

CrossRef DOI of original article:

Instrumental System of Distance Learning DL.GSU.BY and Examples of its Application

Michael Dolinsky

Received: 1 January 1970 Accepted: 1 January 1970 Published: 1 January 1970

Abstract

The basic capabilities of the distance learning instrumental system DL.GSU.BY (hereinafter DL) are described, such as: presentation of the theory/references to students; presentation of tasks to students / sending by them files-solutions; acceptance and automatic verification of the solutions; checking files of arbitrary structure with arbitrary extensions by specialized programs; interactive tasks; manual verification of solutions; assignment of tests; differentiated presentation of tasks;

Index terms— distance learning instrumental system, blended learning, programming, fundamentals of digital electronics.

1 I. Introduction

Among the most frequently mentioned problems are: lack of knowledge in IT, lack of time, technical limitations (Jerry, 2021), lack of training course programs focused on blended learning (Muhuro, 2021), insufficient quality of online courses (Lomer, 2021).

As the most constructive, we can note the works that describe examples of real blended learning: chemistry (Chamberlain, 2021), the basics of medicine (Lovey, 2021), museum work (Lee, 2020), the study of brain structures (Nathaniel, 2021), Euclidean geometry (Stahl, 2021), introduction to educational technologies (Musawi, 2021), the course of Islamic and Asian civilization (Norhapizah, 2021).

Of particular interest are works that describe general ideas such as: the use of learning systems Moodle (Antwi-Boampong 2021; Oktaria 2021), Google Classroom (Astarilla, 2021), the introduction of forums for communication between students and teachers (Barbato 2020; Karamzadeh 2021), problem-based blended learning (Rahmawati, 2020), pre-and post-tests (Setyowati, 2021), a rating system for monitoring the progress of students at all levels (Kolegova, 2021).

Note that almost all the positive aspects noted above are implemented in the DL system, which also contains many additional features.

The distance learning instrumental system DL, developed under the guidance of the author at the faculty of mathematics and technologies of programming of F. Skorina Gomel State University since 1997, not only allows you to create electronic learning tools, but also integrate them into a single educational environment, provide remote access to them for students, teachers and management personnel using the Internet, as well as the collection, processing and presentation of learning outcomes. Thus, on the basis of the DL system, it is possible to build a new technology of the educational process based on the use of network computer technologies and personal computers. This technology provides individualization of the educational process, dynamic adaptation of educational material to the current level of development of the student and powerful tools for analyzing the educational process.

The following article describes the basic capabilities of the DL system, as well as examples of its application.

The basic capabilities of the distance learning instrumental system DL.GSU.BY (hereinafter DL) are described, such as: presentation of the theory/references to students; presentation of tasks to students/sending by them files-solutions; acceptance and automatic verification of the solutions; checking files of arbitrary structure with arbitrary extensions by specialized programs; interactive tasks; manual verification of solutions; assignment of tests; differentiated presentation of tasks; flash lectures and flash tasks integrating learning with control; forum

for academic subjects; surveys; control works; exams; supervised student authentication; special tools for creating tasks; the ability to set new tasks by students; input of results of manual checks (control of the theory, bonuses); flexible result tables; automatic rating; automatic formation of statements of examinations and tests. The word instrumental means that it can be used as a tool for automating distance learning in a wide variety of subject areas. In addition, the paper presents examples of the use/ application of DL, such as: developmental education for preschoolers, teaching text programming (in Pascal) in elementary school, teaching programming in middle and high school; teaching students of the faculty of mathematics and technology of programming of the Gomel State University named after F. Skorina.

e-mail: dolinsky@gsu.by n preparing the article, the author analyzed materials on blended learning, which involves the use of not only traditional classes in classrooms, but also classes using computers and the Internet. This has become especially relevant in connection with COVID- (Alsalihi, 2021), Ghana (Antwi-Boampong, 2021), Norway (Bokolo, 2021), Indonesia (Darma, 2021), Canada (Lane, 2021), Vietnam ??Le, 2021), Hong Kong (Lim, 2021), China (Lu, 2021), Belgium (Poelmans, 2021), France(Porter, 2016), Malaysia (Tan, 2016), Greece (Tzatsou, 2021).

2 I

3 Abstract-

4 II. Basic Capabilities of the Distance Learning Instrumental System

The word instrumental in the name of the distance learning system means that DL can be used as a tool for automating distance learning in a wide variety of subject areas.

The most significant features of the DL system are described below:

Presentation of the theory/references to the students: Each training course can have its own tree-organized theoretical material, including test, audio and video materials and links to third-party sources. The theory is available during collective and individual lessons and can be left available or disabled by the teacher during tests.

Presenting tasks to students/sending solutions: The student can independently take the task, complete it, saving the result of the execution in a file with the required extension, and send this solution file for verification;

Automatic verification/tests concession: As a rule, within a minute the solution is checked by the DL system, and the result is reported to the student. If the solution is wrong, the student can take a test (input data and correct result), on which his solution gives an incorrect answer;

Checking files of arbitrary structure with arbitrary extensions by specialized programs: Currently, programs are checked in the following programming languages: Pascal (Turbo, Free, ABC.Net, Delphi); C++ (GCC, MS Visual), Java, Kotlin, C#, JavaScript, CoffeeScript, Clojure, ClojureScript, Perl, QBasic; assembler for microprocessors/microcontrollers Intel 8051, Intel 8086, Atmel AT90S2313, Atmel AT90S2323, Motorola M68HC05 and Motorola M68HC08; C-MPA (Clike microprogramming language). It also provides verification of functional diagrams of digital devices, solutions of chess and mathematical problems. Interactive tasks: The student is supposed to perform some sequence of actions with the mouse/keyboard. For example: input of output values on the contacts of the presented functional circuit according to the given input values or drawing up a picture from its fragments.

5 Manual verification of solutions:

There is a special type of jobs, when the submitted files are queued in chronological order. The person, who checks these tasks, at a convenient time for him, can take a solution file, analyze it visually or using a program and give an assessment. Everything else (entering into the test protocol, modification of the table of results, etc.) occurs in the same way as in the case of automatic verification of solutions. Differentiated presentation of tasks: Hierarchical means of grouping tasks allow you to organize the management of the sequence of tasks for each student, providing individual navigation through the set of tasks for each student, depending on his level of training and motivation; in particular, if auxiliary tasks are prepared for some task, then when the text of this task is shown, the "I don't know" button appears, clicking on which takes you to the first auxiliary task, and in the auxiliary tasks, the "I understand" button appears, by clicking on which you can return to problematic task.

Flash lectures and flash tasks integrating learning with control: Special the effectiveness of training is ensured by the use of flash programming tools, which allow not only to present theoretical and practical educational material to the student in a colorful and dynamic form, but also to provide interactive learning with built-in control and self-control tools. In connection with the termination of support for flash technology, browsers with flash support and auto-update disabled have been collected, exclusively for working on DL, links to them are given in the news and on the DL forum. Forum for academic subjects: Since September 2006, forums have appeared in DL and immediately began to be used in the educational process to transfer additional educational and organizational information to students; discussing ways to complete tasks; questions of students and answers to them from other students and teachers; Available videos: Video materials are prepared to solve such problems when "it's easier to see once than hear a hundred times", in particular, on the following topics: creating and

debugging circuits in HLCCAD (high-level design of digital electronics functional circuits); solution in HLCCAD tasks 1-10 control 1 on the design of functional diagrams; solving the basic tasks of option 6 of the control slice, examples of search and elimination and errors (ie debugging) in solving problems of option 6 of the control slice; a tutorial on downloading and installing a virtual machine from a DL, fixing sources (for the development of a DL), and porting fixes to a real DL. Polls: Surveys are used to obtain/accumulate and statistically process the opinions of students on various issues of organizing the educational process; Individual assignments: These tasks are collected in folders and subfolders corresponding to the topics and subtopics of the training course. Each task is credited to only one student -the one who passed it before everyone else. When the task tree is displayed, there is written to whom and when the solution of each task is credited. The absence of such information means that the task has not yet been credited to anyone, and it can be solved. For any tasks subfolder teacher can directed that each student can be counted no more than one task from this subfolder -to provide students to solve tasks for all subtopics of the course. Control works: Control works are tasks (the same for all students) that are opened for a limited period of time and serve to check the quality of assimilation of educational material, they also provide automatic operational verification of sent solutions; At the same time, the sameness of tasks for all students allows them to discuss problems and their solutions after class. With the permission of the teacher, discussions can also be held during tests. Exams: Exams are tasks (a random individual option for each student) that open for a limited period of time and serve to check the quality of assimilation of educational material, they also provide automatic online verification of sent solutions; Supervised student authentication automation: During the control works/exams, students are required to log into the network under a special account, in which access to all network resources is closed, except for DL. The DL system ensures that students comply with this rule. If the student is not logged into the network under this special account, he will not be able to submit the solutions of the control works/exams. Special tools for creating tasks: Initially, a job was a folder in the file system containing the job's configuration file and all the necessary files for a job of that type. Therefore, it was possible to create tasks using any file manager and any text editor. Then, for tasks of various types, special tools for their creation appeared, simplifying and speeding up the creation of tasks, up to the Flash Task Constructor.

6 Special software tool for managing training courses and assignments:

It allows you to create, copy and move courses and assignments, automatically download task package archives, and perform many service functions for working with training courses and assignments.

7 Possibility of setting new tasks by students:

The ease of setting new tasks in DL provides the ability to set tasks by the students themselves -and therefore one of the types of learning activities can be the preparation of new tasks. This approach has the following advantages: the educational material is developed and replenished by the students; the range of proposed tasks is expanding; students are given the opportunity to show their creativity.

8 Input of results of manual checks (control of the theory, bonuses):

The DL system supports simple entry of data on manual verification of educational activities, absences/attendance of training sessions, etc., which allows all data on the educational process to be integrated into a single statement;

Automatic system for monitoring absenteeism: The teacher marks passes after each lesson. The student, at any time convenient for him, works out the pass by completing the tasks specified by the teacher, then by clicking on the special icon selects the date of the used pass, after which a message is automatically generated about the work-out of the pass, containing a link to the work-out protocol. The teacher, by clicking on this link, can evaluate the work done and whether or not to recognize this work.

Flexible result tables: They are automatically formed and replenished in accordance with the task tree, allowing teacher and students to analyze the results both for the entire course as a whole and for any course subtree.

Automatic rating: According to the tables of results of the training course, all kinds of rating tables can be automatically built with rating schemes specified by the teacher; Automatic generation of sheets of exams and tests: Among such rating schemes can be directly examination and test sheets.

9 Statistical tables for teachers and students:

The sheer number of tasks (measured in the thousands) enrolled in the main courses makes the main tables inconvenient for teachers and students to analyze. Therefore, a tool for registering a teacher was developed, as well as specifying a teacher in the personal information of a student, as well as many tables filtered by students of a particular teacher. In the 2020-2021 academic year, 47 teachers are registered with the DL and they teach over 7,500 students. Obviously, it is quite difficult to come up with tasks that develop the stated basic mental operations separately. At the same time, you can come up with tasks in which one of the qualities will be dominant. In addition, the course propose concentric training, when the exercises are also divided into difficulty

levels, and at first all qualities are developed at the first level of complexity, then at the second, etc. The ability to read is not required to complete the vast majority of tasks. Tasks are intuitive for preschoolers and are performed mainly by mouse clicks in certain areas of the task or by dragging/rotating drawings with the mouse and the right/left arrow keys.

10 Developmental education for preschoolers:

For the most complex tasks, the addition of auxiliary training tasks based on the principles of differentiated learning is widely used.

For those children who encounter serious difficulties in basic education, special auxiliary task packages (called Technical Minimums) have been developed on the following subtopics: "Tangram. (Parts 1-3)", "Analogy", "Learning to count", "Differences", "Learning to think 0", "Learning to work with the mouse".

Teaching text-based programming (in Pascal) in elementary school: It is based on the successive completion of the following task packages in the Informatics 2015 training course: "Learning to think 2012", "Propaedeutics of words", "Learning words", "Number", "Symbol", "String", "All Together", "String Length", "Character positions", "Built-in functions and procedures", "One Dimensional Array", "Two Dimensional Array", "Geometry", "Strings-2", "Sorting", "Debugger", "Input and Output Files". All task packages are built on the principles of differentiated learning. Additionally, there are task packages "Mathematics (Programs) 1-5 classes" and Charis (Drawing Language). Every year, on the basis of the computer science cabinet of school 27 of Gomel, under the guidance of the author, all interested students of elementary school 27 and other educational institutions in Gomel do such training. In addition, similar classes are held in other schools in Gomel and the Gomel region. Finally, due to free access to all training courses on the DL, anyone can take similar training, and, at the time of this writing, 13497 students from Belarus, Russia, Ukraine were recorded in the table of results of the Informatics 2015 training course. In addition, all students are strongly recommended to check and improve their mathematical preparation by solving problems in the course "Mathematics", which contains various problems in mathematics, including Kangaroo (2001-2020), Beaver (2013-2018), etc. Online classes for teaching programming for junior schoolchildren in Russia: At the time of writing, such circles were organized by Strizhenkov R.V. (St. Petersburg) for younger students in such Russian cities as: St. Petersburg (2556 students), Moscow (672), Ufa (208), Orenburg (108), Ivanovo (87), Obninsk (80), Astrakhan (40). And the company "Astral" (Kaluga) organized similar circles for younger schoolchildren in Kaluga and the Kaluga region (1015 students). In addition to the DL materials, the organizers of the circles have created groups in contact, special websites and video materials.

Regional Olympiads in programming: They are held 5 times in the academic year: in the fall two (school and city) in three age divisions (grades 1-4, grades 5-8, grades 9-11) and in the spring three (school, city, It can be seen that problems 3-7 in the middle division are the same as problems 16-20 in the junior division. Moreover, since 2016, these are the same tasks. Thus, students in grades 1-4 are gradually preparing for the transition to the middle and senior division olympiads, and the best even participate and successfully perform simultaneously in several divisions. Tasks 1-2 in the middle division also correspond to the knowledge gained in teaching the topics "Introduction to Programming" and "One-Dimensional Array" in the junior division.

9th-11th grade in autumn, 8th-9th grade in spring, 15 tasks all for 40 points 1. Introduction to programming 2. One-dimensional array It can be seen that tasks 1-10 in the senior division are the same in terms of topics as tasks in the middle division, moreover, since 2016 these are the same tasks. Thus, schoolchildren of the middle division are gradually preparing to participate in the olympiads of the senior division, and the most advanced ones participate and successfully participate in the olympiads of both divisions.

Fixed task topics, on the one hand, offer teachers and students a training program, and on the other hand, allow them to assess regularly the current level of students' learning.

11 Teaching programming in middle and high school:

The teaching method has changed during the operation and development of the DL, so in fact there are many methods and training routes. Let's point out some of them. Pupils, starting from the 5th grade, are invited to subscribe to the training course "Basic Programming", and in it choose the package of tasks "Accelerated Course 2013". It includes 8 topics corresponding to the first 8 tasks in the olympiads of the middle and senior age divisions: introduction to programming, onedimensional array, two-dimensional array, geometry, strings,

sorting, text problem, research/brute force/elements of number theory. Each topic contains folders of problems with the names "Technical minimum", "Olympiads of 1-4 classes", "Olympiads of 5-8 classes". The "Technimum" folder contains tasks with differentiated learning, covering the necessary basic knowledge on this topic. Olympiad tasks are arranged by subtopics in order of increasing complexity of subtopics and complexity of tasks in subtopics. The next stage of training is a package of tasks "Olympiads of grades 9-11", which contains problems of regional olympiads of grades 9-11 on the topics of tasks 9-15, namely: greedy algorithm, queue, recursion, dynamic programming, graphs, complex data structures, complex DP. Tasks within each topic are structured by subtopics in order of increasing complexity, and within subtopics, tasks also go in ascending order of complexity. At the moment, the author considers this path "Accelerated course 2013" - "Olympics of grades 9-11" to be the main training route for his students. In real practice, other training routes are also used. For example, for students who struggle with "Accelerated Course 2013", there are two easier routes - the easiest is to fall back to "Informatics

2015” and start there, and then move on to Basic Programming. Another slightly more complicated option is to undergo differentiated training in ”Basic Programming”, sequentially on each of the topics ”Introduction to Programming”, ”One-Dimensional Array”, etc. Students/teachers who prefer a freer way of learning can work in the Algorithmic Methods course, where tasks are also grouped by topic and subtopic, but in reverse chronological order.

12 Automation of learning in arbitrary programming languages:

In the summer of 2016, the IOI raised the issue of removing the use of Pascal as the IOI programming language. Since one of our goals is to prepare the best students to perform successfully at the IOI, the question arose of switching to another programming language and developing the corresponding training. We solved this problem in the following way: a program was developed that generates training tasks on the fly, similar to those performed manually for Pascal. To do this, the task folder should contain the author’s solution in the desired programming language, and the program folder should contain a file of correspondences for this language -a Russian/ English word. In addition, a package of tasks ”Accelerated Course 2016” was formed based on the current, at that time, the status of the ”Accelerated Course 2013” task package. At the same time, the tasks were reorganized into four folders: ”Technical minimum”, ”Control”, ”Control *”, ”Training”. For C++, the author himself developed all author’s solutions, for other languages (Java, Kotlin, C#, Python, JavaScript) author’s solutions were developed by students and were not implemented for all tasks. The transition to C ++ by the students of the author is carried out at the request of the student, as a rule, after the successful completion of the package of tasks ”Accelerated Course 2013”. Therefore, to speed up the transition, the ”Control *” and ”Training” folders can be skipped.

Weekly training Olympiads: At the end of each week, from 8.00 Saturday to 20.00 Sunday, two training Olympiads are held: ”Programming-beginners” (for students in grades 1-4) and ”Programmingprofessionals (individual)” (for students in grades 5-11), in which successively regional olympiads of previous years are opened. This allows each student and teacher to ”look in the mirror” weekly and find out which topics are well covered, which are poorly, which have not yet been studied at all. In addition, for the guys who are preparing for the regional and republican Olympiads, from the beginning of December (after the final of the Open Russian Teams Olympiad for Schoolboys/ORTOS) and until the beginning of April (after the Belarusian Republican Olympiad), the tasks of national and international Olympiads, which are open on Sunday, are added to the ”Programming Professionals” course from 9.00 to 14.00. Additionally, in the interval from the beginning of April to the beginning of December, a special course ”Programmingprofessionals (team)” is opened to prepare for the selection and final of the ORTOS, which offers various team Olympiads of past years. For both personal and team Olympiads, those for which there are author’s analyzes are selected. After the Olympiads, all problems are open for completion in special courses for working on errors: Programming-beginners (W/O)”, ”Programming-professionals (personal) (W/O)”, ”Programming-professionals (com)” (W/ O).

Seasonal Cups (according to nominations): Organized to increase motivation for the implementation of educational work in the courses ”Informatics 2015”, ”Basic Programming”, ”Mathematics”. The competition is about who will solve the main problems the most (not in ”I don’t know” folders) for the corresponding season (Autumn, Winter, Spring, Summer) and the entire academic year. In the 2020-2021 academic year, 829 students participated in the Informatics 2015 competition, 268 in Basic Programming, 525 in Mathematics.

From 2020-2021, two new nominations have been added: ”Programming-Professionals (private)” (who will score the most points in the Sunday ”difficult” Olympiads), ”Programming-Professionals (team)” which team will solve the most problems in Sunday team olympiads.

Teaching university students such subjects as: ”Programming”, ”Organization and functioning of computers”, ”Architecture of computers”. Currently, all the possibilities of DL are used in the educational process of the cycle of disciplines related to the study of hardware at the F. Skorina Gomel State University at the Faculty of Mathematics and Programming Technologies:

? ”Architecture of computers” (PI2, IT3, PO4).

In all cases, examination/test sheets are automatically built, in which the following results affect the assessment: control cuts, weekly one and a half hour tests in practice, weekly team tests on theory, solving individual problems, setting new tasks, bonuses for an active and creative position on theoretical and practical classes, during the performance of individual tasks.

The theoretical part of the hardware courses includes the following topics: number systems, logic functions and Karnaugh maps, combinational circuits, automata, a quick dive into the Intel 8086 assembler, the Intel 8086 instruction set, Intel 8086 instruction formats, the algorithm for executing programs by the processor, a rigid logic control machine, a programmable logic control machine, the development of the architecture of the Intel processors from 8086 to 80586, non-Intel processor architectures: digital signal processors, database processors, transputers, computers controlled by data flows , vector and matrix supercomputers.

The practical part includes the development of digital circuit designs, verified by the HLCCAD high-level chip design system; development of low-level (assembler) programs for various microcontrollers, verified by the Winter multiprocessor simulation system; development of microprograms for S-MPA. All the above mentioned software packages are integrated into the DL system.

The DL system is also used for disciplines related to teaching programming: ”Fundamentals of Algorithmization

and Programming” (1st year, specialties -PO and IT), ”Fundamentals of Program Design” (1st year, specialties -PO and IT), ”Programming” (1st year , specialty -PI).

The theoretical part includes the study of the following issues: introduction to programming, debugger, one-dimensional array, two-dimensional array, geometry, strings, sorting, queue, recurrence relations, recursion, graphs. At the same time, the last three topics are studied without lecture material with the help of independent study of the corresponding chapters from textbooks. The practical part includes the following components.

Training: For all theoretical questions from the introduction to programming to the queue, automatic differentiated learning is provided. Everyone is offered the same tasks to solve and everyone gets points for solving each of the main problems.

Technical minimum: To simplify the integration into the educational process of students with minimal prior training in computer science, some of the simple tasks are placed in an additional assessment area.

Individual assignments: Students who consider themselves well-prepared can skip the training (and the minimum) and go straight to individual tasks. In the ”Individual tasks” section it is clear by name, despite the fact that the tasks are offered to everyone the same, points for solving the problem are counted only to the one who FIRST solved it correctly.

For the convenience of working with individual tasks, it is recommended to select the ”Unsolved Tasks” task tree type. In this case, in the task tree, opposite the name of the task, there is the last name of the person who solved it and the date when the task was solved. If there is no surname-date, then this task has not yet been solved by anyone and one can try to get ahead of everyone in solving it. The proposed individual tasks are of five types: Thematic tasks: these are tasks from Internet Olympiads for schoolchildren studying programming on the following topics: one-dimensional array, twodimensional array, geometry, strings, sorting, queue.

Control works: At the end of each week, a test of 10 tasks for an hour and a half is carried out, the assessment for the control work corresponds to the number of tasks completely solved. Exams: This is a test in which each student is presented with their own set of 10 tasks. The final score on the exam cannot be higher than this score. The exam can be rewritten at the request of the student on a weekly basis. This approach to a large extent provides protection against unscrupulous approach of students to learning and at the same time ensures the adequacy of examination marks to the knowledge and practical skills of students. New tasks: The student has the right to develop and install new tasks in the DL system, inventing conditions, tests and an author’s solution.

Special course ”WEB-technologies for beginners”(with automatic verification of solutions, all tasks contain examples of solutions (under the spoiler) and links to the theory) includes: ? Tasks for the development of html files:

commenting, text formatting, lists, tables, links, document blocks, splitting the page into parts on the screen, user interaction, attributes; ? Tasks for the development of css-files: tag selectors; ? JavaScript DOM assignments: Attributes, adding and deleting, event handlers, searching and modifying by tag, class, ID, name, frames -JSP/servlet assignments -Introduction to WEB programming languages, where the minimum technical assignments from ”Accelerated Course 2016” are offered on the topics: introduction to programming, one-dimensional array, twodimensional array, geometry, string sorting, perform in one of the following languages: JavaScript, Clojure, ClojureScript, CoffeeScript, JSP, Python, Java, Kotlin, C#, Python, Ruby. Development of DL as training in WEB-development: All DL functionality was created by schoolboys, students, undergraduate and graduate students. Working on the DL helped them greatly improve their professional training and subsequently easily find a well-paid and interesting job.

13 IV. Conclusion

This paper describes the basic capabilities of the distance learning instrumental system DL (dl.gsu.by), as well as examples of its application for teaching programming to junior, middle and older schoolchildren, first-year students, as well as teaching the basics of digital electronics to students of three specialties (information technology software, computer science and programming technology, applied computer science) on Faculty of Mathematics and Programming Technologies in Gomel State University named after F. Skorina.

.1 Development

- Conference. <https://lirias.kuleuven.be/3414337?limo=0> 31. Porter W., Graham C., Bodily R., ??andberg, D. (2016) A qualitative analysis of institutional drivers and barriers to blended learning adoption in higher education// Internet and Higher Education, vol.
- [, 10.29333/ejmste/10781. <https://doi.org/10.29333/ejmste/10781>
- [, 10.1007/978-981-33-4106-7.
- [Darma et al. ()] , K Darma , G M Karma , M A Santiana . *Validity and Practicality Test of Applied Mathematics Digital Teaching Materials for Blended Learning for Polytechnic Engineering Students//Journal of Social Sciences and Humanities* 2021. 11 (1) p. .
- [Nathaniel and Black] *An Adaptive Blended Learning Approach in the Implementation of a Medical Neuroscience Laboratory Activities// Medical Science Education*, T I Nathaniel , A C Black . 10.1007/s40670-021-01263-5. <https://doi.org/10.1007/s40670-021-01263-5>
- [Dolinsky ()] *An approach to teach introductory-level computer programming// Olympiads in Informatics*, M Dolinsky . 2013.
- [Lovey et al. ()] ‘Basic Medical Training for Refugees via Collaborative Blended Learning: Quasi-Experimental Design’. T Lovey , P O’keeffe , I Petignat . 10.2196/22345. <https://doi.org/10.2196/22345> *Journal of Medical Internet Research* 2021. 23.
- [Antwi-Boampong ()] ‘Blended Learning Adoption in Higher Education: Presenting the Lived Experiences of Students in a Public University from a Developing Country//The Turkish’. A Antwi-Boampong . *Online Journal of Educational Technology* 2021. 20 p. .
- [Yunus ()] ‘Blended Learning in Rural Primary ESL Classroom: Do or Don’t//International Journal of Learning’. Jerry M Yunus , M . *Teaching and Educational Research* 2021. 20 (2) p. .
- [Lu et al. ()] ‘Constructing and Validating University Students’ Blended Learning Acceptance Scale’. W Lu , M Maziha , A Nabilah . *International Journal of Interactive Mobile Technologies* 2021. 15 p. .
- [Lee et al. ()] *Developing Museum Education Content: AR Blended Learning //International Journal of Art & Design Education*, J Lee , H K Lee , D Jeong , J E Lee , T R Kim , J H Lee . 10.1111/jade.12352. <https://doi.org/10.1111/jade.12352> 2020.
- [Oktaria et al. ()] ‘Development of Blended Learning Designs using Moodle to Support Academics of The Curriculum in University of Bengkulu’. S Oktaria , R Sasongko , M Kristiawan . *Jurnal Studi Guru dan Pembelajaran (Indonesia)* 2021. 4 (1) p. .
- [Alsalihi et al. ()] ‘Does Blended Learning Improve the Academic Achievement of Undergraduate Students in the Mathematics Course?: A Case Study in Higher Education’. N Alsalihi , S Al-Qatawneh , M Eltahir , K Aqel . *Science and Technology Education* 2021. 17. (/EURASIA Journal of Mathematics)
- [Khan et al. ()] *Doing a Quiz in Pajamas”: Successes and Challenges of Blended Learning in Cambodian Higher English Language Education//chapter 7 in the book ”Blended Learning for Inclusive and Quality Higher Education in Asia*, B Khan , S Chenda , S Heng , D Coniam . 2021. p. .
- [Karamzadeh et al. ()] *Effectiveness of ethics case based on blended learning approaches on medical students’ learning: A quasi-experimental study//Journal of Education and Health Promotion*, A Karamzadeh , L Mosalanejad , L Bazrafkan . <https://doi.org/10.4> 2021.
- [Lane et al. ()] ‘Engagement and Satisfaction: Mixed-Method Analysis of Blended Learning in the Sciences’. S Lane , J G Hoang , J P Leighton . 10.1007/s42330-021-00139-5. <https://doi.org/10.1007/s42330-021-00139-5> // *Canadian Journal of Science, Mathematics and Technology Education* 2021. 21 p. .
- [Dolinsky ()] ‘Gomel training school for Olympiads in Informatics’. M Dolinsky . *Olympiads in Informatics* 2016. 10 p. .
- [Lim et al. ()] *Grassroots Approach Towards Professional Development in Blended Learning of a faculty at a University in Hong Kong // chapter 2 in the book ”Blended Learning for Inclusive and Quality Higher Education in Asia*, C Lim , D Yang , Y Gao . 10.1007/978-981-33-4106-7. <https://doi.org/10.1007/978-981-33-4106-7> 2021.
- [Jones and Ravishankar] *Higher Education 4.0.(2021) The Digital Transformation of Classroom Lectures to Blended Learning*, K Jones , S Ravishankar . 10.1007/978-981-33-6683-1. <https://doi.org/10.1007/978-981-33-6683-1> Singapore: Springer. 219.
- [Lomer and Palmer ()] *I didn’t know this was actually stuff that could help us, with actually learning’: student perceptions of Active Blended Learning//Teaching in Higher Education*, S Lomer , E Palmer . 10.1080/13562517.2020.1852202. <https://doi.org/10.1080/13562517.2020.1852202> 2021.

[Kolegova and Levina ()] ‘Implementation of the Blended Learning Technology in the’. I A Kolegova , I A Levina . *SERIES: EDUCATION. EDUCATIONAL SCIENCES* 2021. 13 p. . South Ural State University//Bulletin of the South Ural State University

[Bokolo ()] *Institutional factors for faculty members’ implementation of*, A Bokolo . 10.1108/ET-06-2020-0179. <https://doi.org/10.1108/ET-06-2020-0179> 2021.

[One-dimensional array -summation 12. One-dimensional array -counting 13. One-dimensional array -maximum 14. One-dimensional array -summation 12. One-dimensional array -counting 13. One-dimensional array -maximum 14. One-dimensional array -minimal 15. One-dimensional array -search 16. Two-dimensional array -standard algorithm 17. Geometry -coordinates/distances + standard algorithm 18. Strings -non-standard algorithm 19, 10. (Introduction to programming -POS 11. Sorting 20. Text problem Grade 5-8 in autumn and Grade 5-7 in spring, 10 tasks, all for 40 points)

[Poelmans et al. ()] S Poelmans , N Verhaeghe , P Vemuri . *On the Suitability of Blended Learning in Secondary Mathematics Education: Test Results and Perceptions of Belgian 9th Grade Students//15th International Technology*, 2021.

[Barbato et al.] *Polemic (2020) Forums in Blended Learning as New Strategies for a Borderless Higher Education Chapter*, S Barbato , Beraldor , M Gabriela , Fernanda M Gonzalez . 212 p. p. (in the book Gesu D.,)

[Chamberlain et al.] *Tailored (2021) Blended Learning for Foundation Year Chemistry Students//Chimia*, S Chamberlain , D Elford , S Lancaster , Silvef . 10.2533/chimia.2021.18. <https://doi.org/10.2533/chimia.2021.18> 75.

[Norhapizah et al. ()] *The Development Of E-Citac Module In Islamic Education Course Based On Blended Learning Strategy For Higher Education In Malaysia//Multicultural Education*, M B Norhapizah , M Ramlan , M Z Mahfuzah , H Norafifah , M Ishak . 2021. 7 p. .

[Muhuro and Kang’ethe ()] ‘The Effect of Different Blending Levels of Traditional and E-Learning Delivery on Academic Achievement and Students’ Attitudes towards Blended Learning at Sultan Qaboos University//The Turkish’. P Muhuro , S M Kang’ethe . 10.18820/2519593X/pie.v39.i1.2626. <http://doi.org/10.18820/2519593X/pie.v39.i1.2626> *Online Journal of Educational Technology* Musawi A.S., Ammar M.E. (ed.) 2021. 20 p. . (Prospects and pitfalls associated with implementing blended learning in rural-based higher education institutions in Southern Africa//Perspectives in Education)

[Astarilla and Warman ()] ‘The Effect of Google Classroom in Blended Learning on University Students’. L Astarilla , D Warman . *English Ability//Journal of English for Academic* 2021. 8 (1) p. .

[Mekhitarian ()] *The Essential Blended Learning PD Planner: Where Classroom Practice Meets Distance Learning*, S Mekhitarian . 2021. Corwin Press. p. 160.

[Aznam et al. ()] ‘The Implementation of Blended Learning and Peer Tutor Strategies in Pandemic Era: A Systematic Review//Advances in Social Science’. N Aznam , R Perdana , J Jumadi , H Nurcahyo , Y Wiyatmo . *Education and Humanities Research* 2021. 541 p. .

[Antwi-Boampong and Bokolo ()] *Towards an Institutional Blended Learning Adoption Model for Higher Education Institutions//Technology, Knowledge and Learning*, A Antwi-Boampong , A Bokolo . 10.1007/s10758-021-09507-4. <https://doi.org/10.1007/s10758-021-09507-4> 2021.

[Le and Pham] ‘Using (2021) Blended Learning in Teacher Training Programs: Perspectives of Preservice Teachers’. P Le , H Pham . 10.36941/jesr-2021-0035. <https://doi.org/10.36941/jesr-2021-0035> *Journal of Educational and Social Research* 11 (2) p. 127.