

## THE ONLINE PLATFORM „ESCHOOL”

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Submitted on 01.05.2021

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**Abstract:** The internet is a global network that is used in any industry.

Large corporations have long used the electronic way of doing business. Due to the COVID-19 pandemic, more and more government and commercial structures are switching to online and, therefore, using the electronic circulation of documents and other important things for them. Educational institutions were the most unprepared for such changes, and therefore, they faced an acute question of how to transfer everything online.

The purpose of the development is to design and implement a convenient, simple, and most importantly, fast accounting system for educational institutions, which can reflect the educational process in a convenient way, both for students/students and teachers/teachers.

**Index Terms:** .NET Framework, Microsoft SQL Server, Angular, MVC, MVVM, WinForms, online, distance learning.

## I. INTRODUCTION

Now, in the world of electronic resources and their technologies, modern people use various types of electronic media daily, from printers to smartphones and computers. Of course, this simplifies and reduces the time spent on everyday tasks, promotes business communication, news analysis, presentation of your achievements, and so on. Nowadays, it is relevant to conduct electronic accounting of the activities of a certain community: a business team, a team of employees, school students, or students in higher educational institutions.

One of the new forms of the educational process is the distance form, which is associated with the use of information and communication technologies. This technology is being developed and constantly updated to create an open and widely accessible education system aimed at training a competitive qualified specialist [1].

M. Tanas analyzes the term “distance learning”, which is most often found in foreign and domestic publications: distance learning as a form of learning (DL), when the main activity is the activity of a student using the internet, computers, television, radio, etc.; distance learning as a teaching, when the main role is played by a teacher; tele teaching as learning using telecommunications tools; network-mediated learning (teaching by network) as a means of learning [2].

The implementation of a project from an electronic system requires a thorough analysis of the existing way of conducting the educational process, indicating the specifics of filling in, considering related disciplines and classes, the requirements of other teachers, recording certain actions and notes.

The basis of the educational process in distance learning is purposeful and controlled by intensive independent work of the student, who can study in a convenient place, according to an individual schedule, having a set of specialized training tools and an agreed opportunity to contact the teacher.

In the education system, the DL corresponds to the principle of humanism, according to which no one should be deprived of the opportunity to study due to geographical isolation, social insecurity, and inability to attend educational institutions due to physical disabilities or employment in industrial and personal matters. Being a consequence of the objective process of informatization of society and education and, absorbing the best features of other forms, DL entered the 21st century as the most promising, synthetic, humanistic, integral technology of obtaining an education [3].

To design and implement a system with functionality that will allow to manage academic subjects and generally keep records of the curriculum, you need to apply the right approach to implementing basic modules: a web resource “Electronic Journal” and a module for printing appendices to certificates. Provide students, teachers, and parents with free access to information about their learning activities and achievements.

## II. REVIEW OF THE EXISTING PROCESS OF CONDUCTING THE EDUCATIONAL PROCESS

Today, in many educational institutions of Ukraine, the progress of students is recorded by hand, that is, it is handwritten. And this approach can be understood for up to a certain period. In the early 1970s, technology was just beginning: the development of processors, computers, the first televisions, and so on. At that time, no one even thought that it would be possible to give up handwriting and go online, since computers were expensive and inaccessible to the public. The first attempts at automation appeared with the mass availability of computers and printers.

The world kept up with technology but did not take into account the educational process.

It is easy to see that the journal (Fig. 1) itself is a template and the teacher is responsible for filling it out since it is a document, not a draft. All entries must be one-time and correct, without strikethroughs or other nuances. From year to year, only certain provisions in the recommendations for keeping a class Journal change, which must be followed by teachers of educational institutions.

SCHOLARSHIP							
Studies	Periods						
	1	2	3	4	5	6	Total Mark
Reading	S	S	S	S	A	A	A
Spelling	S	A	A	A	A	A	A
English (Language and Conversation)	S	S	S	A	A	A	A
Prose and Poetry							
Handwriting	S	S	S	S	S	S	S
Arithmetic	A	S	S	A	A	A	A
Geography	S	S	S	A	A	A	A
Nature Study							
History							
Civics							
Music	S	S	S	A	A	A	A
Art and Handwork	S	S	S	S	S	S	S
Physical Education							
Health	S	S	S	A	A	A	A

**Explanation of Marks**

A—Means outstanding achievement, superior work.  
 S—Means satisfactory.  
 I—Improving; indicates progress, but not yet satisfactory.  
 U—Unsatisfactory.

Remarks by Teacher: \_\_\_\_\_

**Attendance Record**

	Periods					
	1st	2d	3d	4th	5th	6th
Total School Days	30	30	30	30	30	30
Total Days Absent	0	0	0	1	4	0
Times Tardy	0	0	0	0	0	0

Fig. 1. Example of maintaining manual success records

The conclusion is simple – the transition to electronic accounting of training simplifies the learning process and access to information for all those involved: teachers, students, and their parents, education workers, or other bodies. Extracting information (importing/exporting data) takes only a few minutes, rather than long handwritten document entries.

The transition to electronic accounting and document circulation improves monitoring of the state and academic performance of the educational institution and reduces the time spent on routine filling out of documents.

In general, the analysis of recent studies has shown that many scientists discuss the introduction of remote learning in the educational process, analyzing the experience of domestic and foreign colleagues, and

offering various methods of its organization. Samolyuk N. notes: "...distance learning technologies can be considered as a natural stage in the evolution of the traditional education system from a chalkboard to an electronic whiteboard and computer learning systems, from a book library to an electronic one, from a regular audience to a virtual audience" [5].

### III. SYSTEM COMPONENTS

#### A. DEVELOPMENT OF THE PROGRAM "DODATKY"

To create a program for printing appendix for certificates (Dodatky), .NET Platform was used. In general, C# with Windows Forms (WinForms) – and an open graphical class library (GUI), which is part of Microsoft.NET Framework and provides a platform for writing client applications for desktop computers, laptops, and tablets.

The PDFSharp library, which is an open-source .NET library that allows to easily create and process PDF documents in real-time on the .NET platform. The same drawing procedures can be used to create PDF documents, draw on the screen, or send source data to any printer. A special C# library is responsible for working with Excel, which simplifies access to the Office API.

The Windows Forms application is an event-driven application supported by the Microsoft platform. NET Framework. Unlike a batch program, most of the time it just waits for the user to do something, such as fill in a text field or click a button.

Windows Forms provides access to the Windows User Interface Common Controls by packaging the existing Windows API into Managed Code. Using Windows Forms, the .NET Framework provides a more complete abstraction over the Win32 API than Visual Basic or MFC (Fig. 2) [6].

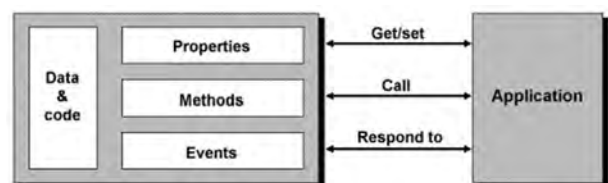


Fig. 2. The relationship between the object and the application

All visual elements in the Windows Forms class library are derived from the control class. This ensures minimal functionality of the interface element, such as location, size, color, font, text, and general events such as clicks. The control class also has docking support, which allows the control to change its position under the parent element.

In addition to providing access to native Windows controls such as Button, TextBox, CheckBox, and ListView, Windows Forms has added its controls for ActiveX, layout, validation, and data binding. These controls are visualized using GDI+.

C# is a general-purpose, type-safe, object-oriented programming language. The goal of the language is programmer productivity. To this end, C# balances simplicity, expressiveness, and performance. The C# language is platform-neutral and works with a range of platform-specific compilers and frameworks, most notably the Microsoft .NET Framework for Windows. C# is a rich implementation of the object-orientation paradigm, which includes encapsulation, inheritance, and polymorphism. Encapsulation means creating a boundary around an object, to separate its external (public) behavior from its internal (private) implementation details. The distinctive features of C# from an object-oriented perspective are:

**Unified type system.** The fundamental building block in C# is an encapsulated unit of data and functions called a type. C# has a unified type system, where all types ultimately share a common base type. This means that all types, whether they represent business objects or are primitive types such as numbers, share the same basic functionality. For example, an instance of any type can be converted to a string by calling its ToString method.

**Classes and interfaces.** In a traditional object-oriented paradigm, the only kind of type is a class. In C#, there are several other kinds of types, one of which is an interface. An interface is like a class, except that it only describes members. The implementation for those members comes from types that implement the interface. Interfaces are particularly useful in scenarios where multiple inheritance is required. (Unlike languages such as C++ and Eiffel, C# does not support multiple inheritance of classes).

**Properties, methods, and events.** In the pure object-oriented paradigm, all functions are methods (this is the case in Smalltalk). In C#, methods are only one kind of function member, which also includes properties and events (there are others, too). Properties are function members that encapsulate a piece of an object's state, such as a button's color or a label's text. Events are function members that simplify acting on object state changes. While C# is primarily an object-oriented language, it also borrows from the functional programming paradigm. Specifically:

Functions can be treated as values. Using delegates, C# allows functions to be passed as values to and from other functions. C# supports patterns for purity.

Core to functional programming is avoiding the use of variables whose values change, in favor of declarative patterns. C# has key features to help with those patterns, including the ability to write unnamed functions on the fly that "capture" variables (lambda expressions), and the ability to perform list or reactive programming via query expressions. C# also makes it easy to define read-only fields and properties for writing immutable (read-only) types 0.

The user interface of the program should not be overloaded with many different buttons and features. In case of multi-functionality, it is better to divide this

functionality into steps or partially transfer it to a separate Settings window [7].

It is equally important that the interface is flexible to different resolutions, that is, it can scale according to changes in the window size.

The application looks like:

The screenshot shows a web application interface. On the left, there is a list of students with the following entries:

- 1 Ivanov Vasil Vasilovich
- 2 Droptin Ivan Ivanovich
- 3 Sidorenko Gadya Petrovna

On the right, a detailed form is displayed for the selected student, Ivanov Vasil Vasilovich. The form includes the following fields:

- Group: 104
- Passport number: XXXX 123456
- Name: Ivanov Vasil Vasilovich
- Birth date: 16.01.1986
- Subjects and scores:
 

Ukrainian language	twelve
Ukrainian literature	eleven
Russian language	ten
Literature	nine
Foreign language (Eng.)	eight

Fig. 3. App appearance

To fill in information about the school and students' scores, use a template that one needs to fill in and save and then import into the app (Fig. 4).

The screenshot shows a template form for a certificate. The header includes the number 9 and the text "Front pages of the document". Below the header, there is a list of subjects and a table for student scores.

Subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ukrainian language	12	11	10	9	8	7	6	5	4	3	2	1	12	11	10
Ukrainian literature	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Russian language	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Literature	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Foreign language (Eng.)	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Algebra	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Geometry	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Information technology	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
History Of Ukraine	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
World history	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Man and society	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Biology	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Chemistry	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Geography	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Physics	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4
Astronomy	1	2	3	4	5	6	7	8	9	10	11	12	7	3	4

Fig. 4. View of the template

You can change the number of items by adding it to the list for all items. Since their number can vary from school to school, this dynamic property ensures the versatility of the application.

All fields and lines can be adjusted according to the actual form using the "Customize the layout of the form" item.

It allows to change all the lines of the front and back of the form and fonts. To make it easier to use the app, you can save/load the form configurations.

Besides the first page of the template is for common information about the school. It will be also included in import process, so you will have 2 ways for setting it: the first option will be on the template and the second one will be directly in application.

Certificate's appendix has difference between 9-th and 11-th forms, therefore you can setup the form only in template and its application it will be locked for change.

After importing students, the view function becomes available when you select a student from the list alone. If you select more than one student, the function is

disabled. Also, it becomes possible to export both individual students and all in general, in addition, export is possible both to separate files for students and to a single file.

For a better user experience, all work takes place in the background, so as not to block the UI flow, which leads to the inability to use the application. Therefore, a progress bar and a text representation of the current execution status have been added specifically for this purpose.

### B. WEB-APPLICATION «ESCHOOL»

In general, for the development of the web interface, the following was chosen: Angular Framework 10 with a combination of HTML, SCSS.

Angular is one of the most known TypeScript (is a superset of JavaScript) front-end framework developed by Google to create dynamic and modern web apps. First introduced in 2009, the framework has gained huge traction over the years for eliminating unnecessary code and ensuring lighter and faster apps.

Currently, angular projects are built with Typescript, as it has been already mentioned, which is a superset of JavaScript which primarily provides optional static typing, classes, and interfaces. One of its salient benefits is to enable IDEs to provide a richer environment for spotting common errors as one types the code.

Unlike CoffeeScript or Dart, TypeScript is not a stand-alone language. With TypeScript, one can easily take the existing ES5 or ES2015+ JS code and it will compile it down based on what you are configuring. It fully supports core ES2015 and ES2016/ES2017 features such as decorators or async/await. Check the following figure for further understanding [8].

Since the web interface communicates with the API for receiving data sets and will only display the received information to the user, we have this type of relationship (Fig. 5).

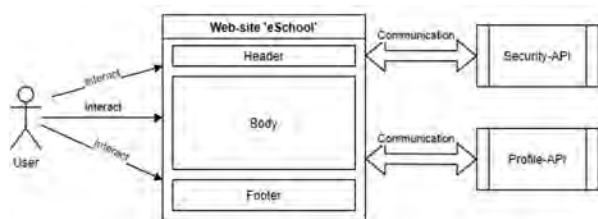


Fig. 5. UML relationship diagram

To communicate with the API, the web interface will send regular HTTP requests, so firstly, a model of interaction with the API was developed written in Angular (Typescript). for this, again, roles were divided in the website, i.e., 2 projects were created: the 1st-for the visual part, the 2nd-for interaction with the API, and custom parts of the interface.

The next step is to create specific services that will be responsible for individual API request groups, such as the Security API, Authentication group, or user authorization request.

Thanks to the idea of free use of the design “Diia”, it was decided to create a web application using the same design with a link to the Website “Design system. Diia”.

In order not to constantly prescribe common parts of the interface (header, footer), a model has been created in which we have Layout and its child modules, using angular routing (Fig. 6).

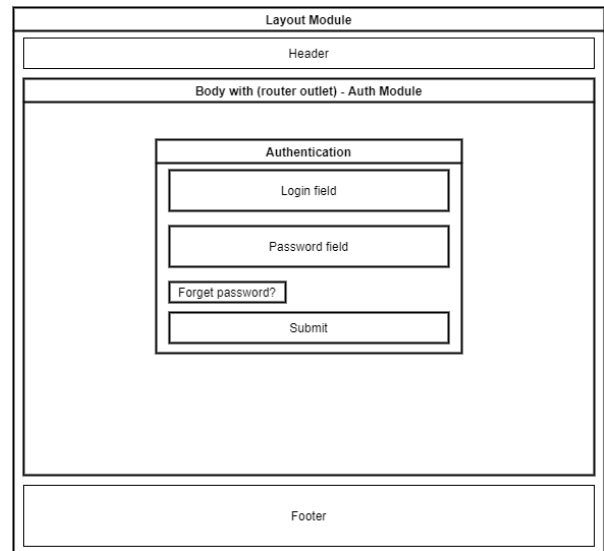


Fig. 6. Layout Module, using the example of the authorization page

We have nested modules, which in turn can have their own routes.

For AuthModule, which is responsible for logging in and resetting pages, a security service (LoginGuard) has been created, which prohibits access to these pages for users who have logged in successfully.

In other words, the service is Injectable, which implements the CanActivate interface using Dependency Injection. The service gets access to AuthService, which contains information about the user, of course, if the user has been authenticated.

Implementation of the login page, all data that is filled in with text is initialized directly in the code and this is implemented throughout the application. This is done to simplify the implementation of the CMS API, which will be able to translate pages, that is, change the site language.

Next, the form is initialized. Even if an authorized user can somehow get to the login page, the condition at the beginning will direct the user to the profile settings page.

If the user has not entered any data, the AsDirty checkbox is set for the fields, which in turn initializes the error output call for the fields to display information, for example, that this field is mandatory for user input.

If the user still enters data, this data is sent by an HTTP request, and if successful, it returns the user to the main page. Otherwise, a data entry error message is added to the password field.

For the needs of the website, we have created our style for Fields on the site and animated buttons that play an animation when the mouse is hovering over the button.

Animation is based on 2 events: mouseenter, mouseleave.

Since fields will often be found on the website, and standard tools are not suitable, we decided to create our style for fields that will fully meet the needs and allow to customize the field as much as possible.

In order not to constantly prescribe common parts of the interface (header, footer), a model has been created in which we have Layout and its child modules, using angular routing.

We have nested modules, which in turn can have their routes.

Today, the web application has the following architectural model (Fig. 7):

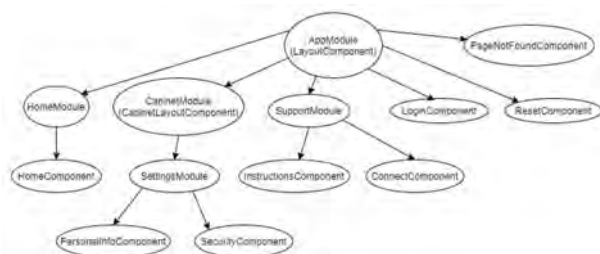


Fig. 7. Architectural model of a web application

#### IV. FORMULATION OF THE PROBLEMS

It is in educational institutions that academic performance records are kept in paper form, and, as a result, access to information about student grades is limited and is possible only in the educational institutions themselves. Usually, a class journal contains information in general for the class – the journal must be passed from lesson to lesson between different teachers. There are often cases of “conflicts”, for example, when one teacher fills out a journal, but at this moment another teacher needs this journal.

But there is another side – not all educational institutions have access to the global internet, which provides unlimited access to resources and encourages the improvement of knowledge of students and students. Since laying cables and/or improving existing equipment is not always appropriate and profitable for telecom operators, it is, therefore, the responsibility of the Ministry of education and the state to provide educational institutions with internet access. Switching to electronic document management makes it easier for teachers, parents, and students themselves to work and access information.

#### V. FUNCTIONS AND FUNCTIONAL PRINCIPLES OF THE ONLINE PLATFORM “ESCHOOL”

The online platform “eSchool” is quite voluminous and contains a lot of functions, but at present, it is still under development, since there are 2 modules:

- Application “Dodatky” – which will help the educational institution save time and partially automate the printing of applications to certificates. The program is quite easy to use, to start the process, you firstly need to fill in the document with data about the educational institution and direct students and their grades, and at the end – make settings for the current form.

- Web application “eSchool” – it is more complex, as it contains significantly more business logic, so its implementation is still under development. For a better user experience, the “Diia” design was used, as it looks quite new. After all, the web application implements all the necessary functions for students and teachers.

The possibility of using machine learning or neural networks to improve students' skills and or highlight students' weaknesses, blockchain technology for a kind of register, is being considered. Improvements to this system will also be made in the direction of performance and new functionality. The online platform «eSchool» can become a platform for all schools, also be adapted to the educational process in colleges and universities and become a national platform for education. And the application printing app is an indispensable tool for teachers to print applications for certificates. It can also be adapted to higher education applications.

#### VI. COMPARATIVE ANALYSIS OF EXISTING ONLINE SYSTEM FOR EDUCATIONAL PROCESS

Today, enough online alternatives have appeared on the internet, both for printing applications to certificates and electronic journals for automating training. Let's start with automation systems for the educational process, there are both free and paid systems, in addition, there are systems supported by the Ministry of education and science of Ukraine.

The most powerful in terms of capabilities is the “Yedyna Shkola” System for educational institutions, which is 4 based on new technologies with cross-platform access to the resource (web application, mobile application, 3 operating systems).

Access to the system is divided by rights: student, teacher, and parents.

Students can participate in online lessons and view videos of these lessons, view the class schedule, view their academic performance, view homework, download educational materials, view the list of teachers and subjects, and pass tests.

For parents, monitoring of homework completion, interactive communication with teachers, prompt and reliable assessments of the child, and timely response to changes in the dynamics of the child's academic performance are available.

For teachers, there are remote lessons, automatic reporting, archived documentation storage, data import/export, printing, grading, recording absences, creating homework with additional files, setting lesson content, and much more.

Analysis of the “Yedyna Shkola” system proves that it is a powerful system with a simple and intuitive interface. But there are 2 nuances: the first one is not described based on which license the system is distributed (free or commercial) and there is no module for printing appendices to certificates.

The next project is “Smart School” – a system for automating the educational process, which applies to a significant number of educational institutions, covering vocational and technical educational institutions and universities of I-II accreditation levels.

The functionality is like the “Yedyna Shkola” system, but the system is available only as a web application, so this imposes some difficulties in using it since applications on smartphones simplify work in this direction. In addition, there is no module for printing appendices to certificates. And of course, this system is paid, and payment is made depending on the number of Students (Students) in the school.

Service e-schools.info is intended for processing and providing information about students' academic performance in a convenient electronic form, as well as related information available via the Internet. The system is provided for free use without commercial licenses.

Information about academic performance contains marks and Omissions, comments on them; notes for lessons; homework; comments; schedule of quarters, classes, and much more. Information is provided in various forms:

- Journal.
- Diary.
- Progress table.
- Academic performance charts for each class and student.
- Reports for teachers after the end of the school period.
- There are 5 main types of site users (Director, Administration, teacher, student, parents). Each of them has a certain set of rights and has the appropriate level of access to information.

Additionally, for educational institutions, it is possible to host a website that contains a large set of functional sections with the ability to create additional text pages.

Features of the “e-School” system:

- Ability to customize many aspects of your work individually.
- Appearance: school documents (journal, diary, etc.) look similar to paper prototypes, but with a modern design.
- The institution's website and electronic success accounting system are interrelated and integrated.

The analysis showed that the system is overloaded with unnecessary blocks and information, and there is no module for printing applications to certificates.

And the last system is «Atoms».

There is quite a bit of information about this project, but one of the advantages is the ability to work under different devices: from a web application to an application on a smartphone.

The system's capabilities are limited: there is only an electronic journal, diary, and schedule. Therefore, this system can replace paper Media, which is already a big plus and a step forward. Users can receive homework assignments, view student progress and attendance, and communicate with teachers using messages based on this system. However, there is also no possibility to print appendices to certificates.

## VII. CONCLUSIONS

The project has been already of practical value, as one of the modules of this project has been successfully used in educational institution No. 7 in Kamianets-Podilskyi since 2017.

In the future, the system will be finalized following the goal tree and a pilot project will be proposed for School No. 7 in Kamianets-Podilskyi to integrate the system into the educational process. The possibility of using machine learning or neural networks to improve students' skills and highlight students' weaknesses, blockchain technology for a kind of register was being considered. Improvements to this system will also be made in the direction of performance and new functionality. The online platform «eSchool» can become a platform for all schools, also be adapted to the educational process in colleges and universities and become a national platform for education. And the application printing app is an indispensable tool for teachers to print applications for certificates, can also be adapted to higher education applications.

## VIII. ACKNOWLEDGMENT

The results presented in this paper were obtained within the framework of the Denys Skrypyk i2021 bachelor's thesis “The online platform “eSchool”” prepared at the Department of Computer Engineering of Lviv Polytechnic National University and recommended by the Examination Board for publication as the best bachelor work.

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