

**PROCEEDINGS**

# AET 2021

**2nd Myroslav I. Zhaldak Symposium on Advances in Educational Technology**

**November 11-12, 2021**

**Kyiv, Ukraine**

## **EDITORS**

Serhiy Semerikov  
Viacheslav Osadchyi  
Olena Kuzminska



# AET 2021

Proceedings of the  
2nd Myroslav I. Zhaldak Symposium on  
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# Using Online Services to Create Comics with Elements of AR in the Educational Process of Elementary School

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**Keywords:** Cloud Services, Comics with AR Elements, Comic Book Creation Algorithm, Readiness, Educational and Methodological Materials.


**Abstract:** The article presents the actual state and practical ways to solve the problem of students and teachers of elementary school readiness to use cloud services to create comics with AR elements. The didactic potential of comics as a means of learning in the educational process has been clarified. A comparison of modern cloud services, programs, and applications for creating comics is given. Their advantages and disadvantages are highlighted. The functionality of AR programs for creating content based on comics (Vuforia, EasyAR, Maxst, ARCore, AR.js, 8th Wall) is analyzed. The results of a survey of teachers on distinguishing the most popular cloud services are given, among them are Pixton, Marvel HD, Comica. Algorithms of the educational materials' development in these cloud services for the creation of comics are presented. The levels of readiness for the use of cloud services for creating comics with AR elements (elementary, basic, creative) have been developed. The real state of readiness of teachers and students to use cloud services to create comics with AR elements is presented and characterized. Educational and methodological support has been developed for implementation in the practice of university education and the teacher development system. The prospects of the study, which are to further monitor the readiness of students and teachers to use cloud services to create comics with AR elements after the introduction of the author's educational and methodological support, are given.


## 1 INTRODUCTION


Modern teaching methods in elementary school focus on the use of non-traditional, in particular interactive and playful methods of working with children. The traditional lesson is often not effective, which encourages teachers to look for new means and forms of teaching. The teacher should become an innovator and be able to organize an interesting lesson-play, lesson-travel, lesson-quest, etc. One of such educational tools is comics, which allow forgiveness, visualization, and virtualization of complex information. The visual quality of comics increases the level of learning. Movies and animation, unlike comics, are visual, but "time-limited". Language and actions in


cinema and animation are "fast-paced". Time in the comic book progresses as fast as the reader moves his eyes across the page. The speed of information transmission is fully determined by the reader. We agree with Chykalova (Chykalova, 2020) that comics is one tool for the development of imagination and fantasy, skills to clearly and capaciously formulate and express their opinion, to distinguish the main, key from the text. Working with comics contributes to the formation of the skills of younger schoolchildren of the 21st century: to emphasize the main thing and be able to cooperate in a team.


Today, educational technologies for the use of comics have proven to be quite effective and productive. As evidenced by the pedagogical experience of the authors of the study, educational materials containing or based on AR technology are especially popular. However, the analysis of the real practice of the educational process in primary school allows us to state a lack of high readiness of teachers to apply comics in pedagogical activities in general and with

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the use of AR in particular. On the one hand, there is a lack of methodological developments on the use of comics with AR elements in training. Another significant problem is the weak capacity of teachers to develop and use comics with AR elements using cloud services. This outlines another significant problem – the preparation of future primary education teachers for the use of cloud services for creating comics with AR elements in professional activities.

## 2 ANALYSIS OF PREVIOUS RESULTS

The importance of comics used as a means of learning is outlined in several studies (Panchenko et al., 2020; Panchenko, 2021; Kuzminsky and Omelyanenko, 2008; Danylenko, 2010; Olshansky, 2002; Pustynnikova, 2013; Danylenko, 2011; Bilousova et al., 2021). Of particular interest in the context of the problems of our work are studies on the use of digital technologies as a means of effective visualization in the use and development of comics. The works (Azman et al., 2016, 2015) analyze the modern software Bitstrips, Comic Life, Pixton, MakeBeliefs-Comix, Cartoon Maker, and Graphix Comic Builder, their functions, characteristics, capabilities, and disadvantages. Fragments of the use of the said software for implementing the educational process are presented. Zerkina et al. (Zerkina et al., 2019) analyzed the possibilities of using Pixton to form the ICT competence of engineering students using a project approach. Different didactic possibilities of the specified cloud service are given in the studies (Meyers, 2014; Cabrera et al., 2018; Hobri et al., 2019). Weber (Weber, 2015) considered the use of cloud-based graphic narrative software in medical ethics teaching. In addition, the theoretical and practical aspects of data visualization and the use of digital technologies for this are presented in the works (Segel and Heer, 2010; Yuksel-Arslan et al., 2016; Sadik, 2017; Bodnenko et al., 2014). The subject of research is the use of augmented reality to work with comic book-based teaching material (Damopolii et al., 2022; Nidhom et al., 2019; Koutromanos and Alivisos, 2018).

## 3 THE OBJECTIVE OF THE RESEARCH

The purpose of the article is to reveal the possibilities of using online services to create comics with AR elements in the educational process of elementary

school.

The purpose of the study is specified in the following tasks: to identify the most popular cloud services for creating comics among teachers and characterize them; to reveal the algorithms for developing educational materials in cloud services for creating comics with AR elements; to investigate the actual state of readiness of future teachers and students to use cloud services for creating comics with AR elements; to develop educational and methodological support for the use of these cloud services in the educational process.

## 4 RESEARCH METHODOLOGY

To implement the study, the following methods were used: theoretical (analysis and synthesis of psychological, pedagogical and methodological sources, programs, handbooks, systematization and generalization of theoretical material; study of the experience with the research problems; clarification of the basic knowledge of the studied problem), empirical (pedagogical observation, interviews with teachers and questionnaires, writing methodological recommendations, formulating conclusions and determining the sequence of research), statistical (Pearson's criteria for identifying the real state of readiness of students and teachers for the use of cloud services).

The study was conducted based on Borys Grinchenko Kyiv University, 11 schools in Kyiv during March – to December 2021. The study was attended by 28 primary school teachers, as well as 84 students of the specialty “Primary Education” of 1–4 years of study.

## 5 RESULTS AND DISCUSSION

### 5.1 Analysis of Cloud Services for Creating Comics

Comics are a new, effective and democratic tool of the primary school teacher in the formation and comprehensive development of the initiative and creative personality of the schoolchild. Combining visual and playful nature, comics can satisfy the interests and meet the peculiarities of the course of mental processes in modern junior schoolchildren, representatives of the generation, to prevent the occurrence of stress during the study (Chykalova, 2020). There are plenty of online services and apps to create comics. However, not all of them are suitable for the teacher to organize work in class. Most services are paid, too



complex, and require special knowledge and skills, or their content is not created for children's audience. Finding the right program, service, or app is difficult and time-consuming, which teachers usually lack.

Lack of time for training is also a problem because the service must not only be found but also learn to work in it and know how and when to use the developed materials.

In the study, we were interested in functional, free and, most importantly, simple services that provide easy access to programs for both teachers and students (table 1).

Each of these online services contains a certain number of templates grouped by types:

- people (children, teens, young men, adults, elderly people);
- animals;
- things;
- transport;
- special characters;
- backgrounds (school, forest, city, houses, historical and mythological views, nature, etc.).

When creating a plot, you can choose the expression of the face, the position of the body, the mood of the hero, change his appearance, clothes, etc.

It should be noted that in table 1 you can also get acquainted in detail with the main characteristics of modern online services, programs, and applications for creating educational comics, which can be used not only for working online but also for working in the classroom with the ability to print material.

All offered by us online services, programs, and applications for creating comics can use instant translation in Ukrainian and maintain it in the services themselves. Using these services, the teacher can diversify the form of educational material presentation, will be able to convey complex ideas and concepts using minimal artistic means, and will be able to organize not only face-to-face but also distance learning qualitatively and interestingly. It is also possible to organize work with services not only individually but also in a group format.

The services are quite simple, so schoolchildren will be able to work with them. Most of them do not require users to register, and they can start working with them right away. Talking about the advantages of using these services, we can note the following:

- Availability of services in material terms (most are free or have the possibility of using the trial/free version);
- Simple interface (intuitive);

- Use of templates (each service has its template database for use);
- The ability to create a completely new product (the ability to download own resources is provided);
- Dissemination of materials (it is possible to disseminate or embed the created materials of the author);
- Versatility (materials can be used to work in any lesson for individual or frontal work, both online and printouts). It is also worth highlighting the disadvantages:
- Other-language interface (most programs are foreign, but there is a possibility of using Google instant translation);
- Preliminary training of teachers and students;
- Conversion (not all file formats are supported; their size is limited).

The creation of training materials such as comics using the specified software can be supplemented with AR elements. The experience of implementing the educational process using AR also allows us to highlight programs for developing and working with AR.

- Vuforia can easily create marker-based AR, markerless-based AR, and cloud-based AR. Provides sufficient support to create an application for minor tasks. In particular, it allows you to recognize 2D and 3D objects, English text (the vocabulary contains over 100,000 words, or you can use your dictionary) and allows you to play videos.
- EasyAR offers its next-generation SDK, which has some features such as SLAM, 2D–3D screen tracking and recording, cloud-based object recognition, and unlimited recognition requests. In addition, the free version can store up to 1000 tags on the device.
- Maxst offers two types of augmented reality software: Maxst AR SDK 2D and Maxst AR SDK 3D. The first tool can only recognize 2D images, and the other is much more powerful and can track 3D objects. The Maxst AR 3D SDK has features such as SLAM, physical engine effect, and occlusion effect. The Maxst AR SDK 2D features multiple image recognition (up to 200 images per channel), video zoom, instant object tracking, image and marker tracking, and a QR/barcode scanner.
- ARCore is not only supported on Android, but also on iOS devices, allowing you to develop

Table 1: Modern online services, apps and applications for creating comics.

<i>Online services</i>		<i>Need to be uploaded</i>	
StoryboardThat	Price: Free basic version; Language: English.	Comic Life	SW: Windows/macOS; Price: Free version – 30 days; Language: choice.
Pixton	Price: Free; Language: Italian.	Krita	SW: Windows; Price: Free; Language: choice.
Make Beliefs Comix	Price: Free; Language: choice.	MediBang Paint Pro	SW: Windows/macOS; Price: Free; Language: choice.
Debate365	Price: Free; Language: English.	<i>Mobile apps</i>	
Canva	Price: Free; Language: Ukrainian.	Comica	SW: Android/iOS; Price: Free; Language: choice.
Write Comics	Price: Free; Language: English.	Comic and cartoon maker	SW: Android/iOS; Price: Free; Language: choice.
Marvel HD	Price: Free; Language: English.	MomentCam	SW: Android/iOS; Price: Free; Language: choice.

cross-platform AR applications. Features of the application include: in addition to identifying key points, ARCore can detect flat surfaces, and can also estimate the average illumination around them; determining the size and location of vertical, horizontal, and inclined surfaces; tracking movement according to the position of the phone, accurate placement of virtual objects; assessing light and understanding depth.

- AR.js is an open-source AR SDK based on JavaScript. Can create AR scenes based on markers. The tool comes with an A-Frame and three.js extension that works with any smartphone, regardless of its OS version, including Android, iOS, and other. Markers are stable but limited in shape, color, and size.
- 8th Wall provides support for markers (Image Target), World Effects, Face Effects, SLAM. Video recording, light evaluation, and relative zoom function are available. Can be used in combination with Unity and Unreal engines.

When choosing modern online services, programs, and applications for creating comics, as well as AR, which a teacher can use in his educational activities to study in elementary school, we were guided by three main criteria:

- Service availability;
- Easy to use;
- Functionality.

As a result of a survey of primary education teachers, it was found that all services meet such requirements, but separately, for working with primary school students, the following services are most often distinguished: for teachers – Pixton; for schoolchildren’s work – Marvel HD, and the app installed on the gadget – Comica.

## 5.2 Algorithms of Development of Educational Materials in Cloud Services for the Creation of Comics

Let’s start with Pixton comic book designer that allows you to create your stories almost from scratch. Allows you to customize models, background images, people’s postures and emotions, and other image details, allowing you to create interactive comics. We start working at Pixton by choosing the type of user (teacher, pupil, parent, or business). We are interested in the user-teacher. A sign-up window appears, indicating that you can sign up for free. After registration, the user is flipped to the configuration panel. Suggested three steps to set up the service.

Step 1 – Watch an introductory video where pupils who work with this service share their impressions. After watching the video, click the “Next Step” button.

Step 2 – Familiarize yourself with the process of creating comics in the Pixton service. Press the button “Create a comic book” and go to the Pixton work

field. The work field contains a page panel, four comic creation toolbars, a search bar, and a comic display area. In the first toolbar, select the background of the comics (for example, the pupil's room) and the main characters (the girl). Use the search bar to enter the name of the desired background or character (in English) or use the suggested groups (under the search bar). You can also upload your own materials – the camera icon under the comic book display area. Go to the toolbar to focus the image. Select the desired type of drawing (for example, “to the right”). Next, go to the text panel and enter the lines of the characters. This can be direct language (round dialog window), thoughts (window-cloud), shout (orange window), and whisper (dotted window). In the face setting panel, choose the desired emotion, for example, a thoughtful look. There is also the option to choose the character's look. The last panel is the position setting of the hero's body. Here you can choose the posture, the direction of movement and the possibility of holding objects in the left or right hand. In the upper-right corner, click the “Finish” button and go to the third step of the settings.

Step 3 – enter the name of the comic book and choose a class. Next, the service offers to make a teacher's avatar, which is created similarly to the comic, following the instructions offered by Pixton. Then the user is moved to the personal account, where the existing 4 sections (created classes, student comics, class photos and printed versions of comics) are also displayed on the right-hand side, where the “Link for pupils” button is displayed, from which the teacher can invite students to the virtual classroom. A fragment of work with the program is shown in figure 1.

The following program, which was chosen by us, is excellent for both individual and group work of junior school students. It is not required to register and fill out various forms here. There is an opportunity to create the simplest comic with ready-made templates.

Write Comics – is the easiest service to create comics and stories. After all, this is just one page where you can set all the parameters of your plot: characters, background; text box.

We start by entering the name of the comic. Scroll the cursor further and select the characters in our story, dragging them to the desired location in the comic book image area. Next, we choose the background, the place where the events of the story take place and enter the lines of the characters. Press the “Finish” button, the comic book is ready (see figure 2).

The next program that can be used to create comics in primary school is Comica. This is an app



Figure 1: Example of a comic created using the Pixton on-line service.

that you can use to create a comic from your own photos. First, you need to download the app and install it on your gadget. It can be done in any user-friendly service (for example, in the Play Market).

Open the app and view the menu: Gallery – processing of one photo in the comic book editor; Camera – instant photo creation; Multi is the comic book editor.

Select “Multi”, set the number of episodes in the picture (for example, 3 pictures), click on the field and select a photo from the gallery. We process the photo in the photo editor and choose the comic style. We individually adjust brightness and contrast, if needed. Next, we select the stickers and the comic book elements that the user needs. We do the same thing with the other two photos and create an episode of the comic. Download the comic book or share it (see figure 3).

These services are quite convenient and understandable. The key value of resources is that in each program there is an opportunity to use ready-made templates of drawings, characters, backgrounds, signs, objects, etc., and to adjust them as needed. Working with these applications does not require special knowledge and skills, which is why it is an immense advantage. After all, even junior school students will be able to work in the service.

However, a significant disadvantage is that the de-



Figure 2: Fragment of work with the Write Comics service.

velopers of these online services and applications do not provide any instructions on how to work with them, so users have to deal with the way applications work by themselves.

### 5.3 Determination of the Real State of Readiness of Teachers and Pupils to Use Cloud Services to Create Comics with AR Elements

As a result of a survey of teachers, it was found that many people “do not know where to start” or consider it an impossible mission to create comics on their own. Many teachers know about cloud services, where you can find ready-made developments, but can not select the appropriate comic for a particular learning situation or lesson. Most teachers do not know how to create comics, including with AR elements, using cloud services. These and some other circumstances keep many teachers from introducing this kind of teaching activity into teaching practice.

The analysis of the student survey also shows that within the informatics disciplines at the university, the use of cloud services for creating comics is not given due attention (table 2).

As a result of the experiment, we found the willingness of teachers and students to use cloud services



Figure 3: Comic Book Editor Comica.

to create and use comics in educational practice. Appropriate criteria and levels of readiness have been identified and developed.

- Level 1 – elementary, characterized by superficial knowledge of working with cloud services to create comics with AR elements;
- Level 2 – basic, characterized by a focus on the use of cloud services at the demonstration level;
- Level 3 – creative, characterized by the active use of cloud services to create comics with AR elements.

As a result of the questionnaires developed by us on the theoretical principles of using cloud services, tasks on working with cloud services and the results of self-assessment, the real state of readiness of teachers and students to use cloud services for creating comics with AR elements was revealed (table 3).

According to the results of the study, students and teachers showed approximately the same ability to use cloud services. Most students (63.1% of the total number of respondents) and teachers (67.9%) have an elementary level of readiness. Only 10.7% of students and 8% of teachers reached the creative level.

The results confirmed the problem of the preparation of future primary education teachers for the use of cloud services for creating comics with AR elements in professional activities.

Table 2: Levels of readiness of teachers and students to use cloud services to create comics with AR elements.

Level	Characteristics of the level	Teacher skill level requirements
Elementary	Lower awareness of cloud services use, in particular AR. The teacher knows fragmentarily about the peculiarities of working with these cloud tools, but does not have a goal to learn how to create comics, cannot relate to the pedagogical expediency of their use.	Using the pedagogical capabilities of comics at the starting level, for example, conducting a lesson with a multimedia presentation or a ready-made animated resource already developed by a bulk product with AR elements. Using didactic materials with the help of cloud services, already developed and ready for the lesson comics.
Basic	Uses cloud services to create comics and AR at the demonstration level (presentations, pictures, slides). Formulates the request in relation to the specific topic of the upcoming lesson. Can associate with the pedagogical feasibility of their use. Can create his own comic book by analogy, including with AR elements, using step-by-step instructions.	Designing tasks for pupils using cloud services that involve the use of comics, including with AR elements in class and outside classroom hours, for example, for homework tasks related to search and selection of information, including on the Internet.
Creative	Actively uses cloud services to create new and use ready-made comics with AR elements. Disseminates its developments and participates in network communities.	Integrated use of cloud services and modern educational technologies: integrated lessons, project activities of pupils using comics with AR elements. Advise colleagues on using and working with resources to create comics with AR elements.

Table 3: The state of teachers and students readiness to use cloud services to create comics with AR elements.

Level	Students (84 persons), %	Teachers (28 persons), %
Elementary	63.1	67.9
Basic	26.2	25.0
Creative	10.7	7.1

Table 4: Critical value of the Pearson criterion  $\chi^2$ .

$\chi^2 (p = 0.05)$	$\chi^2 (p = 0.01)$
5.991	9.21

To compare the results obtained, we used the Pearson criterion  $\chi^2$ . For this purpose, statistical hypotheses are formulated:

H0 – the level of students’ readiness to use cloud services does not exceed the level of teachers’ readiness;

H1 – the level of students’ readiness to use cloud services exceeds the level of teachers’ readiness.

The obtained empirical value of the Pearson’s criterion  $\chi^2 = 0,932$  we compared with the tabular values (for the number of degrees of freedom 2 (table 4).

Thus, we accept the hypothesis H0 that the level of students’ readiness to use cloud services does not exceed the level of teachers’ readiness.

Note that given the insufficiently large sample size, we certainly do not claim a strong scientific justification for the state of this readiness in the context

of the activities of all teachers and students of primary education. The data obtained, rather, indicate an overall trend regarding the research problem and require finding ways to improve it.

### 5.4 Educational and Methodological Support for Teachers

As a result of a survey of teachers, we identified fundamental problems with the use of cloud services. Among them, we can note the lack of time for self-education and learning.

Taking into account this problem, Iryna R. Chopyk have developed a website, where the necessary information was collected and methodological recommendations were prepared on the organization of the teacher’s work using cloud services for creating comics in classes in primary school (<https://blogger090.wixsite.com/comics>).

This educational website helps elementary school students and teachers improve their own competencies in using cloud services to create comics.

Thus, the work of the website is aimed at helping the primary school teacher to create their own development of interactive educational content, as well as using them in lessons in primary school. The website contains 4 sections:

1. Homepage;
2. “About the project”;

3. “For teacher”;

4. Feedback.

The homepage provides a brief description of the project, links to articles, and a contact window where anyone can contact the author of the website if needed. At the top, the site menu is presented, which is intuitive and allows the user to go to the following categories (figure 4).

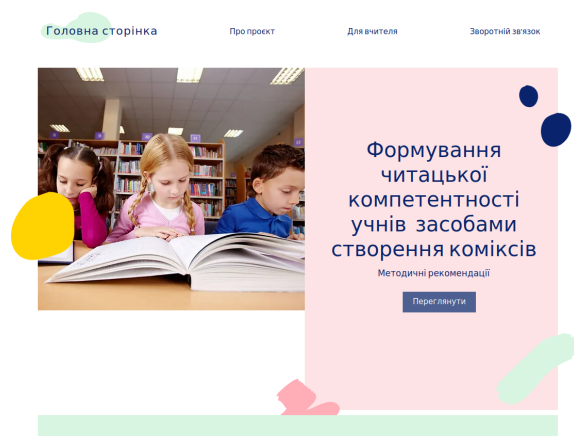


Figure 4: The main page of the developed website.

The section “About the project” provides basic information about the master’s study, the purpose of creating the site, what its work is aimed at, and short theses “Here you will learn”:

- What is a tutorial comic?
- How to work with online services to create comics?
- How to organize work in the classroom using the comic book technique?

The category “For the teacher” contains three subdivisions:

- “Theoretical information”, which provides information about what is the process of reading and its importance in human life, reveals the essence of basic concepts, describes the reasons for the popularity of educational comics, and identifies the strengths of their application in education;
- “Services”, where the user can find a list of free and available online services for creating their educational comics. Separately, in the section, there are links to instructions for the described services.
- “Methodological recommendations”, which provides practical advice and methodological recommendations for working with the technology of using comics in primary school. The unit provides a step-by-step description of the technology of working with comics, describes the preparatory

work with pupils, defines the rules for selecting the subject of comics, provides examples of building educational tasks for working with comics and links to online resources for creating educational comics.

Looking at the “Services” section in more detail, users can see the rating from the TOP-3 online services for creating educational comics. This rating of tools was formed based on three key criteria: functionality, affordability (all services are free) and ease of use of the service for both teachers and pupils.

Each presented service contains instructions for use, which the user will be able not only to view but also to download to himself on a PC as a MS Word document.

Each service title contains a link to its main page, which the user of the site will be able to start working on creating his own educational comic, using the downloaded instructions and methodological recommendations presented on the educational website.

Thus, the work of the educational website is aimed at helping teachers of primary education in the development of relevant educational comics using online services Pixton, Write Comics and Comica for conducting lessons in primary school, as well as for methodological support of educators.

## 6 CONCLUSIONS

1. It has been established that the use of comics with AR elements in primary school is one of the effective didactic means that increases the interest of children in learning, and allows simplifying, visualizing, and virtualizing complex information. As a result of the analysis of modern cloud services, programs and applications for creating comics, their advantages are highlighted: the availability of services in material terms; a simple interface; the use of templates; the possibility of creating a completely new product and distributing materials; versatility. The major disadvantages have been clarified: a foreign language interface, the need for preliminary preparation for working with them; conversion. The functionality of AR programs for creating content based on comics (Vuforia, EasyAR, Maxst, ARCore, AR.js, 8th Wall) is analyzed. As a result of a survey of 28 primary school teachers, considering the availability, ease of use and functionality, the most popular cloud services are highlighted: for teachers – Pixton; for pupils – Marvel HD and the app installed on the gadget – Comica. Algorithms of the development

of educational materials in these cloud services for the creation of comics are presented.

- The levels of readiness for the use of cloud services for creating comics with elements of AR (elementary, basic, creative) are highlighted. It is established that most teachers and students have an elementary level of readiness. To improve the real state of readiness of teachers and students to use cloud services, an educational website has been developed. Its goal is to help primary school students and teachers improve their competencies in using cloud services to create comics. Methodological recommendations on the use of comics in primary school using digital technologies have also been developed.
- The next step of the study will be the implementation of the developed methodological recommendations in the practice of university education, in the system of teachers certification training, as well as further monitoring of the readiness of students and teachers to use cloud services to create comics with AR elements in the main school.

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## REFERENCES

- Azman, F. N., Zaibon, S. B., and Shiratuddin, N. (2015). Digital Storytelling Tool for Education: An Analysis of Comic Authoring Environments. In Badioze Zaman, H., Robinson, P., Smeaton, A. F., Shih, T. K., Velastin, S., Jaafar, A., and Mohamad Ali, N., editors, *Advances in Visual Informatics*, volume 9429 of *Lecture Notes in Computer Science*, pages 347–355, Cham. Springer International Publishing. [https://doi.org/10.1007/978-3-319-25939-0\\_31](https://doi.org/10.1007/978-3-319-25939-0_31).
- Azman, N. F., Zaibon, S. B., and Shiratuddin, N. (2016). Pedagogical analysis of comic authoring systems for educational digital storytelling. *Journal of Theoretical and Applied Information Technology*, 89:461–469. <http://www.jatit.org/volumes/Vol89No2/18Vol89No2.pdf>.
- Bilousova, L., Gryzun, L., and Zhytienova, N. (2021). Interactive methods in blended learning of the fundamentals of UI/UX design by pre-service specialists. *Educational Technology Quarterly*, 2021(3):415–428. <https://doi.org/10.55056/etq.34>.
- Bodnenko, D. M., Radchenko, S. P., and Yurtyin, I. I. (2014). The usage of illustration for material perception improvement in studying natural disciplines. In *Society, Integration, Education. Proceedings of the International Scientific Conference*, pages 225–236, Rezekne, Latvia. <https://doi.org/10.17770/sie2014vol1.776>.
- Cabrera, P. H., Castillo, L., González, P., Quiñónez, A., and Ochoa, C. (2018). The impact of using Pixton for teaching grammar and vocabulary in the EFL Ecuadorian context. *Teaching English with Technology*, 18:53–76. <http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.desklight-65acf8b1-db70-4a7a-9a8c-88afc73583a3/c/ARTICLE4.pdf>.
- Chykalova, T. H. (2020). Didactics possibilities of the use of comics are on lesson at elementary school. *Innovative Pedagogy*, 20(3):52–55. <http://innovpedagogy.od.ua/archives/2020/20/part.3/13.pdf>.
- Damopolii, I., Fridolin, F. P., and Nunaki, J. H. (2022). The Development of Comic Book as Marker of Augmented Reality to Raise Students’ Critical Thinking. *TEM Journal*, 11(1):348–355. <https://doi.org/10.18421/TEM111-44>.
- Danylenko, Y. V. (2010). Didactic possibilities of comics in the process of teaching biology. *Director of school, lyceum, gymnasium*, 6:101–106.
- Danylenko, Y. V. (2011). Didactic comics on biology, as a means of activating the cognitive activity of young adolescents. *Scientific Journal of Drahomanov National Pedagogical University: Biology*, 3:186–191.
- Hobri, Murtikusuma, R. P., and Hermawan, L. I. (2019). Development of e-comic using Pixton and Kelase web on linear program of two variables assisted by Geogebra. *Journal of Physics: Conference Series*, 1265:53–76. <https://doi.org/10.1088/1742-6596/1265/1/012010>.
- Koutromanos, G. and Alivisos, S. (2018). Augmented reality-based creation of comics in primary education. In Kourtis-Kazoullis, V., Aravossitas, T., Skourtou, E., and Trifonas, P. P., editors, *Interdisciplinary Research Approaches to Multilingual Education*, pages 225–236. Routledge. <https://doi.org/10.4324/9781351170086-18>.
- Kuzminsky, A. I. and Omelyanenko, V. L. (2008). *Pedagogy*. Znannia, Kyiv.
- Meyers, E. A. (2014). Theory, Technology, and Creative Practice: Using Pixton Comics to Teach Communication Theory. *Communication Teacher*, 28(1):32–38. <https://doi.org/10.1080/17404622.2013.839051>.
- Nidhom, A. M., Smaragdina, A. A., Dyah, K. N. G., Andika, B. N. R. P., Setiadi, C. P., and Yunus, J. M. (2019). Markerless Augmented Reality (MAR) through Learning Comics to Improve Student Metacognitive Ability. In *2019 International Conference on Electrical, Electronics and Information Engineering (ICEEIE)*, volume 6, pages 201–205. <https://doi.org/10.1109/ICEEIE47180.2019.8981411>.
- Olshansky, D. V. (2002). *Didactic conditions of use comics in teaching foreign languages to junior high school*

- students. PhD thesis, Institute of Pedagogy, Academy of Pedagogical Sciences of Ukraine, Kyiv.
- Panchenko, L. (2021). Digital storytelling in adult education: barriers and ways to overcome them. *Educational Technology Quarterly*, 2021(4):673–688. <https://doi.org/10.55056/etq.41>.
- Panchenko, L. F., Vakaliuk, T. A., and Vlasenko, K. V. (2020). Augmented reality books: concepts, typology, tools. In Burov, O. Y. and Kiv, A. E., editors, *Proceedings of the 3rd International Workshop on Augmented Reality in Education, Kryvyi Rih, Ukraine, May 13, 2020*, volume 2731 of *CEUR Workshop Proceedings*, pages 283–296. CEUR-WS.org. <https://ceur-ws.org/Vol-2731/paper16.pdf>.
- Pustinnikova, I. M. (2013). Increasing students' interest in teaching materials with the help of comics. *Scientific treasury of education of Donetsk region*, 2:105–110.
- Sadik, A. (2017). Students' acceptance of file sharing systems as a tool for sharing course materials: The case of Google Drive. *Education and Information Technologies*, 22(5):2455–2470. <https://doi.org/10.1007/s10639-016-9556-z>.
- Segel, E. and Heer, J. (2010). Narrative Visualization: Telling Stories with Data. *IEEE Transactions on Visualization and Computer Graphics*, 16(6):1139–1148. <https://doi.org/10.1088/10.1109/TVCG.2010.179>.
- Weber, A. S. (2015). Use of Cloud-Based Graphic Narrative Software in Medical Ethics Teaching. *International Association for Development of the Information Society*, 8:167–172. <https://eric.ed.gov/?id=ED562472>.
- Yuksel-Arslan, P., Yildirim, S., and Robin, B. R. (2016). A phenomenological study: teachers' experiences of using digital storytelling in early childhood education. *Educational Studies*, 42(5):427–445. <https://doi.org/10.1080/03055698.2016.1195717>.
- Zerkina, N. V., Chusavitina, G. P., and Karmanova, E. M. (2019). Use of Network Services Web 2.0 for ICT Competence Formation of Students in Engineering with Application of Project Approach. In *Proceedings of the 15th International Scientific Conference "eLearning and Software for Education"*, volume 3, pages 133–139, Bucharest, Romania. <https://doi.org/10.12753/2066-026X-19-155>.