people) ranges on the border of the second and third zone of stress potential (18-29%), where the third zone is understood as an optimal zone, the healthiest one. The other members (the other 12 people) diverge more from the average of the group as far as the inclusion in the zones is concerned. They are more divergent. A half of the common population group (approx. 12 people) is included in the second and third zone (18-41%). The individuals in this group are not as different as in other group. The other members (the other 12 people) do not diverge from the group average as much as top-level athletes do when the inclusion in the zones is concerned.

In the area of *handling stress* it was revealed that 68% of members of the top-level athletes group fall into the 3rd stress

zone, which is the healthiest one concerning handling stress. In the population group 72% of its members fall again into the healthiest third stress zone.

In the area of *psychosomatic symptoms* the group of top-level athletes show in the first place feelings of tiredness and energy shortage (47%). The similar situation is in the group of common population doing sport for pleasure where the feelings of tiredness and energy shortage are also shown in the highest rate (37%). The second position in the table is held by the feelings of tension in nape and back muscles in the athletes group (41%) and also in the common population group (28%). In the third place the top-level athletes show memory disorders (37%) and the common population sportsmen state fast heart rate sometimes connected with excessive heart beat (24%).

On the address http://qol.alltest.eu/stress the original electronic application was created in the Czech and English version thanks to which it is possible to reach much larger sample of respondents because apart from those directly involved in the project other „anonymous“ volunteers can participate in the research. All the recorded data is available immediately after it is entered and thus it can be automatically continuously evaluated.

The improvement of quality of life, life satisfaction and self-perception belong to the positive effects of physical activities on mental health. It is therefore important for current teachers, doctors and psychologists to include exercise activities in the programmes of prevention and health consolidation. Generally it seems that regular physical exercises of medium intensity, which are chosen by people themselves and adjusted to their physical condition, are beneficial to their mental health. It is necessary to respect the level of condition and skills of athletes. *Aerobic activities* are preferred to power activities. Nowadays medium intensity of exercise, minimum of thirty minutes, five days a week is recommended. The exercise is connected with physical health but it is apparently equally suitable for mental health.

Physical activities, exercise and sport can thus represent an effective *prevention* of physical and mental illness development. However the fear of self-presentation may be one of the factors which prevent people from doing exercises and thus make them deprived of these preventive effects. When introducing exercise interventions specialists must take into consideration *individual routine of exercise* in order to ensure the possibility of achieving optimal benefits for a particular individual.

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Maximizing of reusability of test questions by optimizing their randomly generated elements through characteristic text strings

Petr Voborník

***Abstract*—**The article illustrates the unique coding method for describing the properties of different objects of the real and virtual world. This method offers the ability to summarize the basic description of the object in a very short text string comprised only of the basic characters of the alphabet and numbers. These strings describing specific objects can be quickly and easily compared with each other and determine total and partial (differences in specific properties) differences of these objects. This enables us to easily identify the object that is most similar to or most dissimilar from the pattern object. The whole principle of characteristic text strings is subsequently demonstrated on generating random elements in the test questions. A complicated structure of each randomly generated question can be described by the short string thanks to this principle. On the basis of this, such procedures for repeatedly used questions can be suggested that ensure generating of the most different version from versions used previously. The applicability of each of the test questions is thus maximized. Several other areas are proposed in conclusion, where a similar principle can also be applied preferably.

***Keywords*—**Test questions, random elements, Universal Testing Environment, characteristic text strings.

I. Introduction

ONLINE testing system, the *Universal Testing Environment*, allows creating graphically rich, interactive and multimedia enhanced questions of all sorts [1]. In order really not to limit the creative potential of the authors of the test questions, a respective language, QML[1] (based on XML and XAML [2]), was created for defining the structure of the questions. In addition to text, the QML allows the use of vector and bitmap graphics of any kind, animations, and various types of random values at any part of the question. This is achieved by the use of random elements [3] for selecting version of the question, generating random numbers and characters, selecting the text string from multiple variants, and mixing of inner elements structure of the questions.

Like with the selection of questions used in a test [4], it is desirable in this case that the internal mixing is not always entirely random, but it rather provides the opportunity to generate the greatest possible variation of each question that is repeatedly used with the same tested user. Thanks to this, the selection process of random elements in each question should prefer those variations, or their combinations, which would differ the most from the variations used previously.

Determining the degree of difference between individual combinations of random elements should not be computationally complex (e.g. such as multi-distance spatial cluster analysis, see [5]), it should be easily storable in a database, and the structure of such record should be extensible for possible future development of the question.

II. Principle of Comparison of Strings

Firstly, the selected method will be explained using an easily presentable example: comparing of the persons. Table I contains five human properties which will be compared for each person and a description of their data types and ranges (metadata).

Table I – Metadata of persons' properties for comparison

Property	Index	Type	Min	Max	Range	Units	Weight
Height	1	cardinal	40	220	181	cm	1.5
Weight	2	cardinal	1	256	256	kg	0.9
Age	3	cardinal	0	127	128	years	1.0
Sex	4	nominal	1	2	2	-	10.0
Color of eyes	5	nominal	1	6	6	-	2.0

The *range* parameter determines how many possible values the property can take on. The process of its calculation is shown in Equation 1.

$$range_i = max_i - min_i + 1 \quad (1)$$

Properties are differentiated into two main types: *cardinal* and *nominal*. For the cardinal type, differences between values of individual subjects can be directly and precisely calculated, whereas for the nominal values it can only be determined whether the values are identical or not [6]. The calculation of the difference of these two models will therefore vary.

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[1] QML - Questions Markup Language [3]

A. Cardinal values

Each compared subject can essentially be expressed as a vector (e.g. $\vec{a}$ or $\vec{b}$) comprised of the values of individual properties. If each of the cardinal properties had the same weight (e.g. if the difference of one year of age was as significant for the comparison as the difference of 1 cm of height or 1 kg of weight), the difference is in this case formed by a scalar product of a unit vector and a vector composed of the absolute differences of the individual components of the vectors $\vec{a}$ and $\vec{b}$ (see Equation 2).

$$\begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix} \begin{matrix} is \\ different \\ from \end{matrix} \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = \begin{pmatrix} |a_1 - b_1| \\ |a_2 - b_2| \\ \vdots \\ |a_n - b_n| \end{pmatrix} \times \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix} \quad (2)$$

Calculating differences of cardinal properties for entities A and B (Equation 2) can also be expressed using the sum of absolute values of differences of individual properties as shown in the Equation 3.

$$\sum_{i=1}^{n} |a_i - b_i| \quad (3)$$

If differences for each property had a different impact on the overall assessment of the overall similarity of two entities, their weights, which are part of the metadata, can then be taken into account in the calculation ($\vec{v}$, see last column in Table I). Calculation of differences of the cardinal properties of entities A and B with the addition of weights is then shown in Equation 4[2].

$$R_{car.} = \sum_{i=1}^{n} (|a_i - b_i| \cdot v_i) \quad (4)$$

B. Nominal values

For nominal values, although these categories are identified by numbers (for coding), it cannot be determined how much they differ, but only if they are identical or not. If both values are equal, the result is 0, if they are different the result is 1. In this case, either the comparison operator (`if`) can be used for both nominal values, or the *sgn*[3] function to the absolute value of their difference can be applied (see Equation 5). The degree of influence of both types of values on the total difference can be determined by setting the appropriate weight.

$$R_{nom.} = \sum_{i=1}^{m} (sgn|a_i - b_i| \cdot v_i) \quad (5)$$

C. Total difference

The total difference is made up of the sum of the differences of cardinal and nominal values (see Equation 6).

$$R = R_{car.} + R_{nom.} \quad (6)$$

The procedure for particular example of a comparison of two persons is shown in Table II. Differences for individual types of values are calculated with the above equations that are selected according to the types of values (see col. *Type* in Table I).

Table II – Sample of procedure for calculating the difference between persons A and B

Property	Person A	Person B	Difference	Weight	Weighted difference
Height	175	165	10	1.5	15.0
Weight	85	60	25	0.9	22.5
Age	35	25	10	1.0	10.0
Sex	2	1	1	10.0	10.0
Color of eyes	5	1	1	2.0	2.0
Total			**47**		**59.5**

The resulting difference of persons A and B has a value of 59.5. If we considered an extra person C with the same values in all properties as with person B, with the only difference that its height would be 166 cm, then the difference between person A and C would have a value of 58. It follows that the person C would be more similar to person A than to person B. This way, the person that is most similar to or most dissimilar from the pattern[4] person A (from aspect of compared properties) can be found in an arbitrarily large database of people, and the number of comparisons would only be equal to the number of people in the database.

III. Coding

Another requirement to the system of comparison was the ability to easily store values of compared properties in a database. Each value is usually stored atomically in its own field (column of the database table) in a database of persons [7]. In such a database each column must be processes individually, but the necessary calculations can be performed even within the SQL query. For more complex structures, such as the record of internal mixing of the questions, data fields cannot be prepared in advance to effectively cover atomically all the possible combinations. The questions may contain an unlimited number of such combinations. For this reason, only one field was allocated to store combinations of random values.

To store multiple values in a single item, it is necessary to encode them. It is possible to use e.g. the *blob* data type enabling the record of text or binary data of unlimited length,

[2] vector of weights would then replace the unit vector in a vector terms (see Equation 2)

[3] *sgn* function leaves only the input value of 0, all other (positive) values are converted to 1

[4] *pattern* is a term for the entity which other entities are compared with [11]

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or a limited *varchar*[5]. In such items, text strings in a given coding can be stored. Due to the limitation of the symbols for printed form, only 6 bits of each character of a string would be used to encode values, i.e. the range of 64 (2^6) possible characters. With a binary blob it would then be possible to use the whole range of a byte (2^8 = 256 characters) for individual characters.

Characters for encoding 6-bit values can be chosen arbitrarily, but in general they should be selected from between the 32nd and 126th character of the ASCII table, because these are all viewable in printed form and they are not a subject of the national coding. This eliminates any problems with the encoding of character set, without any further problems when sending it via URL parameter or in a XML file. The string is easily readable by humans and it is also capable of being written in a non-digitized (analog) form.

Selection of characters for the following examples was inspired by the Base64 format [8]. Because the system conversion methods could not be used for this purpose, their order and additional characters were more appropriately adjusted (see **Chyba! Nenalezen zdroj odkazů.**).

Table III – The code table for conversion between values (0-63) and characters selected for encoding

0	a	8	i	16	q	24	y	32	A	40	I	48	Q	56	Y
1	b	9	j	17	r	25	z	33	B	41	J	49	R	57	Z
2	c	10	k	18	s	26	0	34	C	42	K	50	S	58	6
3	d	11	l	19	t	27	1	35	D	43	L	51	T	59	7
4	e	12	m	20	u	28	2	36	E	44	M	52	U	60	8
5	f	13	n	21	v	29	3	37	F	45	N	53	V	61	9
6	g	14	o	22	w	30	4	38	G	46	O	54	W	62	-
7	h	15	p	23	x	31	5	39	H	47	P	55	X	63	_

Characters + and / used in the Base64 (see [9]) were replaced by others, because these are subject of coding when it is transferred as the URL parameter. The proposed arrangement of characters is partly legible for humans, because lowercase letters and numbers from 0 to 5 form the first half of the table and the uppercase letters, remaining numbers, and other characters are located in the second half. With a good knowledge of the alphabet, a more precise value can be estimated intuitively out of each character.

Another difference from Base64 is the overall approach towards coding. Base64 losslessly encodes arbitrarily large value to the required number of characters (see the example in Table IV).

Table IV – Process of character encoding from plain "yes" to the Base64 "eWVz"

Data (text)	y								e								s							
ASCII code	121								101								115							
Bit pattern	0	1	1	1	1	0	0	1	0	1	1	0	0	1	0	1	0	1	1	1	0	0	1	1
6-bit number	30				22				21				51			
Base64	e				W				V				z			

In contrast, the proposed method is based on the premise, that the value of each property will be stored as just a one character, i.e. the encoded value will be transferred to the range of 0-63. Larger values will be stored in a lossy format and smaller ones will not use the full range of the character, but thanks to this approach individual properties can be directly individually compared.

For conversion of property values (a_i) to the range of 0-63, each value is first normalized to the range of $\langle 0, 1\rangle$ (n_i, see Equation 7) and then it is multiplied by the maximum value of this range (63). The result rounded to the nearest integer (in this step there is a loss of accuracy) is converted to a character according to **Chyba! Nenalezen zdroj odkazů.**.

$$n_i = \frac{a_i - min_i}{rozsah_i - 1} = \frac{a_i - min_i}{max_i - min_i} \tag{7}$$

This procedure of coding can be applied to all numerical values, including nominal, provided the individual categories are first converted to numbers (indexes). This step is necessary for values bigger than 64, while it is not for discrete values of a lower range. With them, the minimum is sufficient to be subtracted from them and the result can be directly used for encoding without using the entire range. This uniform procedure was selected for the following example and for all types of values. Table V shows the process of encoding values of properties of two persons from the previous example.

Table V – Process of encoding values of properties to characters

Property	Person A				Person B			
	Value	n_i	0–63	Char	Value	n_i	0–63	Char
Height	175	0.750	47	P	165	0.694	44	M
Weight	85	0.329	21	v	60	0.231	15	p
Age	35	0.276	17	r	25	0.197	12	m
Sex	2	1.000	63	_	1	0.000	0	a
Color of eyes	5	0.800	50	S	1	0.000	0	a

As shown in Table V, the characteristics of person A are encoded in a "characteristic" text string of "Pvr_S", and person B's to the string of "Mpmaa". From these strings it is apparent at first glance that these are two different people that do not match in any parameter, including the last two nominal values.

[5] *varchar* – database type for a string of a variable length limited from above [12]

IV. Comparison of Characteristic Strings

Comparing of two characteristic text strings can be done in several ways, or in various stages of coding back to the original value. Various weights must be used to achieve the same result in each of these stages.

The easiest way is the absolute differences of values converted directly from the individual characters (see col. "Code values – difference" in Table VI).

Table VI – The process of decoding individual characters of a text string

Property	Characters		Code values (0–63)		
	A	B	A	B	difference
Height	P	M	47	44	3
Weight	v	p	21	15	6
Age	r	m	17	12	5
Sex	_	a	63	0	1
Color of eyes	S	a	50	0	1
Total					**16**

The second option are the absolute differences of values normalized to the range of ⟨0, 1⟩ n_i, i.e. the previous value divided by 63 (see col. "Normalized values – difference" in Table VII).

Table VII – Back-calculation of the original values (a_i) of individual properties (continued from Table VI)

Property	Normalized values ⟨0, 1⟩			Original value (a_i)		
	A	B	difference	A	B	difference
Height	0.746	0.698	0.048	174.3	165.7	8.6
Weight	0.333	0.238	0.095	86.0	61.7	24.3
Age	0.270	0.190	0.079	34.3	24.2	10.1
Sex	1.000	0.000	1.000	2.0	1.0	1.0
Color of eyes	0.794	0.000	1.000	5.0	1.0	1.0
Total			**2.222**			**44.9**

The third option is to compare the original decoded values (a_i) by the means of inverse operation of calculating n_i (Equation 7) as shown in Equation 8.

$$a_i = n_i \cdot (rozsah_i - 1) + min_i = n_i \cdot (max_i - min_i) + min_i \quad (8)$$

Original weights (see Table I) can be used only in the third stage, i.e. when comparing the original values. However, a one-off conversion of weights saves a need of repeated conversion of coded values to the original ones for each property of each compared subject.

V. Question Mix

Initial setting of encoding conditions (metadata) for the specific cases would be performed by someone who would assess ranges and weights best suited for the particular purpose, or would make experimental measurements and subsequently edit the ranges accordingly. For test questions containing various random elements in various positions of the question, the settings would be very difficult for the creator of questions, in some cases (e.g. for mixing of content position) even impossible. The whole system should thus work completely automatedly in the background.

Since the sequence of the same random elements in a question may differ on each occurrence, and some portions may even be completely omitted, fixed identifiers (`id`) were used to detect the elements. On the first processing of a question the metadata (or the data necessary for coding of values) are listed under their identifiers, i.e. types of values and their minimum and maximum[6]. Numeric identifiers[7] of positions (`index`) and values (`val`) are also assigned to these elements (or their items) if necessary. Through them they will then be encoded into the characteristic string. The order of items (individual characters) in the encoded string then determines the order of their record in this list. List of metadata (e.g. see Code 1) is stored in a database directly within the record of the question and, can be expanded if necessary (when adding new elements or uncovering previously inaccessible elements due to random selection).

```
<metadata>
  <versions index="0">
    <ver id="x" val="0" />
    <ver id="y" val="1" />
  </versions>
  <rnd index="1" id="a" type="car" min="10" max="99" />
  <rnd index="2" id="b" type="car" min="1" max="9" />
  <rnd index="5" id="var" type="nom" /> <!– char A-Z -->
  <mix id="m1">
    <itm index="3" id="i1" />
    <itm index="4" id="i3" />
    <itm index="6" id="i2" />
  </mix>
</metadata>
```

Code 1 – Sample of possible record of question metadata to XML

The string containing random values for each use of each question is stored in the database during the generation of the test, along with other statistics for each instance of the question, in a form of a plain text string (*varchar*). An example of the coding of a question values with random elements described by metadata in Code 1 into the string of "`bMyb#ha`" is shown in Table VIII.

[6] this information is directly specified for random values `<rnd>` of the range and in other cases they are not required

[7] identifiers specified by creator of questions may not be numeric

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Table VIII – Sample of encoding of question random values into the string "bMyb#ha"

Element	Value	Coding process	Character	Index
ver	y	val["y"] = 1	b	0
a	72	$\frac{72-10}{99-10} \doteq 0.7 \rightarrow 0.7 \cdot 63 \doteq 44$	M	1
b	4	$\frac{4-1}{9-1} = 0.375 \rightarrow 0.375 \cdot 63 \doteq 24$	y	2
var	H	index H in {A–Z} = 7	h	5
m1	i2,i1	i1 = 1, i2 = 0, i3 = null	ba#	3,6,4

If any of the values in the list of a current question mix was omitted due to the random selection, it would still have to be included in the code string, so that its individual positions would always correspond to the same elements. For these cases, a special character # (hash, or sharp) will be used as the equivalent of the *null*[8] value, in the following example. It indicates that the item's value is not represented in the string[9]. In this case there are three basic approaches for comparing this value with others.

- Mark both strings as incomparable.
- Set a zero difference for the given property in the comparison of these specific characters.
- Evaluate the fact that the property exists in one case and not in the other, as the maximal difference.

The choice of the optimal approach depends on the particular application. The third option (maximum difference) was selected for comparing question mix.

A. Multiple comparisons

The process of comparing two entities, or their characteristic strings, was explained in the previous chapter. This method can be applied to an arbitrarily extensive list and thus a subject can be found that is most similar or dissimilar to the pattern object. The aim of comparing a question-mix is to determine the difference not only between two subjects but between one entity (generated question) and the group of entities (previously used questions).

If the same tested user has been previously asked the same question more times, then only the last five cases[10] are used for comparing, as it helps to save computational cost. The pattern string is compared with each of them and the total difference is the sum of these values. Individual comparisons, however, do not have the same weight. A similar principle as was the forgetting component at the selection of test questions (see [4]) is used in this case. In this case the weight is only repeatedly lowered[11] by one fifth[12] in order to accelerate the calculations.

B. Most different random values

There are more ways to create the most diverse question to its earlier versions. For example, the whole question can be generated several times and the version which is most different from all the previous versions will be used. This will be evaluated by the comparing of their characteristic strings. Respecting individual values during question creation can also be used, which is possible due to their division into individual characters. This method was selected, because of the complexity of repeated parsing of QML. Therefore, since there is no comparison of a whole question but only at the level of individual elements, weights and mutual ranges of these parameters do not have to be taken into account in the calculation.

C. Versions

Random variant of a question based on the versions <versions> defines a finite number of possibilities, one of which is randomly selected. Individual elements of the question are then shown or hidden, accordingly to which version was randomly selected. In terms of the type of values, versions are *nominal*.

For the nominal values such encoding is used which does not convert the value to the range of 0-63 (unlike the previous example of people comparison), but values are indexed by integers from 0 to the count of versions. The impossibility to include all versions into the calculations if their enumeration contains more than 64 variants is undoubtedly the disadvantageous aspect, but this is only a theoretical possibility. The advantage is the possibility to extend the list of other items at any time (up to 64), without invalidating the data from previously completed testing.

Selection of the version is realised by the means of five random choices from all possible versions. If any of them was not used in the previous five representations of the question, this version is declared as the best and the process is done. However, if all five randomly selected "candidates" were used in the previous five cases, the best of them is determined by the highest total sum of weighted nominal differences from the previous selections (see example in Table IX).

[8] *null* is a special value applicable in databases and some object-oriented programming languages across the data types which indicates that the field of the database record or variable is not set to any value [7]

[9] when encoding to the range of 256, this range can be reduced by one (255) and the last value reserved for the *null*

[10] any number of previous cases can be used for comparison, or even all of them

[11] the time component described in the mentioned source can be also used

[12] the latest variant of the question has a weight of 1, 0.8 for the penultimate, 0.6 for the preceding, etc. and the fifth (the oldest in the selection) has a weight of 0.2

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Table IX – Sample of selection of the most diverse random version (out of five) in relation to the five previous elections

Question		Prior versions		Random versions					
Date of use	Weight	Character	Version	1	4	5	3	1	
2015-02-08	1.0	b	1	0.0	1.0	1.0	1.0	0.0	Weighted nominal difference
2015-02-01	0.8	f	5	0.8	0.8	0.0	0.8	0.8	
2015-01-26	0.6	e	4	0.6	0.0	0.6	0.6	0.6	
2015-01-05	0.4	d	3	0.4	0.4	0.4	0.0	0.4	
2014-12-15	0.2	f	5	0.2	0.2	0.0	0.2	0.2	
Total				2.0	2.4	2.0	2.6	2.0	

The example in Table IX shows the procedure of selecting random version out of five possibilities. All proposed versions (2x1, 3, 4 and 5) were used in the previous five cases. First, the previous uses of questions are sorted in the descending order by the date, and according to this order, weights are assigned to them. In the next step, for each of these selections the relevant character is decoded from the question string to the specific numeric identifier of particular used versions. Subsequently, nominal differences between each previous and proposed versions are calculated (0 for identical, 1 for different) and these results are multiplied by weights reflecting topicality of previous choice. Their sum for each "candidates" is the decisive factor for determining the "winning" version. That is the fourth in this example with the ID number of 3 (`val="3"`), because its overall difference from the previous five versions has a highest value of 2.6.

D. Random values

Generating random values `<rnd>` for the question is also repeated five times. All random values from these five (r_j) are compared (the absolute value of the difference) with values of five previous versions (p_i), and these differences are multiplied by weights (v_i) reflecting the 'age' of questions (see Equation 9).

$$d_{ij} = |r_j - p_i| \cdot v_i \tag{9}$$

The random value (r_j) with the highest total sum of weighted differences is included into the question ($\sum_{i=1}^{5} d_{ij}$, see example in Table X).

Table X – Sample of selection of the most different random integer value (from 1 to 100) with respect to the five previous values

Question		Prior values		Random values					
Date of use	Weight	Character	Value	5	32	17	98	61	
2015-02-08	1.0	s	29.29	24.3	2.7	12.3	68.7	31.7	Weighted difference
2015-02-01	0.8	Y	89.00	67.2	45.6	57.6	7.2	22.4	
2015-01-26	0.6	1	43.43	23.1	6.9	15.9	32.7	10.5	
2015-01-05	0.4	d	5.71	0.3	10.5	4.5	36.9	22.1	
2014-12-15	0.2	p	24.57	3.9	1.5	1.5	14.7	7.3	
Total				118.7	67.2	91.8	160.3	94.1	

The example in Table X shows the procedure of a particular case for selection of the random value in the range from 1 to 100, beginning with the decoding characters to the previous values and ending up with determining the best values from the five possibilities. In this example, this is the fourth ($j=4$) possibility (98), its total difference from the previous five selections is the highest (160.3).

Random selections from the enumerations are treated as nominal, e.g. for values of type *string* (text) or *char* (character). Their selection is similar to the choice of the optimal version. Even in this case it is not necessary to repeat the selection five times, because if the selected value was not in the previous five selections, it can be used directly and the process of selection for this item is over.

E. Random selection

The procedure of mixing the content of the question `<mix>` is more complicated [10]. Each item from a mix `<item>` selection has its own identifier under which (with the prefix of an identifier of the mix or as its sub-element as in Code 1) it is registered in question metadata. A value that is stored below is the position of the item in this mix[13]. If any item is omitted (due to the numerical limitations for the selection), a *null* value (#) is inserted on the position of the item in the string. When an assigned position is compared to a *null* value, the difference is the total count of selected items for the current mix element (becoming a maximum mismatch). When two valid values are compared, their relationship is evaluated as the absolute value of their difference.

Table XI – Example of the procedure of determining the most diverse variant of random selections (4 of 6 items) relatively to the previous five

Prior testing			Random selection																					
Weight	String	Items positions	V1							V2							V3							
		1 2 3 4 5 6	1	2	-	3	-	0	vΣ	3	-	-	2	0	1	vΣ	0	2	-	-	1	3	vΣ
1.0	#c#bda	- 2 - 1 3 0	4	0	0	2	4	0	10.0	4	4	0	1	3	1	13.0	4	0	0	4	2	3	13.0
0.8	bcda##	1 2 3 0 - -	0	0	4	3	0	4	8.8	2	4	4	2	4	4	16.0	1	0	4	4	4	4	13.6
0.6	d#acb#	3 - 0 2 1 -	2	4	4	1	4	4	11.4	0	0	4	0	1	4	5.4	3	4	4	4	0	4	11.4
0.4	#cb#ad	- 2 1 - 0 3	4	0	4	4	4	3	7.6	4	4	4	4	0	2	7.2	4	0	4	0	1	0	3.6
0.2	#bcd#a	- 1 2 3 - 0	4	1	4	0	0	0	1.8	4	4	4	1	4	1	3.6	4	1	4	4	4	3	4.0
Total									39.6							45.2							45.6

Random selection																							
V4									V5														
1	2	3	-	0	-	vΣ	3	2	1	-	0	-	vΣ
4	0	4	4	3	4	19.0	4	0	4	4	3	4	19.0
2	0	4	4	4	0	16.0	2	0	2	4	4	0	9.6
2	4	3	4	1	0	8.4	0	4	1	4	1	0	6.0
4	0	2	0	0	4	4.0	4	0	0	0	0	4	3.2
4	1	1	4	4	4	3.6	4	1	1	4	4	4	3.6
						41.4							41.4

[13] also in the case of coding positions of items of random selection is not resized to the range of 0-63 for the possibility of future extensibility of the selection for other items

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Even in this case, the five possible variants of the selection with different positions of the individual items are generated, and these are compared with the previous five. The differences of individual items within mixes are summed and multiplied by the weight reflecting the topicality of previous version (same as in the previous cases). Their sum for each "candidate" of random selection is then the decisive factor for determining the "winning" variant, which is again the highest value of this sum (see Table XI).

The example in Table XI shows the procedure of a particular case of random selection, beginning with the decoding of previous selections from the fragments of the characteristic strings and resulting in determining the best variant of selection out of five. This is V3, its total difference from the previous five selections is the highest with the value of 45.6. According to this variant, out of the 6 items, the 1st, 5th, 2nd and 6th item (in this order) should be included in the selection.

For better understanding of the relationship between the values in Table XI, three related values are framed. These are the 4th item from V2 selection (2, i.e., the 3rd in order will be registered under the index 4), the same item at the penultimate version of the question (0, i.e., there was a 4th item in the 1st place) as well as the absolute difference in the intersection of the two coordinates (|2-0| = 2, i.e., the proposed position of the item in comparison to the penultimate question is shifted by 2 positions).

VI. Conclusion

The characteristic text strings allow us to encode values of properties of different objects into legible characters and to mutually compare their similarities. The whole process was demonstrated on comparing the basic characteristics of two different people. The procedures and ways of practical use of such strings were also presented used to generate more diverse, rather than purely random test questions for the same tested user. The same procedure can also be used for various tested users during mass preparation of questions at the same time, for a single IP address or a computer lab, as a precaution against possible cheating. Other possible uses were outlined, including various ways of implementation of the entire process or its individual parts.

Thanks to the code strings, database structures can be simplified. Support for searching and comparing these strings directly by SQL functions should not be difficult to implement in some database systems.

Comparing, however, is not always performed on the large database of different subjects, but thanks to the ease of portability of characteristic strings can be realised individually "in the field", e.g. using a mobile phone. In addition to text characters for storing values, it is also possible to use other data structures, e.g. barcode or QR code.

Thanks to the separation of the individual properties to the individual characters, it is also possible to compare only certain parts of them, independently of the rest without decoding the whole string.

Areas of application are broad, and this principle can be used wherever it is necessary to store and compare the cardinal or nominal characteristics. These may include e.g. parameters of goods, searching for people, vehicles, dating etc. Strings encoding characteristics of objects with possibility of fast mutual comparisons are also a very important part of genetic algorithms, where this approach could also be applied.

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Analysis of the use of measurement systems using computers in a school science laboratory at primary schools in the Czech Republic

Radek Nemec

***Abstract*—** This article describes results of the analysis of using measurement systems using computers in a school science laboratory at primary schools in the Czech Republic. The results show that there is a general awareness of such systems. However, only 13 per cent of schools use these systems. If these systems are in schools, they are used, mainly in science, especially physics.

***Keywords*—** analysis, DAQ, measurement system, computer aided experiment, measurement, data collection.

I. Introduction

Measurement system using a computer is used to improve the attractiveness of science subjects due to graphic display of natural phenomena. This view helps increase interest in clarifying and deepening knowledge. The aim of the article was to determine whether teachers in primary schools in the Czech Republic know about these systems, whether these systems are available at schools, are used and in what subjects. Subjective opinion regarding acquiring more knowledge and understanding was inspected.

II. Systems for measuring with computer

Measurement systems using the computer are systems that enable collection, management and processing of data obtained with the measuring device that is connected to a computer. [1] See figure 1. Such experiments are also called computer-aided experiments. [2], [3]

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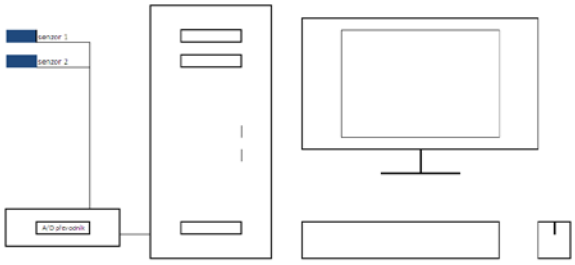

Fig 1 – Schematic picture of the computer and sensors

III. Natural Science laboratories

Natural science laboratories offer a way to observe, document, set hypotheses, draw conclusions and finally gain knowledge about a phenomenon. It is a way how to actively acquire knowledge. [4]

In natural science laboratories when carrying out science experiments the observations and experiments themselves are conducted. This will enrich all science learning and work of pupils and students in the classroom is activated. Students get practical skills for understanding the natural aspects of the world. At the same time scientific observation and experiment is a strong motivator of teaching and it strongly contributes to the development of pupils' interest in science. [5], [6].

IV. Natural science laboratory using systems for measuring with computer

The above mentioned aspects of the science observation and experiment can be realized also by means of a computer. For such experiments and measurement systems are used for measurement using a computer in a school science lab. [7]

There are many reasons why a measurement is carried out using a computer. The main reason is the possibility of obtaining large amounts of data without manual recording, which is done by the connected computer. The processing may be immediately performed on the computer without overwriting previous readings. [8]

Thanks to the systems for measurement using the computer, the above described observations and experiments can be carried out with the use of computers, which is a major advantage in the rapid collection of large amount of data and

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real processing in the form of graphs. Graphical representation helps understand a phenomenon more easily, which is our purpose. [9]

V. The Method of the Analysis

Analysis was performed using a dial interview in randomly selected primary schools in each region of the Czech Republic. The list of schools was selected from the register of schools Ministry of Education, Youth and Sports. [10]

For each region five schools were randomly selected.

If the selected school was a special or practical school, it was replaced by the next school in the list.

The school selected in the sixth place served as a substitution in case of unavailability on the phone of the previous five schools.

Random was conducted in MS Office Excel. The function selected was = RANDBETWEEN(1, XXX). Where 1 is the lower limit and the upper limit is XXX. The upper limit is equal to the number of schools in the region.

The number beside the region indicates the number of schools in the region. The table listing the regions, the number of schools in the region and a randomly generated number can be seen in Table 1.

Table 1. – The list of regions and randomly generated number

Region / Number of school	Quantity/RND
Prague	267
1	220
2	16
3	184
4	39
5	47
6	74
Central Bohemian Region	536
1	332
2	281
3	494
4	133
5	9
6	121
South Bohemian Region	257
1	196
2	10
3	191
4	94
5	6
6	145
Pilsen Region	221
1	216
2	134
3	143
4	185
5	75
6	156
Karlovy Vary Region	110
1	43
2	54
3	42
4	96
5	96
6	99
Usti Region	279
1	185
2	97
3	179
4	44
5	217
6	20
Liberec Region	208
1	153
2	17
3	167
4	52
5	98
6	31
Hradec Kralove Region	269
1	47
2	9
3	258
4	133
5	11
6	52
Pardubice Region	253
1	157
2	200
3	216
4	231
5	179
6	195
Highlands Region	265
1	106
2	241

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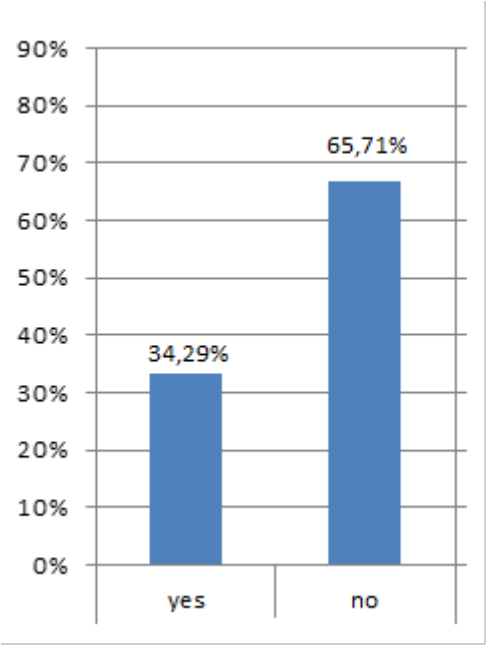
3	255
4	96
5	73
6	1
South Moravian Region	481
1	344
2	103
3	76
4	416
5	34
6	60
Olomouc Region	303
1	209
2	4
3	112
4	34
5	95
6	288
Zlin Region	261
1	199
2	196
3	216
4	209
5	147
6	6
Moravian-Silesian Region	446
1	361
2	247
3	12
4	80
5	234
6	402

VI. The Results of the Analysis Using Measurement Systems Using Computers at Primary Schools in the Czech Republic

The first question concerned the knowledge of these systems, whether teachers know about these systems. Table 2.

Table 2. – The knowledge of the systems

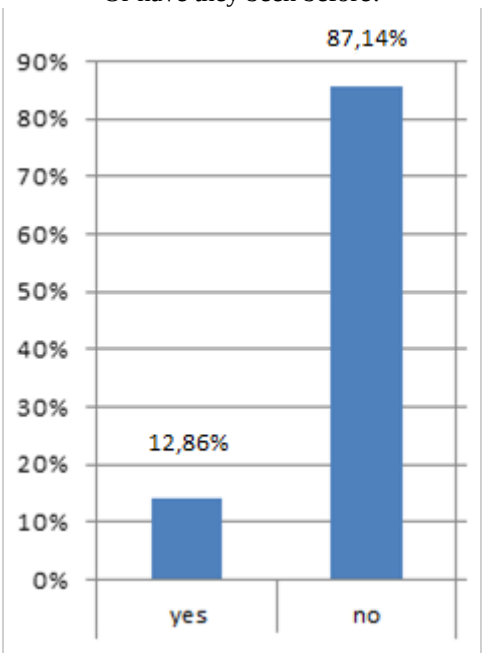
Do you know what measurement systems using a computer are?



The second question asked about the occurrence of these systems, whether these systems are available in schools. Table 3.

Table 3. – Occurrence in schools

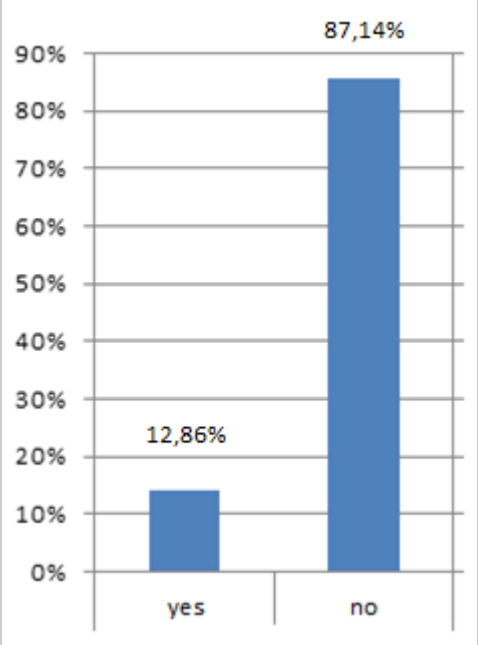
Are such systems available in the school? Or have they been before?



The third question deals with the use of these systems, whether teachers use these systems. Table 4.

Table 4. – The usage of the systems

Do you use these systems in teaching? Or have you used them?



Subsequently, it was asked about subjects in which they are used. Replies were clearly that in science, which is understandable. The most frequent subject was Physics, partly also chemistry and technical subjects.

Another question examined the frequency of using these systems. It was from several times a week to a year after application unit.

The penultimate question was: Do you think or have experience that lessons in which the systems are used for measurement using computers lead to increased knowledge and expertise in the field of sciences? Here teachers answered as follows. The systems lead and entertain, they help primarily thanks to increased interest, clarification and knowledge.

The last question focused on the used systems. These were mainly systems from Vernier, sometimes from Pasco.

VII. Conclusion

The analysis shows that only are third of teachers in the Czech Republic know the systems and they are only available in 13 per cent of schools. If the systems are at teachers' disposal, they are used. This helps increase the interest and consolidation of knowledge and expertise in the field of natural sciences.

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Clinical Laboratory Test Results Reader

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***Abstract*— Deciphering the medical laboratory test results is not ease to read or understand by most of people; leaving them with more questions than answers. This paper points out some of the different sections that may be found on a typical lab report and proposes a mobile application to alert patient in case of outside the normal results and provides basics treatment options. The application induces patients to discuss the lab test results with their health practitioner in case of major un-healthy results. Through a usable graphical interface, the user enters the selective results values, the application process the results using an algorithm to determine the status of the results and displays a compatible alert message which includes results status(normal or outside the normal) and a first aid in case of un normal results[1],[12].**

Keywords—component; e-lab, Smart phone, m-health, Clinical lab tests, and QR scanner.)

I. INTRODUCTION

Smart phones are growing rapidly in our global societies and it is spreading among all types of demographics all over the world. It creates a new era that makes our lives more controllable, manageable and enjoyable [4]. It presents many types of applications such as games, maps, education, business, news, etc[5].

In this paper we are proposing a new smart phones application specializes in reading the medical laboratory test results and to help patient to read and understand their results. Due to the lack of knowledge and experience of a large segment of patients in reading and understanding their lab test results; medical lab test results become irritate for most of the patients. The application will increase the patients' awareness and encourage them to discuss their results with their health practitioner. [6][3]

The application will allow users to read their major lab test results and get a basic understanding of those results. It will show the user different types of alerts messages depending on patient's gender, age and test results as well which will direct the patient to act in a healthy manner [7].

The application is an Android technology as a first release product; it reads and notifies the user with the basic type of medicine laboratory tests, advices and educates users on understanding the major medicine test results as Anatomic pathology and Clinical pathology and others.[5]

It informs the users with the vital information about the results and directs them to take the correct action to protect their health from any initial diseases. [9]

Although there are many mobile applications and web based applications which help in reading laboratory test results; but neither the mobile application nor the web based application provide alert messages and first aid directions to the users and do not support Arabic language.

The Graphical User Interface (GUI) of the application supports bi-lingual languages (English and Arabic) and will be usable for all type of users.[11]

i. THE PROBLEM

Most patients are suffering from understanding their lab test results specially Arabic language speakers;[1] they feel frustrated from that since they are not being able to read and understand the results as soon as they received it from the lab which might lead to major health diseases if they did not share it with their health practitioner on time. In addition, there are no such application generates different types of alert messages to the user in order to help the user act correctly.

ii. System Objectives

1.To guide patients in their medical laboratory test results and aware them from any diseases to avoid any health complications.

2.To guide junior medical graduates in reading and understanding their patients results to be able to lead them to the correct diagnosis and lab technician as well.

II. BACKGROUND

- Lab testingOnline:

It provides detailed information about many laboratory test results with diseases description, diagnosis and treatment of a board range of conditions and diseases.

Application disadvantages:

The application provides huge amount of data which may be un understandable for many users. In addition, the app does not support Arabic language.[10]

-Quick LabRef:

It provides quick look at the up-to-date information on the most commonly used clinical laboratory values and other useful relevant information.

Application disadvantages:

It is only English language version, supports android devices only, it has limited functionality and it displays only information about the different clinical test results.[12]

III. Analysis

The application is usable for all types of users with different backgrounds and experiences. It will be deigned specially for patients to understand their medical laboratory test results and give them an initial feedback on their results.
The application will be developed with the latest mobile technology to insure flexibility, portability, usability and maintainability for users which will make the patients easily read and understands their medical laboratory test results. It will provide vital information about different type of test results and a clear explanation of the numerical results for each test in the result sheets which will be readable by using QR scanner technology.
The application will be portable with both iOS and Android operating systems.[2][3]

i. Data collection techniques

It is mandatory for all application development to insure the correctness, accurateness and high quality of the application data. We had chosen among various data collecting techniques more than one techniques as follow:

•Interviews: we have conducted several interviews with several number of physicians to understand the necessarily data for patients and major diseases and medical tests. In addition, we have met several numbers of medical lab technicians to understand the analysis techniques of the numerical test results.[8][7]

•Related researches and books.
•Official web sites.

Recommendations

After the data analysis phase, we came up with the following results:

Categorizing the major medical laboratory tests based on human body parts as follow:

1. General Tests
   A. CBC "Complete Blood Count"
   B. Urine test
   C. Stool test
2. Liver functions tests
   A. SGPT
   B. SGOT
   C. ALP
   D. Bilirubin
3. Thyroid Hormone Tests
   A. Total thyroxine (T4)
   B. Triiodothyronine (T3)
4. Kidney tests
   A. Creatinine blood
   B. Creatinine clearance
   C. Creatinine urine
   D. Uric Acid
5. Lipid blood tests
   A. Cholesterol
   B. Triglycerides
6. Diabetes
   A. RBS
   B. H1C
   C. FBS
   D. BMI

Following tables are samples of the average numerical tests results:

- ✓ Complete Blood count(CBC) test
  It is one of the major tests requested by physicians for all patients. It measures the number of red and white blood cells plus the Hemoglobin, Platelets and Ferritin Blood.[11]

Test Name	**Test purpose**	**Normal numeric results**
RBC	Red blood cell	4.2 – 5.9 m/mcl
Hemoglobin – Hb	Hemoglobin values	13 – 18 male 6-12 female
MCV	Mean corpuscular volume	86 – 98
WBC	White blood cell count	4,300 – 10,800 cell/mcl
Platelets	Number of Platelets	150,000 – 400,000 P/mcl

Table1: CBC test

- ✓ Liver functions tests

Test Name	Test purpose	Normal numeric results
SGPT	enzyme	0 – 45 /L
SGOT	enzyme	0 – 41 IU/L
ALP	Alkaline phosphatase	24- 71 IU/L
Bilirubin	bilirubin in the blood 1. IDBIL 2. DBIL	0.1 – 1.0 mg/dl

Table2: Liver function tests

- ✓ Thyroid Hormone Tests

Test Name	Test purpose	Normal numeric results

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T4	Hormone	5-12 mcg/dl
T3	Hormone	0.07 – 0.17 mcg/dl

Table3: Thyroid Hormone Tests

- ✓ Kidney tests

Test Name	Test purpose	Normal numeric results
Creatinine blood	Creatinine in the blood	0.5 -1.5 mcg/dl
Creatinine clearance	Creatinine Clearance Test	90 – 140 ml/min male 80 – 125 ml/min female
Creatinine urine	Measure urea	20 – 40 mg/dl
Uric Acid	Measure uric acid	3-7 mg/dl male 2-6 mg/dl female

Table4: Kidney tests

- ✓ Lipid tests:
  - Cholesterol test

Normal average	Age
120 – 230 mg/dl	1 -20 years
120 – 240 mg/dl	21 – 30 years
140 – 260 mg/dl	31 / 40 years
150 – 290 mg/dl	41 – 50 years
160 – 300 mg/dl	51 – 60 years

Table5: Cholesterol test

  - Triglycerides

Normal average	Age
10 – 140 mg/dl	1-30 years
10 – 150 mg/dl	31 – 40 years
10 – 160 mg/dl	41 – 50 years
10 – 170 mg/dl	51 – 60 years

Table6: Cholesterol test

- ✓ Diabetes (Glucose Analysis)

Test Name	Test purpose	Normal numeric results
Fasting Blood Glucose	Test Glucose while fasting	70 – 110 mg/dl
Post Prandial Blood Glucose	Test Glucose post prandial	<140 mg/dl

Table7: Diabetes (Glucose Analysis

- ✓ BMI: Body Mass Index is a measure of body fat based on height and weight that applies to adult men and women[4].
  - ✓ BMI = Mass (kg) / (High (m))^2

BMI records	Status
<18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
>30	Obesity

Table8: BMI

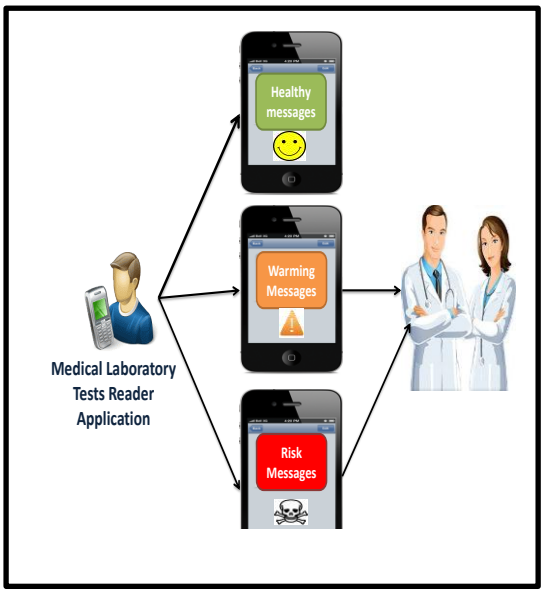
BMI is a useful measure of overweight and obesity. BMI is an estimate of body fat and a good gauge of patient risk for diseases that may occur with more body fat. High BMI means higher risk for certain diseases such as heart disease, high blood pressure, type 2 diabetes. BMI helps doctors with determining how much medication to give, and how would the diet be, to control weight and reduce possible complications and risks[9][3].

ii. *System Functional Requirements*

After deep research to analyze data collected from various recourses, system functional requirements are:

End-user functional requirements

a. Self-assessment: the user enters the medical laboratory test results via QR scanner or by entering the results; the application makes a comparison between normal numerical results and the user results and give an immediate feedback about the results condition.
The application shows three types of feedback messages:
   1. Health messages: if the results are normal and within the range.
   2. Warming message: if the results are in middle range.
   3. Risk message: if the results are far from the normal results.



c. Generate mini-report: the user ca
Figure1: Messages types

b. Generate first aid mini-report on the user health condition if the results were out of the normal value results.

iii. System non- Functional Requirements

- Scalability.
- Availability.
- Usability.
- Security.

vi. *System Design and Interface*

A. Database Design –Diagram

The database is a core component in our system. It has the normal records of the lab tests components and their classifications. The database consists of 5 tables representing the following entities: **Test Values, Test, Test Patients, Test Faid, Age and Gender**

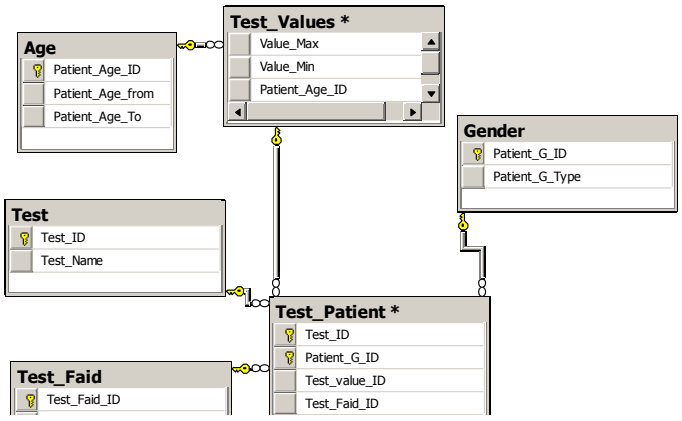


Figure2: Database Diagram

B. Use Case Diagram

Object oriented design technique used to build the system relations and operations for all the entities classes to show how the system components' interact and operates.

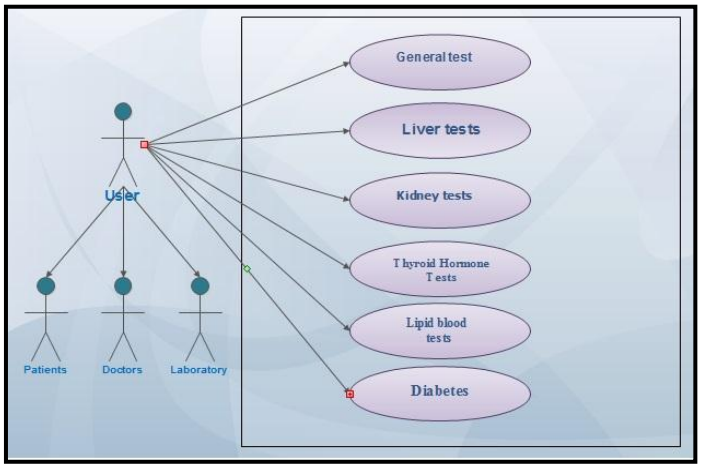


Figure3: Use case Diagram

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C. User Interface Diagram

The Interface design follows the human computer interaction strategies to serve all type of users easily. Figure below illustrate the system interface

Figure4: Main menu

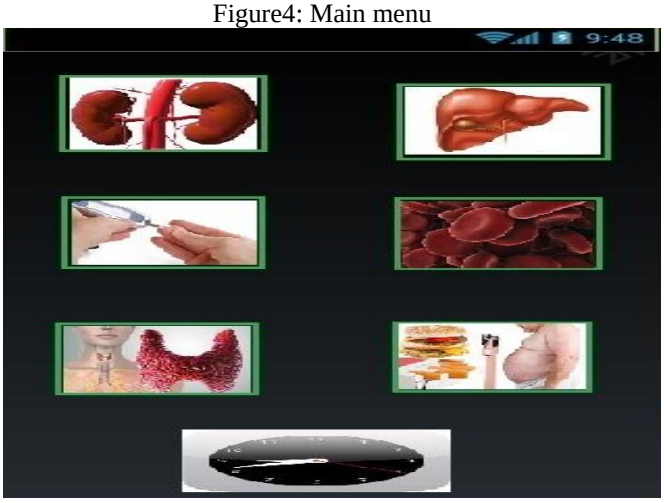

Figure5: Lab test menu

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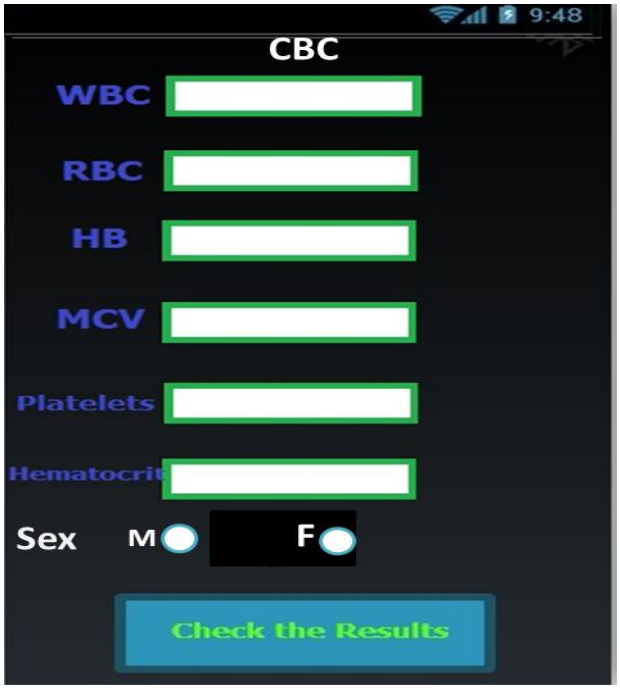

Figure5: CBC Test Menu

System messages design:

Figure6: Health message sample

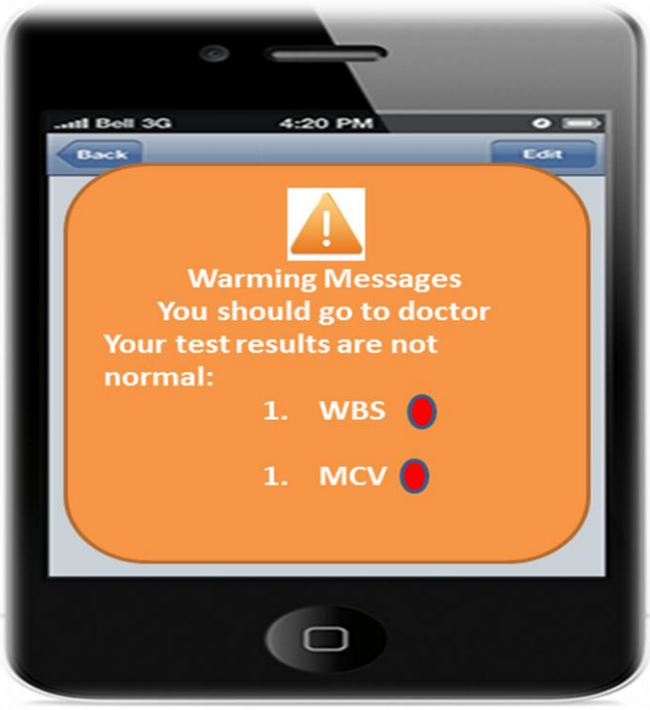

Figure7: Warning message sample

Figure: Risk message sample

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IV. System Implementation

Eclipse Programming platform will be used to build the system since it is open source software, it uses plug-ins to provide functionality within and on top of the runtime system, it's a lightweight software component framework, it supports Tomcat, GlassFish and many other servers. The figure below illustrates **the system algorithm:**

```
Read Gender, Age
If MCV selected
Then
  Get result values
  Compare value in data base as for gender and age
  Calculate differences in values
  Generate suitable alert message
    If message type = warning or risk
    Display test name types and value differences
    Search internet for best first aid
    Display first aid directions
    Update data base
    End if
End if
```

Acknowledgment and Future Work

Mobile apps have changed the world in just a few years' especially the medical applications. In this paper we present a prototype for a mobile application to help users to read and understand their lab test results. It depends on generating alert messages to the user to act correctly in a healthy manner and save time. The application will be expand to cover all type of lab test types and will introduce more interface languages. In addition, the system will be able to send the results as a report to the user health practitioner via email or SMS.[7]

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The Effectiveness of Higher Order Thinking Skills for Generating Idea among Technical Students

Yee, Mei Heong, Jailani, Md Yunos, Widad, Othman, Razali, Hassan, Tee, Tze Kiong, and Mimi Mohaffyza, Mohamad

***Abstract*—** Higher order thinking skills (HOTS) is an imperative aspect in teaching and learning especially at higher education institutions. Students with higher order thinking skills are able to find new ways to solve their daily problems and make appropriate decisions. Hence, the purpose of this research was to evaluate the effectiveness of HOTS for generating idea among technical students. This quantitative approach research used the quasi-experimental design with one treatment groups and one control group comprising 81 students. Marzano HOTS was used for generating idea in this research. Meanwhile, individual assignment evaluation rubric was modified to assess the level of achievement on the students' assignments. The findings showed that there was significant differences between treatment group and control group on the overall individual post assignment result. There were significant differences between treatment group and control group on the five evaluation criteria of individual post assignment result. Besides that, the findings revealed that treatment group have significant differences between individual pre and post assignment on overall and five evaluation criteria result. Consequently, learning HOTS by using self-instructional manual approach for generating ideas is significantly effective.

***Keywords*—** Generating idea, Marzano higher order thinking skills, quasi-experimental, technical students.

I. Introduction

IN this era of globalization, knowledgeable and skilled workforces are indispensable in a country's economic growth [1]-[2]. Workforce must be equipped with the skills to think like efficiency information handling, problem solving, collaboration, critical and creative thinking [3]-[4]. Reference [5] states that the ability to generate creative ideas also are the skills required in the job market. This is because generating ideas is a crucial part in decision making and resolving a problem [6]-[8].

Nowadays, world continuous change thrives on creative individual. The important keys to success in today's intensely competitive and dynamic environment are creativity and innovation [9]. Creativity has always played a central role in generating idea. Core part of the innovation process are ideas [10]. Each innovation begins with an idea [11]. Idea is a basic element of thought which can be visual, concrete or abstract [12]. Idea also is all stages of the cycle of abstract thinking [13]. Consequently, idea defined as something such as a thought or conception that potentially or actually exists in the mind as a product of mental activity [14].

However, generating idea is a process of creating, developing and communicating ideas. Therefore, generation of ideas is categorized as a higher order thinking skills (HOTS) activities that require high level creative thinking and action [15]-[16]. Complex thinking skills such as problems solving, creating, analyzing, evaluating and others are needed to process the collected information [17]-[18] for generating an idea.

Idea generation occurs in our brain through cognitive, metacognitive, chemical and biological process [15]. HOTS is the highest level in the hierarchy of cognitive processes. HOTS enable students to overcome the challenges that too much information in this information age, but the time for processing is limited [19]. HOTS can help individuals analyze information in a systematic way to solve unique problems [20]-[22].

Additionally, HOTS challenges us to interpret, analyze and manipulate information [23]-[24]. An individual with high level thinking will be able to use the new information or prior knowledge and manipulate information to obtain a reasonable response to new situations [25]-[26]. Consequently, creative ideas can only be generated through high level thinking, instead of the low level thinking through the application of knowledge learned in daily lives.

In conclusion, mastering HOTS is important to nurture talent for inventions because HOTS can help an individual to generate and produce new ideas, hypotheses and to confirm by experiment and observation. HOTS is one of the factor to achieve success in one's inventions [27]. In other words, HOTS is needed to build the essential elements to produce an

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unique, original and useful creation.

II. PROBLEM BACKGROUND

In the 21st century, students at Institute of Higher Education (IHE) are given a variety of academic and non-academic projects that require them to solve problems creatively. University students need to generate ideas to complete their coursework either in the form of written assignments or completing a project [28]. Thus, [29] stated that generating new ideas is often emphasized as students' assignments become more complex and challenging. .

Good ideas cannot be generated easily. Interesting ideas are not instant successes but need to take time to develop it. A number of obstacles in understanding and application of idea generation techniques also exist among students [30]. According to research [6], the majority of technical students regardless of gender, year of study or intake have difficulty in generating ideas when completing coursework assignments individually.

Many technical students have difficulty generating ideas whether it is to be used to produce concrete or abstract product [31]. Technical students have a high level of difficulty in producing projects (concrete idea), and a moderate level of the difficulty in completing a written assignment (abstract idea) for engineering education courses [32].

This finding is consistent with studies of [33] stating that most students are not able to think outside of the box and generate ideas intuitively and spontaneously. The factor contributing most to the difficulty in generating ideas among technical students is deadlock of ideas. Deadlock of ideas is a reflection of the weakness of a thinking skills [34].

Based on research [35], a total of 375 technical students responded that none of the technical students perceived their thinking skills' levels to be high. Only four Marzano HOTS, namely comparing, inductive reasoning, deductive reasoning and investigation are rated at the moderate level. On contrary, nine Marzano HOTS are rated as low.

Students who are weak in HOTS cannot complete the tasks based on cognitive and metacognitive effectively [36]. Implications, academic performance will be affected. The need to generate multiple ideas has become a necessity for every student in order to complete their course assignments. Consequently, overcoming the difficulty in generating ideas is crucial.

As a solution, students need to learn HOTS to address the difficulty in generating ideas [37]. This is because HOTS is a metacognitive process that teaches how to use a method of observing and learning process information in idea generation.

We hypothesized that using HOTS can address the difficulty in generating ideas effectively. It may lead to the problem in completing students' course assignments. Consequently, to test this hypothesis, the following research objectives were arisen. The specific objectives of this study are to identify:

i. The difference in overall mean scores of individual post assignment between treatment group and control group.
ii. The difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group.
iii. The difference in overall mean scores between pre and post individual assignment for treatment group and control group.
iv. The difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group.

III. RESEARCH METHODOLOGY

The effectiveness of using HOTS in generating ideas was identified based on the quasi-experimental design. Quasi-experimental design is one of suitable research design which is particularly suitable for evaluating the effectiveness of a treatment on thinking skills [38]-[39]. Marzano HOTS was used for generating idea in this research through self-instructional manual. This quasi-experimental design consists of one control group and one treatment group (Table 1). Both groups were given pre and post individual assignment. The present study is commonly referred to as a quasi-experimental study, a design that could also be called a hybrid form between an observational study and an intervention. The total study extended over a period of 10 weeks. After the pre individual assignment (O_1), treatment group started the treatment by using the Marzano HOTS self-instructional manual (X_T), whilst the control group without any treatment but remain by using ordinary learning module (X_C). After the treatment, both group were given post individual assignment (O_2). Both pre and post individual assignments were marked by their lecturer based on individual assignment evaluation rubric.

Table I Pre and post individual assignment

Treatment Group	O_1	X_T	O_2
Control Group	O_1	X_C	O_2

A. Population and Sample

Population is a group of people who have similar characteristics. Population should be identified appropriately based on the research to be conducted [40]. In this study, the target population was the year 1, 2, 3 and 4 technical students in Bachelor of Civil Engineering, Electrical and Electronic Engineering and Mechanical Engineering.

A total of 81 technical students who were taking the subject *Creativity and Innovation* (CNI) were involved with the quasi-experimental design on assessing the effectiveness of Marzano HOTS in assignment achievement. These 81 technical students are second year students from Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia. There were 41 students for treatment group and 40 students for control group.

The sampling procedure used for this research was cluster random sampling. This is because this sampling procedure allows the selection of respondents were able to donate a lot of relevant information in depth [41] to the research. The

Levene's test (> .05) showed that at the pre intervention period, both groups of student were homogeneous.

B. Research Instrument

Two set of individual assignments and individual assignment evaluation rubric have been used as research instrument. Both sets of individual assignments consisting of pre and post individual assignments have the same topic that is generating ideas for new solutions based on the given terms.

Individual assignment evaluation rubric is used to evaluate pre and post individual assignments. The mean scores of individual assignments among respondents can be identified. The evaluation of individual assignments include five main criteria, namely Idea, Design, Functions, Material and Dimensions. Each criterion is equipped with a rubric level from level 1 to level 5 which shows the achievement of idea generation.

Verification of content and design of individual assignments and individual assignment evaluation rubric have been done by the eight experts which consists of design of research instrument, thinking skills, technical and language. Prior to the actual research, a pilot test was conducted to determine the reliability of the instrument and to achieve the desired objective of this study. The internal-consistency reliability value for two set of individual assignments is .81 and .83 respectively.

For individual assignment evaluation rubric, the reliability between raters (Inter-Rater) was obtained by using Cohen's Kappa test which involving two assessors. Cohen's Kappa for reliability score between the two raters for this evaluation rubric is $\kappa = .758$. This means that all research are suitable and reliable for obtaining stable scores.

C. Data Analysis

Each assignment allocated 15 marks. The weightage of mean scores for five evaluation criteria are different (Table II). The mean scores of individual assignments were analyzed using SPSS software. Statistical analysis was done via an "intention to treat" comparison of post intervention scores and comparison of the change in scores from pre- to post intervention.

Table II Weightage of mean scores for five evaluation criteria

Evaluation Criteria	Weightage of Mean Scores
Idea	4.00
Design	3.00
Functions	3.00
Material	3.00
Dimensions	2.00

The statistics selected for data analysis was based on the research questions as illustrated in Table III. Inferential test analysis is used to answer all the research questions. The findings are presented in the table format with calculation of mean score.

Table III Summary of research questions and statistical techniques used in the study

No	Research Questions (RQ)	Statistical Techniques
RQ1	Is there any significant difference in overall mean scores of individual post assignment between treatment group and control group?	ANCOVA
RQ2	Is there any significant difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group?	MANCOVA
RQ3	Is there any significant difference in overall mean scores between pre and post individual assignment for treatment group and control group?	MANOVA
RQ5	Is there any significant difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group?	MANOVA

IV. Results And Discussion

Inferential statistics were used as analytical tools. Parametric statistical techniques were used with the inferential statistics.

A. The Difference in Overall Mean Scores of Individual Post Assignment between Treatment Group and Control Group

Result of ANCOVA analysis test in Table IV shows that there was significant difference in overall mean scores of individual post assignment between treatment group and control group. Results of this analysis confirm that the treatment has a positive impact on student achievement in ideas generation after controlling control variables gender, academic achievement, socio economic status (SES), learning styles and mean scores of pre individual assignment.

HOTS is an indispensable component for generating ideas [42](Othman & Rahman, 2011). Idea generation is HOTS activity that requires creative thinking and action on higher level [16]. HOTS has an ability that is essential in the process of idea generation. For example, students with HOTS are able to combine elements together to form an interlinked or serve as a reorganization or elements to a new idea, pattern or structure [43] (Anderson & Krathwohl, 2001).

Table IV Difference in overall mean scores of individual post assignment between treatment group and control group

Group	N	Mean Scores	SD	*p*
Treatment	41	10.01	2.20	*** .00**
Control	40	6.03	2.00	

*Difference is significant at the .05 level.

B. The Difference in Mean Scores of Five Evaluation Criteria of Post Individual Assignment between Treatment Group and Control Group

Result of MANCOVA analysis test in Table V indicates that there was significant difference in mean scores of five evaluation criteria between treatment group and control group.

This is because HOTS is the highest level in the hierarchy of process thinking [44] (Bloom et al., 1956), which emphasized metacognitive to teach students how to receive and process information and experience [23]-[24] (Mohamed, 2006; Ea et al., 2005) to generate ideas.

HOTS allow students to think better [45] (Othman et al., 2010) and know how to use a variety of techniques or strategies to obtain relevant results through information and details of sources used [43] (Anderson & Krathwohl, 2001), exploring new opportunities, generate new ideas [46] (Milvain, 2008) and thus improve academic achievement [47]-[48], [23] (Tee, 2013; Subramaniam, 2009; Mohamed, 2006). Consequently, treatment group students are capable of generating an idea that encompasses all five criteria ideation in detail

Table V Difference in mean scores of five evaluation criteria of post individual assignment between treatment group and control group

Criterias	Group	Mean Scores	SD	*p*
Idea	Treatment	2.62	0.82	*** .00**
	Control	1.46	0.68	
Design	Treatment	2.21	0.65	*** .00**
	Control	1.34	0.62	
Function	Treatment	2.17	0.73	*** .00**
	Control	1.22	0.57	
Material	Treatment	1.80	0.57	*** .00**
	Control	1.28	0.53	
Dimension	Treatment	1.22	0.54	*** .00**
	Control	0.74	0.61	

*Difference is significant at the .05 level.

C. The Difference in Overall Mean Scores between Pre and Post Individual Assignment for Treatment Group and Control Group

Result of MANOVA analysis test in Table VI tabulates that there was significant difference in overall mean scores between pre and post individual assignment for treatment group. Whilst, there was no significant difference in overall mean scores between pre and post individual assignment for control group.

This shows that the treatment group using Marzano HOTS self-instructional manual has succeeded in increasing the mean scores of 24.3 percent from the 15 marks. On the other hand, there is increasing very low mean scores between pre and post individual assignments for control group, so there is virtually no increase. The findings of this study have shown that if a longer duration of treatment used in this study be able to get higher achievement in generating idea.

This is in line with the opinion of [49] and [38] Masek & Yamin (2012) and Behar-Orenstein & Niu (2011) who asserts that a longer treatment period will result in a higher significant increase on achievement of idea generation. Thus, learning and practice HOTS in a long period can improve student achievement in generating idea more effectively [50] (Miri, David & Uri, 2007).

Table VI Difference in overall mean scores between pre and post individual assignment for treatment group and control group

Group	N	Pre		Post		*p*
		Mean Scores	SD	Mean Scores	SD	
Treatment	41	6.46	1.96	10.10	2.16	*** .00**
Control	40	5.85	1.60	6.03	2.00	.66

*Difference is significant at the .05 level.

D. The Difference in Mean Scores of Five Evaluation Criteria between Pre and Post Individual Assignment for Treatment Group and Control Group

Result of MANOVA analysis test in Table VII shows that there was significant difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group. Whilst, there was no significant difference in mean scores of five evaluation criteria between pre and post individual assignment for control group.

For treatment group, mean scores increased the most between pre and post individual assignments are ideas and design criteria. This was followed by the criterion function, dimensions and materials. This is because Marzano HOTS provide some stimulus questions that are used to help students think diverge. There are eight types of Marzano HOTS. Each type of Marzano HOTS has its own graphic management and evaluation form.

So, with stimulus questions, more information can be collected and analyzed in the graphic management. Each step of the HOTS process will be done by the student when all the part of graphic management were completed with the information obtained. With these information, then the process of idea generation can be carried out smoothly and effectively.

Table VII Difference in mean scores of five evaluation criteria between pre and post individual assignment for treatment group and control group

Criterias	Group	Pre		Post		*p*
		Mean Scores	SD	Mean Scores	SD	
Idea	Treatment	1.44	0.63	2.66	0.82	*** .00**
	Control	1.44	0.63	1.50	0.66	.70
Design	Treatment	1.19	0.52	2.24	0.64	*** .00**
	Control	1.19	0.52	1.34	0.62	.24
Function	Treatment	1.41	0.60	2.19	0.73	*** .00**
	Control	1.13	0.45	1.22	0.57	.44
Material	Treatment	1.53	0.41	1.8	0.58	*** .00**
	Control	1.32	0.58	1.28	0.53	.74
Dimension	Treatment	0.89	0.48	1.23	0.54	*** .00**
	Control	0.74	0.52	0.78	0.59	.73

*Difference is significant at the .05 level.

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V. Conclusion and Recommendations

This study indicated that the HOTS has a positive impact on student achievement either overall or five evaluation criteria in ideas generation after controlling control variables gender, academic achievement, SES, learning styles and mean scores of pre individual assignment. The research findings support the teaching and learning of HOTS that will enable students to be aware of their own thinking skills and using it while generating idea. Through this awareness, students can improve their performance on those tasks. Models, strategies, techniques, and activities are model lesson plans showing how thinking skills could be taught together with subject matter using the integrated approach have been implemented in the school system [25]. Nevertheless, a self-instructional manual can be an alternative approach because it can cater to the more extendable individual differences of learner's abilities, interest and degrees of application. Consequently, students should be assisted to acquire HOTS; either through the conventional teaching and learning environment or a self- instructional, individualized manual for generating idea.

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Optimization investigation of a stand-alone hybrid energy system design in Kirkuk technical college.

Sameer Al-Juboori, Amer Mejbel, Ali Mutlag

***Abstract*—** In this paper a methodology has been developed for optimum planning of hybrid PV, Wind and diesel generator system with some battery backup in Kirkuk Technical College in Iraq. The local solar radiation, wind data and components database from different manufactures are analyzed and simulated in HOMER model to assess the technical and economic viability of the integrated system. Performance of each component was evaluated and sensitivity analysis was performed to optimize the system at different conditions. Optimal hybrid model has been selected on the basis of cost associated with the system and reliability using HOMER. The optimal cost of energy from the proposed hybrid system is (0.154 $/ kWh.). Comparison was also made with the cost per kilowatt hour from the National grid.

***Keywords*—** stand-alone, hybrid energy system, homer.

1. INTRODUCTION

Renewable energy is defined as the energy generated from natural resources such as sunlight, wind, and geothermal heat, which are renewable. The application of renewable energy system has become an important alternative when the conventional sources are depleted and the price of oil reaching its highest level [1-2]. Hybrid power systems usually integrate renewable energy sources with fossil fuel based generators to provide electrical power. Hybrid systems offer better performance, flexibility of planning and environmental benefits compared to the diesel generator based stand-alone system. Hybrid systems also give the opportunity for expanding the generating capacity in order to cope with the increasing demand in the future [3-6].

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2. HYBRID POWER SYSTEMS

Hybrid energy system usually consists of two or more renewable energy resources used together to provide increased system efficiency as well as greater balance in energy supply [7-8]. Hybrid power systems usually integrate renewable energy sources with fossil fuel, (diesel/petrol) based generators to provide electrical power and traditional diesel system acting as back-up in case of lack of the primary source [9].

3. MODELING OF HYBRID SYSTEMS

In order to design a mini-grid hybrid power system, one has to be provided with information for the selected location. Typical information's required are; the load profile that should be met by the system, solar radiation for PV generation, wind speed for the wind power generation, initial cost for each component, cost of diesel fuel, annual interest rate, project lifetime, etc. Then using these data one can perform the simulation to obtain the best hybrid power system configuration. One of the available tools for this purpose is the HOMER software from USA National Renewable Energy Laboratory (NREL) [10]

4. RESEARCH METHOD

The proposed hybrid renewable consists of wind turbine and solar photovoltaic (PV) panels with battery; generator and inverter are added as part of back-up and storage system. Proposed system is shown in Figure1 and the project building load demands are shown in Figure 2.

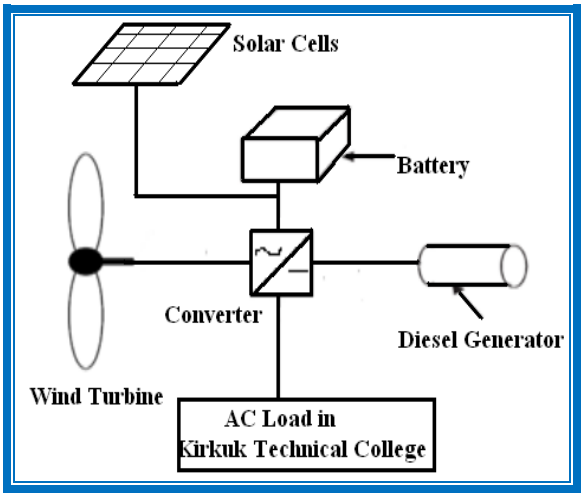

Figure 1: The proposed hybrid system.

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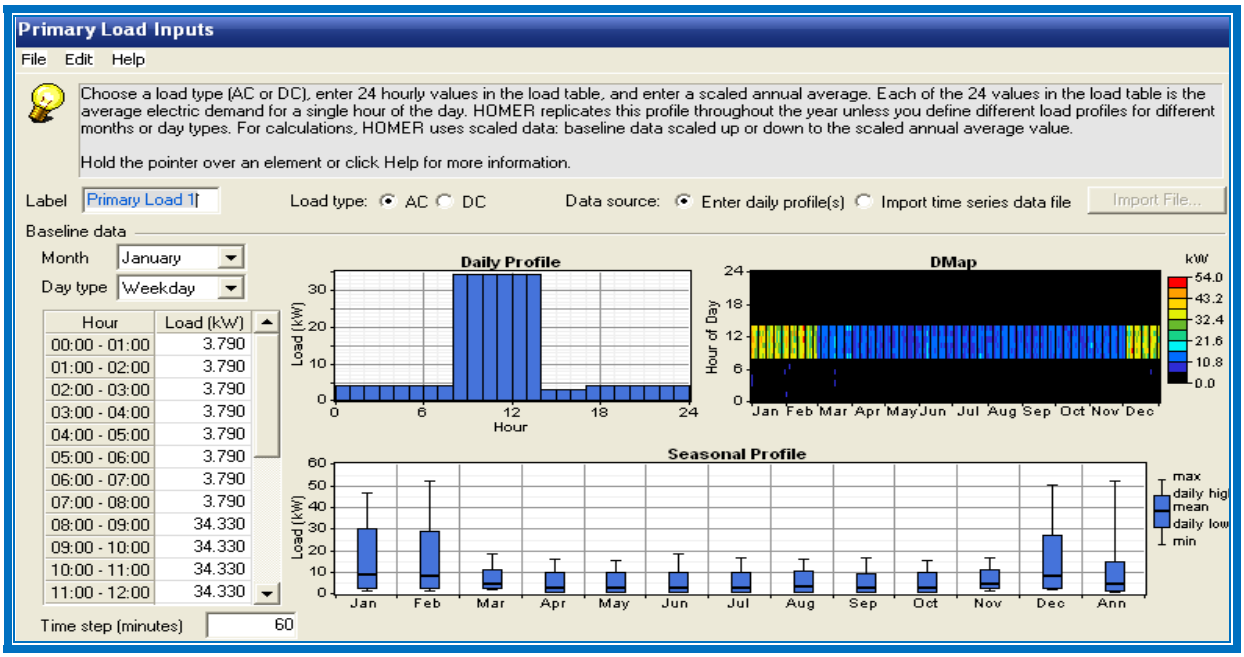

Figure 2: Project building load demand.

In this paper, Hybrid optimization model of renewable energy (HOMER) has been used to optimize the best energy efficient system for the dean office in Kirkuk Technical College (KTC), see Figure 3, considering different load and wind photovoltaic (PV) combinations. The study site location Latitude is 35° 5̀ north and 44° 4̀ east. Daily solar radiations in the study site and wind speed were got from NASA web site. [11].

Figure 3: The building of the dean of Kirkuk Technical College

4.1 SOLAR PV PANELS

The proposed solar power system is 40kW. The supposed cost is 7000 $/kW and the lifetime of the panels will consider to be 25 years. Figure 4 shows the solar resource profile considered over a span of one year. The monthly averages of daily global solar insolation data are normally available for several locations in a region. The data should be such that it covers a larger range of latitudes. These data are then reduced to the monthly average daily clearness index (KT) by taking the ratio of measured global solar insolation to the calculated extra-terrestrial horizontal insolation. The annual average solar radiation was scaled to be 5.27kWh/m2/day and the average clearness index was found to be 0.634. The graph plot in the Figure 4 shows that solar radiation is available throughout the year; therefore a considerable amount of PV power output can be obtained.

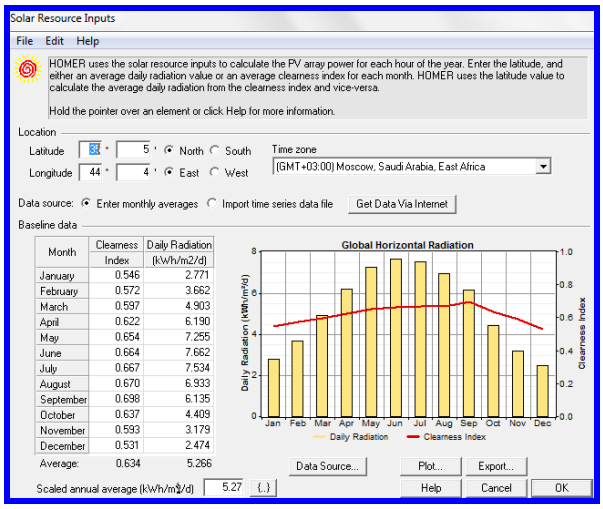

Figure 4: The daily solar ratio and clearness index

4.2 WIND TURBINE

Wind turbine type PGE 20/25 was choosed among many manufactured turbines, has a capacity of 20 kW. Its initial cost is $20000 and its replacement cost is $16000. Annual operation and maintenance cost is $1000 per year. Its hub and anemometer is proposed to located at 10 m height. Lifetime is assumed for 15 years. The choosed wind turbine specifications, capital and replacement costs were shown in Figure 5 [12], and the wind speed for our case study location is 5.758m/s as shown in Figure 6. Also it shows that there are 16 hours of peak wind speed. The wind speed variation over a day (diurnal pattern strength) is 0.14 and the randomness in wind speed (autocorrelation factor) is 0.93.

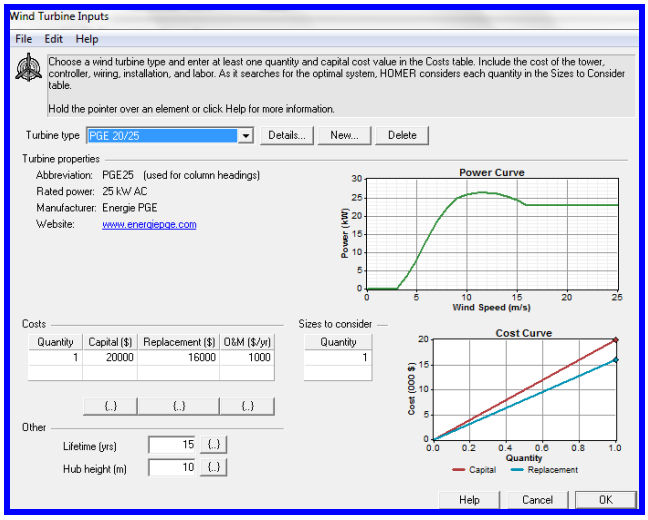

Figure 5: PGE20/25 wind turbine specifications

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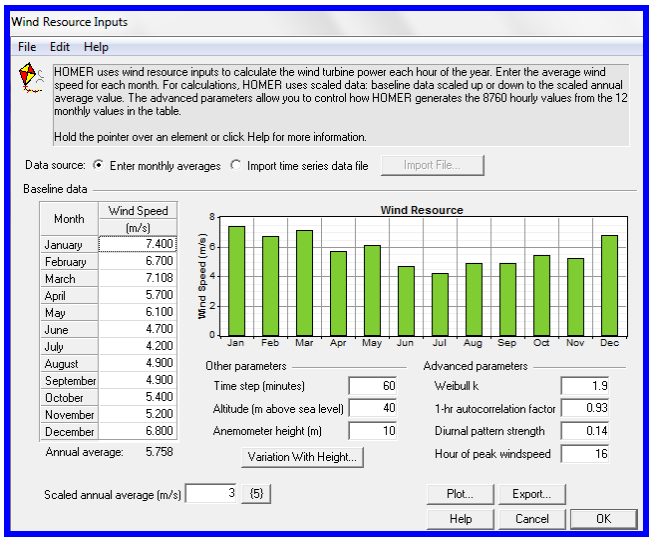

Figure 6: Wind speed in the project location.

4.3 DIESEL GENERATOR

STAMFORD AC generator from NEWAGE INTERNATIONAL LIMETED ENGLAND which was already installed in the college, has a capacity of 170 kW. Its initial and replacement costs are 30000$ and 28000$ respectively.

The operation and maintenance is 5$ per hour. Its lifetime is estimated to be 5000 operating hours. Other details of generator were shown in Figure. 7.

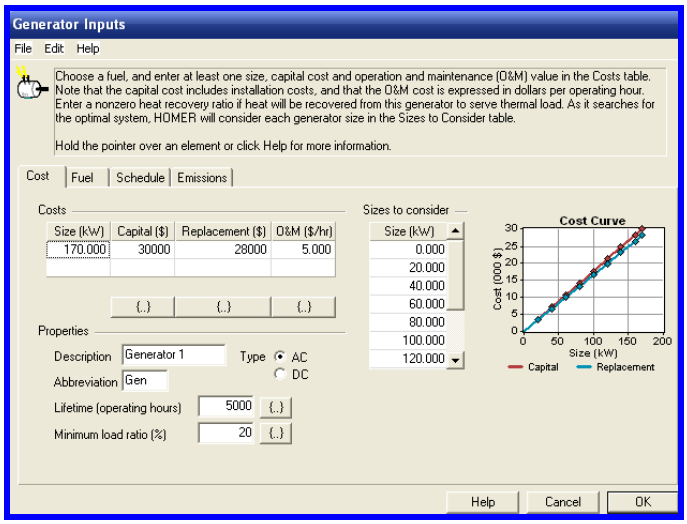

Figure 7: Diesel generator specification.

4.4 CONVERTERS:

A converter is a device that converts electric power from dc to ac in a process called inversion, and/or from ac to dc in a process called rectification. HOMER can model all types of converters.

The converter size, which is a decision variable, refers to the inverter capacity, meaning the maximum amount of ac power that the device can produce by inverting dc power. The user specifies the rectifier capacity, which is the maximum amount of dc power that the device can produce by rectifying ac power, as a percentage of the inverter capacity. The rectifier capacity is therefore not a separate decision variable.

HOMER assumes that the inverter and rectifier capacities are not surge capacities that the device can withstand for only short periods of time, but rather, continuous capacities that the device can withstand for as long as necessary. The economic properties of the converter are its capital and replacement cost in dollars, its annual operation and maintenance (O&M) cost in dollars per year, and its expected lifetime in years.

5. DESIGNE RESULTS

The overall optimization results table by HOMER will show system configurations sorted by total net present cost which contain a few of the key simulation results: namely, the total capital cost of the system, the total net present cost, the levelized cost of energy (cost per kilowatt hour), the annual fuel consumption, and the number of hours the generator operates per year. HOMER can also show a subset of these overall optimization results by displaying only the least-cost configuration within each system category or type as shown in Table 1 for the five least cost.

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6. THE FIRST LEAST-COST RESULT (as shown in the first row of Table 1): wind turbine, diesel generator, converter and batteries.

The schematic diagram is shown in Figure 8. There are two busbars DC and AC. The load, turbine generator PGE 20/25 and diesel generator are connected to AC busbar. Batteries are connected to DC busbar, while converter is connected to both DC and AC busbars.

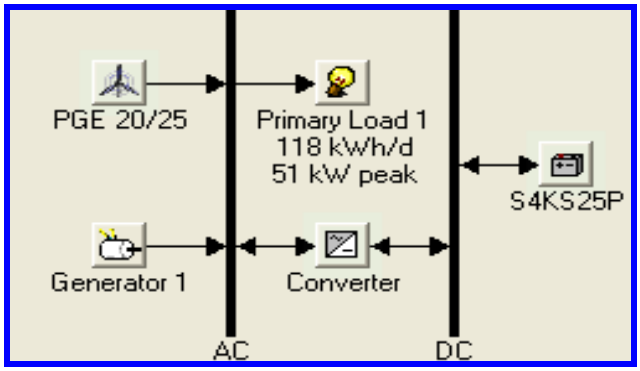

Figure 8: The first schematic design.

6.1 COST CALCULATIONS:

Renewable and nonrenewable energy sources typically have dramatically different cost characteristics. Renewable sources tend to have high initial capital costs and low operating costs, whereas conventional nonrenewable sources tend to have low capital and high operating costs. In its optimization process, HOMER must often compare the economics of a wide range of system configurations comprising varying amounts of renewable and nonrenewable energy sources. To be equitable, such comparisons must account for both capital and operating costs. Life-cycle cost analysis does so by including all costs that occur within the life span of the system. Figure 9, shows the first design cost summary: Wind turbine= 34,940$, Diesel generator12,358$, Batteries= 13,361$, Converter= 9,283$ and the system total cost is 69,941$.

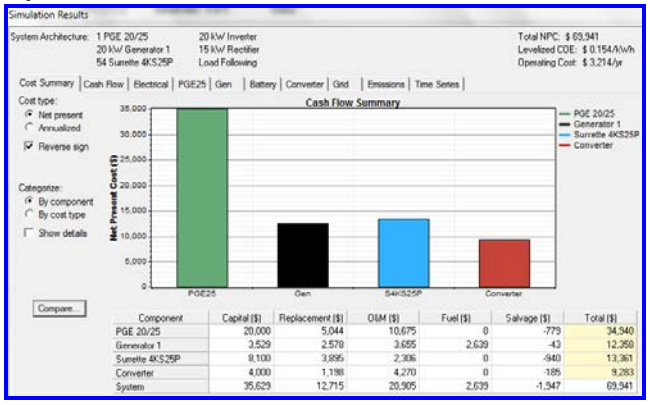

Figure 9: The first design cost summary (by components).

6.2 MONTHLY AVARAGE ELECTRIC PRODUCTION

The percentage of electric production from wind generator and diesel generator are 94%, and 6% respectively. The details of the monthly electric production are show in Figure 10.

Figure 10: The details of the monthly electric production.

6.3 WIND TURBINE:

Wind generator (PGE20/25) rated capacity, mean and maximum output are 25, 9 and 26.3kW respectively. Total production is 78,464 kWh/yr. Details of simulation results are shown in Figure 11.

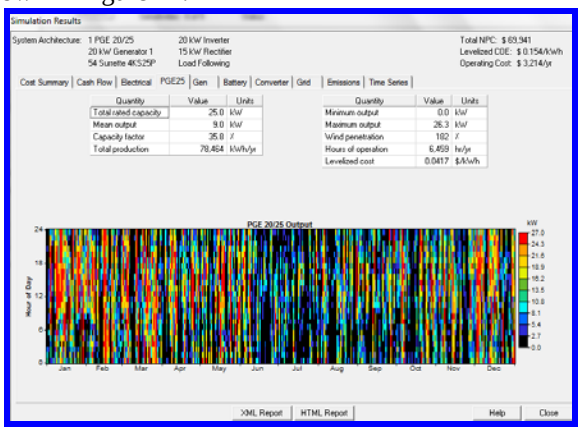

Figure 11: wind generator PGE20/25 simulation results details.

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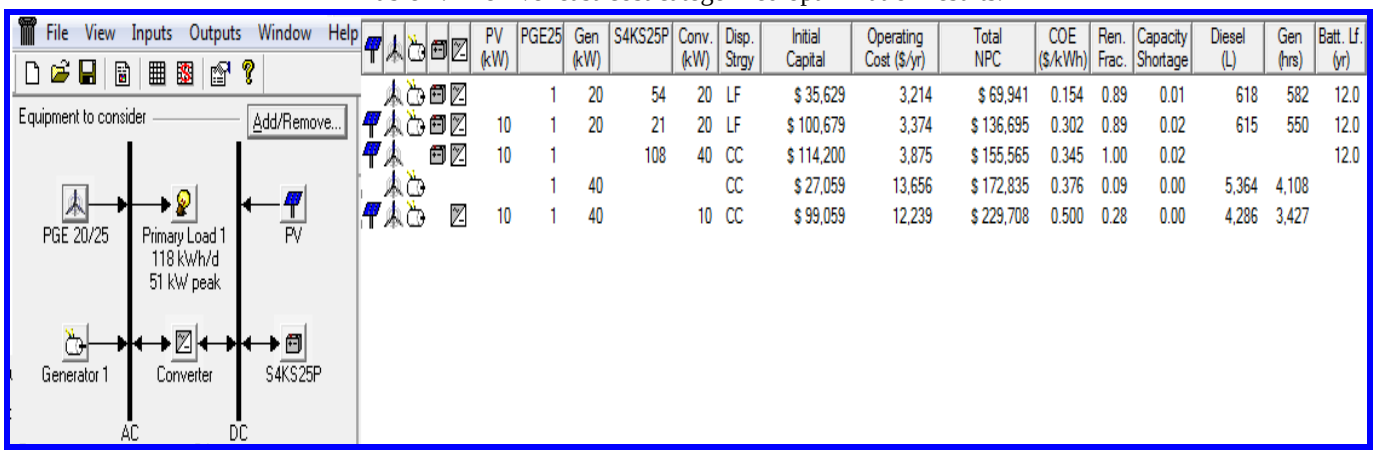
Table 1: The five least-cost categorized optimization results.



PV (kW)	PGE25	Gen (kW)	S4KS25P	Conv. (kW)	Disp. Strgy	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Gen (hrs)	Batt. Lf. (yr)
	1	20	54	20	LF	$ 35,629	3,214	$ 69,941	0.154	0.89	0.01	618	582	12.0
10	1	20	21	20	LF	$ 100,679	3,374	$ 136,695	0.302	0.89	0.02	615	550	12.0
10	1		108	40	CC	$ 114,200	3,875	$ 155,565	0.345	1.00	0.02			12.0
	1	40			CC	$ 27,059	13,656	$ 172,835	0.376	0.09	0.00	5,364	4,108	
10	1	40		10	CC	$ 99,059	12,239	$ 229,708	0.500	0.28	0.00	4,286	3,427	

6.4 DIESEL GENERATOR:

Diesel generator in the 1st design works 582 hr/yr. and produce 16,546kW/yr. The specific fuel consumption is 0.132L/kWh and diesel generator consumes 618 L/yr.

6.5 BATTERIES:

The dc bus voltage in the system is 12V. Among battery types and specifications we choosed the battery type (Surette 4KS25P) of 4V terminal voltage for its good specifications. The string size is 3 to get 12V dc. We use 16 strings in parallel and the overall will be equal to 16*3=48 batteries total. Figure 12 shows battery simulation results in details.

Figure 12: Battery simulation results.

HOMER calculates its fixed and marginal cost of energy for comparison with other dispatchable sources. Unlike the generator, there is no cost associated with ''operating'' the battery bank so that it is ready to produce energy; hence its fixed cost of energy is zero. For its marginal cost of energy, HOMER uses the sum of the battery wear cost (the cost per kilowatt-hour of cycling energy through the battery bank) and the battery energy cost (the average cost of the energy stored in the battery bank).

6.6 CONVERTER

The inverter and rectifier capacity are 20kW and 50kW respectively. Figure 13 shows capacity, maximum output, minimum output, capacity factor, energy in, energy out and losses for both inverter and rectifier.

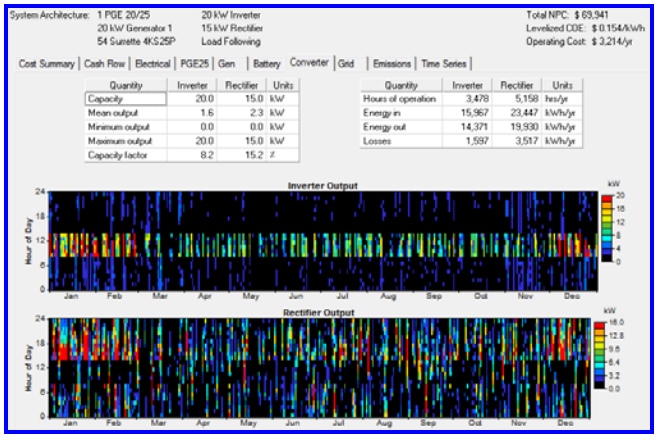


Figure 13: Converter simulation results.

6.7 Grid Extension Cost vs Stand-alone Hybrid System

It is important to compare the hybrid system with the National grid. In Homer model, the National grid inputs as shown in Figure 14 are: capital cost= 8000$/km, operating and maintenance cost= 600$/yr./km and grid power price as 0.4$/kWh.[10]

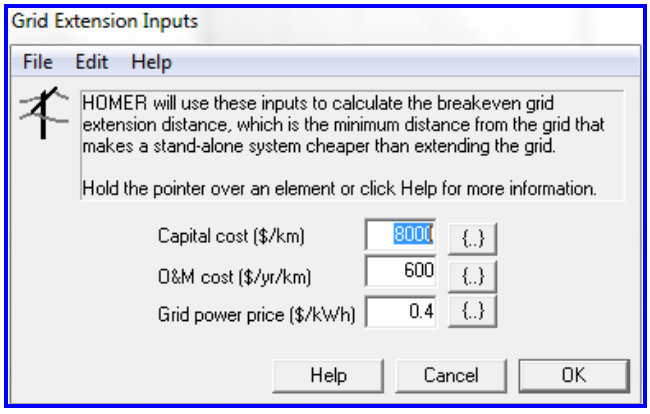


Figure 14: Grid Extension Inputs.

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Homer will use these inputs to calculate the breakeven grid extension distance, which is the grid minimum distance that makes cost of energy COE in a stand-alone system cheaper than COE in extending the grid.

In the 1st design the breakeven grid extension distance is (-8.54) km. The negative distance value means that COE in hybrid system is cheaper always than COE in National grid.

6.8 GAS EMISSIONS:

Most of the pollutants result from the production of electricity by the generator(s), the production of thermal energy by the boilers and the consumption of grid electricity. The amount of pollutants for the 1st design category are shown in the table2

Table2: The amount of pollutants for the 1st design category.

Pollutant	Emissions (kg/yr)
Carbon dioxide	1,627
Carbon monoxide	4.02
Unburned hydrocarbons	0.445
Particulate matter	0.303
Sulfur dioxide	3.27
Nitrogen oxides	35.8

6.9 THE OTHER LEAST-COST RESULTS:

6.9.1 THE SECOND LEAST-COST RESULT: wind turbine + solar panels + diesel generator + converter + batteries. Cash flow summary is shown in Figure 15. The schematic diagram is shown in Table 3a.

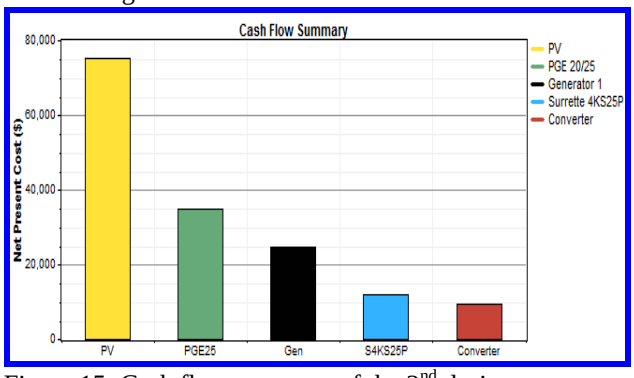

Figure 15: Cash flow summary of the 2nd design.

In the 2nd design, the breakeven grid extension distance is (-3.54) km. The negative distance value means that COE in hybrid system is cheaper always than COE in National grid.

6.9.2 THE THIRD LEAST-COST RESULT: wind turbine + solar panels + converter + batteries. The schematic diagram is shown in Table 3b. In the 3rd design, the breakeven grid extension distance is (-2.12) km. The negative distance value means that COE in hybrid system is cheaper always than COE in National grid.

6.9.3 THE FORTH LEAST-COST RESULT: wind turbine + solar panels + converter + batteries. The schematic diagram is shown in Table 3c. In the 4th design, the breakeven grid extension distance is (-0.830) km. The negative distance value means that COE in hybrid system is cheaper always than COE in National grid.

6.9.4 THE FIFTH LEAST-COST RESULT: wind turbine + diesel generator. The schematic diagram is shown in Table 3d. In the 5th design, the breakeven grid extension distance is (3.43) km. This means that COE in hybrid system is cheaper than COE in National grid for distances greater than 3.43 km as shown in Figure 16.

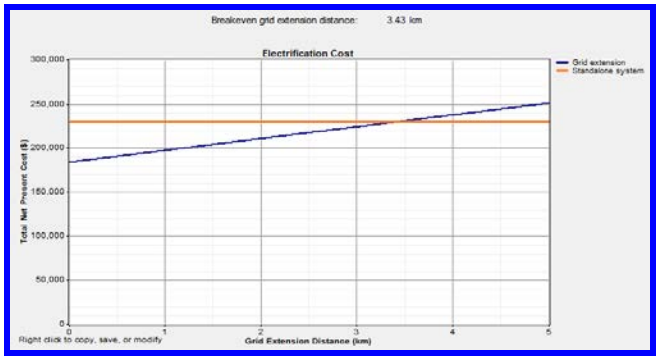

Figure 16: Break even grid extension distance = 3.43km.

6.10 COMPARISON BETWEEN OPTIMAL and OTHER CATOGERIS.

Comparison between the hybrid systems in total cost, levelized COE, operating cost, fuel consumption, grid distance and CO2 is shown in Table 4.

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Table 3: The system schematic designs (a, b, c and d).

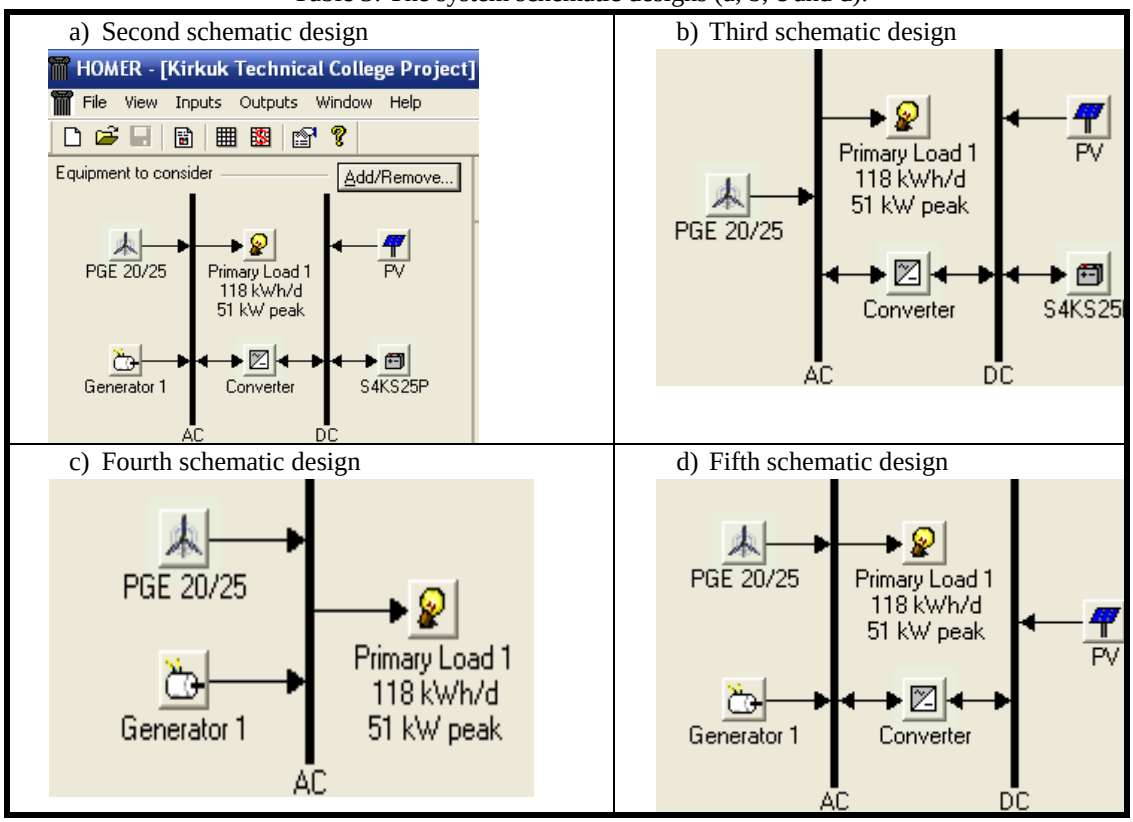

Table 4: Comparison between Optimal and Other Categories.

Design	Total Cost[$]	Levelized COE [$ / kwh]	Operating Cost[$/yr]	Fuel Consumption [L]	Breakeven Grid Extension Distance [km]	CO2 Emission [kg/yr.]
1st	69,441	0.154	3,214	618	-8.54	1,627
2nd	136,695	0.302	3,374	615	-3.54	1,620
3rd	155,565	0.345	3,875	0.0	-2.12	0
4th	172,835	0.376	13,655	5,364	-0.83	14,124
5th	229,708	0.5	12,239	4,286	3.43	11,287

6.11 CONCLUSIONS:

The systems based on PV alone, wind alone, solar-battery, solar-Diesel Generator (DG), wind-battery, wind-DG, wind solar- battery, and wind-solar-DG and other possible configuration for the utilization of distributed generating systems were investigated. For a given location, optimization is carried out on the basis of the cost and reliability of the system. As shown in Table 4, it is found that the hybrid system based on wind turbine, diesel generator, battery storage and converter is the best hybrid generating system for the given location in Kirkuk city.

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Future Trends of Mechatronics Engineering in Pakistan

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Abstract —The paper presents a survey based approach in order to observe the level of awareness regarding Mechatronics in society of Pakistan and the factors affecting the future development trend of Mechatronics in Pakistan. With the help of these surveys a new direction for making a Mathematical model for the future development trend of Mechatronics in Pakistan is also suggested.

Keywords— Mechatronics Society Survey, Future Development Trend of Mechatronics in Pakistan, Probability Estimation, Mathematical Model.

I.INTRODUCTION

Mechatronics, being a new discipline in Pakistan has to face many risks in its successful establishment and growth [1]. A discipline owes its implementation and growth to the factors such as Industry acceptance level, Society acceptance level, need of curriculum and need of research regarding that discipline. The future development trend of any discipline is dependent upon the affect of these factors.

In Pakistan, in order to see the level of acceptance of society regarding the emerging discipline "Mechatronics" , a survey based approach has been used.

II. MECHATRONICS SOCIETY SURVEY

A survey was carried out in society to know where Mechatronics stands in our society. To know how many people actually know what mechatronics is. The survey participants were some Engineering institutes teaching faculty members and the freshly inducted engineering students (other than mechatronics students) and their families. The survey questions are given in the Appendix A. These survey participants were chosen intentionally to know whether they had knowledge of Mechatronics engineering or not.

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To know the reasons why they opted engineering field other than Mechatronics, did they opt other engineering field by choice in spite of having complete knowledge of Mechatronics or they did not know about Mechatronics. Figure 1 shows the percentage of family occupation of the participants of survey.

25% of the participants had Engineering, 5% had Medical, 30% had business as their family occupation. 5% of the participants belonged to families having Academic background and 35% of the participants belonged to families having other occupation or more than one occupation.

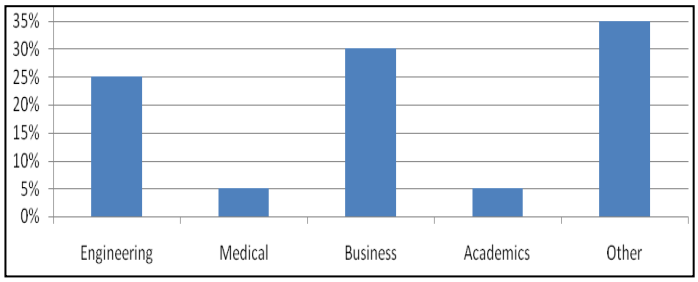

Figure 1. Family Occupation

In the survey, participants were asked to tell if they have any family member as Engineer.

Figure 2 shows the results. 55% participants have Engineers in their family while 45% said that they don't have a single family member as an Engineer.

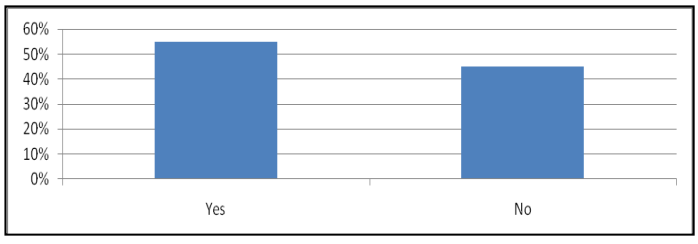

Figure 2. Family Member as Engineer

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The survey comprised of a question to know whether the participants have ever heard about Mechatronics. The result is shown in Figure 3.

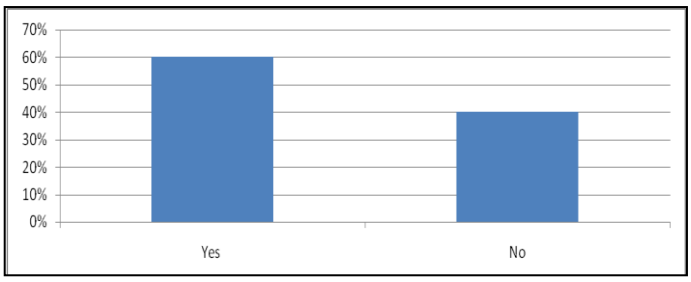

Figure 3. Heard about Mechatronics

60% of the participants claimed that they have heard about Mechatronics Engineering while 40% replied that they have not even heard about Mechatronics Engineering. This means in our society, still people are not aware of Mechatronics Engineering to such an extent that they have not ever heard about it.

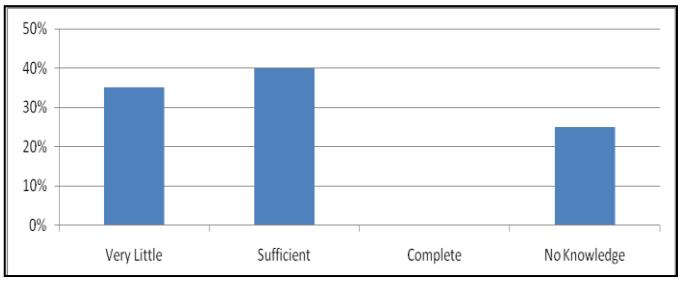

Figure 4. Knowledge about Mechatronics

In order to know the level of the knowledge that the participants had about Mechatronics, we asked about the level of their knowledge related to Mechatronics. The result is shown in Figure 4.

35% of the participants had very little about Mechatronics, 40% of them said they had sufficient knowledge, 25 % said they had no knowledge of Mechatronics. No one said that they had complete knowledge about Mechatronics. Figure 5 shows the results of the question asked from the participants: According to their knowledge what mechatronics is.

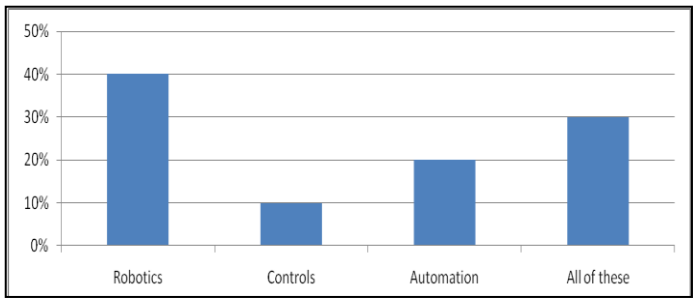

Figure 5. What is Mechatronics

40% of them were of the view that Mechatronics is related only to Robotics, 10% said is all they know about mechatronics is that it is related to controls. 20% claimed that Mechatronics is related to automation and 30% said Mechatronics is related to all of these three areas.

The participants were asked if they can tell how many universities in Pakistan are offering Mechatronics Engineering. The correct answer was 7. Only 35% of them knew the correct answer. 10% said the number is 15, 35% said it is 3 in number and 20% said that there are 5 universities in Pakistan that are offering Mechatronics Engineering. The result is shown in Figure 6 as follows :

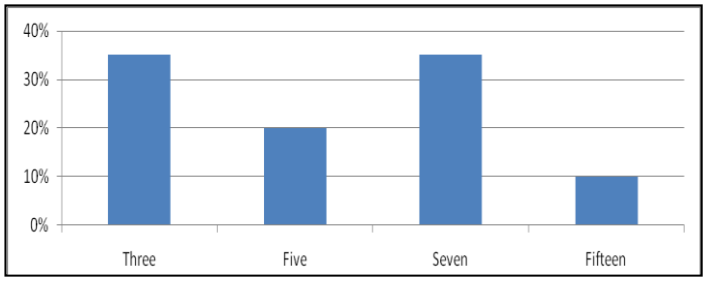

Figure 6. Number of Universities offering Mechatronics Engineering programs

In the survey, the participants were asked to give any two names of the universities that are offering degree in Mechatronics Engineering. 80% of the participants were able to give two names while 20% did not know any name of the university in this regard.

Also, a question was asked from participants if they knew in which industries Mechatronics Engineers are in demand. Almost 80% of them were able to correctly answer the question and gave almost 2 names of the industries in which Mechatronics Engineers are in demand. 20% of the participants did not know the names of the industries where Mechatronics Engineers are in demand.

III. FUTURE DEVELOPMENT TREND OF MECHATRONICS ENGINEERING IN PAKISTAN

A survey was conducted in order to see the vision of the people of society about future development trend of Mechatronics Engineering in Pakistan. The people rated different parameters depending upon the effect of those parameters on the future development of Mechatronics in Pakistan.

The survey form is available in the Appendix B and the survey results are being compiled in form of a bar chart as shown in the Figure 7. The participants of the survey were from Engineering faculty.

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The bar chart of Figure 7 uses estimation approach [2]. The data compiled is for the survey results taken in 2012 – 2013. Figure 7 shows the results that are valid only in case of Engineering Faculty. Similarly one can conduct a survey in different sectors of the society and make a model for each sector to observe the trend of development of Mechatronics. If this type of survey is conducted after every six months or a span of one year, we can observe a clear trend line for the development trend of Mechatronics and can make a mathematical model out of it easily. This is pictorially explained in figure 8.

The mathematical formula for the probability estimation of the parameters shown in Figure 7 is derived as :

$$Y(X) = P(SA^X)\,W_1 + P(A^X)\,W_2 + P(D^X)\,W_3 + P(SD^X)\,W_3 \quad \text{..... (1)}$$

Where
X = Parameters Affecting the development of Mechatronics
Y(X) = Estimation of Affect of X on Future Development of Mechatronics
SA= Strongly Agree, A= Agree, D= Disagree, SD= Dis-Agree

$P(SA^X)$, $P(A^X)$, $P(D^X)$, $P(SD^X)$) are the probabilities of SA, A, D, SD for a given parameter X
W_1, W_2, W_3, W_4 are the weightage given to Probabilities of SA, A, D, SD respectively [3].

For n number of parameters, the mathematical formula for probability estimation can be written in a matrix form.

$$\begin{pmatrix} Y(X_1) \\ Y(X_2) \\ . \\ . \\ Y(X_n) \end{pmatrix} = \begin{pmatrix} P(SA^{X1}) & P(A^{X1}) & P(D^{X1}) & P(SD^{X1}) \\ P(SA^{X2}) & P(A^{X2}) & P(D^{X2}) & P(SD^{X2}) \\ . & . & . & . \\ . & . & . & . \\ P(SA^{Xn}) & P(A^{Xn}) & P(D^{Xn}) & P(SD^{Xn}) \end{pmatrix} \begin{pmatrix} W_1 \\ W_2 \\ . \\ . \\ W_n \end{pmatrix} \quad \text{.... (2)}$$

Using the average values of the probabilities of the parameters, one can get the estimation of overall trend of Y with respect to time for all parameters collectively using the following estimation formula :

$$Y(t) = Avg(P(SA^X))W_1 + Avg(P(A^X))\,W_2 + Avg(P(D^X))\,W_3 + Avg(P(SD^X))\,W_3 \quad \text{..... (3)}$$

Where Avg = Average

If we have the data of previous years, then by using it and conducting surveys in future we can make a mathematical model for future development trend of Mechatronics Engineering in Pakistan [4].

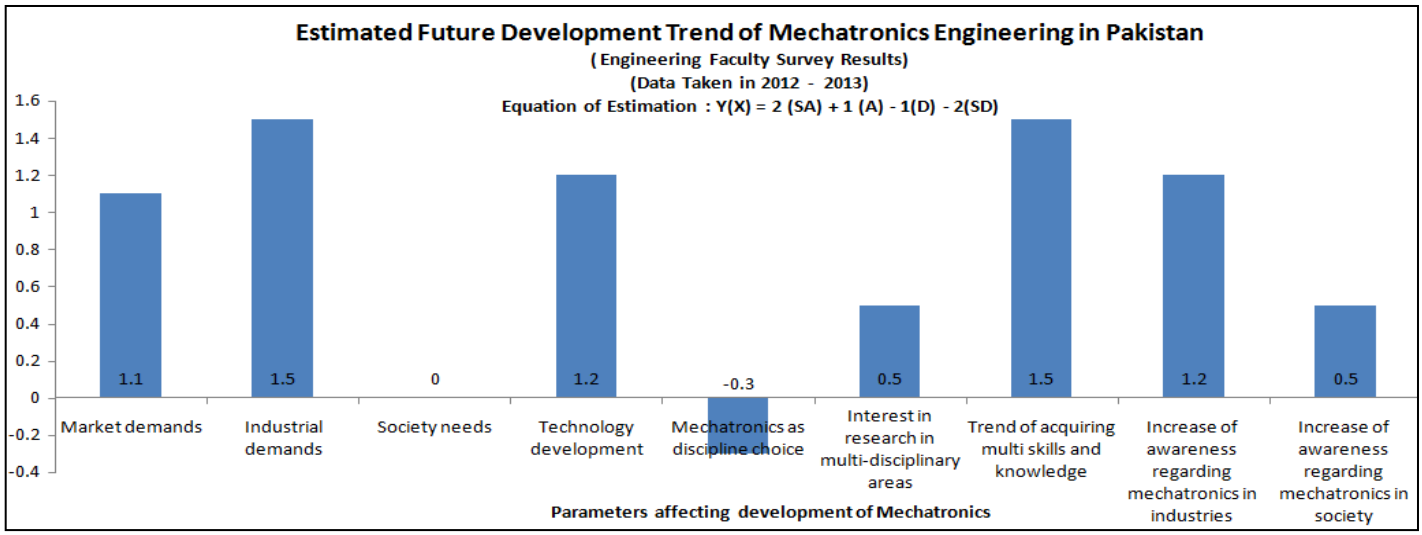

Figure 7. Estimated Future Development Trend of Mechatronics Engineering in Pakistan

Figure 8 shows the example of such a model.

IV. CONCLUSION AND RECOMMENDATIONS

The increase in the importance of mechatronics in the world is due to the power, uniqueness and versatility of mechatronics. This increasing worth of mechatronics urges engineers to think of being getting familiar with the basic theory and engineering practice of mechatronics. Mechatronics is so wide field that there is no end or limit to the application of mechatronics and to

the contribution mechatronics is adding to the concept of inter-disciplinary areas. But the mechatronics engineers in Pakistan have to face many problems in seeking appropriate jobs because of the lack of awareness in the industries as well as society of Pakistan regarding mechatronics engineers.

It is expected that in the years to come, Mechatronics will gain the status of most important engineering discipline in Pakistan from industrial point of view and mechatronics engineers will be in great demand.

Following recommendations are made on the basis of the research.

- Awareness campaign regarding Mechatronics by arranging seminars and using electronic media should be initiated immediately
- A Survey should be conducted every year in order to know the future development trend of Mechatronics and by using previous and present data Mathematical Model for Mechatronics can be made easily

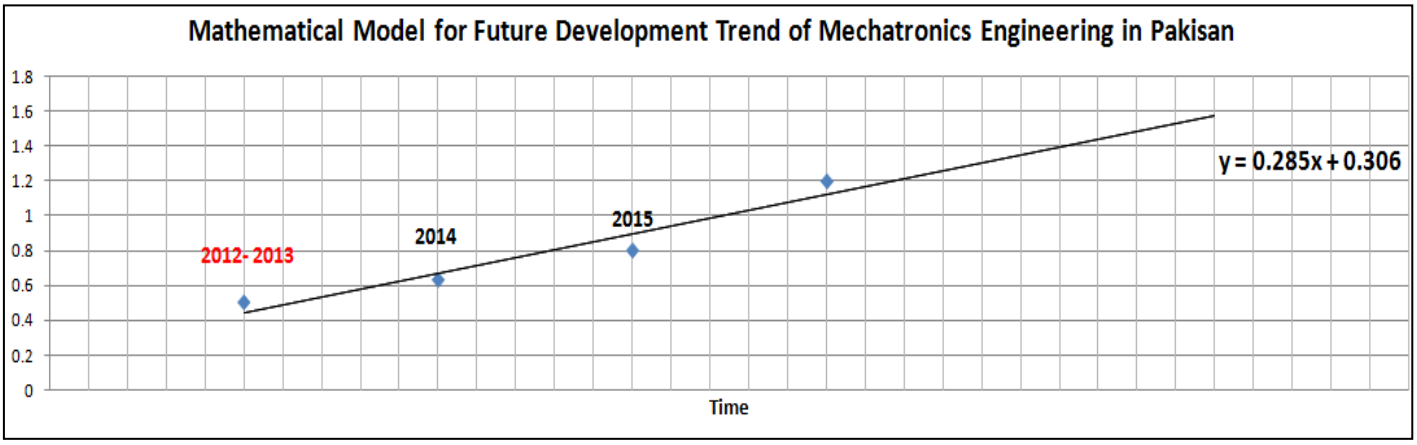

Figure 8. Mathematical Model for Future Development Trend of Mechatronics Engineering in Pakistan

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Appendix A : Mechatronics Society Survey Questionnaire

Mechatronics Society Survey

Name: _____ Age: _____

Qualification: _____

Occupation : _____

1. What is your family occupation?
a. Engineering b. Medical c. Business d. Academics e. Other

2. Is any of your family members an Engineer?
Yes / No

3. Have you ever heard about Mechatronics Engineering?
Yes / No

4. How much knowledge do you have related to Mechatronics Engineering?
a. Very Little b.Sufficient c. Complete d. No knowledge

5. According to your knowledge, Mechatronics Engineering is related to:
a. Robotics b. Controls c. Automation d. All of these

6. Do you know how many universities in Pakistan are offering Mechatronics Engineering?
a.3 b.5 c.7 d.15

7. Can you name any two universities which offer degree in Mechatronics Engineering?

_____
_____
_____
_____

8. Can you name any two industries where Mechatronics Engineers are working or in demand?

_____
_____
_____
_____

Appendix B: Survey - Future Development trend of Mechatronics Engineering in Pakistan

Name : _____
Profession:_____

Rate the following parameters according to their effect on the future development of Mechatronics Engineering in Pakistan

Dependent Parameters	Strongly Agree	Strongly	Disagree	Strongly Disagree
Market demands				
Industrial Demands				
Society Needs				
Technological Development				
Mechatronics as a discipline choice				
Interest of people in carrying out research in multidisciplinary areas				
Trend of acquiring multi-disciplinary skills and knowledge				
Increase of awareness regarding mechatronics in industries of Pakistan				
Increase of awareness regarding mechatronics in society of Pakistan				

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Assessment of Remedial and Introductory Math Courses : a Case Study

Lionel Khalil, Marie Khair, Marie-Joelle El Hajje

***Abstract*—** This study presents a statistical model that assesses the effectiveness of remedial and introductory courses at a private university in Lebanon. Math courses performance is defined by change of major rate, dropout rate and GPA level. The performance is reduced along two factors: High school level, and Major. The findings suggest that the global level of math in High school is going down since 10 years. Remedial math courses are a filter to allow the access of difficult majors to appropriate students. As a filter remedial courses have an impact on the dropout rate and on the orientation of the students in an appropriate major related to their level.

***Keywords*—**Quality assessment, math level, remedial courses

I. Introduction

REMEDIAL or developmental courses effectiveness was always an important educational research and investment topic due to the impact that these courses may have on the students. About 60% of the students in the United States needed a remedial math and/or English course [1], while in [2], it was shown that in the UK that remedial courses have no impact on the other math courses student's performance. Worthiness and effectiveness of mathematical remedial courses in a Lebanese university have been already studied by Nasser and Nauffal [3]. Indeed the impact of the remedial courses on the attrition rate is one of the findings of their work. Previously we couldn't identify inflation in the historical GPA for the same Lebanese university that has been abundantly described by the literature since 2007 until now [4].

In Lebanon, the choice of the university is driven by the language of study (English, French or Arabic), Nauffal and Nasser [5] have compared French and American Education on Lebanese students and the perceptions of quality in higher education. Francophone High School Students moving to Anglophone universities can feel that Anglophone institution concerns include the mental and physical development of the students with more integrated student affairs bodies.

Remedial mathematics was always thought to be the best way to fill the gap between the high school students' competencies and the university and college admission requirements. However, while providing this advantage; remedial courses may have some impacts on the drop out level and performance level.

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II. Literature Review

Three theories provide a framework on first year retention that can be used to identify the performance of the students in Remedial (Mat 1xx) and Introductory (2xx): Astin's conceptual model of input-environment-outcome (I-E-O) [6], Tinto's Student Integration Model [7] and Beans' Student Attrition Model [8], Bean developed a model along three factors individual (motivational factors), environmental (student background factors), and institutional factors (academic performance). Those frameworks are not entirely overlapping to explain students' persistence. Finally based on Beans' Model, the expectancies framework defined by Bank et al [9] segregate expectations such as self-labels, own norms and attributed norms from other social expectancies. Those expectations are better predictors of students' persistence rather than social expectancies. Finally, Anderson [10] distinguishes between forces that promote persistence generally and those that promote academic achievement.

Remedial courses aims to improve student skills necessary to complete a regular university program. Nasser and Nauffal [3] have found in a university in Lebanon that the more remedial courses students take the lower the cumulative GPA. Weissman [11] have already found the same results in the USA. Researches have study the performance in a course and student satisfaction on this course. Course evaluation by the students is correlated with students expected grade [12]. Isley and Singh [13] and McPherson [14] have shown that student's expected grade is correlated with their real grade.

III. Our Case Study

A. Research questions

Are remedial courses playing their role of filter by orienting students to the appropriate major ? To what extent remedial math courses are correlated to drop-out students ?

To what extent remedial math courses are an indicator of the future academic performance and the grade point average (GPA) of the students ?

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B. Methodology

Instrumentation. The data from 1994 until 2012 were obtained from student enrollment database from a private university in Lebanon. Data includes students' courses and grades. Several transformations of the demographics were necessary to exploit the data.

Student Evaluation of Instructors (SEI) aims to give a feedback to the instructor for merit assessment and quality improvement. Several works have been done on identifying correlation with some variables like instructor enthusiasm, instructor rank, student expected grade … In the studied university, SEI is a composite score of 18 equally weighted questions all aspects of the Course. The composite score is based on a mapping from 1 to 7 of a Likert Scale. The distance between each attribute is assumed equal intervals and therefore the quantitative measures assigned to the qualitative attributes will be used in parametric tests. Analyses were conducted on the two semesters of the academic years 2013-2014. The reliability of the scale was measured with Cronbach's alpha; Cronbach's alpha was in the acceptable range of .9, across the main dimensions of the study (Faculty, and Course level). The response ratio of 66 % was high enough to ensure a confidence level of 95% and a Margin of error of 5%.

Treatment of Data. Blue System (Explorance) was used to collect SEI surveys. SPSS version 11.5 was used in processing the data for ease and accuracy. Correlations, Means and Standard Deviations were calculated.

IV. Key Findings on the Database Analysis

A. Global degradation of the Math and Sciences level over the last 10 years

For the courses taught during 20 years from 1994 until 2012 the level is going down. We can distinguish 3 periods 1994 - 2000 degradation of the level from 2.3 down to a minimum at 1; 2000-2007 up to a stable level at an average of 1.5; 2008-2012 –degradation of the level down to an average of 0.8 (Figure 1). The general level of the university is stable at 1.7 and the sciences level is dropping with the Math level. Meanwhile other courses are slightly improving during the same period up to 2.

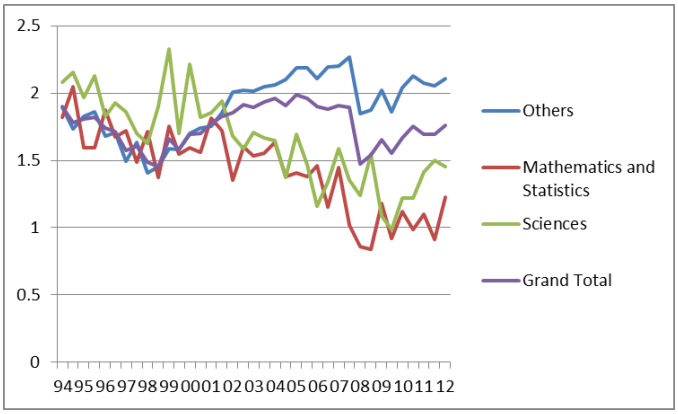

Figure 1: Comparison of courses GPA average – 1994-2012

A detailed analysis of Math courses per level shows the following : Mat 2xx level have a slipping slope from 2.6 down to 2 in 20 years; meanwhile Mat 1xx level reflect the same 3 periods 1994 -2000 degradation of the level from 1.9 down to 1.5; 2000-2007 stable at 1.5 , 2008-2013 –degradation of the level down to 1. (Figure 2). This low performance in Mat 1xx explains that the repeating ratio in Mat 1xx is high at 15% compare to 5% for Mat 2xx.

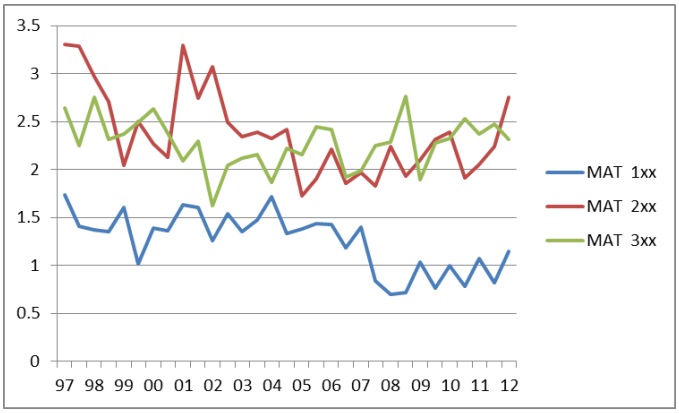

Figure 2: GPA in Mat 1xx, Mat 2xx, Mat 3xx

B. Relationship between High School strand and Mat 1xx performance

Students graduate from High School from four strands: Math Elementary, Humanities, Life Sciences and Economy. By law, any student from any strands can choose freely its Major at the university (except specific majors). Nevertheless, in practice, chosen Majors are in line with the strand. Students from a strand in math and Life sciences have a level in Math that generally does not require remedial courses in Math. Students from a strand in Humanities choose a major that does not include Math courses. As a matter of fact, remedial math courses (Mat 1xx) are in practice only for the students from Math (50%), Life Sciences (30%) and Economy (20%).

The performance of students from Economy strand is degrading year after year down to 1.5/4; the performance of students from the Life Sciences strand is stable at 2.4/4; the performance of students from Math strand is improving year after year up to 2.9/4.

C. Remedial courses are selective

According to each major curriculum a minimum level of Math is needed. From 8 % up to 40% of students in the 15 Sciences majors with an average of 25% have taken remedial courses and respectively from 24% up to 52% of students in the 18 Business majors with an average of 37%.

Remedial courses are selective. In the period 2007-12, almost half (49%) of the students pass the remedial course for Business students, and just more than half (55%) of the students pass the remedial course for Sciences students.

D. No clear impact on first-year student dropout rate

We have compared the results in remedial math (Mat 1xx) of the students from different Faculties. The average GPA has

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started to converge to the same level independently from the Faculty (Figure 3).

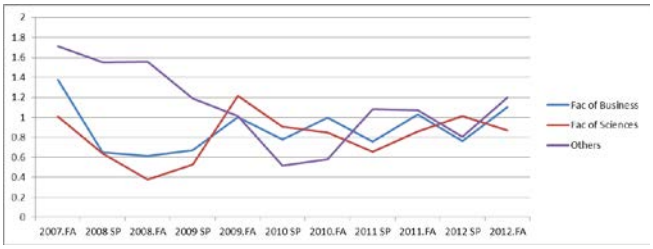

Figure 3: Convergence of the level of students at 1xx by Faculty

Table 1 shows that if there is an impact in the Faculty of Business of 3% in the dropout rate. There is no impact in the Faculty of Sciences.

Dropout	Fac. of Business	Fac.of Sciences
w/o Remedial	8%	8%
MAT 1xx	11%	8%

Table 1: Dropout rate per Faculty (3 years)

E. Remedial course are filters to access competitive majors

The benefits of remedial courses are clear for students in the Faculty of Sciences seeking a change into Engineering Majors and getting C or above in the remedial Math course (see Table 2). Remedial course works as a filter to access engineering majors. In Business curriculum, remedial Mat 1xx courses are a filter to stay in the highly demanding majors such as Banking and Finance and Business management. The students who fail the Remedial are oriented to easier majors; indeed those students are transferred from Banking and Finance and Business management to another major less demanding in Math skills like Bachelor of Hotel Management and Tourism.

Transfer from	with Mat 1xx		w/o Mat 1xx
	Grade C & more	Grade D & Less	
Fac. of Business	30%	41%	29%
Fac. of Sciences	44%	23%	33%

Table 2: Distribution of students changing major

V. Key findings on the Student Evaluation survey analysis

We explore this data for evidence of a correlation between the SEI scores and the student grades. The first question of the SEI asks students their expected grade. Expected grades are positively correlated with the SEI score.

Student expected grades in Mat 1xx show a high distribution in failure (Fail and Withdraw) for Mat 1xx that confirms McPherson [14] results showing that student's expected grade is correlated with their real grade.

Student personal involvement in hours of personal work remains in the range for Mat 1xx and Mat 2xx.

Strangely Course satisfaction in Mat 1xx courses is high (92%) compared to the average of 1xx courses at 88% and 2xx courses at 86%. Mat 2xx at 86% of satisfaction is in the average of 2xx courses. It is unexpected that students have a high satisfaction in a course that has a high failure ratio.

VI. Conclusion

In the very competitive environment of higher education it is essential that the university understands the means to give the best orientation to first-year students and indeed improves the retention rates. The present study was consistent with the literature regarding the impact of Mat 1xx and 2xx. This work identified the role of filter of the Math remedial courses to access highly demanding majors. Definitely failing students will be at risk to either leave the university or transfer to another major more adapted to their real skills.

Strategies in the spirit of social integration can be a solution to increase the interest in Math. Part of the action of the Student affairs office could be the creation of space for self-development, and the improvement of student-university member interactions and relationships.

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Quality infrastructure in higher education – The case of Serbia

J. Ruso, A. Horvat, M. Djuric, and A. Trajkovic

***Abstract*—**The growing educational opportunities and needs for development of education are creating a changing environment for higher education systems throughout the world. The majority of countries have developed an entire industry of higher education with the strong influence of quality standards through the accreditation systems, as part of national quality infrastructure (NQI) and more specifically of the educational quality assurance process regarding the ways to meet the needs of different stakeholders and interested parties. Accreditation as main cohesive factor of other NQI elements aims at providing necessary levels of students' confidence and trust, in the long run. In accordance with the Serbian National Accreditation Body report, we investigated trends with regard to data from different scientific fields Serbian public and private universities belong to, as well as timing of their accreditation. High quality of distance learning (DL) curricula is among the critical success factors for the higher education industry. Thus, we put an additional effort to take into consideration DL data, since this dimension of education becomes increasingly popular and attractive in Serbia.

***Keywords*—** accreditation, higher education, quality assurance, quality infrastructure

I. Introduction

Most countries have developed an entire industry of service providers that specialize in the diffusion of quality and standards through the provision of quality assessments, technical assistance, information, and training services. Higher education institutions are one of the public institutions that are the important link in developing of national quality infrastructure (from now on referred to as: NQI). Nowadays, a functioning quality infrastructure (hereinafter referred to as: QI) is a prerequisite for access to regional and global education market and a key determinant of competitive advantage.

Quality infrastructure provides the underpinnings that enable organizations to compete regionally and internationally, meet stakeholders' requirements and manage risks. It includes both public and private institutions and the regulatory framework within which they operate. As in [1] national quality infrastructure "helps to promote sustainable development" of what is done and improve the current situation. QI is supported by four main pillars: metrology, standardization, conformity assessment and accreditation, including certification, testing and quality management. [2] In our research we will only focus on accreditation as a tool for achieving high quality and customer satisfaction (including all stakeholders and interested parties).

Globalization, the massive expansion of educational opportunity and educational developments are creating a changing environment for higher education systems across the world. This environment is, in turn, creating pressure for concerted action by institutions and government agencies within and across countries to improve the way they approach quality assurance. [3] Quality assurance and quality as results of accreditation were a long time ago imported into the university vocabulary from industry. [3] In [4] is highlighted that quality in education is "only the fortunate peak of a vast pile of dreary teaching and wasted learning". It is becoming important, particularly so in higher education, where the products/services of the system, can have a direct impact on quality of their employer organizations." [5] Also, [6] stressed that quality "has come to be seen as a continuous process of assessment and improvement".

The aim of research is to provide the basic insight in the current state of accreditation system in higher education in Republic of Serbia, as a part of NQI, and to investigate which of accredited faculties of the Universities are the first one which adopted appropriate standards, and get a certificate of accreditation. Also, we will classify faculties by type and observe some significance between fields in which faculties belong to and the year of accreditation. In addition, within this analysis, distance learning will be taken into account.

Firstly, literature review will give the insight in importance of the issue (Table 1 and Table 2) and the accreditation system in higher education in Serbia will be presented according to year of accreditation of each faculty in regular and distance learning. After results, the paper includes discussion and some of the recommendations for next investigations.

II. Accreditation and Quality Assurance in Higher Education

The modern University faces the challenge of adjusting to a complex world with new demands for professions and skills associated with the knowledge society. To successfully meet these important challenges, it is fundamental that universities'

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governing bodies have good relation with the academic community in order to respond to the social and productive needs of its environment. [7] Good practice showed that the accreditation system is an appropriate way to organize a national educational system and to improve the quality of the services. As explained by [8], accreditation was born in the U.S. as voluntary and professionally initiated the process. Most accreditation programs focus on quality improvement as well as on quality assurance, and many accreditation initiatives are government initiated. [9] Recently, existing quality assurance concepts, criteria and assessment methodologies for new developments in higher education has been fuelled to a great extent by the rapid growth in distance education, open and distance learning, e-learning, distributed learning or whatever concept is used. [10] Therefore, it is instructive to look at the quality assurance and accreditation issues raised by distance education and e-learning and the recent initiatives taken in this regard. The growth of distance learning has an international dimension as well, since countries around the world are using distance learning technologies to enlarge their course, program, and degree offerings and to import and export education programs and services. [11] Therefore, the accreditation is recognized as a necessary tool for quality assurance in distance learning too.

"One of the key functions of accreditation in education is to provide some measure of validity to the credential acquired by students" [12] and "met all the specified measures of quality" [13]. In addition, [14] defined accreditation in education as"the recognition given by an association or agency to institutions that satisfy specific standards of educational quality". Quality assurance is "a process where key elements of higher education are measured. Most quality assurance schemes begin with a self-study or self-review of the institution or program being evaluated". [6] They claimed that self-study usually culminates in a report that documents the process and the results. The report is typically considered by a team of external evaluators who visit the institution and write a report of their own, assessing the validity of the self-study. According to [15] some of benefits of accreditation in higher education are shown in Table 1.

Table1. Potential Benefits of Accreditation in Faculties

Benchmarking	Accreditation allows faculties to determine how their program compares to other similar faculties.
Internal Assessment	Accreditation makes faculties reexamine how they do things and what can be done to improve.
Peer Review Consulting	As part of the accreditation process, a faculty gets consulting from the Peer Review Team on what it can do to improve its programs.
Examine Continuous Improvement Processes	The accreditation review causes a faculty to examine its internal processes for maintaining and improving its programs.
External Recognition	Accreditation gives a faculty external recognition among its peers and in the community it serves.
Competition For Students	Accreditation can give a faculty an advantage in attracting quality domestic and international students.
Fund Raising	Accreditation gives a faculty an edge in fund raising over its non-accredited competitors.

Many authors wrote about accreditation and quality assurance in areas such as health services [16] and education. In Table 2 there are some of the literatures which investigated accreditation and quality assurance in higher education in different countries.

Table2. Literatures about accreditation and quality assurance

Authors	Topics
[7]	Accreditation in higher education in Chile
[17]	Quality assurance and accreditation in higher education
[18]	International accreditation in Taiwan higher education
[19]	RPL for accreditation in higher education
[20]	Accreditation in Vietnam's higher education: focus on input or outcome
[21]	Quality systems in private higher education in Kuwait
[10]	Trends and models in international quality assurance and accreditation in higher education in relation to trade in education services
[22]	Quality assurance of engineering education through accreditation
[23]	Accreditation and Religiously Affiliated Law Schools
[24]	Understanding Accreditation: Contemporary Perspectives on Issues and Practices in Evaluating Educational Quality

III. Accreditation system in higher education in Serbia

Serbia operates an integrated national quality assurance system complying with the Standards and Guidelines for Quality Assurance (QA) in the European Higher Education Area. The Commission for Accreditation and Quality Assessment (CAQA) is legally responsible for organizing and monitoring the quality assurance scheme for all higher education institutions in Serbia. During the development of the QA system, the European Standards and Guidelines (ESG) were used as the main source of information. Higher education institutions have a legal obligation to develop internal quality assurance systems. Implementation of the standards for internal quality assurance is in the first place the responsibility of the institutions. Eight public universities (around 85 faculties), eight universities established by non-state founders (around 40 faculties) and more than 80 colleges of applied sciences (under the primary domain of the CAQA) are subject to compulsory national accreditation. [25] Studies conducted

at the faculties of the University are adapted to the principles of the Bologna Declaration.

To find significances between scientific fields in which universities belong and the year of accreditation, firstly we classified them into six areas:

1. ET - Engineering and Technology,
2. NS - Natural Sciences,
3. MH - Medical and Health Sciences,
4. SS - Social Sciences,
5. H – Humanities,
6. IMT - Interdisciplinary, Multidisciplinary and Transdisciplinary Sciences.

This section encompasses the situation regarding accreditation in higher education at Serbian Universities. It also gives a comparison analysis between public and private universities by the accreditation process. We investigated trends concerning data from the Serbian National Accreditation Body report by different scientific fields Serbian public and private universities belong to, and also the year of their first accreditation. In Serbia we recognize eight public universities: University of Belgrade, University of Arts in Belgrade, University of Novi Sad, University of Kragujevac, University of Nis, University of Pristina, Public University of Novi Pazar and University of Defense. Also, we recognize 11 private universities: Singidunum University, Megatrend University, University Business Academy in Novi Sad, Edukons University, Metropolitan University, Union University, Union - Nikola Tesla University, Alfa BK University, Europe University, University of Fine Arts, University of Novi Pazar.

Differences in years of first accreditation for public universities are given in Fig. 1. We can see that first had accredited the University of Belgrade, the University of Novi Sad and the University of Nis in the year 2008.

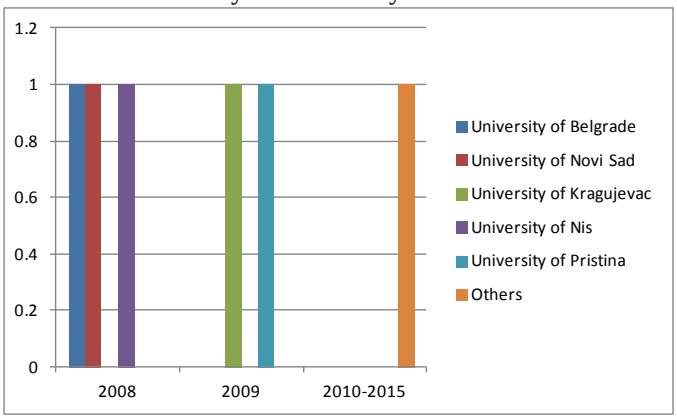

Fig. 1 Years of first accreditation at public Serbian Universities

Regarding the Scientific fields by year of first accreditation, the chart clearly shows that first had accredited Social Sciences, Natural Sciences and Engineering and Technology fields. (Fig. 2)

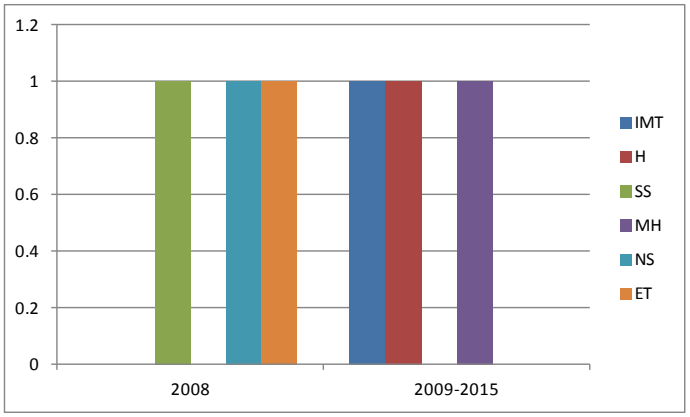

Fig. 2 Scientific fields by year of first Accreditation

Also, we concluded from the Serbian National Accreditation Body report that private universities have accredited a year before (2007) all public universities. If we compare data for the accreditation process for DL programs at universities, we can conclude that private and public universities had accredited in the same year, precisely at 2009. for the first time.

IV. Conclusions

In the light of growing competition between state and privately owned (for-profit) universities, we analyzed the ways both groups strive to assure and ensure satisfaction of students and other stakeholders and interested parties of higher education system. Some of the issues regarding these private-public higher education institutions competition in Serbia were explained by [26]. For example, it includes lack of national university ranking system to shed some light on the quality of both the public and private academic sector or the fact that students can attend only public universities for free, as the Republic of Serbia does not provide scholarships for the private educational institutions.

As far as we speak about the core accreditation process, the things work this way: „The Commission for Accreditation and Quality Assessment (CAQA) is legally responsible for organizing and monitoring the quality assurance scheme for all HEIs in Serbia. CAQA is formed (June 2006) as an independent expert body of the NCHE. CAQA designs standards, protocols and guidelines for the NCHE's approval and publication as bylaws and helps institutions in creating their respective quality management systems. CAQA carries out quality assurance processes in forms of accreditation and external quality assurance of all higher educational institutions and study programmes according to LHE. During the development of the QA system, the ESG document was utilized as the main source of information. Therefore, the existing accreditation standards, which do include QA topics, fully comply with the ESG.” [27]

The analysis of official data provided have shown that within five Serbian public universities 3 of them fulfilled accreditation requirements for the following scientific fields in 2008 (according to the categorization from [28]):

- engineering and technology,
- natural sciences,

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- social sciences.

On the contrary, private universities have shown more offensive approach to quality assurance and entered the accreditation process a year earlier, in 2007. This may be explained through the fact that these private universities in Serbia were founded much later than state universities [29] and that they often encounter problems with public opinions and perceptions on the quality of service they provide, sometimes for very objective and undisputable reasons (see, for example [30]).

Within the distance learning studies curricula market, the first to enroll the full state accreditation was a private university that received accreditation in the field of social sciences during 2009, while the first public university that was accredited for the DLS was from the area of engineering and technology during the same year. Reference [31] discussed that this field of competition among academic institutions in Serbia becomes more and more popular and attractive, as the new education platforms emerged with the growing interests – curricula in English language, joint master programs with other Universities, partnerships with different organizations regarding students' internships etc.

As opposed to the findings of [32], who compared satisfaction with administrative work at public vs. private universities to show that there were very few differences in their target group and those were limited to the satisfaction with extrinsic rewards, we can finally conclude that competition in produces much bigger variations, as it is shown in this paper.

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Use of Business Competitions to Enhance Student Employability in Higher Education

Satya, Shah, Sara, Al-Badri and Syed, Hassan

***Abstract*—** The research exemplifies student learning and skills gained within higher education (HE), by illuminating learning patterns and motivation through competitions that gain students skills and employability prospects.

Competition implies rivalry, contest and opposition. There is still some amount of controversy as to whether competitions in HE are a positive or negative. Having students learn through the style of competitions based on real life situations, they experience how to solve problems, and can learn both content and thinking strategies. It is evident through research that by allowing students to undertake project-based learning through competitions, it further enhances their engagement and increase motivation. By looking at three core aspects: 'Competitions, Learning Patterns and Employability' it will showcase positive perceptions of this theory within HE institutions, and with the key emphasis and importance of identifying how psychology plays a role in increasing a student's skill sets that employers seek in graduates. This allows students (i.e. future graduates) to improve upon time employability prospects in the future.

The research aims to investigate and identify the factors towards improving the employability prospects through competition based learning. This research concentrates on the learning output and skill sets via competitions, therefore as a result gains a medium of skills for employability. Throughout this research, there will be many assessment components and methodologies discussed with the use of primary and secondary tools; whilst taking a deep look into psychology aspects of learning patterns in particular motivational modes of learning.

***Keywords*—**Business Competitions, Higher Education, Employability, Learning Practices, Collaborative Learning, Competitive Learning

I. Introduction

This research mainly focuses on the perceptions of competitions within higher education (HE) institutions, and with the key emphasis and the importance of identifying how psychology plays a role in increasing student's skill sets. This allows the HE institutions to further improve the students (i.e. future graduates) employability prospects in future. The aim is to address the growing concerns on the use of nonacademic methods such as the competitions within the learning in HE.

There is still controversy whether competitions in higher education are a positive or negative effect on learning. It's uplifting because it encourages individuals to do better and work harder. However, rivalry can also be negative because it might discourage vast amounts of people whilst it can apply pressure and stress to others. Nevertheless, it will also intend to address the lack of encouragement it provides students towards exceeding expectations not just academically but towards attaining practices towards working harder and fulfilling the necessary skills and training gap. Rivalry can be seen as negative because it can discourage vast amounts of students, whilst it can apply pressure and stress to others. Through learning via competitions the following proverb is very significant because it indicates that being involved in an activity will be more beneficial than just being told what to do in the activity.

"Tell me and I'll forget, show me and I may remember; involve me and I'll understand" [1]. Competitions can help extend students learning boundary and increases motivation that engages them to achieve successful learning outcomes, and initiate new learning habits [2]. Competitions and Commercial Stimulation Games help boost morale, the individual's entrepreneurial skills blossom, bettering the student and helping gain confidence as well as employability [3]. The benefits of student engagement are well accepted, but the means to achieve it are less well established and agreed. Through this research it will concentrate on the learning output and skill set via competitions, therefore as a result gains a toolbox of skills for employability [4]. Human competition is a contest where two or more people strive for a goal that cannot be shared, usually resulting in a victor and a loser. It is an official participation of something whether it's sports or a business agenda [5].

A theory suggests that by having students learn through the experience of solving problems, they can learn both content and thinking strategies as described within the theory of "Learning through a problem" [7]. Through these components and methodologies the students tends to gain imperative skills and thus increasing their confidence as well stimulation towards adaptive learning. It has been evident that looking at students learning patterns allows researcher to establish ways in which competitions can have a positive impact. Hence by

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adoption of these techniques and methods it will allow students to attain these attributes that are very valuable to future prospective employers within real world. We are a society now made up of equal opportunities so this could be a positive step of how we enable forthcoming students to receive the best possible experience, and open their chances of employability. This research will show an overview of three vital sub sections: how competitions instigate better learning and skills, the adoptions of competitions in higher education to help initiate employability and the psychology behind competitions in higher education through learning patterns.

II. Literature review

The first outline the research depicts is that all academic degrees (whether or not they are integrated with competition based activities) are part of academia and have relevance. Competitions are a vital role for students: it enables them to work in a team, gain invaluable skills, become self-motivated and gain confidence. The problem and key issues lie when UK universities don't use competitions in their vicinity, which results in students' deficient of bettering themselves and gain employability prospects. This could be down to various reasons ranging from non-competitive streaks in individuals, no incentive to take part or enough time. Another factor could be the cost implications involved or for the simple fact it's not heavily publicized. (If it were named e.g. 'business competition' students not studying a business disciple would maybe not apply). Psychology/Marketing aspect of the wording needs to be altered in order to change views. Through extensive research and methodical evidence the research aims to demonstrate if there are any indications as to why there is controversy in competitions. There is empirical evidence that suggests that there is a higher success rate of employability for graduates who have been associated with competition based learning. With such great outcomes from competition-based exercises, this should prompt all universities that don't currently undergo any internal/external competitions to start.

A. Economy and Employment

England is the driving force behind the UK economy; it does in fact rank one of the highest in the world. England in particular was the powerhouse for manufacturing and foreign trade (pre-recession). London is renowned as the financial center. However the UK took a turn for the worse, the recession hit Britain and countries across the world. This stemmed as a result of the credit crunch (2007) and as a result, the British economy was officially declared to be in recession in January 2009 [8]. The study also states that the reason the UK came into a recession was because the UK's economy wasn't growing fast enough, according to statistics over a twenty five year period, Britain was always in the 2.5% and 3% area, which is below par and has no spare capacity or room. The first thing that the recession targeted was jobs. Research also suggests that the private sector was the first to increase its employment after the boom. Figures showed that in 2008-9 employment decreased by 4.2% and only rose by 1.5% in 2009-2010 and up 1% in 2010-2011 (Corry et al, 2011).

As we are now in a highly competitive market, the economy stipulates new ways of working and thinking. As the years progress the type of jobs and tools have altered, the level of schooling and skills necessary have also reformed. Research also suggests that there are two concerns for employers in today's market: seeking good employees and secondly training them accordingly [9].

Employability in the UK is a very crucial aspect for the UK to succeed, which is why HE bodies are feeding employability skills to their students, as part of the curriculum. According to research the government is constructing a strategic policy that will enhance employability of those students completing a degree to extend skills across the UK [10]. One of the greater skills that employers seek is how to solve a problem in a creative and methodical approach [11] [12]. Nearly everything in life is a problem and is a central part of our lives. When a person has a problem, they need to know how to identify it and solve the problem in hand. Once this process is adopted, the individual must define the scope and goals. Davidson and Sternberg [13] followed this process formally known as the problem solving cycle (PSC) that is broken down into seven steps:

- Recognizing or identify a problem
- Define and represent the problem mentally
- Acquire a solution strategy
- Organize his/her knowledge about the problem
- Allocate mental and physical resources for solving the problem
- Monitor his/her progress towards the goal
- Evaluate the solution for accuracy

Not all PSC need to go into this level of detail and certainly shouldn't imply that all problem solving has to be in this sequence. To be a successful problem solver, is to be flexible. Another way to explain a problem to put it simply, is where you have a scenario where you need to act to find a solution but you don't know how to solve it or what to do. A published definition as to what a problem is: within problem solving there are two problem classes: problems that are considered well defined and those that are classed as ill defined. Well-defined problems are those that are a clear goal or path to resolving the problem (for example: a sale in a shop, working out the discount, finding out the new price) this is a straightforward problem based on the information given. An ill-defined problem is not so clear; it has no direct path to resolute the problem. With this vague scenario it is deemed challenging and more work does need to be involved (for example - how to find your life partner?). It is not a question that can have an easy answer as the well-defined problem can. In life, we often make unwarranted assumptions in our everyday problem solving. Such assumptions can interfere with our ability to discover a novel solution to an ordinary problem.

B. Competitions and Learning Environments in HE

The following section provides an overview of the use and impacts of competitions towards learning environments in HE. Research studies states that competition implies rivalry, contest and opposition [3]. In educational terms it implies that

a student goes above and beyond the usual effort, through working on a competition based activity to seize better marks. Competition suggests the need to do better than other/student(s)/teams in order to flourish rather than just do well overall. It has also been seen that competitions engage students and motivate their learning patterns [3]. Literature also states that competitions are seen as ubiquitous [14].

Whilst relating it to a working environment, employees eagerly try to achieve a promotion, create an innovative idea or win a race. Another research suggested learning in a cognitive way of gaining skills, the different approaches to thinking, acting and increasing knowledge [15]. The cognitive style emphases on the in-house practices and another cognitive view are through psychology, by looking at how we as beings understand the world. With the information of what we know already and understand, we as beings link this with new knowledge and piece all the parts together, to build our own understanding of a concept. As humans we are born intrinsic: we have the desire to learn. However, it has also been argued in literature that universities goals are primarily to prepare students in higher education towards work. This is the same view of employers and educators so collaboration between both should be considered.

1) Competitions and Relation to Learning

Competition can stimulate learning by enhancing student engagement and encouraging student motivation. By harnessing their natural competitive nature, student centered learning can be increased and active learning takes place. Researchers look at why competitions are a good stimulant for students. If competitions were well organized, then it would certainly increase their learning and undoubtedly stimulate and enhance the student(s) learning and motivation [16]. One example follows the traditional assumption of learning, whereby learning through education via your educators, and then putting it into practice on real life situations within the student's future [17].

In the business world a key thing employers look for is problem solving which is discussed further in section 3.6. It has been evident through research that by allowing students to undertake project-based learning through a competition, it can be used as further engagement of students and towards motivation of teaching [3]. By using a competition based method it also meets skills that employers seek in graduates. Another study encourage students to engage in skills based competitions as they set a high benchmark not only for the student, but employers they wish to work for and those other students applying to the same type of role [18]. Skills based competition benefits everyone from the learner, educator, management and employers. Both research studies [6] and [22] agree that competitions not only encourage students to have an active learning, but also increase their motivation. The significant thing about competitions is that it involves every type of student from the intellect ranging to a challenged student. They each have a place in a competition; it not only shows off their strengths, but is also an enabler for learning new things, and attributes that are in high demand of the world after academia. Competition can develop employability skills of a high standard that employees seek [18]. By undergoing such activities this also enables students to gain:

- Business knowledge
- Work experience
- Working as a team
- Motivation
- Self esteem
- Learning new things
- Fun and confidence booster/better morale

2) Competitions and Employability

The skills that are learnt during competitions are the same skills sought by employers. This also explains by saying it's 'giving learners the edge'. This type of (extra) curricular activity is an additional advantage and looks fantastic on a student(s) CV. By gaining these proficiencies and experiences at university, it allows students to then become familiar with these surroundings and put them into practice at interviews, and in front of employers when seeking employability [18].

3) Disadvantages of Competitions

According to literature it has shown that competitions can develop a negative effect on students because it's said to focus more on the goal than the actual learning process [7]. Another undesirable effect that competitions may impose on students is the stress that may develop. These two are the core underlying reasons why competitions are very controversial and can be seen as a negative. However, it has also been argued that if you provide students with artificial competitions, then this will teach them what we (the older generation, the educator) to believe what the real world consists of and not by using their own initiative or findings [22]. To avoid competitions having no sense of importance or real value, the competition needs to be short. The length of the competition is crucial. It reciprocates how motivated the students will be throughout the activity. If it's too long, students will become less inclined to work at it and it will not be fun or motivating any longer [6].

By relating this back to students working in a team for a competition, this makes the students play off each other in a hostile, rivalry manner in order to attain a praiseworthy mark. By doing this, it exposes a negative influence as it makes the competition about the prize or outcome rather than what the students are meant to gain from the experience; which is learning, motivation, skills, self-esteem and real life experience. Through a lot of research a popular feedback that is aired is the amount of preparation it takes to conduct a small competition internally. This being said the benefits are outstanding and really does increase a students learning and motivation [18]. Another factor is the cost implications competitions seem to have. Internal competitions don't need to have a budget or a large one that will be expensed via the university, as it would benefit all students.

4) Advantages of Competitions

By inserting competitions to the curriculum it will not only motivate the students but also enable them to learn in the style they learn best which is very good tool for the educators or assessors. It is important to remember that it is not just about external competitions; they can be embedded in lessons within

the curriculum. The crucial element is how teaching and student learning is enhanced by competitions [18]. By implementing a rival type activity into a classroom this is enjoyed by students and they find the problem solving a very insightful practical approach [3]. It also goes on to say how learning stimulates students and consequently harnesses their competitive spirit in a positive light. Studies claim that competition based learning brings out the best in students individually making them want to learn more [21]. By focusing on real life situations it will prepare them for similar encounters outside education. It has been agreed by [6] that:

(a) The competitive/rivalry aspect of competitions is used as an incentive for students including the weaker ones; and
(b) That there is a substantial amount of evidence that conclude competitions are beneficial and also not harmful

There needs to be certain guidelines for this theory to work however: the prize of winning needs to have no symbolic value, the competition as a whole needs to be completed in a short amount of time, students need reassurance that they individually or in groups can and might win, there needs to be learning development and a reflection for students to gain something productive from the activity.

5) Adoption of Competitions within HE Environment

Universities that take part in competitions can raise their profile and enhance their overall prospects towards employability [18]. The initial planning for an educator setting up internal competitions or workshops may take some time. The amount of progress or learning students can gain and benefit should outweigh the preparation as it results in better motivation, good grades and an increase of learning. If budgets are the main concerns for universities to conduct competitions, internally or externally, then another approach may be to seek funding from employers as they request graduates with the skills competitions seem to possess [18].

It has already been seen through research and practice evidence that higher education institution should be adopting towards competition based learning and to adopt the following key options:

- There should be a realistic budget for competitions;
- Competition should be seen in the curriculum and in the government agenda;
- Employers should be backed by the competition to raise awareness;
- Competition should be seen as enhancing a students learning and motivation;
- Competitions are not about the winning – it's the taking part;
- Data collection after competitions to see how they enrich students' progress and identify areas of improvement;

By allowing students to take part in competitions, it enables them to develop skills, be within those surroundings and become comfortable, greater their motivation and understand what to expect around employers. Students will learn from the experience and know what to expect at the next competition, whilst gaining more skills and development [18]. This should outlay a solid foundation that through competitions, students get a real life business approach; problem based solving and portrays business competition learning in a positive light.

C. Competitions and its Psychological Aspects within HE Environments

It is also important to address the psychological aspects within higher education environments and its relevance towards competition based learning. However, within psychology there are many areas that can all be linked and addressed, but the research will only aim to address the ones which are linked towards students learning and its relevance towards competitions. Through the use of competitions in higher education, there is an element of student engagement and motivation. To reach these parameters, PBL has been the trigger and is a learning style. By looking at learning styles this would address why some students are motivated in different ways as a result by their individual learning style.

Additionally psychology can also be known as a science discovering a person or groups mental attitude. Psychology is a new discovery, so there are many theories and few facts on the subject. The difficult topic of psychology is that it is difficult to prove some things, which is why it is measured and observed. Social psychology is the exploration of how people are influenced by others in thoughts, goals, feeling and behavior. The reason behavior is monitored is because it can be observed and measured. The reason it is called 'social' psychology is because it deals with how people are affected by other beings that are present at the time or imagined to be present. The main difference of the two types of psychologies is that in psychology, a psychologist would generally be concerned to why a person might overestimate the size of a coin. Whereas a social psychologist would want to understand why a person might emphasize if the coin has value (if an individual or group has influenced that person), it changes their initial perception and therefore influences them. Social psychology looks at how people affect each other.

D. Problem based Learning

Problem based methods are renowned to support experience-based learning [6]. The key to this type of learning style is to learn through solving a problem and develop a holistic range of lifelong skills such as:

- Flexible knowledge
- Problem solving skills
- Working in a team
- Intrinsic motivation

Research studies explains PBL as student based strategy that student learn collectively to solve problems and learn from the experience. Within PBL a student is expected to problem solve and gain a real sense of learning. Literature also goes on to portray just how important PBL is when it comes to gaining employability skills [20]. The idea is that the problem is based upon a real life situation so the skills you develop, will aid you in profession. Students are more motivated when the task is personalized and the student values what he or she is learning. Students work in collaborative groups to identify what they

need to learn in order to solve a problem. Educators are interested in PBL because of emphasis on active, transferable learning and its potential for motivating students. Teachers and lecturers acknowledge that motivation is a core aspect of student learning within higher education environments [6] [7].

III. Research Methodology

Through the literature review conducted has allowed the authors towards a structure and three key areas to focus on which are: competitions, learning patterns and employability.

As seen below is how the three sections are divided, within each section they then indicate the core three points that stem from the hypothesis of this research study. The arrows depict the starting point being at 'competitions'. This then has a psychological impact on the student(s) that makes them use motivation/cognitive elements to gain new styles/learning patterns or skill set. Subsequently, this transacts to the next segment 'employability'. The ultimate reason behind the three sections is:

1) To discover the reasons why competitions are an important learning curve for students and understand what skills and knowledge students get from competing
2) Exploring how employers recognize the student(s) skills set and what they believe to be valuable. Thus this should expose employer's perspectives on how business competitions make a student more employable
3) Through learning and new learning styles this will convey a new type of skill and the psychological impact to the student

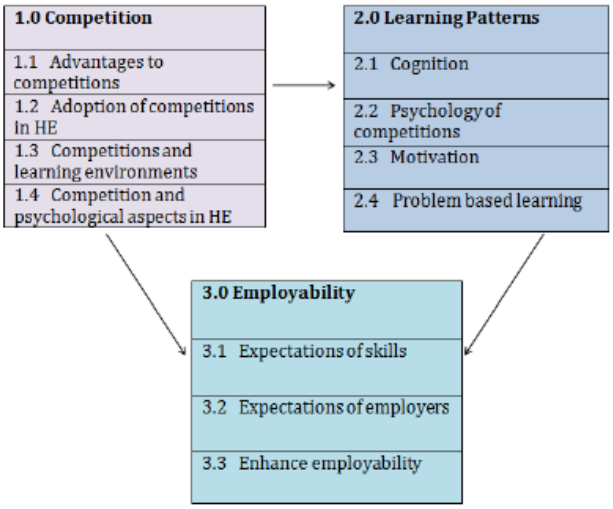

Figure I: The Research Framework

It is important that the information inputted within the survey is reliable, designed in a methodical and flowing approach for the participant, ethical and appropriate for the target audience. In each of the surveys there are very short opening statements to ask appropriate questions based on the information found through the literature review.

Factor	Criteria	Research Model	Question
1			Competition
	1.1	Competition	Advantages to competitions
	1.2	Competition	Adoption of competitions in HE
	1.3	Competition	Competitions and learning environments
	1.4	Competition	Competition and psychological aspects in HE
2			Learning Patterns
	2.1	Learning Patterns	Cognition
	2.2	Learning Patterns	Psychology of competitions
	2.3	Learning Patterns	Motivation
	2.4	Learning Patterns	Problem based learning
3			Employability
	3.1	Employability	Expectations of skills
	3.2	Employability	Expectations of employers
	3.3	Employability	Enhance employability

Figure II: The Research Framework Sections and Categories

A. Student Survey Design

Starting with the student survey, the first segment after the generic questions is competitions. By asking if the participant has taken part in competitions or elaborates on what they enjoy most by taking part and if they achieved better marks by competing in a competition this would give the author a good reason to believe or assume that competitions are a good spectrum of learning. The second segment is learning patterns. These styles of questions ask the student to give an opinion in a closed question scenario on how they learn best. By adding factual information this encourages the participant to read the text before answering the questions, so when faced with problem solving questions and how they learn in a problem solving situation they can relate back to a real life example from their past, and way of thinking is already focused on learning so should trigger them to be honest and as thorough as they can be within the survey. The final segment is employability and this is the most interesting data that will be collected as this is the vital part of the thesis that will indicate whether or not learning through a competition would give a student employability prospects. The design of the questions is aimed to discover if students find employability skills and business acumen a valuable thing to acquire.

B. Employer Survey Design

After the three nonspecific questions the competition segment aims to get the employer to identify their understanding of what a competition is. This is an actual question in an open question format to employers. If there is a collective response in the same direction then it will emphasize their knowledge of competitions whether it is through student competitions or simply competition within the work environment. By having four questions on competitions this will verify if the employer believes that competitions are a valuable learning tool in HE. The second part of the survey is learning patterns. This is a series of five closed questions that ask the employer if completion based learning is a good stimulant for learning and if they see students who have the skills they require through competitions. Finally if there is a link between learning and the psychology behind learning. Then concluding with employability, this section again is a vital part of the thesis that will indicate whether or not learning through a competition would give a student employability prospects. One of the questions is an open question to get the insight from an employer on what makes a student employable when applying for their company.

C. Alumni Survey Design

The alumni survey has five generic questions as they have already graduated; the final two of the five generic questions asks what the person's current state of employment is and how long it took them to find the role since graduating. This allows the author to recognize how useful their degree course and experience of competitions were along with what employability skills they acquired. The importance of the learning patterns section tried to indicate whether they were able to link their prior experience of competition gained skills into their current work practice. By adding factual information as a background, this encourages the participant to read the text before answering the questions, so when faced with problem solving questions and how they learn in a problem solving situation they can relate back to a real life example from their past, and way of thinking is already focused on learning so should trigger them to be honest and as thorough as they can be within the survey. The final segment is employability and this is the most interesting data that will be collected as this is the vital part of the thesis that will indicate whether or not learning through a competition would give a student employability prospects. The design of the questions is aimed to discover if students find employability skills and business acumen a valuable thing to acquire.

IV. Preliminary Results

The total number of participants for the student survey conducted was 137; however within the survey there was a selected few questions that were only designed for students that had participated in competition based projects. One of the key questions aims to identify what students gain from being involved within a competition. The question was derived to find out what incentives were being taking part, and learning behind being involved in competition based activities. The major response from the survey as seen in graph 1 was towards new learning styles at 19% (which equated to 71 persons), being recognised for what you do 18% (68 persons) and 18% also said meeting new people (67). The other end of the spectrum indicated that working in a diverse group and winning something was not an important aspect. Ultimately, the general consensus was that students gain one core-learning objective through a competition: gaining a new learning style. Authors agree that competitions not only enhance an active learning but they pose as an enabler for learning new things [19].

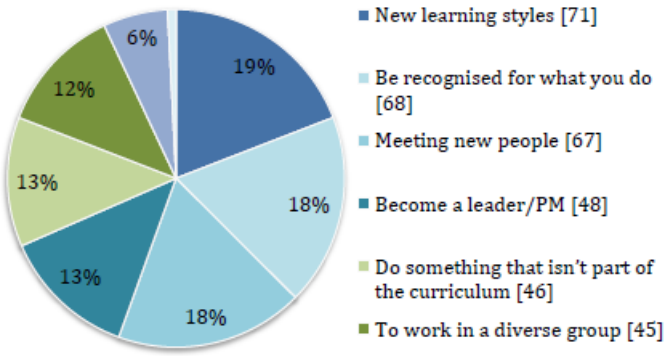

Figure III: The Business Competitions Incentives

With regards to the data collected based upon the incentives behind being involved with in competition based activities, the two major responses from the survey was towards strongly agreeing (43%) and agreeing (45%). This is indicating that PBL and problem solving was a crucial part of the learning within a competition. Figure 4 indicated actual numbers of where the participant fell into the categories. It is evident that there were a lesser amount of students unsure of either the question, how relevant it is to them or where problem solving fits into their curriculum if they do not take part in competitions. The key thing to remember about PBL is that the student learns through a problem and/or experience that make the challenge more motivating. Literature also identifies this by stating motivation is the underlining reason for such activities to be set by lecturers, teachers within academia [7].

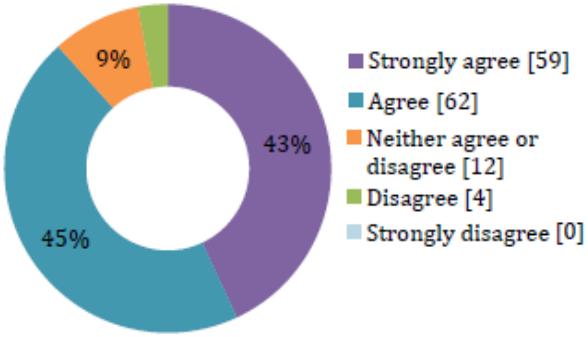

Figure IV: The Benefits of Problem Based Learning in HE

Having analysed the data, the research has shown how competitions impact a students learning, thus making them have better employability prospects. By looking at competition based activities (internally or externally) they enable great engagement and interaction between students. It increases many things from motivation, confidence and most importantly skills. The most imperative attributes that students gained whilst being involved within a competition was:

- Learning through new styles
- Being recognised for what the individual does
- Meeting new people
- Motivation to go above and beyond to achieve better grades
- Problem solving skills

This has been the same positive result through primary and secondary recourses. The data does strongly back up the quantitative studies within the literature review. The analysis collected indicates that competitions are seen as a positive outcome by the student audience group. The surveys target three core attributes that are the underlying basis of this paper; 'competitions, learning patterns and employability'.

V. Conclusions

The existing research outlined in this paper has laid a solid foundation and basis for the research. The introduction presents how competitions develop a students learning and increase motivation and skill set that ultimately makes the student employable. Based on the obtained knowledge and research carried out, the overall aim of the research is to identify the importance of business competitions in HE and

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their learning outcomes. The research covered both primary and secondary data; this was used to discover findings and analysis. Throughout this paper there were two types methodical tools used to collect data both Qualitative and Quantitative research methods were implied within the research.

These methods are used to gather information and increase knowledge on the chosen subject. A literature review and in-depth survey methods were applied within the research. The literature review explored theorist's views on how competitions impacted academia and a student's skills set. The survey accumulates data and analysis to develop further findings. From the start of the research it was evident that there was controversy as to whether competitions in HE are a positive or negative. A key aspect of the research was to identify the importance of students gaining employability skills, thus making the individual more employable and gaining business acumen. By starting with a brief history of the British economy and the aftermath of the recession in 2008, this really illustrated just how important the next generation of students and employees will have on the industry. With years passing by, there are new ways of doing things and markets are constantly innovating to be the best in the current climate and market. By educating HE students with this knowledge and offering a toolbox of skills they are ready and prepared for the workplace of their generation. By implementing competition based activities to the curriculum, it is important to acknowledge that it doesn't have to only be for business students. Future work is currently been carried out through the use of case studies which aims to exemplified how existing business competitions are backed by employers and to identify how the skills gained benefited a student and made them more employable.

There will always be pros and cons to any given scenario so this area could still be further researched and developed. Research studies agreed with this theory and state that a competition is not harmful for student and only increase their learning and skill set [6]. The literature studies and analysis from the three surveys conveyed a high level of correlation in many ways. In literature, the skills that are found through business competitions are the same as those from the existing/alumni students taking part in business competitions. Business competitions should be introduced to more degree programs as students really benefit from such activity. Employers want to employ more students with business acumen skills. The role of competitions improves a students learning, motivation and skill set. Competition based skills are invaluable and give students 'the edge'

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