UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN

ITROCONFERENCE 13
INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

PROCEEDINGS

ZRENJANIN, November 2022

UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY "MIHAJLO PUPIN"
ZRENJANIN
REPUBLIC OF SERBIA

XIII INTERNATIONAL CONFERENCE OF

INFORMATION TECHNOLOGY AND DEVELOPMENT OF EDUCATION ITRO 2022

PROCEEDINGS OF PAPERS

XIII MEĐUNARODNA KONFERENCIJA

INFORMACIONE TEHNOLOGIJE I RAZVOJ OBRAZOVANJA ITRO 2022

ZBORNIK RADOVA

ZRENJANIN, NOVEMBER 2022

Publisher and Organiser of the Conference:
University of Novi Sad, Technical faculty „Mihajlo Pupin", Zrenjanin, Republic of Serbia

For publisher:
Dragica Radosav, Ph. D, Professor,
Dean of the Technical faculty „Mihajlo Pupin", Zrenjanin, Republic of Serbia

Editor in Cheaf - President of OC ITRO 2022:
Dragana Glušac, Ph. D, Professor

Proceedings editor:
Marjana Pardanjac, Ph. D, Associate Professor

Technical design:
Snežana Jokić, Ph. D, Assistant Professor
Maja Gaborov MSc, Assistant
Nemanja Tasić MSc, Assistant

Circulation: **50**

ISBN: 978-86-7672-362-1

CIP - Каталогизација у публикацији
Библиотеке Матице српске, Нови Сад

37.01:004(082)(0.034.4)
37.02(082)(0.034.4)

INTERNATIONAL Conference of Information Technology and Development of Education ITRO (13 ; 2022 ; Zrenjanin)
Proceedings of papers [Elektronski izvor] / XIII International Conference of Information Technology and Development of Education ITRO 2022 = Zbornik radova / XIII međunarodna konferencija Informacione tehnologije i razvoj obrazovanja ITRO 2022, Zrenjanin, November 2022 ; [editor in chief Dragana Glušac]. - Zrenjanin : Technical Faculty "Mihajlo Pupin", 2023. - 1 elektronski optički disk (CD-ROM) : tekst, ilustr. ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Elektronska publikacija u formatu pdf opsega XI, 221 str. - Tiraž 50. - Bibliografija uz svaki rad.

ISBN 978-86-7672-362-1

а) Информационе технологије -- Образовање -- Зборници б) Образовна технологија -- Зборници

COBISS.SR-ID 107092745

PARTNERS INTERNATIONAL CONFERENCE

South-West University „Neofit Rilski”
Faculty of Education, Blagoevgrad,
Republic of Bulgaria

SOUTH WEST UNIVERSITY
"NEOFIT RILSKI"

Technical University of Košice
Faculty of Electrical Engineering and Informatics
Slovak Republic

University Goce Delcev Stip
Republic of Macedonia

THE SCIENCE COMMITTEE:

Sashko Plachkov, Ph.D, Professor, South-West University "Neofit Rilski"/Department of Education, Blagoevgrad, Republic of Bulgaria

Nina Bijedić, Ph.D, Professor, Applied mathematics, Faculty of Informatics Bosnia and Herzegovina

Mirjana Kocaleva, Ph.D, Professor, Faculty of Informatics, University "Goce Delčev", Štip, North Macedonia

Narendra Chotaliya, Ph.D, Professor, MP Shah Arts & Science College, Surendranagar, Saurashtra University, Rajkot, India

Madhusudan Bhatt, Ph.D, Professor, R.D. National College, affiliated to University of Mumbai, India

Csaba Szabó, Doc. Ing., Technical University of Košice, Slovakia

Dragoljub Krneta, Ph.D, Professor, Elektrotehnički fakultet, Univerzitet u Istočnom Sarajevu, Bosnia and Herzegovina

Gordana Jotanović, Ph.D, Professor, Univerzitet u Istočnom Sarajevu, Saobraćajni fakultet, Doboj, Bosnia and Herzegovina

Žolt Namesztovski, Ph.D, Professor, Učiteljski fakultet u Subotici, Serbia

Dušan Starčević, Ph.D, Professor, Faculty of Organizational Sciences, Belgrade, Serbia

Josip Ivanović, PhD, Professor, Hungarian Language Teacher Training Faculty, Subotica, Serbia

Mirjana Segedinac, Ph.D, Professor, Faculty of Science, Novi Sad, Serbia

Branko Markoski, Ph.D, Professor, Faculty of Technical Sciences, Novi Sad, Serbia

Dragica Radosav, Ph.D, Professor, Technical Faculty "Mihajlo Pupin" Zrenjanin, Serbia

Ivana Berković, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Biljana Radulović, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Miodrag Ivković, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Dragana Glušac, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Marjana Pardanjac, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Vladimir Brtka, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Željko Stojanov, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Dalibor Dobrilović, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Zoltan Kazi, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Ljubica Kazi, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Đurđa Grijak, Ph.D, Professor, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Snežana Jokić, Asst. Ph.D, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Vesna Makitan, Asst. Ph.D, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Eleonora Brtka, Asst. Ph.D, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

Višnja Ognjenović, Asst. Ph.D, Technical Faculty “Mihajlo Pupin” Zrenjanin, Serbia

THE ORGANIZING COMMITTEE:

Dragana Glušac, Ph.D, Professor, Technical Faculty "M. Pupin" Zrenjanin, R. of Serbia
- Chairman of the Conference ITRO 2022
Dragica Radosav, Ph.D, Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Jelena Stojanov, Ph.D, Associate Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Marjana Pardanjac, Ph.D, Associate Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Đurđa Grijak, Ph.D, Associate Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Snežana Jokić, Ph.D, Assistant Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Vesna Makitan, Ph.D, Assistant Professor, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Nemanja Tasić, M.Sc, Assistant, Technical Faculty "M. Pupin" Zrenjanin, Serbia
Maja Gaborov, M.Sc, Assistant, Technical Faculty "M. Pupin" Zrenjanin, Serbia

All rights reserved. No part of this Proceeding may be reproduced in any form without written permission from the publisher.

The editor and the publisher are not responsible either for the statements made or for the opinion expressed in this publication.

The author warrants that the article is original, written by stated author/s, has not been published before, contains no unlawful statements, does not infringe the rights of others, is subject to copyright that is vested exclusively in the author and free of any third party rights, and that any necessary written permissions to quote from other sources have been obtained by the author/s.

Authors retain the following rights:
- *copyright, and other proprietary rights relating to the article, such as patent rights,*
- *the right to use the substance of the article in future works, including lectures and books,*
- *the right to reproduce the article for own purposes, provided the copies are not offered for sale,*
- *the right to self-archive the article.*

The Proceedings have been published in a digital format on the Faculty web site.

INTRODUCTION

This Proceedings comprises papers from the International conference on Information technology and development of education that is held on line on November 25th 2022. The International conference on Information technology and development of education has had a goal to contribute to the development of education in Serbia and in the region, as well as, to gather experts in natural and technical sciences' teaching fields. The expected scientific-skilled analysis of the accomplishment in the field of the contemporary information and communication technologies, as well as analysis of state, needs and tendencies in education all around the world and in our country have been realized. The authors and the participants of the Conference have dealt with the following thematic areas: - Theoretical and methodological questions of contemporary pedagogy - Personalization and learning styles - Social networks and their influence on education - Children security and safety on the Internet - Curriculum of contemporary teaching - Methodical questions of natural and technical sciences subject teaching - Lifelong learning and teachers' professional training - E-learning - Education management - Development and influence of IT on teaching - Information communication infrastructure in teaching process All submitted papers have been reviewed.

The papers presented on the Conference and published in this Proceedings can be useful for teacher while learning and teaching in the fields of IT, informatics, technics and other teaching subjects and activities. At the end of the conference, and based on the papers of our participants, we conclude that the main focus points of this moment in education. Contribution to science and teaching development in this region and wider has been achieved in this way.

The ITRO Organizing Committee would like to thank the authors of papers, reviewers and participants in the Conference who have contributed to its tradition and successful realization.

Chairman of the Organizing Committee
Ph.D Dragana Glušac

IN MEMORIAM PROFESSOR DIJANA KARUOVIĆ
1978-2022.

We especially want to pay tribute to our late colleague professor Dijana Karuović PhD, as one of the founders of the ITRO conference.

To all of us who knew her, professor Dijana Karuović will be a symbol of professional attitude towards work, dedication and loyalty to the institution to which she belonged. Behind HER remain her wonderful children, her many scientific works, her goodness and her love.

We are grateful to have known her.

Also, we will always remember our dear colleague professor Ivan Tasić, PhD, who passed away in 2019.

Our team thus suffered an irreparable loss, and their names will forever remain on the pages of the conference proceedings.

Professor Dijana Karuović and professor Ivan Tasić

CONTENTS

INVITED LECTURE

Ž. Namestovski, A. Buda, G. Molnár, Z. Szűts
SKILL AND COMPETENCE DEVELOPMENT AT THE WORLD ROBOT OLYMPIAD (WRO) COMPETITION 3

SCIENTIFIC PAPERS

D. Karuović, M. Pardanjac, S. Jokić
ABILITIES TO ORGANIZE LEARNING AS FACTORS OF SUCCESS OF DISTANCE LEARNING 11

D. Letić, I. Berković, V. Ognjenović, B. Radulović and V. Makitan
GENERAL WALLIS INTEGRAL FORMULA IN THE DEFINITION OF PRECISE HYPERSPHERICAL CAPS 15

I. Borjanović, D. Popović, Ž. Eremić, N. Tihi
COMPUTING SUMMER SCHOOL 19

A.R. Afshari, D. Radosav, S. Stanisavljev
IOT PROJECT MANAGEMENT 22

D. Tadić, B. Maljugić, A. Kovačević
IMPACT OF SOCIETY 5.0 ON EDUCATIONAL INSTITUTIONS AND EDUCATIONAL WORKERS 28

V. Tadić, Á. Odry, Z. Király, Z. Vízvári, G. I. Szabó, J. Sárosi, I. Bíró, P. Odry
MICROORGANISMS DETECTION USING CIRCULAR GABOR FILTER 33

D. Čolović, Lj. Kazi, V. Amižić, D. Bomble, V. Popov
CLEAN CODE PRINCIPLES USED IN PHP APPLICATION 38

S. Raičević, V. Nikolić, V. Premčevski, B. Markoski, A. Sofić
CLUSTERING SERBIAN TEXT DOCUMENTS 44

N. Bijedić, D. Gašpar, S. Kapetanović, I. Memić
STUDENTS' NETWORKING WITH INDUSTRY FOSTER SUCCESSFUL IT CURRICULUM COMPLETION 51

Z. Kazi, Lj. Kazi, N. Chotaliya
INTRODUCING THE R PROGRAMMING LANGUAGE IN UNIVERSITY TEACHING 55

R. Timovski, T. A. Pachemska, D. Iliev, B. Aleksov
ASSESSMENT REPORT AND FUNCTIONAL QUALITATIVE ANALYSIS OF THE CURRENT CONDITION REGARDING THE QUALIFICATION STANDARD: TEACHER IN HIGHER EDUCATION IN REPUBLIC OF NORTH MACEDONIA ... 60

D. Kovač, M. Bakator, M. Kavalić, E. Terek Stojanović, V. Gluvakov, M. Gaborov
EDUCATION AND TRAINING OF EMPLOYEES AS INFLUENCING FACTORS ON BUSINESS PERFORMANCE 65

E. Pavlova Tosheva
EDUCATIONAL ROBOTICS IN TECHNOLOGICAL EDUCATION..... 70

M. Mattová, M. Kapa, B. Sobota, Š. Korečko
TEXT-ICONIC METHOD OF LEARNING WITH SIGN LANGUAGE SUPPORT IN SHARED VIRTUAL SCHOOL ENVIRONMENT 73

V. Gluvakov, M. Bakator, D. Kovač, S. Stanisavljev, D. Bajić
THE RELATIONSHIP BETWEEN EDUCATION MANAGEMENT AND ORGANIZATIONAL LEARNING AS PART OF KNOWLEDGE MANAGEMENT..... 79

N. Pop Tomov, N. Koceska and S. Koceski
THE USE OF AUGMENTED REALITY IN GEOMETRY TEACHING 84

B. Sobota, M. Mattová, Š. Korečko
EXPERIMENTAL USE OF ALTERNATIVE BIOMETRIC DEVICES IN A MULTIMODAL USER INTERFACE FOR TRUSTWORTHY INTERACTION IN A VIRTUAL REALITY ENVIRONMENT 88

M. Gaborov, D. Milosavljev, J. Grujić, V. Gluvakov, D. Kreculj, N. Ratković Kovacevic
OVERVIEW OF CELLULAR VEHICLE-TO-EVERYTHING AND VEHICLE-TO-EVERYTHING BASED ON DEDICATED SHORT-RANGE COMMUNICATION..... 94

A. Kovačević
THE IMPORTANCE OF APPLICATION OF INDUSTRY 5.0 IN THE EDUCATION SYSTEM..... 100

J. Stojanov, T. Sekulic, D. Risteski
HOW TO INCREASE MATHEMATICS TEACHER'S DIGITAL COMPETENCIES 103

N. Stojkovikj, L. K. Lazarova, A. S. Ilievska, B. Tashkova
APPLICATION OF SORTING ALGORITHMS IN SHOPPING ASSISTANT APPLICATION 107

D. Ćoćkalo, M. Bakator, S. Stanisavljev, M. Nikolić, E. Terek Stojanović, M. Kavalić
YOUTH ENTREPRENEURSHIP DEVELOPMENT THROUGH EFFECTIVE EDUCATION MANAGEMENT: FRAMEWORK, CHALLENGES, AND GUIDELINES 112

J. Grujić, M. Gaborov
DIGITALIZATION IN LANGUAGE SCHOOL TEACHING- RUSSIAN LANGUAGE TEACHING ON THE TERRITORY OF THE AUTONOMOUS PROVINCE OF VOJVODINA 116

N. Stojanović, V. Makitan, E. Brtka and V. Brtka
LATEST TECHNOLOGIES IN WEB SITE/APPLICATION DEVELOPMENT 122

D. Bogatinov, A. Stojanova Ilievska
MICROCOMPUTER TK8-A FOR SOLAR SYSTEM 127

S. Jokić, V. Srdić, M. Hadžić, A. Ilić
FORMATIVE ASSESSMENT IN DISTANCE EDUCATION – EXAMPLES FROM THE PRACTICE OF ENGLISH LANGUAGE TEACHING IN PRIMARY SCHOOL 131

Cs. Szabó, B. Osif and E.M.M. Alzeyani
PROJECT PLANNING SUPPORT FOR WATERFALL SOFTWARE PROJECT MANAGEMENT SIMULATIONS 135

E. Karamazova Gelova, M. Kocaleva Vitanova
ANALYSIS OF STUDENT ACHIEVEMENTS IN TEACHING MATRIX USING GEOGEBRA SOFTWARE 141

M. Kocaleva Vitanova, B. Zlatanovska, E. Karamazova Gelova, A. Stojanova Ilievska, M. Miteva
APACHE HTTP SERVER AS FORWARD PROXY SERVER 147

N. Stojanović, V. Makitan and E. Brtka
ANALYSIS OF THE RESULT OF IT PROJECT “BANDGRID PLATFORM” 154

M. Kovačević, M. Lazić, N. Tasić
QUALITY ASSURANCE SYSTEM IN HIGHER APPLIED EDUCATION 160

M. Petrović, A. Filipović, V. Nikolić
EXAMPLE OF FCM APPLICATION IN SUBJECTIVELY ORIENTED PROBLEMS 165

P. Petrović, N. Ćoso, S. Maravić Čisar, R. Pinter
TRAINING AND UTILIZING A GENERAL-PURPOSE SOUND CLASSIFICATION MODEL USING TENSORFLOW LITE AND FLUTTER 170

S. Šević, S. Jokić, M. Pardanjac, D. Šević
SCHOOL AND COMMUNITY COLLABORATION 176

M. Mabić, D. Gašpar, I. Ćorić
STUDENT'S UNDERSTANDING OF DIGITAL LITERACY 180

R. Pinter, S. Maravić Čisar, L. Sedmina
MEASURING READABILITY AND UNDERSTANDING OF PROGRAM CODE THROUGH EYE TRACKING 185

D. Banović, D. Glušac
THE AUTHORITY OF COMPUTER SCIENCE TEACHER 191

D. Nedic, G. Jotanovic
LEARNING MATHEMATICAL CONTENTS USING SMART EDUCATIONAL TECHNOLOGIES 196

S. Koceski, N. Koceska
USING EDUCATIONAL GAMES FOR LEARNING NATURAL SCIENCE 200

M. Kovačević, M. Lazić, N. Tasić
THE ROLE AND IMPORTANCE OF PRINCIPLES, SUBJECTS, AND MEASURES FOR QUALITY ASSURANCE IN THE QUALITY ASSURANCE SYSTEM OF HIGHER SCHOOLS OF APPLIED STUDIES 204

K. Kuk, V. Nikolić, B. Popović, P. Čisar, V. Stojanović
IMPLEMENTATION THE SIMILAR-TASK ALGORITHM IN GRAPH AND RELATIONAL DATABASE 209

S. Mihajlović, M. Mazalica and D. Dobrilović
OVERVIEW OF SIMULATION TOOLS FOR FOG, EDGE AND CLOUDING COMPUTING 215

Assessment Report and Functional Qualitative Analysis of the Current Condition Regarding the Qualification Standard: Teacher in Higher Education in Republic of North Macedonia

R. Timovski*, T. A. Pachemska**, D. Iliev*** and B. Aleksov****
* Goce Delcev University /E-Index department, Stip, Republic of North Macedonia
** Goce Delcev University/Faculty of computer science, Stip, Republic of North Macedonia
*** University St. Kliment Ohridski/Faculty of pedagogy, Bitola, Republic of North Macedonia
**** Ministry of education and science/Higher education sector, Skopje, Republic of North Macedonia
riste.timovski@ugd.edu.mk, tatjana.pacemska@ugd.edu.mk, dean.iliev@uklo.edu.mk,
borco.aleksov@mon.gov.mk

Abstract - The role of a higher education teacher is just one of the dimensions and attributes of the academic profession. Anyone with the necessary qualifications, engaged in the academic world is expected to possess a pool of professional academic roles through the whole career, such as teacher, researcher, manager, contributor etc. We have worked on a development of a Standard of qualification: Teacher in higher education within the international Erasmus + project, where one of the activities was evaluation of the current condition with the proposed key qualifications for the teachers in higher education and their expectations in the future, using mathematical modeling techniques. This resulted in a determination of the current qualitative levels regarding different categories of teachers, in terms of the specific qualifications of the teacher, called key job tasks, provided within the Standard.

I. INTRODUCTION

The teacher qualification standard in higher education is directly related to the:

Needs of the labor market. The qualification: Teacher in higher education primarily refers to the acquisition of knowledge, skills and attitudes for the realization of teaching activities in higher education institutions. The qualifications standard includes the competencies that teachers in higher education have acquired during their formal education (undergraduate level, master's level and doctoral level), includes the experiences gained during their classes/teaching in higher education and also the competencies that the teacher in higher education should acquire and upgrade during lifelong learning process and through various forms of professional development. All of the above mentioned strongly improves the qualities of the teacher in higher education and develops competencies that make the same teacher more competitive on the labor market. It is expected that the labor market in our country will establish conditions and criteria for advancement that each of the teachers will identify with.

Continuation of education. The teacher qualification standard in higher education is inextricably connected and conditioned by the informal learning and professional development of teachers. Each of them needs to continue their education in order to maintain and develop the quality of their knowledge, skills and attitudes.

The needs of the individual and/or society. The qualification teacher in higher education is related to the need of the individual to acquire personal competencies to improve his knowledge, skills and attitudes for successful and high-quality realization of work tasks arising from the profession itself. Achieving the standards of qualifications leads to self-actualization, satisfaction of the teacher's internal motives, but also recognition and validation of the desires, affinities and achievements of teachers by the institutions in the system.

II. KEY JOB TASKS OF THE STANDARD AND METHODS USED FOR EVALUATION

Based on the implementation document of the Qualification Standard: Teachers in higher education in Republic of North Macedonia, 10 different key job tasks regarding the qualification and related competencies were evaluated in order

to determine parameters describing the current condition about their fulfillment between the teachers, each containing specific number of different areas of competences and learning outcomes in each of them:

- Has knowledge in the scientific field;
- Realizes scientific and professional research and their application in the teaching process;
- Realizes and supports teaching, learning and studying;
- Values students;
- Mentors students;
- Applies new technologies in teaching, learning and studying;
- Communicates and cooperates with all participants in the teaching process;
- Permanently and life-long improves professionally and collaboratively;
- Acts entrepreneurial, and
- Practices and creates media and critical literacy.

A. *Surveys*

Towards collecting the necessary data to be processed through the proposed model for evaluation of the current and expected condition related to the 10 key job tasks of the qualification teacher in higher education, complex survey was conducted among the teachers in higher education in Republic of North Macedonia during the period 15.2.2022 – 5.3.2022, targeting different universities, titles, types of financing of the institution and scientific field of the title acquired:

- Surveys answers: 160
- Universities targeted: 8
- Different titles targeted: 8 (Full professor, Associate professor, Assistant professor, Senior lecturer, Lecturer, Senior lector, Professor of a Higher Vocational School, Assistant doctoral student)
- Different scientific fields targeted: 6 (Natural and mathematical sciences, Technical-technological sciences, Medical Sciences and Health, Biotechnical Sciences, Social Sciences and Humanities).

For evaluating the current qualitative level of possession of each learning outcome (key job task) which are questions in group Q1, their current practicing, realization and application, following levels were used:

TABLE I. ASSESSMENT LEVELS OF THE CURRENT CONDITION OF POSSESSION OF THE KEY JOB TASKS RELATED TO THE QUALIFICATION STANDARD

Evaluation level: Type 1	**Evaluation level: Type 2**	**Number**
Almost never	Completely disagree	1
Rarely	Closer to NO	2
Often	Closer to YES	3
Almost always	Completely agree	4
Do not have an opinion		0

For evaluating the level of need for improvement regarding the key job tasks which are questions in group Q2, following levels were used:

TABLE II. ASSESSMENT LEVELS OF THE NEED FOR IMPROVEMENT OF THE KEY JOB TASKS CURRENT CONDITION

Evaluation level	**Number**
Not necessary	1
Have an insignificant need	2
Have an exceptional need and necessity	3
Have a significant need	4

For evaluating the level of readiness of the teacher to contribute as an educator, which are questions in group Q3, following levels were used:

TABLE III. ASSESSMENT LEVELS OF THE READINESS FOR CONTRIBUTION IN THE IMPROVEMENT PROCESS

Evaluation level	**Number**
Would not make any contribution	1
Would make a small contribution	2
Would make a significant contribution	3
Would make an outstanding contribution	4

B. *Mathematical modeling technicues and evaluation model*

Two optimization techniques were used to build the evaluation model:

- AHP – Analytic Hierarchy Process, and
- DEA – Data Envelopment Analysis.

AHP enables creation of listing (depend on the criteria) showing (in this application of AHP) the most present key job task among the HE teachers (with best evaluation levels), with the importance of the criteria included and bias excluded.

DEA enables generation of final QA report, pointing to the relatively efficient and inefficient titles in HE depending on the level of presence of the key job task, related to the resources invested in gaining those key job tasks.
The proposed model is shown on the figure.

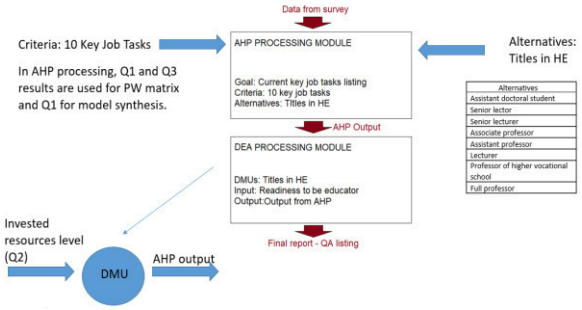

Figure 1. Evaluation AHP+DEA model

The criteria that are used in AHP are represented with the 10 key job tasks. Units that are used as alternatives in AHP, and in the same tame are Decision Making Units (DMUs) in DEA are the 8 different titles that are targeted with the model. The processing of the data via AHP is done using Super Decisions software. The processing of the data via DEA is done using OSDEA software.

III. RESULTS AND DISCUSSION

The result from the surveys Q1, Q2 and Q3 is shown as an average indexes assessed by the targeted teachers from all categories mentioned above, shown in the following table.

TABLE IV. ASSESSMENT LEVELS OF THE READINESS FOR CONTRIBUTION IN THE IMPROVEMENT PROCESS

Criterion	**Key job task**	**Average level / Current condition (Q1)**	**Need for improvement (Q2)**	**Readiness to be educator (Q3)**
1	Has knowledge in the scientific field	3,22609	2,5652	3,4222
2	Realizes scientific and professional research and their application in the teaching process	3,20838	2,6666	2,8863
3	Realizes and supports teaching, learning and studying	3,5996	2,2666	3,4418
4	Values students	3,7413	2,3333	3,2727
5	Mentors students	3,8063	2,1555	3,409
6	Applies new technologies in teaching, learning and studying	3,6776	2,6666	3,1363
7	Communicates and cooperates with all participants in the teaching process	3,7938	2,5277	3,2045
8	Permanently and life-long improves professionally and collaboratively	3,6746	2,3778	3,25
9	Acts entrepreneurial	3,3923	2,4666	2,7045
10	Practices and creates media and critical literacy	3,6083	2,5555	2,8604

Based on the results in table IV:

- Related to Q1, highest score belongs to the key job task **Mentors students**, and the lowest score belongs to the key job task **Realizes scientific and professional research and their application in the teaching process**. This means that most effort by the teachers is invested into mentoring students, working individually and in small groups, which can be evaluated as pretty good. On the other hand, teachers are aware about their weak involvement into research activities and their implementation into the teaching materials.
- Related to Q2, highest score in the context of determination what is the weakest spot that needs most improvement, **Applies new technologies in teaching, learning and studying** is detected as an issue that needs most resources involved in the future (use of computers, tablets, smartboards etc.). **Mentors students** has the lowest score, which completely matches with the results from Q1.
- Related to Q3, key job task **Realizes and supports teaching, learning and studying** has the highest score. This means that regarding the readiness to help and be included in the conduction of the teaching process, teachers evaluated themselves with a highest grade. On the other hand, lowest score refers to the key job task **Act entrepreneurial**. This means that the teachers needs education and training on how to improve their entrepreneurial skills (teamwork, leadership, communication, customer service, financial skills, analytical and problem-solving skills etc.) in order to be able to transfer them to the students via the teaching process.

When processed via AHP model, priorities of the 10 criteria are generated. Results are shown on the next figure.

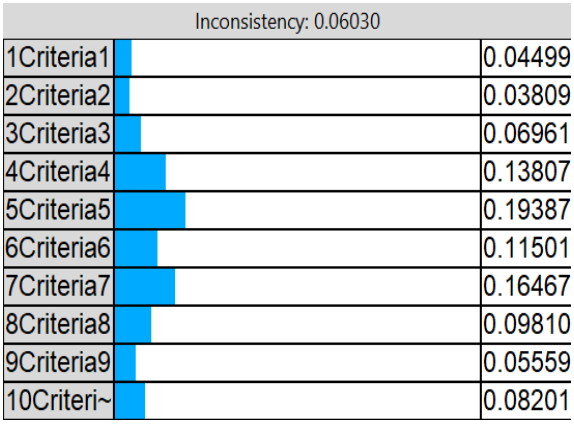

Figure 2. Priorities of the key job tasks

Based on the results, highest priority goes to Criteria 5, which is key job task **Mentors students**. According to the teachers, this is most important key job task a teacher should possess. On the other hand, lowest priority refers to Criteria 2, which is key job task **Realizes scientific and professional research and their application in the teaching process**. This means that these results about the importance of the key job tasks based on the teachers' perception are close to the level of the resources that teachers invested during their professional life into improvement their teaching capabilities (Best/Highest in mentoring their students and Worst/Lowest in expansion of their research activities towards implementation of new content and/or practical activities in their teaching). The index of incostistency is:

$$R.I. = 0.06030 \quad (1)$$

which means that the level of inconsistency of the judgements of the teachers is 6.03% and is bellow the highest possible rate of inconsistency that is 10%, so the results are acceptable and can be used for further processing. Bearing this in mind, with the complete processing of the data through the AHP model, the following results are generated:

TABLE V. AHP RESULTS

Name	Ideals	Normals
Senior Lecturer	1	0.136864
Associate Professor	0.951581	0.130237
Full Professor	0.930628	0.127369
Assistant Professor	0.92737	0.126923
Professor of HVS	0.924684	0.126556
Assistant Doctoral Student	0.904968	0.123857
Senior Lector	0.846694	0.115882
Lecturer	0.820608	0.112312

Based on the results, highest score in this environment of importance of the 10 key job tasks processed via AHP is achieved from the teachers with title Senior lecturer. Lowest score is achieved from the teachers with title Lecturer.

The processing of the data via DEA, based on the answers about resources invested in achieving the key job tasks / inverted index of the need to be educated towards achieving these key job tasks is shown in the following table (output index is the output of the AHP model):

TABLE VI. DEA MODEL

Evaluation Level	Input Resources Index	Name (DMU)	Output
3,6	1,4	3SeniorLecturer	1
NoData	NoData	6Lecturer	0.820608
NoData	NoData	2SeniorLector	0.846694
1,8	3,2	1AssistantDoctoralStudent	0.904968
1,9	3,1	7ProfessorofHVS	0.924684
2,78	2,22	5AssistantProfessor	0.927370
2,6285	2,3715	8FullProfessor	0.930628
2,1214	2,8786	4AssociateProfessor	0.951581
	DEA Model (1 input, 1 output)		

With processing the data with output oriented VRS DEA model, the results obtained are shown bellow:

TABLE VII. FINAL DEA (EVALUATION) RESULTS WITH THE MOST AND LEAST EFFICIENT TITLES OF TEACHERS

DMU Name	Objective Value	Efficient
3SeniorLecturer	1	Yes
4AssociateProfessor	0,951581	
8FullProfessor	0,930628	
5AssistantProfessor	0,92737	
7ProfessorOfHSV	0,924684	
1AssisstantDoctoralStudent	0,904968	

This QA analysis positions the title Senior Lecturer as relatively most efficient category in this moment, regarding the current investment of resources in obtaining the Key Job Tasks (10 criteria) and their current possession and importance. On the other side, title Assistant Doctoral Student needs biggest changes towards improvement of these skills. Nevertheless the results point out relatively close final scores, improvements are possible. With further DEA mathematics, precise percents of the improvement

that needs to be done related to specific key job tasks can be calculated.

IV. CONCLUSION

The proposed model is designed in accordance to the Qualification standard: Teacher in higher education in Republic of North Macedonia. With networking the key job tasks that define this standard and their assessment from the teachers, reports can be generated giving precise information about their importance and present fulfillment related to different titles and/or scientific fields. We can agree that this kind of a model would require massive surveys to be conducted towards obtaining better picture of the current condition with the teachers' skills and capabilities. The model can be used as a mechanism for qualitative evaluation periodically or promptly, depending on the needs. These results can be compared to other countries and for sure used to create strategies and make further planning of additional training and education of certain titles / groups of teachers in higher education towards improvement of their weak skills and competencies through a life-long learning process, because of the dynamic world we live in.

REFERENCES

The research and the results shown in the paper are realized within the Erasmus+ project **Better Academic Qualifications through Quality Assurance – BAQUAL,** May 20202 – Nov 2022. Web: https://www.baqual.hr/en

[1] B.Aleksov, T.A.Pacemska, and D. Iliev, "Standard for qualification: Teacher in higher education in Republic of North Macedonia", proposed document. June, 2021.

[2] S. Gass, "The Analytic Hierarchy Process-An Exposition.". Operations Research. 49. 469-486. 10.1287/opre.49.4.469.11231, 2001.

[3] C.L.Hwang, and K. Yoon, "Multiple Attribute Decision Making: Methods and Applications: A State-of-the-Art Survey", Springer-Verlag, New York, NY, 1981

[4] A. Charnes, W.W. Cooper, L.A. Lewin and M.L. Seiford, "Data Envelopment Analysis, Theory, Methodology and Applications", Kluwer Academic Publishers, Norwell, Massachusetts, 1994.

[5] H.A. Taha, "Operational Research, Introduction", Pearson Education, Inc., 2007

[6] W.W. Cooper, M.L. Seiford and J. Zhu, "Data Envelopment Analysis: History, Model and Interpretations", Springer, NY, USA, 2011

[7] R.W.Saaty, "The analytic hierarchy process – what it is and how it is used*"* Math Modelling, Vol. 9, No. 3-5, pp 161-176. 0270-0255/87, 1987

[8] Y.Wang, J.Liu and T.M.Elhag, "An integrated AHP-DEA methodology for bridge risk assessment", Computers &Industrial Engineering, Vol. 54, No. 3, pp 513-525, 2008

[9] T.L. Saaty, "The Analytic Hierarchy Process", McGraw-Hill Internatinal Book Company, 1980

[10] Z. Sinuany-Stern, A. Mehrez and Y. Hadad, "An AHP/DEA methodology for ranking decisionmaking units", International Transactions in Operational Research, 7, pp.109-124, 2000