

# REMA 2025

6<sup>th</sup> International Conference  
Education Across Borders

Reimagining Education in the Modern Age

## CONFERENCE PROCEEDINGS

Bitola, 2026



UNIVERSITY "ST. KLIMENT OHRIDSKI"



UNIVERSITY OF WESTERN MACEDONIA



FAN S. NOLI UNIVERSITY

University St. Kliment Ohridski – Bitola  
Faculty of Education – Bitola

CONFERENCE PROCEEDINGS

6th International “Education Across Borders” Conference

“Reimagining Education in the Modern Age”

3-4<sup>th</sup> October  
Bitola, 2025

Bitola, 2026

**Publisher**

University St. Kliment Ohridski – Bitola  
Faculty of Education – Bitola

**Editor-in-Chief**

Prof. Dr. Danche Sivakova –Neshkovski, Dean of the Faculty of Education – Bitola

**Editors**

Prof. Dr. Silvana Neshkovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Assist. Prof. Dr. Josif Petrovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia

**Scientific committee**

Prof. Dr. Danche Sivakova Neshkovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Violeta Janusheva, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Jove D. Talevski, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Silvana Neshkovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Valentina Gulevska, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Daniela Andonovska Trajkovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Prof. Dr. Biljana Cvetkova Dimov, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Assist. Prof. Dr. Vesna Stojanovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Assist. Prof. Dr. Josif Petrovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia  
Assoc. Prof. Dr. Jonela Spaho, Fan S. Noli University, Albania  
Prof. Dr. Aida Mosko, Fan S. Noli University, Albania  
Assoc. Prof. Dr. Rafail Prodani, Fan S. Noli University, Albania  
Prof. Dr. Juliana Çyfeku, Fan S. Noli University, Albania  
Prof. Dr. Edlira Xega, Fan S. Noli University, Albania  
Prof. Dr. Sofia Iliadou - Tachou, University of Western Macedonia, Department of Primary Education (Florina), Greece  
Prof. Dr. Ioannis Thoidis, University of Western Macedonia, Department of Primary Education (Florina), Greece  
Prof. Dr. Georgios Tzartzas, University of Western Macedonia, Department of Early Childhood Education (Florina), Greece  
Prof. Dr. Georgios Lappas, University of Western Macedonia, Communication and Digital Media Department (Kastoria), Greece  
Assoc. Prof. Dr. Stergiani Giaouri, University of Western Macedonia, Department of Primary Education (Florina), Greece  
Prof. Dr. Lothar Tschapka, University of Vienna, Austria  
Prof. Dr. Tomaž Onič, Faculty of Arts, University of Maribor, Slovenia  
Prof. Dr. Gabija Bankauskaite, Villnius University, Kaunas Faculty, Institute of Languages, Literature and Translation Studies, Lithuania  
Prof. Dr. Desislava Cheshmedzhieva-Stoycheva, Konstantin Preslavsky University of Shumen, Department of English Studies, Bulgaria  
Prof. Dr. Hasan Saliu, AAB College, Prishtina, Kosovo  
Prof. Dr. Aida Alla, AAB College, Prishtina, Kosovo  
Prof. Dr. Zvonko Taneski, Constantine the Philosopher University in Nitra, Slovakia  
Prof. Dr. Juan Jose Varela Tembra, CESUGA, San Jorge University, Spain  
Prof. Dr. Grozdanka Gojkov, Universtiy of Belgrade, Serbia  
Acad. Prof. Dr. Marjan Blazic, University of Novo Mesto, Slovenia  
Prof. Dr. Danimir Mandic, Faculty of Teacher Education, University of Belgrade, Serbia  
Prof. Dr. Łukasz Tomczyk, Institute of Pedagogy, Jagiellonian University, Poland

Prof. Dr. Matjaž Duh, University of Maribor, Faculty of Education, Slovenia  
Prof. Dr. Tomaž Bratina, University of Maribor, Faculty of Education, Slovenia  
Prof. Dr. Jerneja Herzog, University of Maribor, Faculty of Education, Slovenia  
Prof. Dr. Maja Žmukić, University of Sarajevo, Faculty of Educational Science, Bosnia and Herzegovina  
Prof. Dr. Medina Vantić-Tanjic, University of Tuzla, Faculty for Special Education and Rehabilitation, Bosnia and Herzegovina  
Prof. Dr. Marijana Županić Benić, University of Zagreb, Faculty of Teacher Education, Croatia  
Assist. Prof. Dr. Blaženka Bačlija Sušić, University of Zagreb, Faculty of Teacher Education, Croatia  
Dr. Sc. Mirna Sabljarić, Academy of Arts and Culture in Osijek, Croatia  
Assist. Prof. Dr. Dubravka Kušćević, Faculty of Philosophy in Split, Croatia  
Prof. Dr. Vedrana Marković, University of Montenegro, Music Academy, Cetinje, Montenegro  
Assist. Prof. Dr. Kristinka Selakovic, University of Kragujevac, Faculty of Education in Jagodina, Serbia  
Prof. Dr. Rositsa Petrova Mihaylova, Konstantin Preslavsky University of Shumen, Faculty of Education, Bulgaria  
Prof. Dr. Teodora Simeonova, Konstantin Preslavsky University of Shumen, Faculty of Education, Bulgaria  
Assist. Prof. Dr. Mirena Legurska, University "St. Kliment Ohridski" Sofia, Bulgaria  
Assist. Prof. Dr. Zühal Dinç Altun, Karadeniz Technical University, Fatih Faculty of Education, Trabzon, Turkey  
Prof. Dr. Taner Altun, Karadeniz Technical University, Fatih Faculty of Education, Trabzon, Turkey  
Assist. Prof. Dr. Sibel Oğuz Haçat, Kastamonu University, Faculty of Education, Kastamonu, Turkey  
Prof. Dr. Zekeriya Yerlikaya, Kastamonu University, Faculty of Education, Kastamonu, Turkey  
Prof. Dr. Vedat Bajrami, University of Prizren Ukshin Hoti, Department of Education, R. Kosovo  
Assist. Prof. Dr. Esad Kurejšepi, University of Prizren Ukshin Hoti, Department of Education, R. Kosovo  
Assist. Prof. Dr. Alma V. Lama, University for Business and Technology, R. Kosovo

### **Organizing committee**

Prof. Dr. Dean Iliev, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Tatjana Atanasoska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Marija Ristevska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Biljana Gramatkovski, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Jasmina Kochoska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Gordana Stojanoska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Prof. Dr. Mazanna Severin, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Assist. Prof. Dr. Evdokija Galovska, University "St. Kliment Ohridski" – Bitola, RN - Macedonia  
Assist. Prof. Dr. Valentina Nikolovska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Teaching Assistant,  
MA Marija Stojanoska, University "St. Kliment Ohridski" – Bitola, RN Macedonia English Language Instructor,  
MA Elena Shalevska, University "St. Kliment Ohridski" – Bitola, RN Macedonia Senior English Language Instructor  
MA Stela Bosilkovska, University "St. Kliment Ohridski" – Bitola, RN Macedonia  
Assoc. Prof. Eris Rusi, Fan S. Noli University, Albania, Prof. Dr. Ilir Shyta, Fan S. Noli University, Albania  
Prof. Dr. Suela Dinellari, Fan S. Noli University, Albania  
Assoc. Prof. Dr. Eriola Qafzezi, Fan S. Noli University, Albania  
Assoc. Prof. Dr. Magdalini Vampa, Fan S. Noli University, Albania  
Prof. Dr. Juliana Çyfeku, Fan S. Noli University, Albania  
Assist. Prof. Dr. Anna Karolina Retali, University of Western Macedonia, Department of Primary Education (Florina), Greece

Assist. Prof. Dr. Evmorfia Kipouropoulou, University of Western Macedonia, Department of Primary Education (Florina), Greece

Ioannis Kaskamanidis, Laboratory and Teaching Personnel (EDIP), University of Western Macedonia, Department of Primary Education (Florina), Greece

Assoc. Prof. Dr. Vasiliki Pliogkou, University of Western Macedonia, Department of Early Childhood Education (Florina), Greece

Assist. Prof. Dr. Menelaos Tzifopoulos, University of Western Macedonia, Department of Primary Education (Florina), Greece

Nikolaos Tamoutselis, Laboratory and Teaching Personnel (EDIP), University of Western Macedonia, Department of Early Childhood Education (Florina), Greece

### **Editorial Board**

Prof. Dr. Silvana Neshkovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Valentina Gulevska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Ljupcho Kevereski, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Dean Iliev, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Tatjana Atanasoska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Mazanna Severin, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Daniela Andonovska Trajkovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Biljana Cvetkova Dimov, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Marija Ristevska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Biljana Gramatkovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Jasmina Kochoska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Assist. Prof. Dr. Vesna Stojanovska, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Assist. Prof. Dr. Josif Petrovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Assist. Prof. Dr. Evdokija Galovska, University “St. Kliment Ohridski” – Bitola, RN - Macedonia

Assist. Prof. Dr. Anita Angelevska, University “St. Kliment Ohridski” – Bitola, RN - Macedonia

Prof. Dr. Zoran Nikolovski, University “St. Kliment Ohridski” – Bitola, RN Macedonia

Prof. Dr. Sonja Chalamani, University “St. Kliment Ohridski” – Bitola, RN Macedonia

### **Cover page**

Jane Stevanoski, University “St. Kliment Ohridski” – Bitola, RN - Macedonia

## CONTENT

### PLENARY TALKS

THE ROLE OF STEM EDUCATION RESEARCH IN MODERN TEACHING AND LEARNING ..... 11

Dean Zolman

ARTIFICIAL INTELLIGENCE: A CATALYST FOR ENHANCING QUALITY IN EDUCATION ..... 17

Danimir Mandić

FROM AI TO GAMIFICATION: TRANSFORMING EDUCATION FOR THE DIGITAL GENERATION...23

Vladimir Trajkovik, Maja Videnovik

### WORKSHOPS

IMPROVISATION THEATRE – AN INTERACTIVE WORKSHOP ..... 33

Lothar Tschapka

### LANGUAGE AND LITERATURE

HUMOUR IN EDUCATION ..... 39

Lovorka Zergollern-Miletić, Kristina Vujnović, Marita Pavlović

THE ILLUSION OF ARTISTRY: EVALUATING AI-GENERATED LITERARY AND VISUAL WORKS: A STUDENT-BASED ANALYSIS ..... 48

Tatjana Srceva-Pavlovska

TEACHING ABSTRACT WRITING IN ESP COURSES AT THE UNIVERSITY LEVEL – A CASE STUDY ON AGRICULTURE STUDENTS ..... 55

Danijela Đorđević, Katarina Ivanović, Tijana Vesić Pavlović

UNDERSTANDING TWEEN AND TEEN SLANG: EXPLORING THE IMPACT OF SOCIAL MEDIA LANGUAGE ON ENGLISH PROFICIENCY AND COMMUNICATION SKILLS ..... 63

Vesna Prodanovska-Poposka

AI-ENHANCED LITERATURE TEACHING WITHIN EFL INSTRUCTION: TEACHERS' PERSPECTIVES, OPPORTUNITIES AND CHALLENGES ..... 74

Elena Shalevska, Marija Stojanoska

THE USE OF AI TOOLS FOR HOMEWORK ASSIGNMENTS IN THE EFL CLASSROOM ..... 83

Elena Boshevska, Silvana Neshkovska

USING CONCEPTUALISATION AND VISUALISATION IN TEACHING POLYSEMIOUS TERMS IN ESP: FOCUS ON ENGINEERING, MEDICAL AND ECONOMIC TERMINOLOGY ..... 91

Tijana Vesić Pavlović, Ivan Milošević

INVOLVE ME AND I WILL LEARN – DRAMA TECHNIQUES IN LEARNING ENGLISH AS A SECOND LANGUAGE ..... 102

Jasminka Sekulova

GET THEM TO SPEAK: USING THE 3RS—READ, RETAIN, AND RECREATE—TO FOSTER CLASSROOM COMMUNICATION ..... 109

Sandra Serafimovska

ENHANCING THE SPEAKING SKILL IN THE ELF CLASSROOM.....	118
Marijana Klemenchich	
DIGITAL VS. TRADITIONAL ELT: EXPLORING COMMUNICATION SIMILARITIES AND DIFFERENCES.....	126
Tatjana Jovcheska	
DIGITAL BRIDGES: INTEGRATING TECHNOLOGY TO FOSTER COLLABORATION AMONG ENGLISH LANGUAGE LEARNERS AT THE UNIVERSITY LEVEL - A CASE STUDY OF SECOND-YEAR ENGLISH LANGUAGE STUDENTS.....	135
Alma Lama	
TEACHING FIGURATIVE LANGUAGE: A PRACTICAL GUIDE FOR EFL EDUCATORS .....	146
Ardian Sallauka	
VARIANTS THAT EXIST IN ENGLISH LANGUAGE AND THE WAY TEACHERS USE THEM DURING THEIR CLASSES .....	151
Vesna Milevska	
FROM CHALKBOARDS TO CHATBOTS: PBL IN THE DIGITAL AGE .....	163
Samir Skenderi	
ALTERNATIVE ASSESSMENT IN ELT: A GLOBAL PERSPECTIVE AND INSIGHTS FROM KOSOVO AND NORTH MACEDONIA.....	171
Nuray Çürt Aşikferki, Daniela Andonovska-Trajkovska	
URBAN LINGUISTIC LANDSCAPE STUDIES – SOCIOLINGUISTIC AND EDUCATIONAL ASPECTS.....	177
Aglia Dobreva	
“SHAPING MINDS AND CULTURES: HOW MEDIA COMMERCIALS TRANSMIT SOCIAL AND CULTURAL VALUES”.....	186
Edlira Xega, Juliana Çyfeku	
TEACHING FRENCH: PARISIAN STANDARD OR FRANCOPHONE DIVERSITY?.....	197
Zoran Nikolovski	
I PLAY AND COMMUNICATE IN GREEK: A PROGRAM FOR BEGINNERS OF THE GREEK LANGUAGE.....	205
Marija Vasilevska	
THE RACISM IN THE NOVEL “TO KILL A MOCKING BIRD”.....	209
Maja Janusheva	
HISTORICAL CONTEXTUALIZATION AND THEMATIC - MOTIF COMPARATIONS IN SERDAR, THE DEATH OF SMAIL AGA - CHENGICH AND GORSKI VENEC .....	215
Anita Angelevska	
DECONSTRUCTING "PATRIARCHY" IN GRAPHIC NOVELS: THE CASE OF MARTA BREEN AND JENNY JORDAHL. CREATIVE WRITING ACTIVITIES FOR CHILDREN .....	218
Fani Mylona, Triantafyllos H. Kotopoulos	
THE MEANING OF LITERATURE FOR CHILDREN FOR THE CHILD'S DEVELOPMENT .....	226
Anica Zlatevska	

LITERARY TEXT ANALYSIS IN PRIMARY EDUCATION: THE INFLUENCE OF STUDENTS' AGE ON THE USE OF INTERTEXTUAL, INTRATEXTUAL, AND EXTRATEXTUAL CONNECTIONS ..... 229

Daniela Andonovska-Trajkovska

POSSIBILITIES OF THE NEW ERA FOR FOREIGN LANGUAGE LEARNING ..... 239

Aleksandra Gojkov Rajić

BETWEEN THE DESERT AND THE UNKNOWN: DINO BUZZATI'S VISION OF THE HUMAN CONDITION ..... 250

Eris Rusi, Jonela Spaho

THE INFLUENCE OF PRIVATE SCHOOLS ON FOREIGN LANGUAGE LEARNING IN REPUBLIC OF NORTH MACEDONIA ..... 258

Evdokija Galovska, Valentina Nikolovska, Marija Talevska

## **PSYCHOLOGY**

THE IMPACT OF INTEROCEPTIVE AWARENESS ON STUDENTS' MOTIVATION AND SELF-REGULATION ..... 267

Sofija Filipovska Jordanovska, Marija Ristevska

PSYCHO-SOCIAL, MORAL, SECURITY, EDUCATION AND COMMUNICATION CHALLENGES DURING CRISIS AND THEIR RELATION TO PERSONAL SECURITY, SUBJECTIVE WELL-BEING AND THE RIGHT TO CHOICE ..... 272

Miroslav Pendaroski

EXPLORING THE CONCEPT OF HAPPINESS: A STUDY OF PERCEPTIONS IN SIX-YEAR-OLDS..... 278

Magdalini Vampa, Mitjana Profiri, Elona Kodhel

THE CONCEPT OF PEER VIOLENCE AND THE MEASURES TAKEN AGAINST PEER VIOLENCE ... 285

Daniela Trajkovski, Teodora Lozanovska

THE INFLUENCE OF PRESCHOOL TEACHER EDUCATION FACULTIES ON THE UNDERSTANDING AND DEVELOPMENT OF SOCIAL COHESION AMONG STUDENTS ..... 292

Tatjana Koteva-Mojsovska, Florina Shehu

FROM GENES TO GENIUS: SECRETS OF EXTRAORDINARY MINDS ..... 298

Ljupco Kevereski, Ivanka Korez, Milka Kevereska-Sapkaroska

## **PEDAGOGY**

INTERCULTURAL PEDAGOGY: NECESSITY OR LUXURY? ..... 304

Evmorfia Kipouropoulou, Ilias Vasileiadis

“LEARN, ENGAGE AND TRANSFORM”: EMPOWERING GREEK PRIMARY STUDENTS WITH ACTIVE CITIZENSHIP SKILLS ..... 313

Evangelos Dimitriou, Eleni Griva, Vassiliki Pliogou, Ioannis Bounovas

EDUCATORS' EXPERIENCES ON THE ROLE OF PROFESSIONAL DEVELOPMENT IN WORKING WITH CHILDREN AGED 3-6 ..... 319

Mevlude Aliu-Gashi, Lirie Dobra

EDUCATIONAL NEEDS OF TEACHERS FOR THE IMPLEMENTATION OF SUCCESSFUL REFLECTIVE TEACHING ..... 329

Iliev Dean, Aleksova Mirjana, Chonevski Antonio, Farizi Fariz

"OUR VOICES IN OUR VOTES": A PEDAGOGICAL AND EDUCATIONAL INTERVENTION FOR DEVELOPING ACTIVE CITIZENSHIP COMPETENCES IN EARLY YEARS .....	339
Pliogou Vassiliki, Tsouli Panagiota	
DIDACTIC STRATEGIES FOR THE EXPECTED COMPETENCIES OF GIFTED STUDENTS .....	349
Aleksandar Stojanović, Grozdanka Gojkov	
<b>EDUCATIONAL SCIENCES</b>	
ROMA CHILDREN: SCHOOL ACCEPTANCE AND STEREOTYPES .....	368
Anna Bafiti, Evmorfia Kipouropoulou, Ilias Vasileiadis	
LOCKE'S PEDAGOGICAL IDEAS AND MODERN EDUCATION .....	379
Valentina Gulevska, Sonja Stankovska	
LIFE-LONG LEARNING AND TEACHERS' PROFESSIONAL DEVELOPMENT .....	385
Froska Smilkova	
"YOU' RE NOT AN ALBANIAN?!! (FORTUNATELY): DISCRIMINATION STORIES OF ALBANIAN IMMIGRANT WOMEN IN GREECE IN SCHOOL TEXTBOOKS AND ON TIKTOK. A TEACHING PROPOSAL IN THE CONTEXT OF MULTILITERACIES .....	392
Irimi Koutrouba	
TEACHER COMPETENCES AS THE BASIS OF THE ORGANIZATION AND REALIZATION OF THE EDUCATIONAL PROCESS .....	401
Umit Suleymani	
MIND THE GAP: THE DISCREPANCY BETWEEN TEACHERS' PERCEPTIONS AND PRACTICES IN CULTIVATING STUDENTS' COMMUNICATION AND INTERCULTURAL SKILLS AND STRATEGIES .....	408
Koukosisia Ioanna	
BLENDED LEARNING FOR DEVELOPING LITERACY OF ROMA PUPILS IN PRIMARY SCHOOL ..	416
Natasha Todorovska, Maria Kovachevska	
CHALLENGES AND OPPORTUNITIES FOR THE PROFESSIONAL DEVELOPMENT OF TEACHERS IN CONTEMPORARY SECONDARY EDUCATION IN GREECE .....	425
Zioga Evagelia, Mandraveli Nikoleta, Papadopoulou Sofia	
TEACHING CITIZENSHIP: PRIORITY IN THE TRANSFORMATION OF SCHOOL EDUCATION .....	432
Eleni Karamanoli	
SOCIAL JUSTICE: AN ESSENTIAL PROJECT IN MODERN MULTICULTURAL EDUCATION .....	441
Eleni Karamanoli	
MOBILITY OF TEACHERS AND STUDENTS FOR THE INTERNATIONALIZATION OF HIGHER EDUCATION .....	451
Natasha Angeloska Galevska, Ivan Trajkov, Vladimir Ilievski	
EXPLORING ACADEMIC STAFF'S VALUES ACROSS THE SOUTH CAUCASUS REGION: IMPLICATIONS FOR VALUE-BASED CURRICULUM REFORMATIONS .....	459
Dimitris Pnevmatikos, Triantafyllia Georgiadou, Angeliki Lithoxoidou	
EDUCATING THE HEALERS: REIMAGINING LEARNING FOR THE NURSES OF TOMORROW .....	466
Angjelka Jankulovska	

ACCREDITATION OF PRIOR EXPERIENTIAL LEARNING FROM THE PERSPECTIVES OF HEIS .....	472
Valbona Nathanaili, Blerta Drenofci (Cani)	
QUANTITATIVE ANALYSIS IN THE FUNCTION OF CONTEMPORARY LINGUISTIC METHODOLOGY .....	479
Gordana Bursac	
THE PERCEPTIONS OF PRESCHOOL AND EARLY PRIMARY SCHOOL CHILDREN REGARDING LEISURE TIME AND 'WORK' DURING THE TRANSITION FROM PRESCHOOL TO PRIMARY SCHOOL .....	493
Athina Athanasiou, Thoidis Ioannis, Golia Paraskevi	
DIGITAL TECHNOLOGIES IN EDUCATION	
TEACHING THROUGH DIGITAL TECHNOLOGIES IN PRIMARY SCHOOL: A QUALITATIVE APPROACH.....	497
Dimitra Kalemkeridou, Menelaos Tzifopoulos	
E-DISPILIO: INNOVATIVE TECHNOLOGIES FOR INFORMAL LEARNING OF THE NEOLITHIC ERA .....	505
Kostas Kotsakis, Tryfon Giagkoulis, Kostas Kasvikis	
ENHANCING EDUCATION THROUGH INTELLIGENT TUTORING SYSTEMS .....	511
Josif Petrovski, Vesna Stojanovska, Kristina Petrovska	
IMPLICATIONS OF EDUCATIONAL TECHNOLOGY ON MODERN TEACHING .....	517
Suzana Nikodinovska Bancotovska	
AI AS A LEARNING COMPANION: SUPPORTING CRITICAL THINKING AND RESEARCH SKILLS .....	523
Syzanë Merovci, Biljana Cvetkova Dimov	
APPLICATION OF DIGITAL TOOLS IN EDUCATIONAL ACTIVITIES WITH CHILDREN IN KINDERGARTEN .....	532
Gabriela Durchevska Georgieva, Marija Vasilevska, Violeta Angjelkoska	
INCLUSIVE EDUCATION	
POLICIES AND STRATEGIES FOR EDUCATIONAL SYSTEM MANAGEMENT .....	537
Blagojche Anastasov, Biljana Gramatkovski, Jasminka Kochoska	
ARTIFICIAL INTELLIGENCE AS AN INCLUSION TOOL IN SPECIAL EDUCATION: OPPORTUNITIES, CHALLENGES AND PERSPECTIVES .....	546
Stergiani Giaouri, Maria Charisi	
SURVEY OF THE PHYSICAL ADAPTED ACTIVITY IN THE SOCIAL SERVICES .....	556
Rosica Mihaylova, Teodora Simeonova, Hristina Kolarova-Vasileva	
CROSS-LINGUISTIC RESEARCH ON PRONOUNS IN CHILDREN WITH AUTISM SPECTRUM DISORDERS .....	562
Iskra Sotirovska	
DESIGN AND IMPLEMENTATION OF DIFFERENTIATED INSTRUCTION IN THE ANTHOLOGY OF LITERARY TEXTS FOR 5TH AND 6TH GRADE PRIMARY SCHOOL STUDENTS WITH DYSLEXIA: A CASE STUDY .....	571
Zafeiro Matzari, Tryfon Mavropalias	

CHALLENGES AND OPPORTUNITIES FOR THE PROFESSIONAL DEVELOPMENT OF TEACHERS IN CONTEMPORARY SECONDARY EDUCATION IN GREECE .....	581
Zioga Evagelia, Mandraveli Nikoleta, Papadopoulou Sofia	
ADAPTIVE LEARNING AND ASSISTIVE TECHNOLOGY FOR STUDENTS WITH CEREBRAL PALSY.....	588
Denis Arsovski, Natasa Chichevska Jovanova	
THE ROLE OF MULTIMEDIA TOOLS IN ENHANCING LEARNING EXPERIENCES FOR STUDENTS WITH DIVERSE NEEDS.....	597
Saranda Shabani	
BEYOND HIGH IQ - GIFTEDNESS IS NOT JUST A NUMBER.....	607
Gorica Popovska Nalevska, Marina Kuzmanovska	
 <b>TEACHING MATHS</b>	
AN ASSESSMENT OF FIFTH GRADE PUPILS REGARDING NUMBER OPERATIONS.....	617
Sonja Chalamani, Elena Kotevska, Marzanna Sevveryn-Kuzmanovska, Verce Koneska	
THE VARIATION IN COMMON AND UNCOMMON FRACTION OPERATIONS AFFECTS EDUCATORS' UNDERSTANDING.....	626
Charalampos Lemonidis	
STUDY OF IN-SERVICE TEACHERS' COMPUTATIONAL ESTIMATION STRATEGIES IN PERCENTAGE PROBLEMS .....	633
Charalampos Lemonidis, Androniki Sarigianni	
 <b>EDUCATIONAL MANAGEMENT</b>	
POLICIES AND STRATEGIES FOR EDUCATIONAL SYSTEM MANAGEMENT.....	641
Blagojche Anastasov, Tatjana Atanasoska	
THE FUTURE OF HIGHER EDUCATION: ARCHITECTURAL AND URBAN STRATEGIES FOR A MODERN AND SUSTAINABLE CAMPUS-CITY SYMBIOSIS .....	649
Filis Ajrush Risteska	
IMPROVING EDUCATION QUALITY: THE USE OF EUA EVALUATION REPORTS BY THE MACEDONIAN STATE UNIVERSITIES.....	656
Suzana Pecakovska	
ENTREPRENEURIAL ATTITUDES AND INTENTIONS AMONG STUDENTS OF THE FACULTY OF EDUCATION – BITOLA .....	664
Vesna Stojanovska, Dance Sivakova – Neshkovski, Josif Petrovski	
OPPORTUNITIES AND CHALLENGES FOR MANAGING PARTNERSHIPS IN TEACHER EDUCATION FACULTIES.....	670
Florina Shehu, Tatjana Koteva Mojsovska	

# ADAPTIVE LEARNING AND ASSISTIVE TECHNOLOGY FOR STUDENTS WITH CEREBRAL PALSY

**Denis Arsovski**

University St. Kliment Ohridski Bitola, Higher medical school Bitola, North Macedonia  
denis.arsovski@uklo.edu.mk

**Natasha Chichevska Jovanova**

University Ss. Cyril and Methodius Skopje, Faculty of Philosophy  
Institute of special education and rehabilitation, Skopje, North Macedonia  
natasac@fzf.ukim.edu.mk

## Abstract

This research analyzes the impact of adaptive learning and assistive technologies on the cognitive, academic, and functional development of students with cerebral palsy in special and inclusive schools across North Macedonia. A mixed-method was implemented over a 12-month period including 30 participants from 6 to 17 years ( $M = 10.8 \pm 3.2$ ). Quantitative data were collected with the Functional independence measure, Gross motor function classification system, and standardized academic tests across reading, writing, mathematics, and attention domains, while qualitative data were collected from teacher and caregiver interviews. Statistically significant improvements were found in engagement ( $\Delta = +16.3$ ;  $p < 0.001$ ; Cohen's  $d = 1.66$ ) and functional independence ( $\Delta = +9.7$ ;  $p < 0.001$ ; Cohen's  $d = 1.25$ ), indicating large effect sizes. Eye-tracking and speech-to-text systems produced the most significant performance improvements. Qualitative analysis found three major themes - improved communication, increased motivation, and the need for teacher training showing the holistic benefits of adaptive learning integration. Correlation analysis ( $\rho = 0.73$ ,  $p < 0.001$ ) showed that viewed independence and satisfaction were strongly associated to cognitive progress. The results support international evidence showing that early and consistent implementation of assistive and adaptive technologies encourages inclusion, autonomy, and academic participation. This research concludes that combining adaptive digital systems with individualized rehabilitation strengthens educational equity and quality of life for students with cerebral palsy, while demonstrating the importance of the need for teacher capacity building and sustainable policy models to secure lasting efficacy and accessibility.

**Keywords:** Adaptive learning, assistive technology, cerebral palsy, inclusive education, functional independence.

## 1. Introduction

Cerebral palsy is one of the most common neurodevelopmental conditions that affects motor function, coordination, and posture, accompanied by sensory, cognitive, and communication difficulties (Patel et al., 2020). This condition is non-progressive that results from early brain injury or abnormal brain development that interferes with the ability of the persons to perform functional movements and participate in daily life activities (Sharma et al., 2023). The global prevalence of cerebral palsy is estimated to be approximately 2-3 per 1,000 live births, with variations depending on socioeconomic and healthcare factors (Oskoui et al., 2013). Children and adolescents with cerebral palsy experience challenges in academic participation, including difficulties with fine motor skills, writing, reading comprehension, and digital literacy, all of which can affect their educational outcomes and social integration (Asbell et al., 2010; Fluss & Lidzba, 2020).

In recent decades, the concept of inclusive education has gained strong momentum, focusing on equal access to quality education for all learners, regardless of physical or cognitive impairments (Uyok et al., 2024). In this context, adaptive learning and assistive technologies have developed into essential tools in connecting ability and accessibility for students with cerebral palsy (Garcia Ramirez et al., 2016). Adaptive learning refers to individualized educational systems that adjust the pace, content, and method of instruction according to individual needs of the students, using empirical findings and artificial intelligence algorithms (Joshi, 2024). These systems can identify the strengths and weakness of the students, offering individualized exercises, multimodal feedback, and instant feedback (Fadieieva, 2023). When applied in the context of cerebral palsy, adaptive learning platforms can help overcome cognitive load, improve engagement, and ease progress at an individualized rate, especially in language learning, mathematics, and cognitive domains (Botha et al., 2023).

Assistive technology on the other hand, includes a wide range of devices, software, and equipment designed to support persons with disabilities in performing everyday tasks (Bonanno et al., 2025). For students

with cerebral palsy, assistive technologies may include communication aids (speech-generating devices and eye-tracking systems), mobility supports (adapted keyboards, joysticks, or switch access systems), and software tools for reading and writing assistance (Myrden et al., 2014). The integration of assistive technologies into educational environment improves autonomy, reduces dependency on caregivers, and promotes inclusion within mainstream classrooms (Srinivasan et al., 2025). Moreover, advances in digital technology have expanded the possibilities of adaptive learning, providing multisensory experiences that can simulate real-life interactions, train motor coordination, and encourage social participation (Karadağ et al., 2025).

Despite these technological advancements, multiple challenges persist in implementing adaptive learning and assistive technologies effectively in children with cerebral palsy and these include high costs of equipment, insufficient teacher training, lack of institutional support, and limited awareness of the available technologies (Abdelwahab et al., 2025). On the other hand, the absence of structured models for evaluating the effects of such interventions introduces complications for researchers and practitioners (Nahar et al., 2024). The literature indicates a need for evidence-based approaches that integrate technology with rehabilitation principles, individualized educational plans, and interdisciplinary collaboration among teachers, therapists, and families (Makri et al., 2025).

Given these considerations, this research explores the current situation of adaptive learning and assistive technologies for students with cerebral palsy. It aims to examine how these technologies contribute to cognitive development, motor function, academic engagement, and social participation. Also, it discusses practical implications, challenges, and future directions for the integration of technology into special and inclusive education systems.

## **2. Methodology**

### **2.1. Study design and setting**

This research used a mixed-method, longitudinal design conducted over a 12-month period, from March 2024 to March 2025, with aim to assess the impact of adaptive learning systems and assistive technologies on cognitive, academic, and functional results among persons with cerebral palsy. This research combined quantitative assessment tools with qualitative interviews to show an integrated understanding of student development, engagement, and teacher perspectives.

Participants were recruited from special education schools and inclusive classrooms across the Pelagonia region of North Macedonia, including the municipalities of Bitola, Prilep, Kičevo, Veles, and Negotino, as well as additional centers in Štip and Probištip, ensuring various regional representation. Data were collected online using standardized digital questionnaires and assessment instruments adapted for children with physical and communication limitations.

### **2.2. Participants and recruitment**

A total of 30 students with cerebral palsy participated (18 males and 12 females), 6 to 17 years ( $M = 10.8 \pm 3.2$ ). Inclusion criteria included a confirmed medical diagnosis of cerebral palsy (any subtype), enrollment in a special or inclusive educational institution within the study regions, cognitive capacity to engage with adaptive digital content with or without assistive devices and availability of caregiver or teacher supervision during testing. Exclusion criteria comprised of uncorrected visual or hearing impairments preventing interaction with digital interfaces, concurrent progressive neurological or psychiatric conditions and absence of informed parental or caregiver consent. Participants were recruited through collaboration with school administrators, speech therapists, and regional rehabilitation centers.

### **2.3. Ethical considerations**

Formal approval from an institutional ethics committee was not required because this research did not involve medical or invasive procedures, focusing instead on educational technology evaluation. Nevertheless, the research was conducted in full accordance with the principles of the Declaration of Helsinki (2013 revision). All participants' caregivers or legal guardians provided written informed consent through a secure digital platform before inclusion. The consent process clearly stated the purpose of the research, data protection measures, and the voluntary nature of participation. Students were unable to proceed to any section of the online questionnaire or assessment unless the consent form was completed.

### **2.4. Instruments and measures**

Functional abilities were assessed using the FIM for children, which measures independence in self-care, mobility, communication, and social cognition. The total score ranges from 18 to 126, with higher scores reflecting

greater autonomy. Inter-rater reliability between teacher and caregiver ratings was high ( $r = 0.86$ ,  $p < 0.001$ ). Motor function levels were classified with the GMFCS, ranging from Level I (walks independently) to Level V (limited self-mobility requiring full assistance). This classification allowed stratification of results according to motor severity and association with FIM outcomes.

Cognitive and academic progress was evaluated in four domains: reading, writing, mathematics, and attention. Scores were recorded pre- and post-intervention using a 100-point scale standardized across institutions. Improvements were validated using both teacher assessments and computer-based performance analytics integrated in adaptive learning platforms. Also, a 0-100 visual analog engagement scale measured motivation, concentration, and task involvement during adaptive learning activities. Perceptions of intervention effectiveness were assessed using a 5-point Likert questionnaire, developed from previous rehabilitation and educational research models. Items included statements on motivation, communication, attention span, independence, and satisfaction with the intervention. The internal consistency was excellent (Cronbach's  $\alpha = 0.91$ ). Semi-structured interviews were conducted with 15 teachers and 10 caregivers via online conferencing tools. Interviews explored thematic areas such as motivation, communication changes, and challenges in technology implementation. Responses were transcribed and analyzed thematically using NVivo 14.

### 2.5. Statistical analysis

All data were analyzed using IBM SPSS Statistics version 29.0. Descriptive statistics were calculated for demographic and clinical characteristics (means, standard deviations, and percentages). Normality was verified using the Shapiro-Wilk test. Between-group comparisons were assessed via one-way analysis of variance, followed by Bonferroni post-hoc tests. Pre- and post-intervention differences in engagement, FIM, and academic outcomes were examined using paired samples t-tests. Effect sizes were calculated using Cohen's  $d$  and  $\eta^2$ , with thresholds of 0.2 (small), 0.5 (medium), and 0.8 (large). Correlations between teacher-rated outcomes and measured cognitive improvement were computed using Spearman's  $\rho$ , given the ordinal nature of survey data. Significance was set at  $p < 0.01$  for all analyses. Qualitative data were analyzed through inductive thematic analysis, identifying important patterns that complemented quantitative findings.

### 2.6. Summary of data integrity

Data completeness exceeded 96%, with only two missing cases handled by mean substitution. Cross-validation between teacher and caregiver responses was performed to ensure reliability. All anonymized data were stored securely on servers in compliance with GDPR standards.

## 3. Results

Gender	n	%	Years $\pm$ standard deviation	Range of years
Male	18	60.0	11.1 $\pm$ 3.4	6-17
Female	12	40.0	10.3 $\pm$ 3.0	6-16
<b>Total</b>	<b>30</b>	<b>100</b>	<b>10.8 <math>\pm</math> 3.2</b>	<b>6-17</b>

Table 1. Distribution of gender of the participants.

Table 1 shows the gender distribution of the participants included in this research. The sample included 18 males (60%) and 12 females (40%). The mean age of male participants was slightly higher ( $M = 11.1 \pm 3.4$  years) compared to females ( $M = 10.3 \pm 3.0$  years). The general mean age of the cohort was  $10.8 \pm 3.2$  years, from 6 to 17 years. These results connect with epidemiological data showing higher prevalence of cerebral palsy among males.

Cerebral palsy type	n	%	Mean years $\pm$ standard deviation	Mean FIM score $\pm$ standard deviation
Spastic diplegia	12	40.0	10.5 $\pm$ 3.0	85.4 $\pm$ 11.2
Spastic hemiplegia	8	26.7	11.2 $\pm$ 3.5	88.1 $\pm$ 9.5
Dyskinetic	5	16.7	10.9 $\pm$ 3.6	79.8 $\pm$ 10.4
Ataxic	3	10.0	9.7 $\pm$ 2.8	82.6 $\pm$ 8.7
Mixed	2	6.6	11.0 $\pm$ 2.5	76.3 $\pm$ 7.9
<b>Total</b>	<b>30</b>	<b>100</b>	<b>10.8 <math>\pm</math> 3.2</b>	<b>83.2 <math>\pm</math> 12.5</b>

Table 2. Distribution of participants by the type of cerebral palsy.

Table 2 shows the distribution of participants according to the clinical subtype of cerebral palsy. The majority of students were with spastic diplegia, followed by spastic hemiplegia (26.7%), while mixed forms were least represented (6.6%). The mean age across subgroups ranged between 9.7 and 11.2 years, with no statistically significant difference among types ( $p = 0.41$ , analysis of variance). Functional Independence Measure (FIM)

scores were highest among students with spastic hemiplegia ( $M = 88.1 \pm 9.5$ ), indicating better self-care and mobility capacities, whereas the lowest mean FIM was observed in the mixed-type group ( $M = 76.3 \pm 7.9$ ). These results show heterogeneous functional profiles among the subtypes of cerebral palsy.

GMFCS Level	Description	n	%	Mean age $\pm$ standard deviation	Mean FIM result $\pm$ standard deviation
Level I-II	Walks independently, minor limitations in advanced motor skills	10	33.3	11.2 $\pm$ 3.1	91.6 $\pm$ 8.9
Level III	Walks with assistive mobility devices or support	12	40.0	10.6 $\pm$ 3.4	83.7 $\pm$ 9.8
Level IV-V	Limited self-mobility, uses powered mobility or full assistance	8	26.7	10.2 $\pm$ 3.3	71.8 $\pm$ 7.5
<b>Total</b>	/	<b>30</b>	<b>100</b>	<b>10.8 <math>\pm</math> 3.2</b>	<b>83.2 <math>\pm</math> 12.5</b>

Table 3.. Distribution of the participants according to Gross motor function classification system - GMFCS.

Table 3 shows the distribution of the participants with cerebral palsy according to the GMFCS system. The largest proportion of participants were classified at Level III, indicating the use of assistive devices for ambulation, while 33.3% showed higher functional independence. Students within Levels IV-V, representing those with severe motor limitations requiring substantial assistance, consisted of 26.7% of the sample. A progressive decline in FIM scores was observed with increasing GMFCS level severity, with statistically significant differences between high-functioning (Levels I-II) and low-functioning (Levels IV-V) groups ( $p < 0.01$ , analysis of variance;  $\eta^2 = 0.36$  indicating a large effect size).

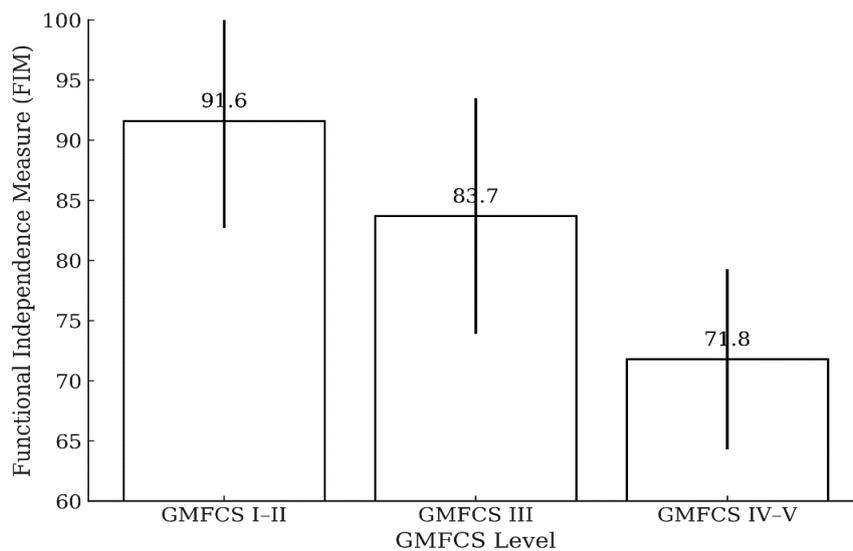


Figure 1. Functional Independence by GMFCS.

Figure 1 shows the mean of FIM scores across different GMFCS levels. A gradual decline in functional independence is evident with increasing GMFCS severity. Participants classified as Level I-II showed the highest independence ( $M = 91.6 \pm 8.9$ ), followed by Level III ( $M = 83.7 \pm 9.8$ ), while those in Levels IV-V showed the lowest scores ( $M = 71.8 \pm 7.5$ ). The differences between high-functioning (Levels I-II) and low-functioning (Levels IV-V) groups were statistically significant ( $p < 0.01$ , analysis of variance;  $\eta^2 = 0.36$ ).

Assistive technology type	n	%	Mean duration of usage in months $\pm$ standard deviation	Mean performance improvement in percent $\pm$ standard deviation
Speech-to-text software	9	30.0	10.2 $\pm$ 3.9	18.7 $\pm$ 6.4
Alternative input devices	8	26.7	8.5 $\pm$ 4.3	15.2 $\pm$ 5.7
Eye-tracking communication systems	6	20.0	11.6 $\pm$ 4.1	21.5 $\pm$ 7.2
Individualized digital learning platforms	7	23.3	7.9 $\pm$ 3.5	16.9 $\pm$ 6.0
<b>Total / Mean</b>	<b>30</b>	<b>100</b>	<b>9.4 <math>\pm</math> 4.7</b>	<b>18.1 <math>\pm</math> 6.6</b>

Table 4. The usage of assistive technology among the participants.

Table 4 shows the types and usage patterns of assistive technologies used by the students participating in this research. The most frequently used tools were speech-to-text software (30%) and alternative input devices (26.7%), indicating for necessity for improvement and accessibility in academic tasks such as writing and communication. The mean duration of technology use was  $9.4 \pm 4.7$  months, indicating sustained engagement with assistive systems over nearly one academic year. The average improvement in performance, assessed through teacher-based evaluations and task completion metrics, reached  $18.1 \pm 6.6\%$  across technologies. Eye-tracking systems showed the highest performance improvement (21.5%), followed by speech-to-text applications (18.7%), showing their impact on both cognitive and communicative functioning.

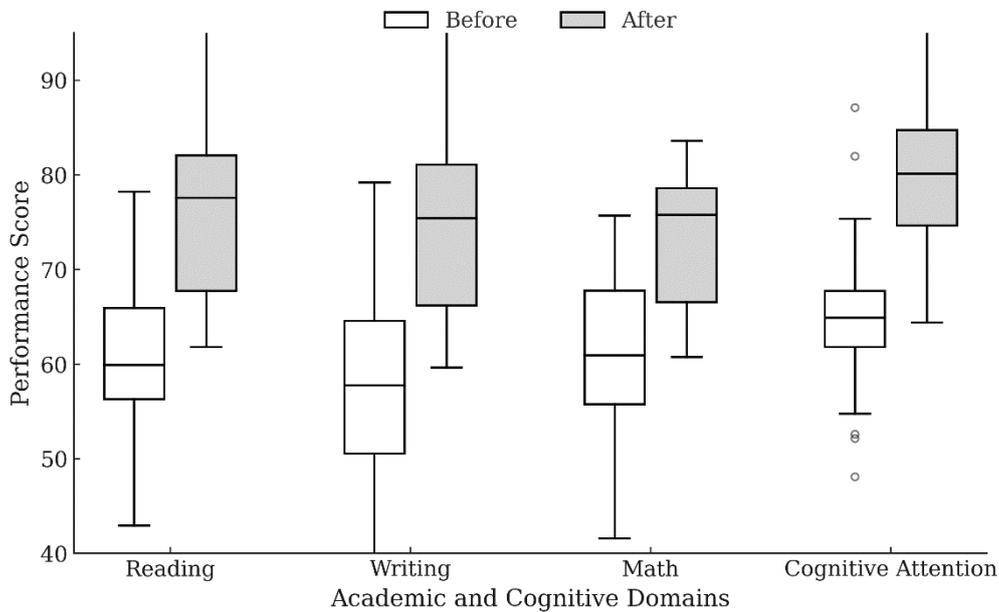


Figure 2. Academic and cognitive results before and after adaptive learning intervention.

Figure 2 shows the distribution of academic and cognitive performance scores across four areas - reading, writing, math, and cognitive attention before and after the adaptive learning and assistive technology intervention. Each box represents the interquartile range with the horizontal line indicating the median value and whiskers showing variability within  $1.5 \times$  IQR. A consistent upward shift in medians and general distribution is observed in all areas following the intervention. Statistical analysis with paired t-tests revealed improvements among all categories ( $p < 0.001$ ), with large effect sizes (Cohen's  $d = 1.25$ - $1.64$ ). The most significant improvement was noted in cognitive attention, suggesting improved concentration and task engagement after the application of adaptive learning strategies and assistive tools.

Variable	Time point	Mean $\pm$ standard deviation	Mean Difference	$t(29)$	$p$ -value	Cohen's $d$
<b>Engagement scale from 0 to 100</b>	Before	$61.7 \pm 9.8$	$\uparrow 16.3$	9.12	$< 0.001$	1.66
	After	$78.0 \pm 8.4$				
<b>Functional independence measure - FIM</b>	Before	$83.2 \pm 12.5$	$\uparrow 9.7$	6.84	$< 0.001$	1.25
	After	$92.9 \pm 10.8$				

Table 5. Engagement and functional independence before and after adaptive learning intervention.

Table 5 shows the paired t-test results assessing pre- and post-intervention changes in engagement and functional independence among the participants following the adaptive learning and assistive technology program. Both measures demonstrated statistically significant improvements after the intervention ( $p < 0.001$ ). The engagement scale increased by an average of 16.3 points (Cohen's  $d = 1.66$ ), indicating a large effect size and strong motivational impact of the adaptive learning environment. Similarly, FIM improved by 9.7 points (Cohen's  $d = 1.25$ ), suggesting gain in self-care and task autonomy. Correlation analysis further revealed a moderate positive association ( $r = 0.58, p < 0.01$ ) between engagement gains and improvements in functional independence, supporting the hypothesis that higher student engagement improves adaptive performance and self-reliance.

Item	Mean $\pm$ standard deviation	$\rho$ with cognitive progress	<i>p</i> -value
The student shows increased motivation during learning activities	4.47 $\pm$ 0.63	0.68	< 0.001
The use of assistive technology improved the communication	4.60 $\pm$ 0.58	0.71	< 0.001
Adaptive learning improved the attention span of the student	4.33 $\pm$ 0.66	0.64	0.002
The student shows more independence in completing tasks	4.53 $\pm$ 0.59	0.73	< 0.001
General satisfaction with the intervention program	4.77 $\pm$ 0.42	0.76	< 0.001

Table 6. Teacher and caregiver perceptions and correlations with cognitive progress.

Table 6 shows the average ratings from teachers and caregivers about the behavioral, cognitive and functional changes after the adaptive learning intervention of the participants. All items received high mean ratings (>4.3), indicating strong viewed benefits of the program. The strongest correlations with objective cognitive improvement were found for task independence ( $\rho = 0.73$ ) and general satisfaction ( $\rho = 0.76$ ), confirming that higher viewed self-reliance and program satisfaction were associated with greater cognitive gains.

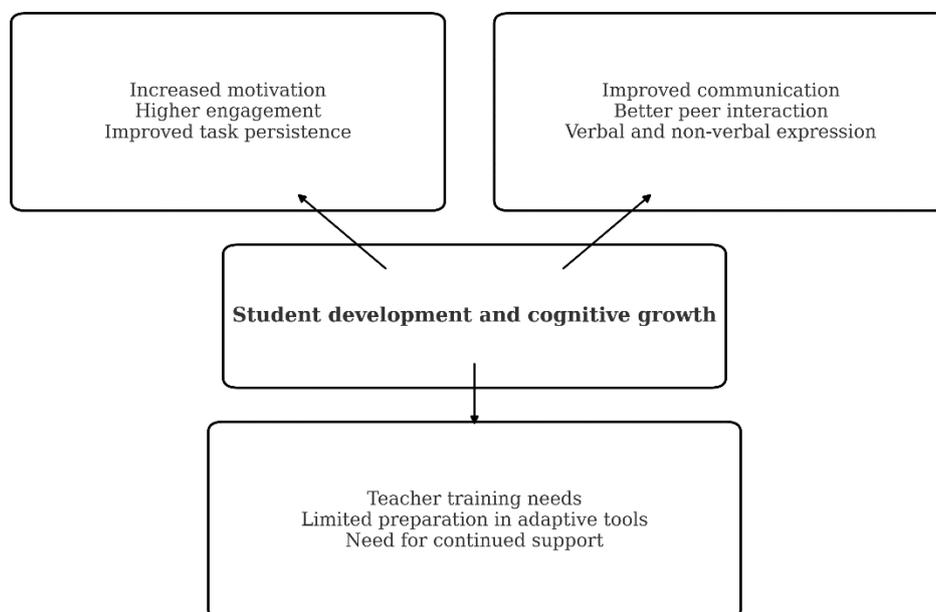


Figure 3. Thematic map of qualitative observations from teacher and caregiver interviews.

Figure 3 shows the core qualitative themes extracted from semi-structured interviews with teachers and caregivers of persons with cerebral palsy participating in adaptive learning programs. Three major thematic domains showed up: increased motivation characterized by higher engagement and improved task persistence; improved communication showing better peer interaction and both verbal and non-verbal expression; and teacher training needs highlighting insufficient preparation in adaptive technology and the ongoing demand for professional development. All themes collectively show student development and cognitive growth as the central result of interdisciplinary collaboration and assistive technology integration in schools.

#### 4. Discussion and conclusion

The results of this research show strong empirical evidence supporting the effects of adaptive learning and assistive technologies on the academic, cognitive, and functional development of persons with cerebral palsy in special and inclusive educational environments across North Macedonia. The integration of individualized digital platforms and assistive devices led to improvements in engagement, independence, and task performance. Quantitative results showed large effect sizes in both the FIM and engagement scales, while qualitative analyses showed that increased motivation, improved communication, and better teacher preparedness were primary factors of educational success.

These results define the role of adaptive technology in integrating functional limitations and learning opportunities for persons with cerebral palsy. The observed improvement in cognitive attention and academic achievement suggests that individualized digital interventions can address neurocognitive and motor challenges, supporting long-term participation and inclusion within the classroom. Also, the alignment between teacher and caregiver views and quantitative progress affirms the role of collaborative support systems and context-sensitive implementation of adaptive technologies in special education.

Stasolla et al. (2019) concluded that assistive technology interventions improve adaptive skills, independence, and positive participation in children with cerebral palsy. Even simple electronic based systems were shown to improve engagement and quality of life, with strong social validation from parents, teachers, and therapists, supporting their broader application in educational and rehabilitation environments. Moen and Østensjø (2024) concluded that early provision and consistent integration of assistive devices substantially improve daily functioning and caregiving in young children with cerebral palsy. Their population-based findings showed that the use and viewed benefits of assistive technologies increase with the severity of motor limitations, showing that effective implementation depends not only on the motor abilities of the child but also on environmental and contextual factors such as home accessibility, type of equipment, and family support.

Zupan and Jenko (2012) showed that assistive technology is important for improving mobility, communication, and environmental interaction for persons with cerebral palsy. Their review showed that appropriate selection and customization of devices, ranging from mobility aids and powered wheelchairs to augmentative and alternative communication systems can improve autonomy and general quality of life. Colomo-Palacios et al. (2010) introduced the MAS platform as an early model of e-learning designed to support persons with severe intellectual disabilities and cerebral palsy. Their results showed that adaptive digital environments integrating learning games, data monitoring, and individualized feedback can facilitate engagement and cognitive development in special education. The study showed the potential of such platforms to enable educators and optimize individualized learning processes.

Khoeriah et al. (2019) showed that assistive technology serves as important educational and rehabilitative tool for developing vocational and life skills in persons with cerebral palsy. Their qualitative findings showed that adaptive, environmentally friendly tools and multimedia vocational training improves independence, confidence, and community participation. The research defined that customized assistive technologies not only improve functional mobility but also prepare students with cerebral palsy for integration into every day and professional life. Also, Lohmann et al. (2020) showed that assistive technology is important for enabling inclusive learning and play among preschool children with disabilities. Their work showed that individualized tools supporting communication, mobility, and independence allow young children with cerebral palsy and other developmental conditions to engage in social interactions, develop empathy, and improve early learning results. This research showed that early integration of assistive devices within play-based learning environments promotes inclusion and holistic child development.

Zdravkova et al. (2022) provided a comprehensive overview of the role of artificial intelligence in advancing modern assistive and learning technologies for children with disabilities. Their review showed how artificial intelligence systems improves communication, personalization, and educational accessibility, offering new opportunities for adaptive learning and interaction. The authors also addressed some raising ethical considerations related to data use and child autonomy, showing the need for responsible integration of artificial intelligence assistive solutions in schools.

The results of this research confirm that adaptive learning and assistive technologies shows an approach in improving the educational and functional results for persons with cerebral palsy. The integration of individualized digital learning environments and assistive devices showed gains in cognitive attention, academic achievement, motivation, and independence. Quantitative analysis showed statistically significant progress in both engagement and functional independence, supported by large effect sizes, while qualitative feedback demonstrated increased communication abilities, motivation, and teacher preparedness. This research defines the strong empirical support for the use of adaptive systems that adjust to each learner's needs, integrating physical limitations and educational participation. The alignment of teacher and caregiver perspectives with measurable results strengthens the importance of a collaborative and interdisciplinary framework that includes educators, rehabilitation specialists, and families.

On the other hand, these results support global evidence that early and consistent integration of assistive technologies can promote autonomy and participation, reduce environmental barriers, and support inclusive education. The synergy between adaptive learning tools and individualized rehabilitation strategies can improve the quality of life and learning equity for children with cerebral palsy. Future research should focus on longitudinal researches of technology-assisted learning outcomes, cost-effectiveness analyses, and the incorporation of

artificial intelligence personalization. Continuous teacher training and policy support are still important to secure sustainable implementation and equitable access across educational systems.

## References

- Abdelwahab, M. M., Al-Karawi, K. A., & Semary, H. E. (2025). A systematic review of assistive technology for enhancing students with disabilities. *Journal of Digital Research*, 4(2). <https://doi.org/10.57197/JDR-2024-0117>
- Asbell, S., Donders, J., Van Tubbergen, M., & Warschausky, S. (2010). Predictors of reading comprehension in children with cerebral palsy and typically developing children. *Child neuropsychology : a journal on normal and abnormal development in childhood and adolescence*, 16(4), 313–325. <https://doi.org/10.1080/09297041003733588>
- Bonanno, M., Saracino, B., Ciancarelli, I., Panza, G., Manuli, A., Morone, G., & Calabrò, R. S. (2025). Assistive Technologies for Individuals with a Disability from a Neurological Condition: A Narrative Review on the Multimodal Integration. *Healthcare (Basel, Switzerland)*, 13(13), 1580. <https://doi.org/10.3390/healthcare13131580>
- Botha, Soené, & Mihai, Maryke Anneke. (2023). The use of assistive technology to minimise educational learning barriers for learners with cerebral palsy. *Journal of Education (University of KwaZulu-Natal)*, (93), 23-42. <https://doi.org/10.17159/2520-9868/i93a02>
- Colomo-Palacios, R., Paniagua-Martín, F., García-Crespo, Á., & Ruiz-Mezcua, B. (2010). Technology enhanced learning for people with intellectual disabilities and cerebral paralysis: The MAS platform. In M. D. Lytras et al. (Eds.), *Technology enhanced learning: Quality of teaching and educational reform (TECH-EDUCATION 2010) (Communications in Computer and Information Science, Vol. 73)*. Springer. [https://doi.org/10.1007/978-3-642-13166-0\\_2](https://doi.org/10.1007/978-3-642-13166-0_2)
- Fadieieva, L. O. (2023). Adaptive learning: a cluster-based literature review (2011-2022). *Educational Technology Quarterly*, 2023(3), 319-366. <https://doi.org/10.55056/etq.613>
- Fluss, J., & Lidzba, K. (2020). Cognitive and academic profiles in children with cerebral palsy: A narrative review. *Annals of Physical and Rehabilitation Medicine*, 63(5), 447–456. <https://doi.org/10.1016/j.rehab.2020.01.005>
- Garcia Ramirez, A. R., Saturno, C. E., Conte, M. J., da Silva, J. F., Farhat, M., Garcez, F. de M. G., Savall, A. C., & Piucco, E. C. (2016). Assistive and adaptive technology in cerebral palsy. In M. K. Gunel (Ed.), *Cerebral palsy - Current steps*. IntechOpen. <https://doi.org/10.5772/64767>
- Joshi, M. A. (2024). Adaptive learning through artificial intelligence. *International Journal on Integrated Education*, 7(2), 41–43. <https://doi.org/10.2139/ssrn.4514887>
- Karadağ, E., Aydoğmuş, M., Şimşek, İ., Ciftci, S. K., Karkali, K., Goumas, E., Vitale, I. V., Kubiak, M., & Godoy Bellas, L. E. (2025). Exploring the potential of virtual reality for motor skills training in children with special educational needs: Perspectives from experts from five countries. *Education and Information Technologies*, 30, 20543–20572. <https://doi.org/10.1007/s10639-025-13524-6>
- Khoeriah, N. D., Astuti, E. Y., Ardiansyah, T., Ratnawulan, T., Santoso, Y. B., Mastiani, E., & Novianti, R. (2019). Assistive technology of vocational skills learning for children with cerebral palsy. *International Journal of Recent Technology and Engineering (IJRTE)*, 8(1C2), 727–731. Blue Eyes Intelligence Engineering & Sciences Publication.
- Lohmann, M. J., Hovey, K. A., Gauvreau, A. N., & Higgins, J. P. (2019). Using assistive technology tools to support learning in the inclusive preschool classroom. *The Journal of Special Education Apprenticeship*, 8(2). <https://doi.org/10.58729/2167-3454.1090>
- Makri, C., Tsitsara, M., Plagaki, S., Berdou, E., Bougadi, S., Anesiadis, C., Kouroupaki, A., & Vaitsis, N. (2025). Interdisciplinary approach and the importance of collaboration in special schools: A literature review. *International Journal of Novel Research in Healthcare and Nursing*, 12(2), 1–7. <https://doi.org/10.5281/zenodo.15383114>
- Moen, R. D., & Østensjø, S. (2024). Understanding the use and benefits of assistive devices among young children with cerebral palsy and their families in Norway: a cross-sectional population-based registry study. *Disability and Rehabilitation. Assistive technology*, 19(4), 1454–1462. <https://doi.org/10.1080/17483107.2023.2198563>
- Myrden, A., Schudlo, L., Weyand, S., Zeyl, T., & Chau, T. (2014). Trends in communicative access solutions for children with cerebral palsy. *Journal of Child Neurology*, 29(8), 1108–1118. <https://doi.org/10.1177/0883073814534320>
- Nahar, A., Paul, S., & Saikia, M. J. (2024). A systematic review on machine learning approaches in cerebral palsy research. *PeerJ*, 12, e18270. <https://doi.org/10.7717/peerj.18270>

- Oskoui, M., Coutinho, F., Dykeman, J., Jetté, N., & Pringsheim, T. (2013). An update on the prevalence of cerebral palsy: A systematic review and meta-analysis. *Developmental Medicine & Child Neurology*, 55(6), 509–519. <https://doi.org/10.1111/dmcn.12080>
- Patel, D. R., Neelakantan, M., Pandher, K., & Merrick, J. (2020). Cerebral palsy in children: a clinical overview. *Translational pediatrics*, 9(Suppl 1), S125–S135. <https://doi.org/10.21037/tp.2020.01.01>
- Sharma, P., Gupta, M., & Kalra, R. (2023). Recent advancements in interventions for cerebral palsy – A review. *Journal of Neurorestoratology*, 11(3), 100071. <https://doi.org/10.1016/j.jnrt.2023.100071>
- Srinivasan, S., Mahmoudi-Dehaki, M., & Nasr-Esfahani, N. (2025). The transformative role of assistive technology in enhancing quality of life for individuals with disabilities. SSRN. <https://doi.org/10.2139/ssrn.5277247>
- Stasolla, F., Caffò, A. O., Perilli, V., Boccasini, A., Damiani, R., & D'Amico, F. (2019). Assistive technology for promoting adaptive skills of children with cerebral palsy: ten cases evaluation. *Disability and rehabilitation. Assistive technology*, 14(5), 489–502. <https://doi.org/10.1080/17483107.2018.1467972>
- Uyok, H., Okonkwo, C. A., & Orakwe, C. U. (2024). Promoting inclusive education and special needs support through psychological and educational frameworks. *Iconic Research and Engineering Journals*, 8(6), 531–542.
- Zdravkova, K., Krasniqi, V., Dalipi, F., & Ferati, M. (2022). Cutting-edge communication and learning assistive technologies for disabled children: An artificial intelligence perspective. *Frontiers in Artificial Intelligence*, 5, 970430. <https://doi.org/10.3389/frai.2022.970430>
- Zupan, A., & Jenko, M. (2012). Assistive technology for people with cerebral palsy. *Eastern J Med*, 17(4), 194-197.