Report on the e-learning platforms utilization in research-based education

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EDURES: Technology education in the digital era supported by the significant use of research results

Intellectual Output 2: *Development of the digital platform methodologies for utilization of research results in technology education.*

Intellectual Output 2 lead:

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- CENTOFORM SRL
- NATIONAL TECHNICAL UNIVERSITY OF ATHENS - NTUA
- HOCHSCHULE FURTWANGEN

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Report on the e-learning platforms utilization

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Introduction

E-learning platforms have become popular nowadays and they have also proved great usability for higher education during pandemic of COVID-19. There are many various software solutions including e-learning platforms enabling distance learning/teaching activities.

However, their utilization for the aims of research results implementation is still developed. This may concern research presentation, results and data downloading and sharing, on-line seminars and supervision, conducting research in a distance mode, etc.

This document presents some possibilities of abovementioned utilization of e-learning environments for the aims of teaching and learning activities supporting e-learning methodologies. It is developed in the frame of the EDURES project methodology supporting research results sharing among teachers and learners.

The first chapter describes briefly existing digital e-learning platforms which are used at partner universities of the EDURES project. In the second chapter selected tools/templates/procedures/algorithms are developed for utilization of research results into digital platforms. The third chapter presents selected tests and verifications of the abovementioned solutions and approaches developed by the EDURES project partners.

1. Analysis of existing digital e-learning platforms and possibilities of their adaptation for utilization of research results in technology education

Report of Politechnika Rzeszowska im. Ignacego Łukasiewicza

- **Brief description of the example and research the example concerns.**

The example concerns the e-learning course, created by using the Moodle software and presenting the results of investigations conducted in the field of contact and non-contact coordinate measurements. The course was prepared based on the following paper:

Magdziak M. Determining the strategy of contact measurements based on results of noncontact coordinate measurements. Procedia Manufacturing 2020, 51, 337-344.

The paper presents the algorithm of determining the strategy of contact measurements in the field of distributing measurement points on curvilinear surfaces. The strategy of contact coordinate measurements of free-form surfaces may include many elements e.g., methods of the distribution of measurement points, which determine the final accuracy of measurements. Measurement points, at which contact coordinate measurements are conducted, should be in the parts of surfaces of investigated objects which are characterized by the poor quality of manufacturing to decrease the time of measurements and increase the accuracy of a measurement task.

The new method is mainly intended for measurements conducted by using coordinate measuring machines. The algorithm considers the results of non-contact coordinate measurements. The application of initial non-contact measurements in the mentioned algorithm is aimed at increasing the accuracy of contact coordinate measurements and speeding up the whole measurement process of complex products.

- **Stages of creating an e-learning course with special attention to e-learning platform functions that are useful when creating a research-based course.**

At the beginning of creating a new course the user of the Moodle software has the possibility of editing the course settings, which include, among others, the start and end dates of a course, the course full and short names, the course visibility for students and the course summary. Fig. 1 presents the course summary created based on the abstract of the considered research paper. The user of the software can influence the format of the text. Additionally, the summary of the course may include, among others, figures, links, tables, and equations.
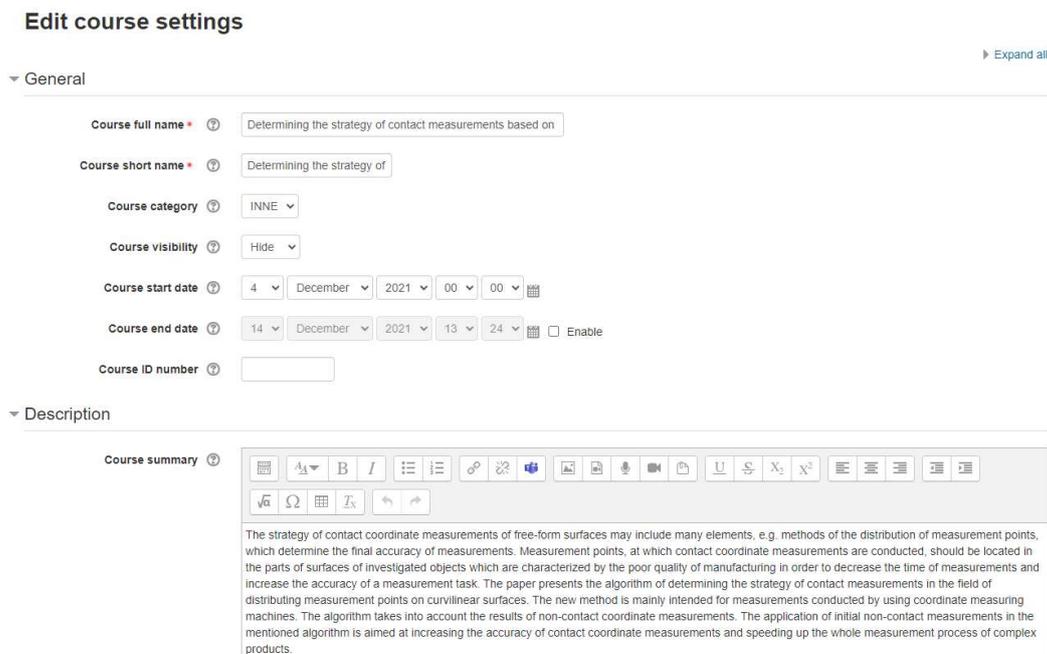
Fig. 1. The course summary

The important stage of creating a new course is the definition of the enrolment methods available for students (Fig. 2). Manual and self-enrolment methods are possible. Moreover, the access for guests may be also available. The user of the software can create the password to prevent unauthorized access to the course. The self-enrolment is a good solution if the course is prepared for students within the same organization.

Enrolment methods

Name	Users	Up/Down	Edit
Manual enrolments	1	↓	👤 ⚙
Self enrolment (Student)	0	↑	✕ ⊘ ⚙

Add method   Choose...

Fig. 2. The enrolment methods

Fig. 3 presents the additional settings of the course. The user can modify the course format and its appearance. For example, in the case of the course created based on the research paper all sections are visible on one page.

▾ Course format

Format	?	Topics format
Hidden sections	?	Hidden sections are shown in collapsed form
Course layout	?	Show all sections on one page

▾ Appearance

Force language		Do not force
Number of announcements	?	5
Show gradebook to students	?	Yes
Show activity reports	?	Yes

Fig. 3. The additional settings of the course

Figs. 4 and 5 show the layout of the course, which was created based on the selected research paper. The sections of the course correspond to the sections and subsections of the article. The third section, which concerns experimental investigations, is divided into five subsections.
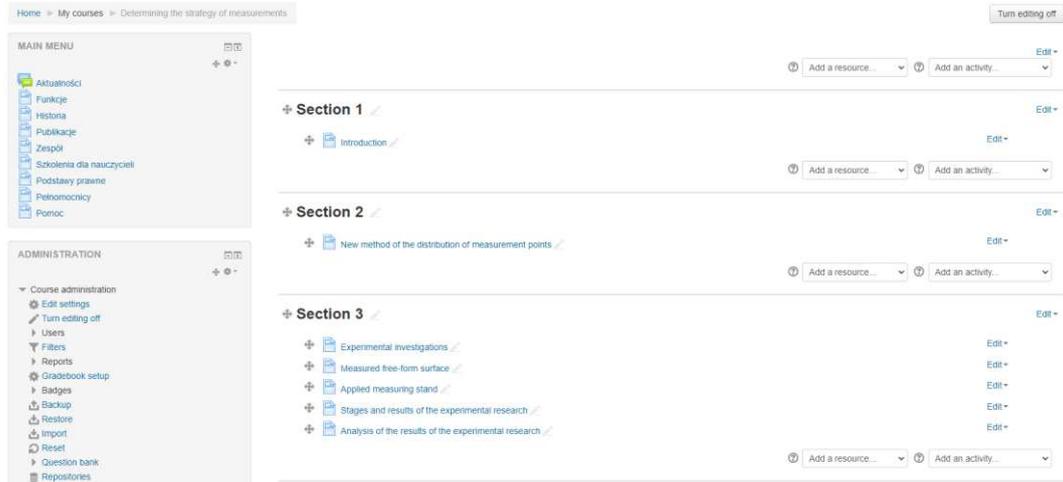
Fig. 4. The layout of the course
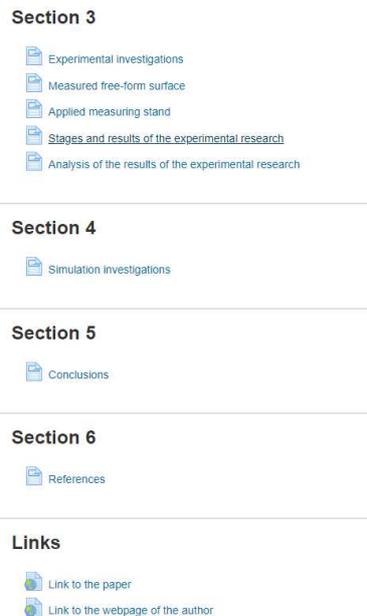
Fig. 5. The layout of the course

In the case of each section pages can be added. Fig. 6 presents how to add content to a page. The page may correspond to parts of the research paper. The user can easily include figures and tables which are often used by authors of research papers.
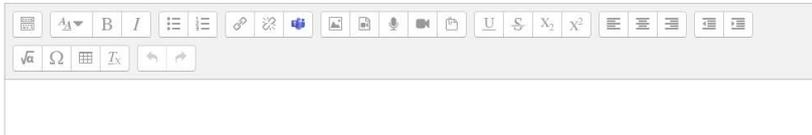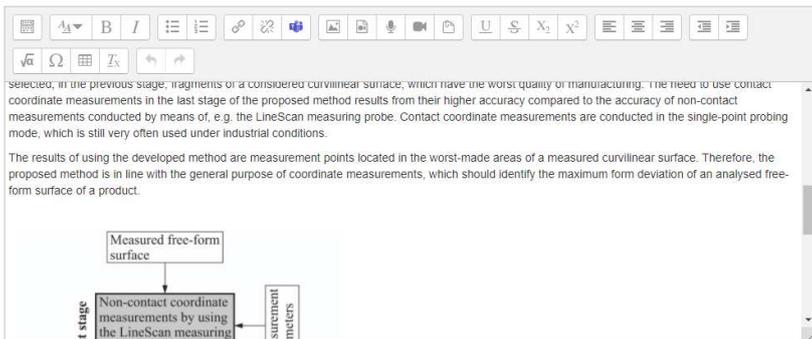
Fig. 6. Adding content to a page

Fig. 7 presents the sample page content, which includes both the text and selected figure. The user of the Moodle software can define the format of text, add equations, tables, bullet points, etc. Moreover, movies can be added to present students how investigations were conducted.

Fig. 7. The sample page content

Fig. 8 presents the stages of adding figures to the page. The user of the Moodle software can change the size of a figure, include a description, and define alignment of a figure.
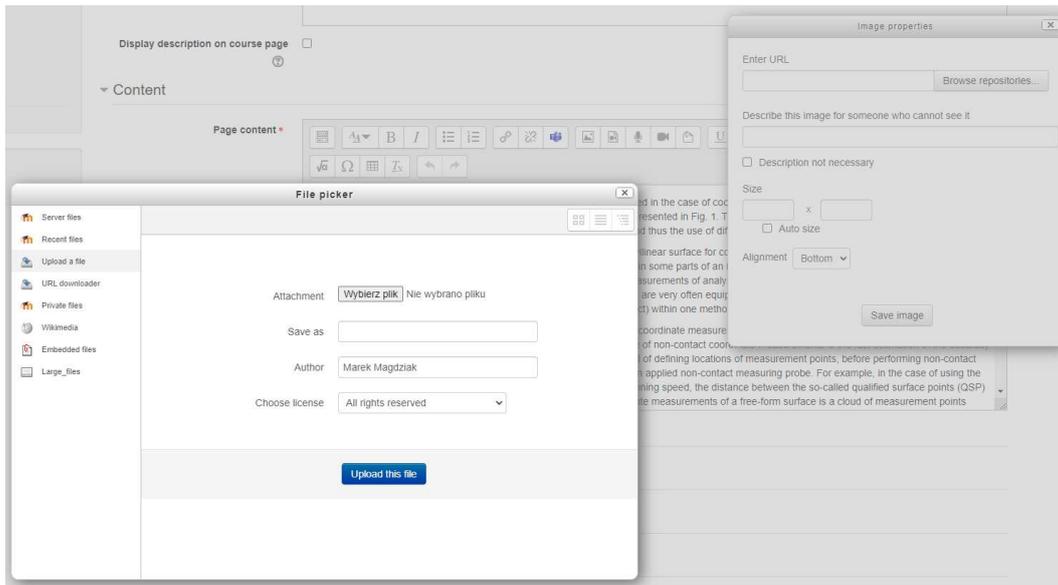
Fig. 8. Adding figures to the page

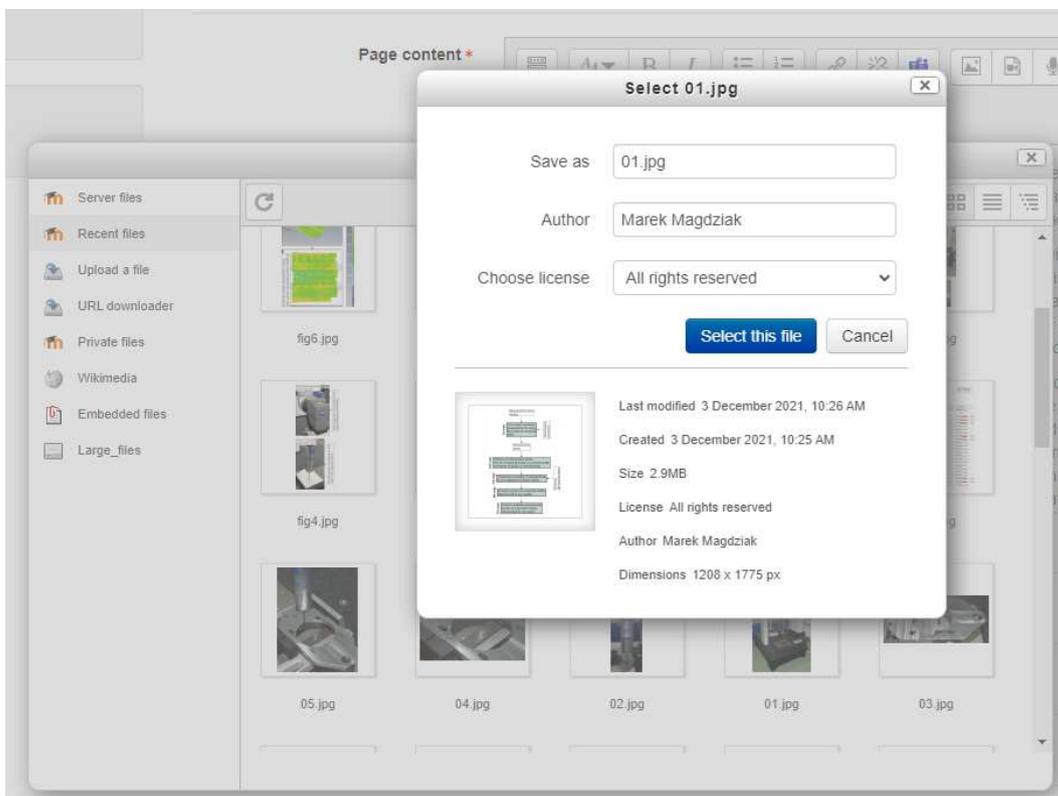Figures can be added to a course from the database of figures (Fig. 9).

Fig. 9. Adding figures to the page

Moreover, the user of the Moodle software can create tables. The example of the table, corresponding to the table included in the paper, is presented in Fig. 10.
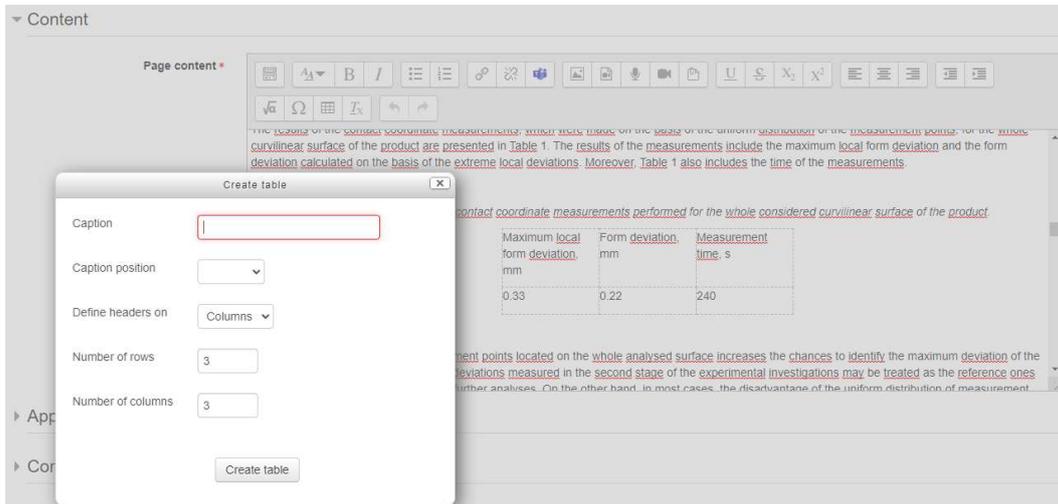

Fig. 10. The example of the table

Fig. 11 presents the first section of both the course and paper. It only includes the text of the part of the considered article.

Fig. 11. The first section of both the course and paper.

The next section of the course includes the first figure, which presents the stages of the proposed strategy of coordinate measurements of curvilinear surfaces of products (Fig. 12).

The last stage of the new method of the distribution of measurement points located on free-form surfaces concerns contact coordinate measurements of selected, in the previous stage, fragments of a considered curvilinear surface, which have the worst quality of manufacturing. The need to use contact coordinate measurements in the last stage of the proposed method results from their higher accuracy compared to the accuracy of non-contact measurements conducted by means of, e.g. the LineScan measuring probe. Contact coordinate measurements are conducted in the single-point probing mode, which is still very often used under industrial conditions.

The results of using the developed method are measurement points located in the worst-made areas of a measured curvilinear surface. Therefore, the proposed method is in line with the general purpose of coordinate measurements, which should identify the maximum form deviation of an analysed free-form surface of a product.
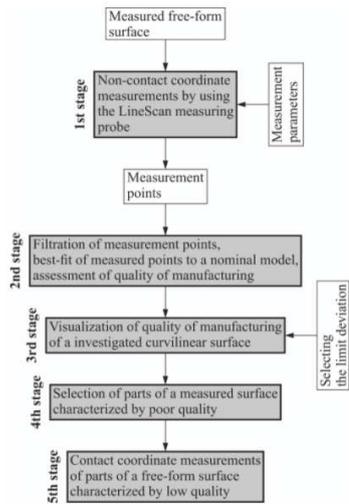
Fig. 1. The stages of the proposed method of defining locations of measurement points for contact coordinate measurements of free-form surfaces.

Fig. 12. The section of the course which includes the first figure

In the case of the section entitled *'Simulation investigations'* the user of the Moodle software created the page which includes the text, bullet points and figure (Fig. 13).

Simulation investigations

The simulation research concerned the comparison of the times of coordinate measurements of two series of products composed of ten parts each. The calculations of the measurement times of two mentioned series were carried out assuming that:

- each series of parts consists of the products characterized by the shape presented in Fig. 3,
- the time of the coordinate measurements conducted for the whole considered free-form surface by using the uniform distribution of the measurement points is equal to 240 s (Tab. 1),
- the time of the non-contact measurements during conducting the first stage of the new method of distributing measurement points is 167 s,
- the measurements of the fragments of the investigated curvilinear surface which are presented in Fig. 9 c during the last, fifth stage of the proposed method are conducted. The time of these measurements is equal to 39 s (Tab. 3).

The results of the simulation research are shown in Fig. 11, which presents:

- the calculated overall measurement time of the series of the products measured by using the uniform distribution of the measurement points, shown in Fig. 7, in the case of each measured item,
- the overall measurement time of the series of the considered parts measured by using the new method of defining locations of measurement points.
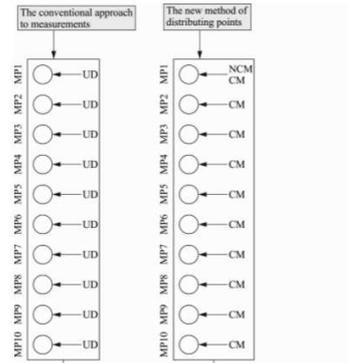
Fig. 13. The sample course section

Fig. 14 shows the page content which includes both the text and table. The links to the sections of the course were created automatically by the Moodle software.

The results of the contact coordinate measurements, which were made on the basis of the uniform distribution of the measurement points, for the whole curvilinear surface of the product are presented in Table 1. The results of the measurements include the maximum local form deviation and the form deviation calculated on the basis of the extreme local deviations. Moreover, Table 1 also includes the time of the measurements.

Table 1. The results and the time of the contact coordinate measurements performed for the whole considered curvilinear surface of the product.

Maximum local form deviation, mm	Form deviation, mm	Measurement time, s
0.33	0.22	240

The uniform distribution of the measurement points located on the whole analysed surface increases the chances to identify the maximum deviation of the measured surface. Therefore, the form deviations measured in the second stage of the experimental investigations may be treated as the reference ones and thus they may be the reference for further analyses. On the other hand, in most cases, the disadvantage of the uniform distribution of measurement points is a long duration of contact coordinate measurements.

The third stage of the experimental research, corresponding to the last step of the new method of defining positions of measurement points, concerns the contact coordinate measurements of the selected fragments of the considered free-form surface which were characterized by the worst quality of manufacturing determined based on the results of the non-contact coordinate measurements carried out by means of the LineScan laser probe. Four different examples of the distributions of the measurement points, located approximately in the places of the measured free-form surface of the worst quality, were used. The first applied distribution of the measurement points is shown in Fig. 8. Three further distributions are presented in Fig. 9. The measurement points were automatically generated by using the Free-form surface measurement element, which is available in the Calypso software of the Carl Zeiss company.

Fig. 14. The page content which includes the text and table

At the end of the course the user of the considered software defined some links which can be used to find the paper based on which the course was created and the information about the author of the research (Fig. 15).

Fig. 15. Adding some links to the course

Moreover, the user of the Moodle software can create a course by importing data from other courses (Fig. 16).

Fig. 16. Creating a course based on other courses

MindMeister

MindMeister is a program which enables to create mind maps. Mind Meister is a SaaS (Software as a Service) product - it is not installed on a computer, it works only on-line, and requires a stable network connection.

Mind Meister is fully integrated with the internet so you can add images and videos to your mind map, which can be accessed via a web browser installed directly in the software.

Running the application is very easy. The first screen provides a bar with different map formats (Fig. 17).
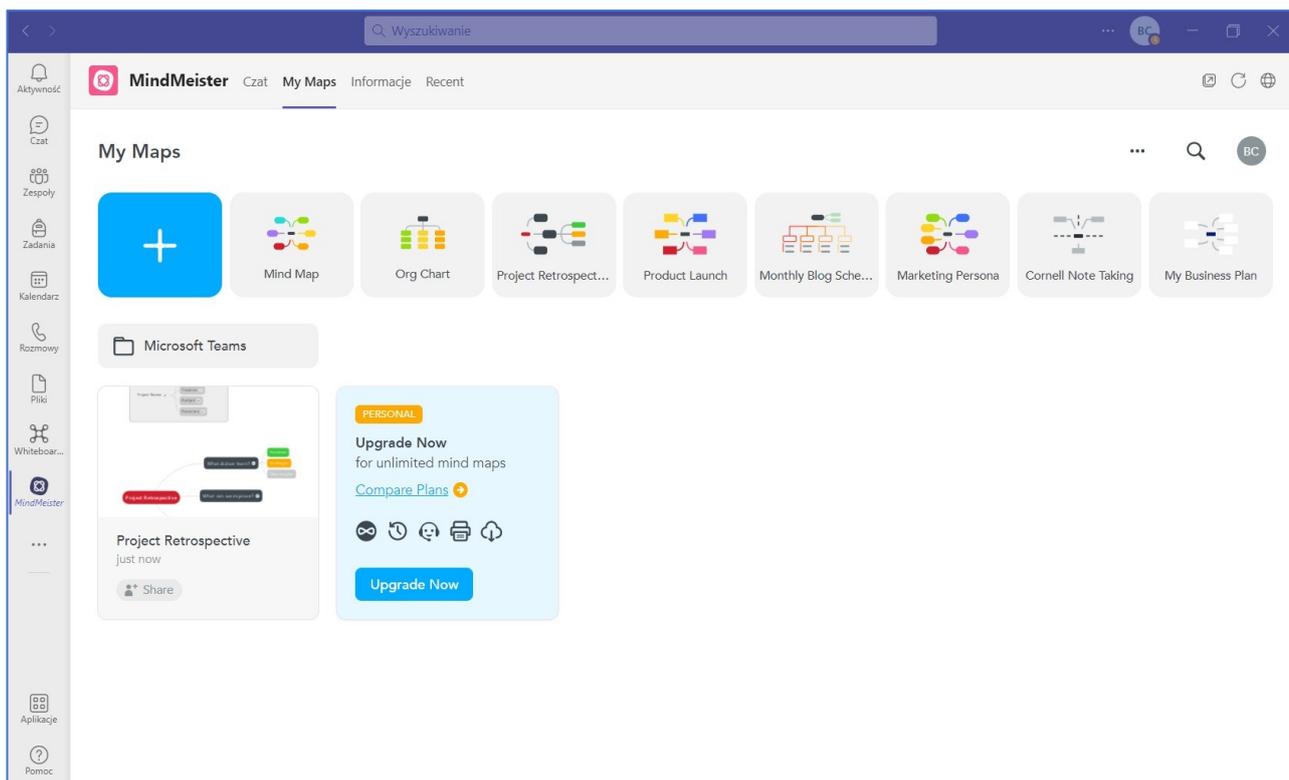
Fig. 17. Selecting a map type

MindMeister allows multiple people to co-create live mind maps, which makes it very easy to work in groups, such as student groups. It is a very good tool for brainstorming of team. People are invited to join the team using the top right button. (Fig. 18)

A created mind map can be immediately shared on social media. The map is interactive, you can comment on it, you can use all the links it contains. Drawing the map is intuitive.
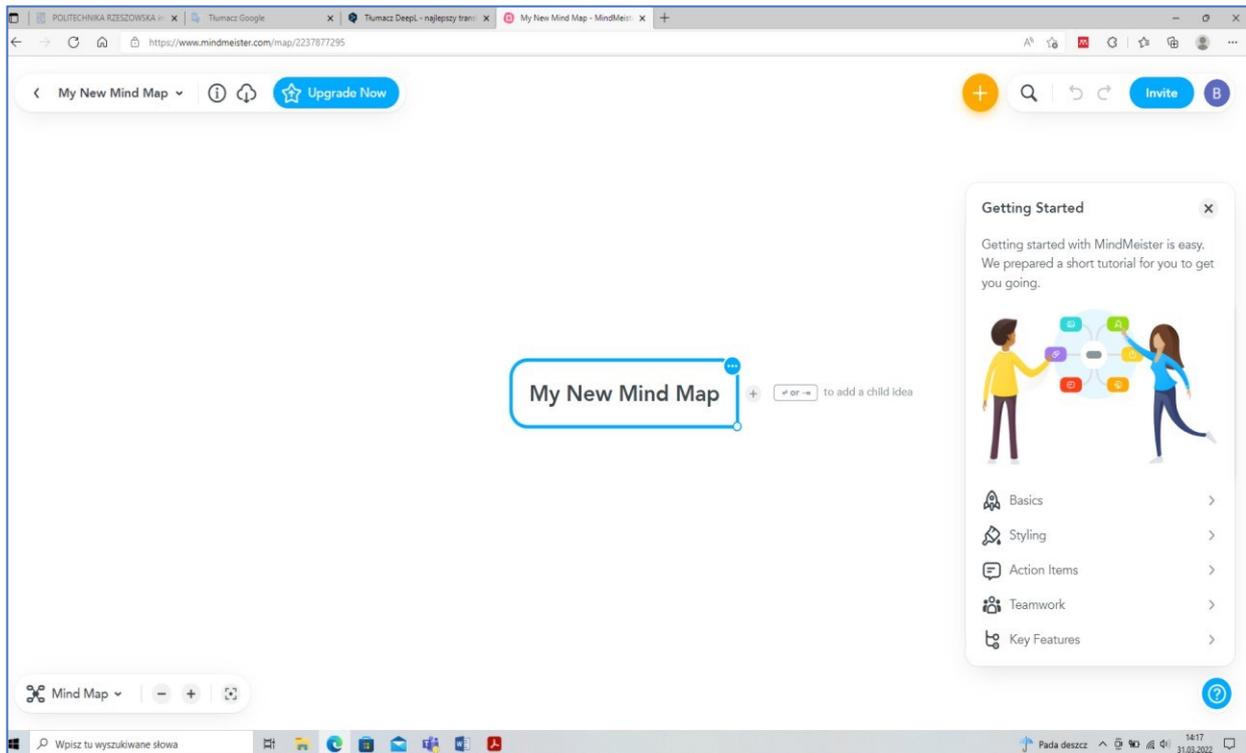
Fig. 18. The beginning of drawing - the possibility of teamwork

The next participants propose new connections on the map. These can be seen in the example in Fig. 19. Different colours are used to present the paths - ideas to the problem to be solved.
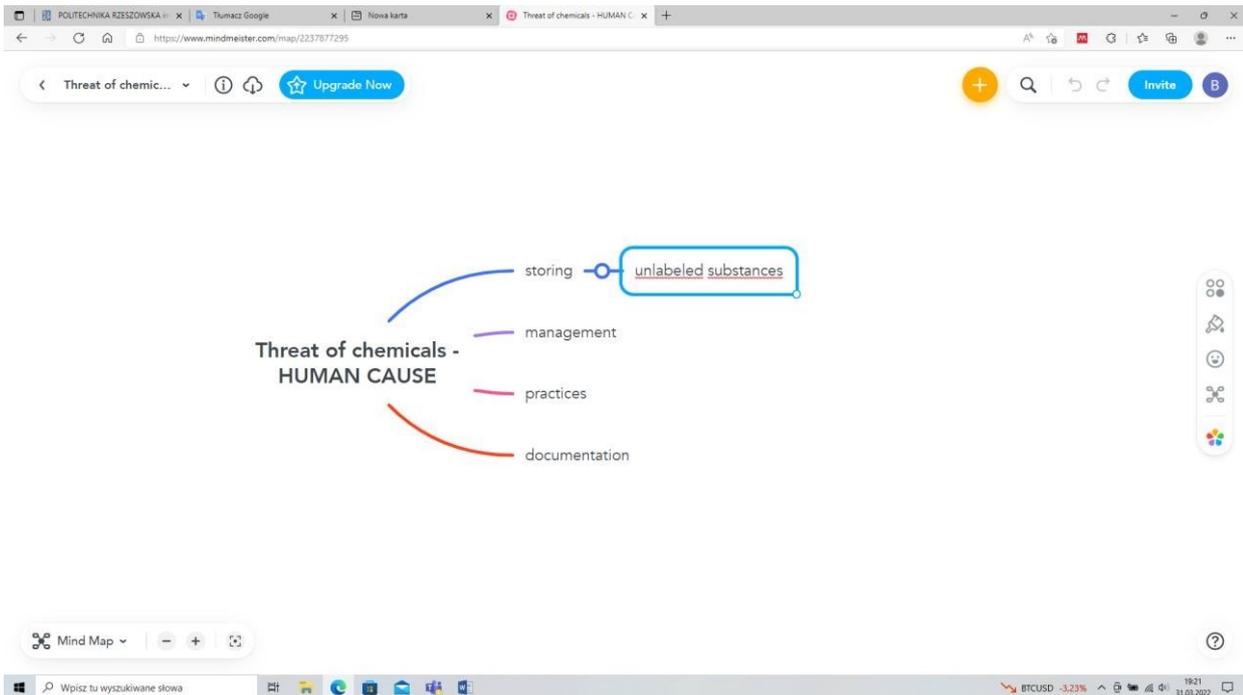
Fig. 19. New map elements marked by dedicated colour

Participants of brainstorm can draw new paths, but also add other possible solutions to those already prepared in the mind map (Fig. 20).

a) .... b)
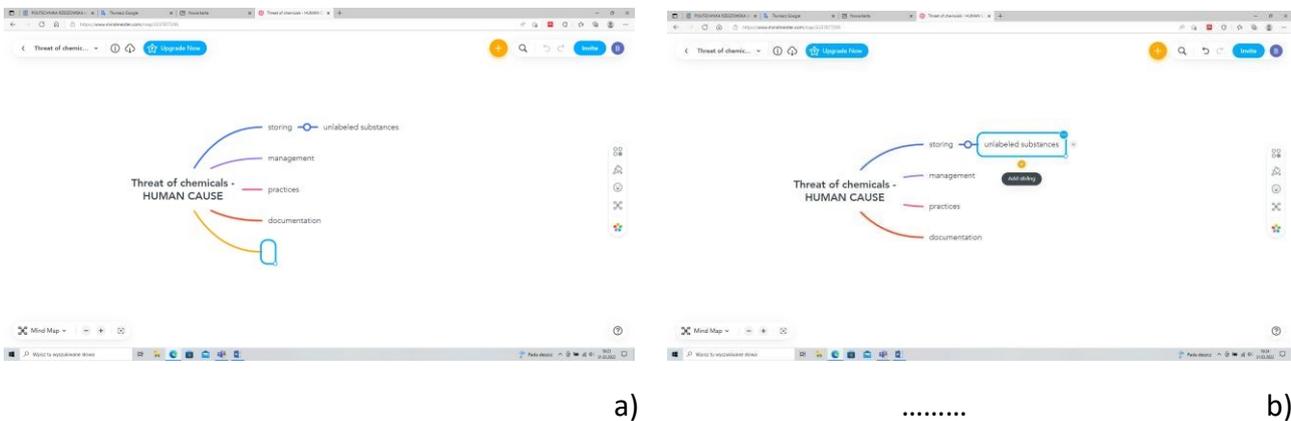
Fig. 20. Ideas drawing: a) new, different solution, b) continuation of a solution already proposed

A mind map which requires significant space is possible to be drawn, the image can be enlarged and reduced (Fig. 21).
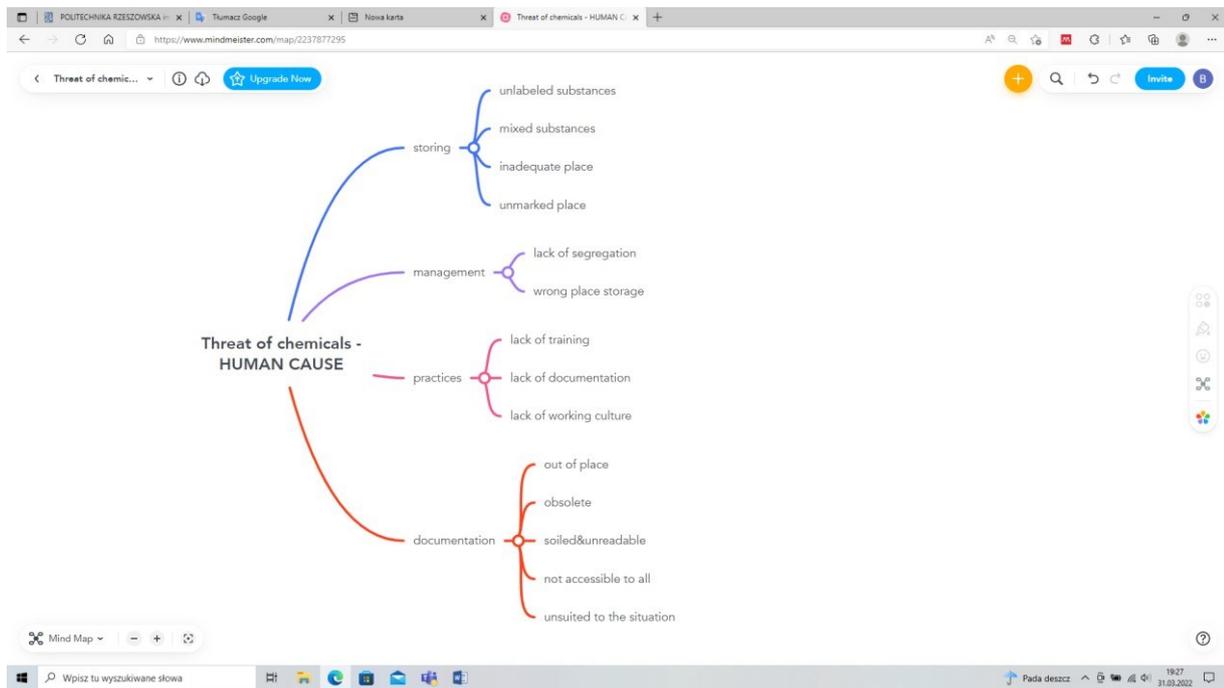
Fig. 21. Ready-made mind map of the problem "Threat of chemicals - human causes"

In Mind Meister, it is possible to create a presentation based on the map we have made, because there is a presentation wizard or a manual option to create slides.

Elements from the mind map can be transformed into a task and a selected team member, e.g. a student, can be assigned to complete it. This is a very useful option for working on projects to complete.

The mind map can be exported to several formats (Fig. 22):

- .jpg / .png - mind map graphic

- .pdf - contains the mind map and its transcription arranged in points

- .rtf - text document - contains the text entered in the mind map itself, arranged by points.

The Pro version also offers the possibility to export to Word and PowerPoint documents and other formats: - XMind

- FreeMind

- MindManager
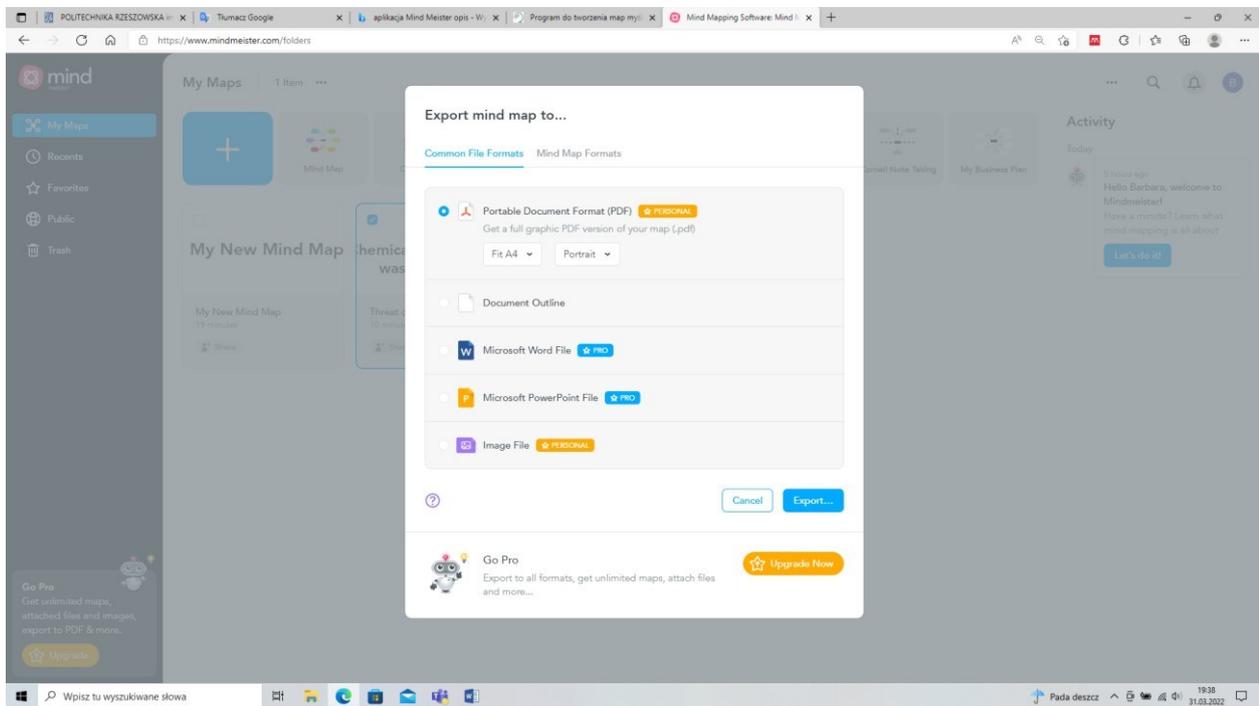
Fig. 22. Export mind map to other data formats

Mind Meister gives the option to print complete mind maps as posters. This option is very useful for extended mind maps, because it can be print out the whole thing divided into A4 sheets, and then pin it to a whiteboard and see the whole picture.

The formats available for printing range from A0 to A4.

Testportal

Testportal is a popular testing platform. It enables independent creation of tests, sharing and analysing the results. In the application it is possible to edit questions in different ways, the application has built-in algorithms for question randomisation. It is also possible to set the time limit for answering. The teacher can also supervise the solved tests and analyse the results and produce statistics. The application can be useful for testing knowledge in classes or during exams.

The progress of the test for each person can be monitored. The teacher can independently define the algorithm for the selection of questions from the selected subject area.

Making a test available is done by sharing the test in a team. Then only people from this team can take the test.

The creation of a test can be started by defining the test category, its description and language (Fig. 23).
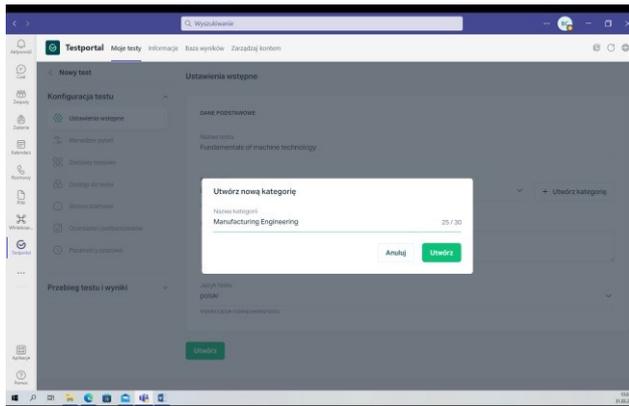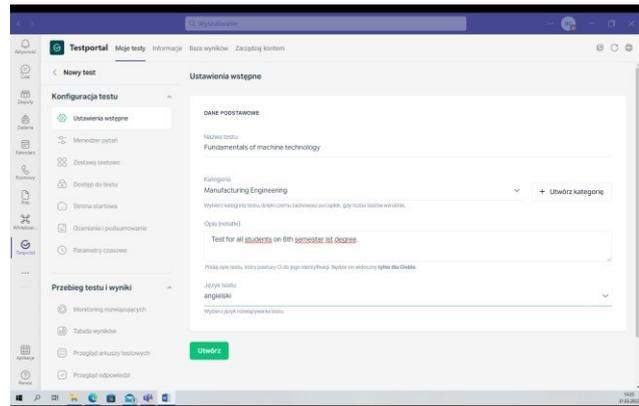
a)   b)

Fig. 23. Beginning of work on the test

The test is visible in the test inventory with a tab "under setting".

All the tests available to the teacher with the selected status are visible. This is a useful option if you are working on many tests. Then it is possible to control the degree of completion of a test (Fig. 24).

Fig. 24. Screen with available tests

Creating test content is easy. The test configurator allows you to enter question content one by one, create random sets of questions, set access to the test for a specific group of students, etc. (Fig. 25).
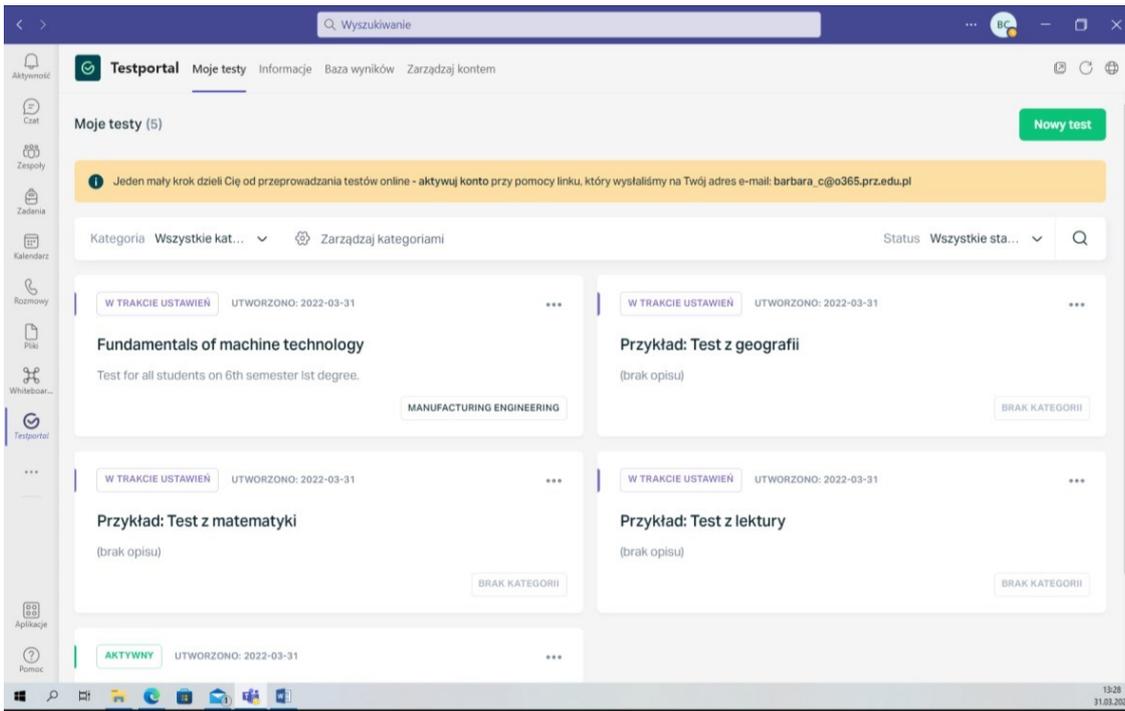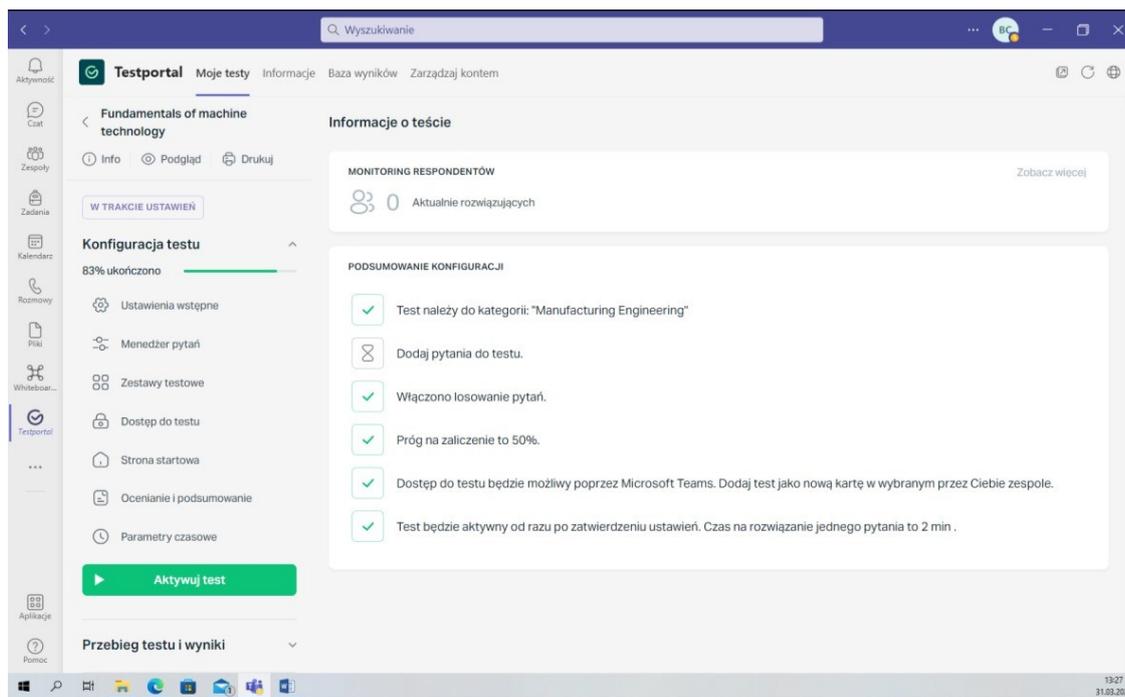

Fig. 25. Test wizard in Polish

Editing question content is similar to a typical editor. In the relevant windows you enter the content of the question, the possible answers and the correct answer. It will be highlighted later, but only for the teacher's use. Students will see a uniform text (Fig. 26).

a)   b)
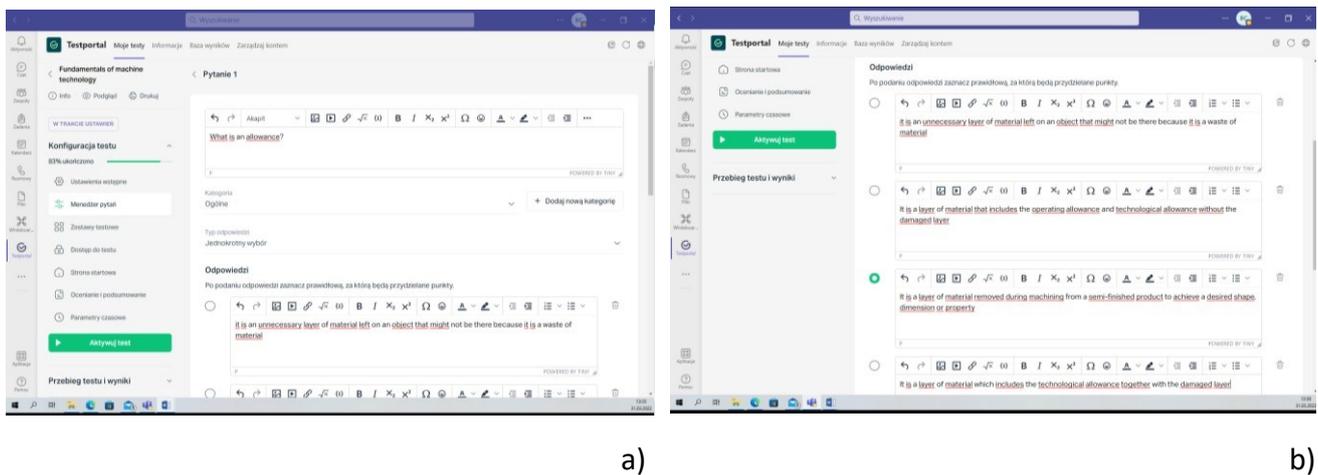
Fig. 26. Edit question and answer: a) the text of the question, b) the answers with the correct answer marked

In your test, you can set the scoring rules, i.e. you can specify the number of points possible for each question, as well as the number of questions necessary to achieve a pass (Fig. 27).
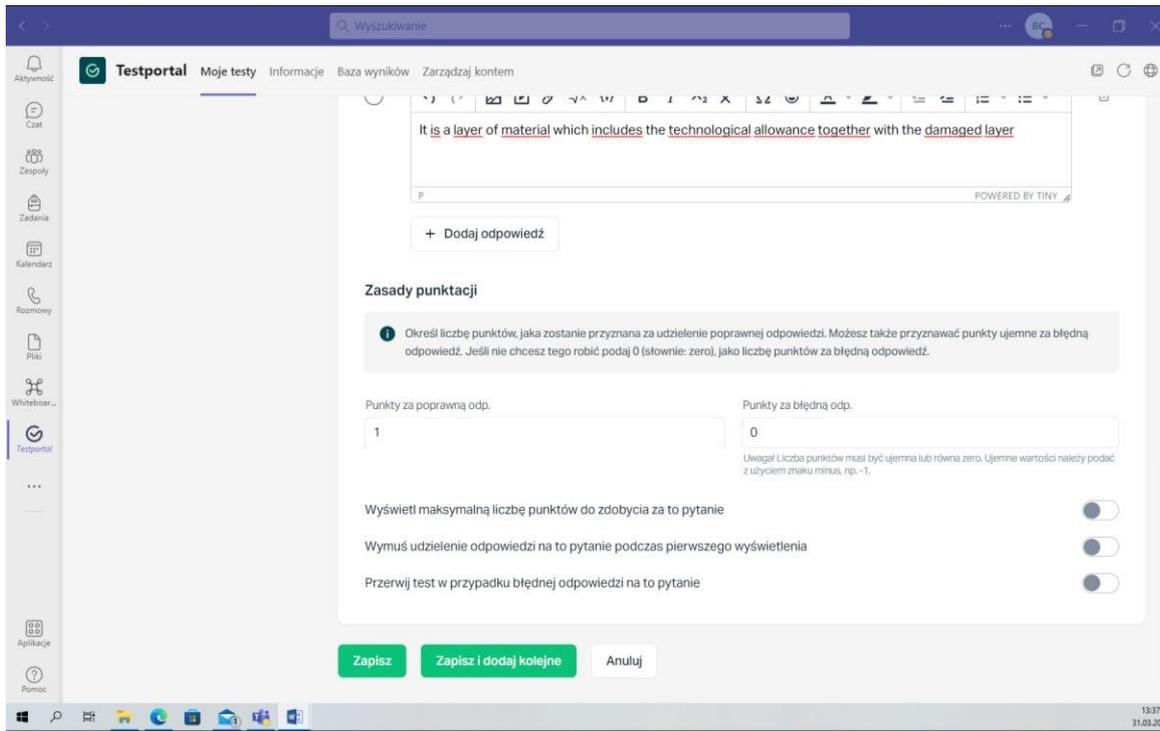
Fig. 27. Definition of scoring rules

In the application, you can control how questions are edited via the "page preview" button (Fig. 28).
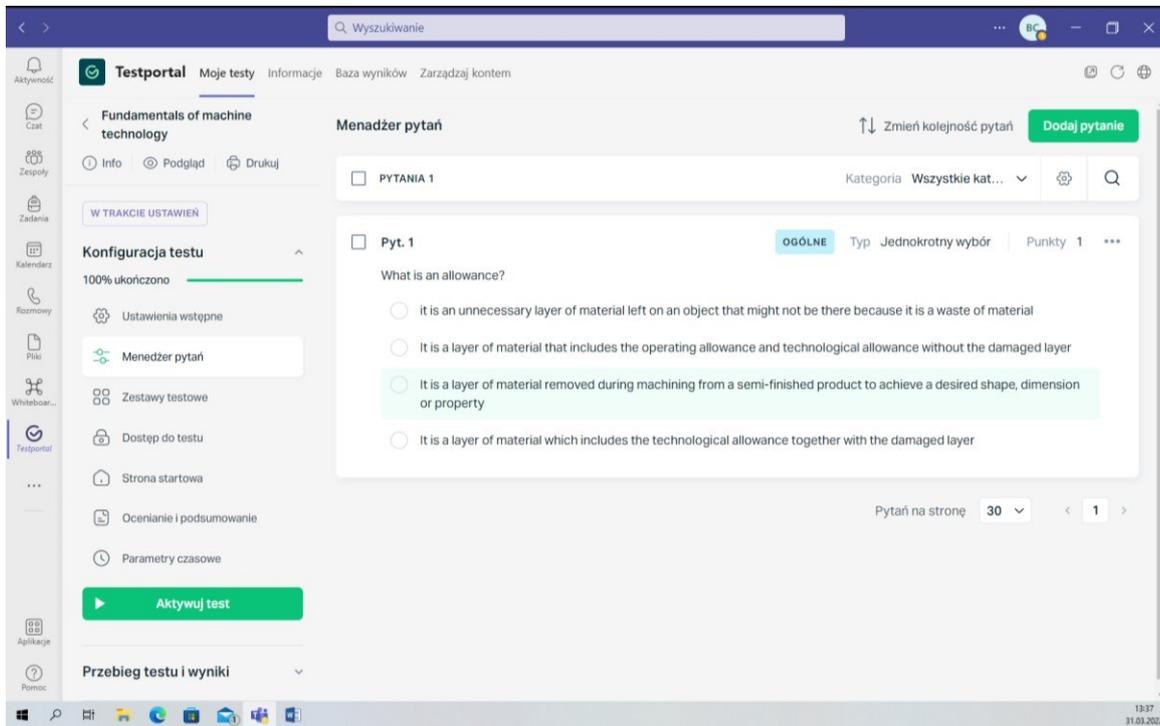
Fig. 28. Preview of the finished question on the page

The question editor also allows you to insert a drawing, video, attachment, equations, etc., if the purpose of the question requires it (Fig. 29).

Fig. 29. Adding a drawing to a test question

You then set whether the order of the questions will be fixed or random (Fig. 30).

Fig. 30. Determining the order of questions

In order to increase the reliability of the test results, it is possible to activate a mechanism that controls the browser tab in which the test is solved. This way, any exit from the test, e.g. to search for information or to communicate with others, will be recorded and will be additional infor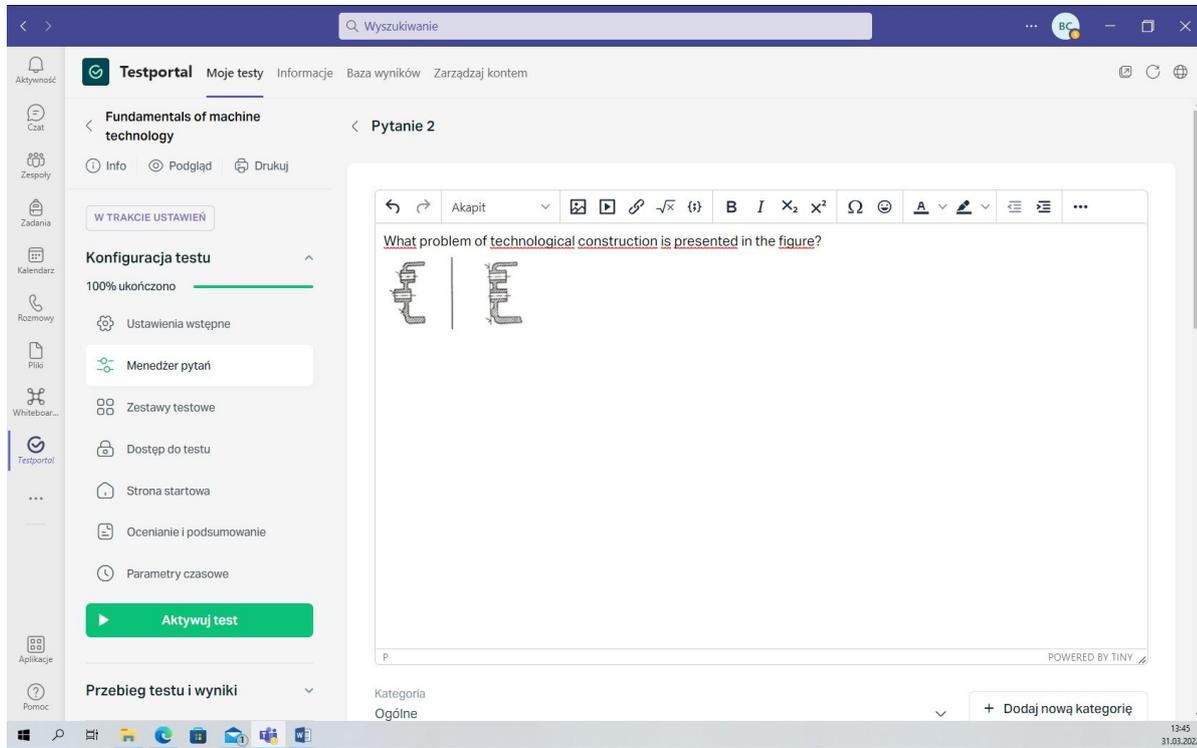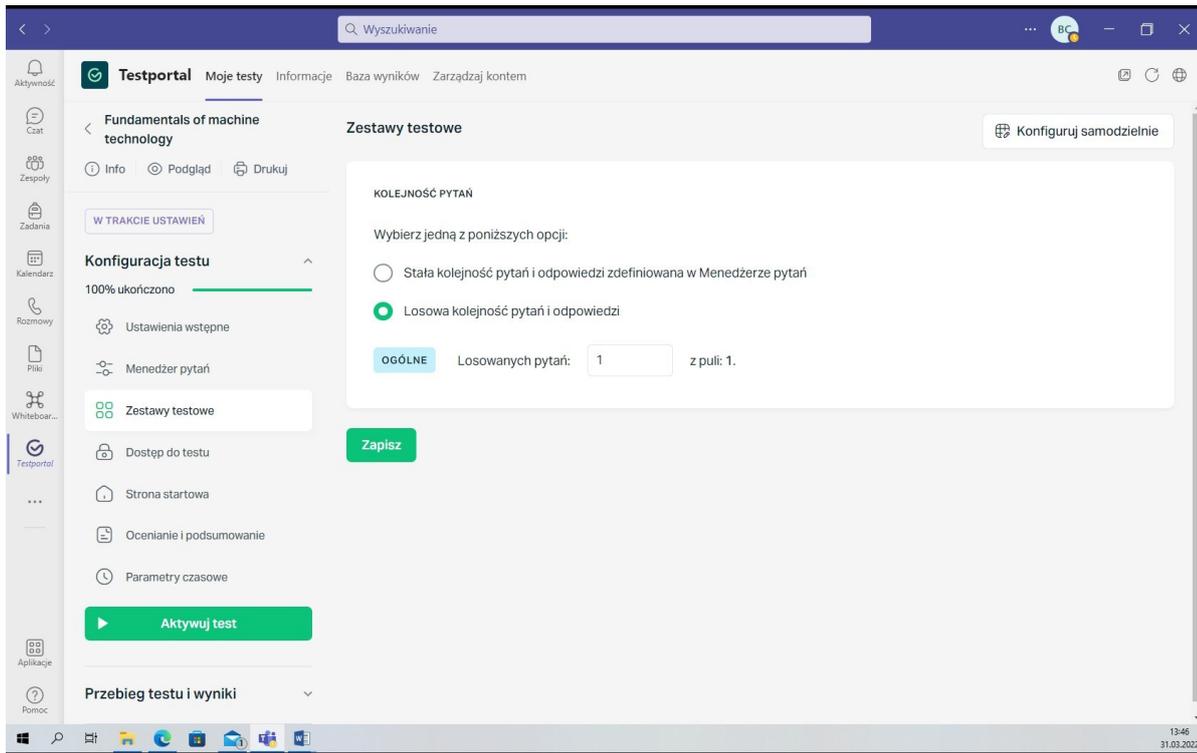mation available when analyzing the results. If a test is missed, the solver will see a warning. His or her test may also be blocked if the allowed number of test misses is exceeded. If the Honest Solver technology is enabled, the solver will be informed by a message displayed on the test start page. It tells them to focus only on the test, turn off background programs and mute system notifications (Fig. 31).

Despite this, it is possible that a test taker may leave the test accidentally. This can occur, for example, by muting the volume, inadvertently clicking outside the test area, or using the system button on the keyboard that activates the taskbar. When taking a test on a mobile device, an incoming phone call or opening a notification from another app may also be the cause.
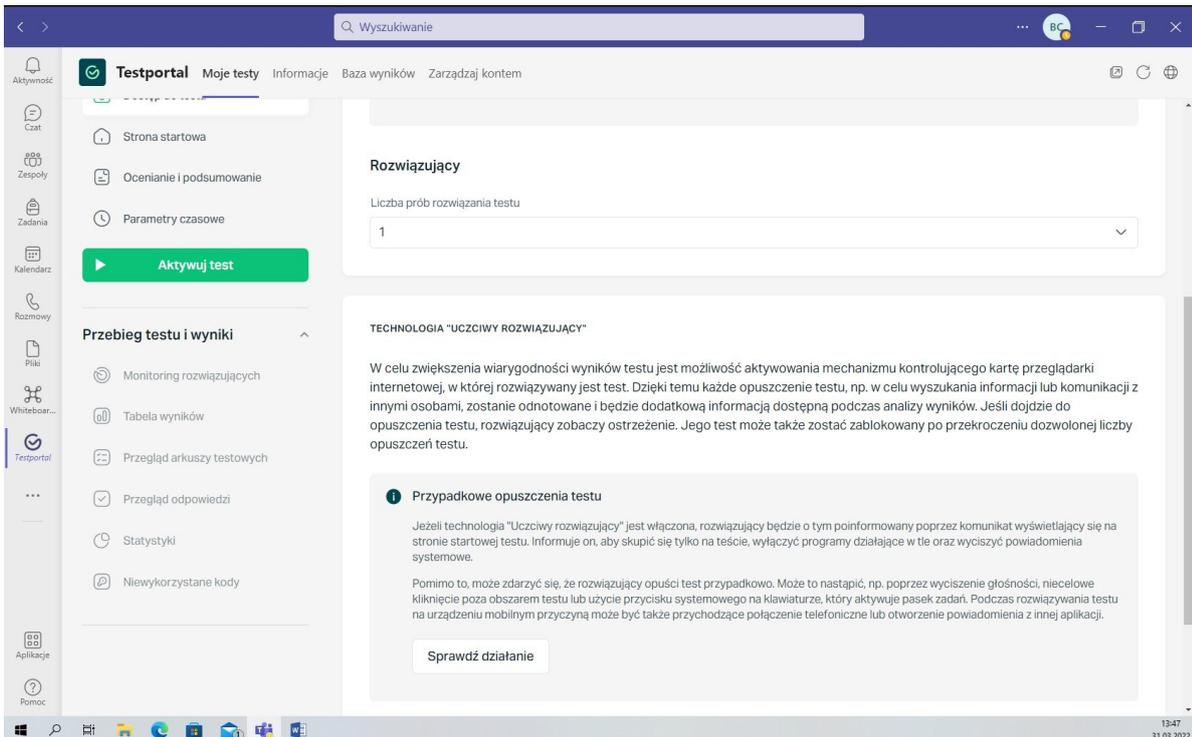
Fig. 31. Information about those leaving the test

A useful feature is the time setting. There are two possibilities, either you define the time for answering one question or the duration of the whole test (Fig. 32).
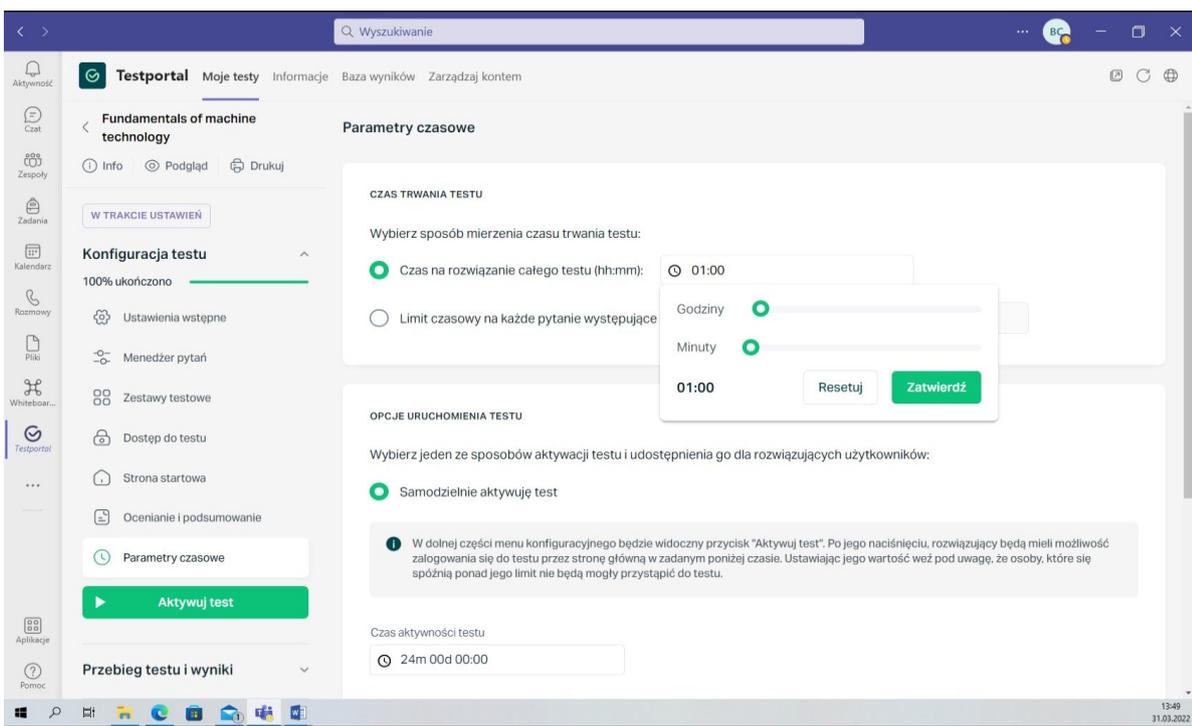
Fig. 32. Definition of test duration

At the end of a test's editing it is possible to define the content of a message to the student in case he or she has passed or failed the test, including the sum of the achieved points, the percentage of correct answers (Fig. 33).
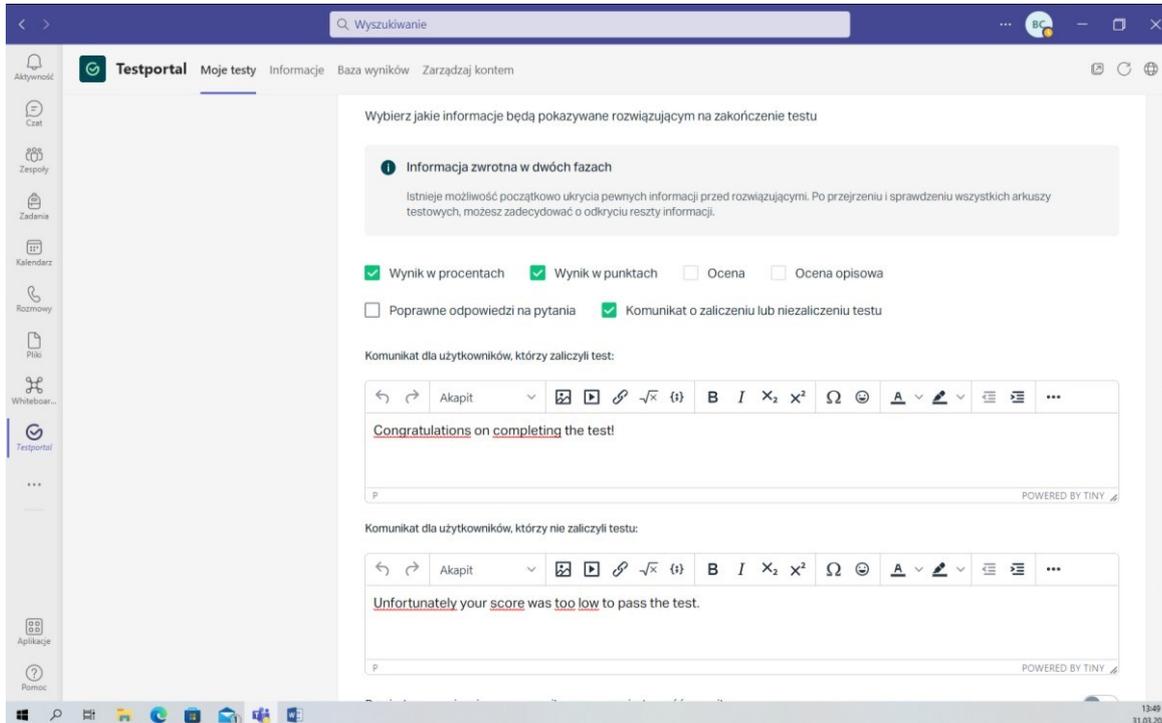
Fig. 33. Definition of final messages

In order to have an aesthetically appealing test layout, you can also set up a test start page (Fig. 34).
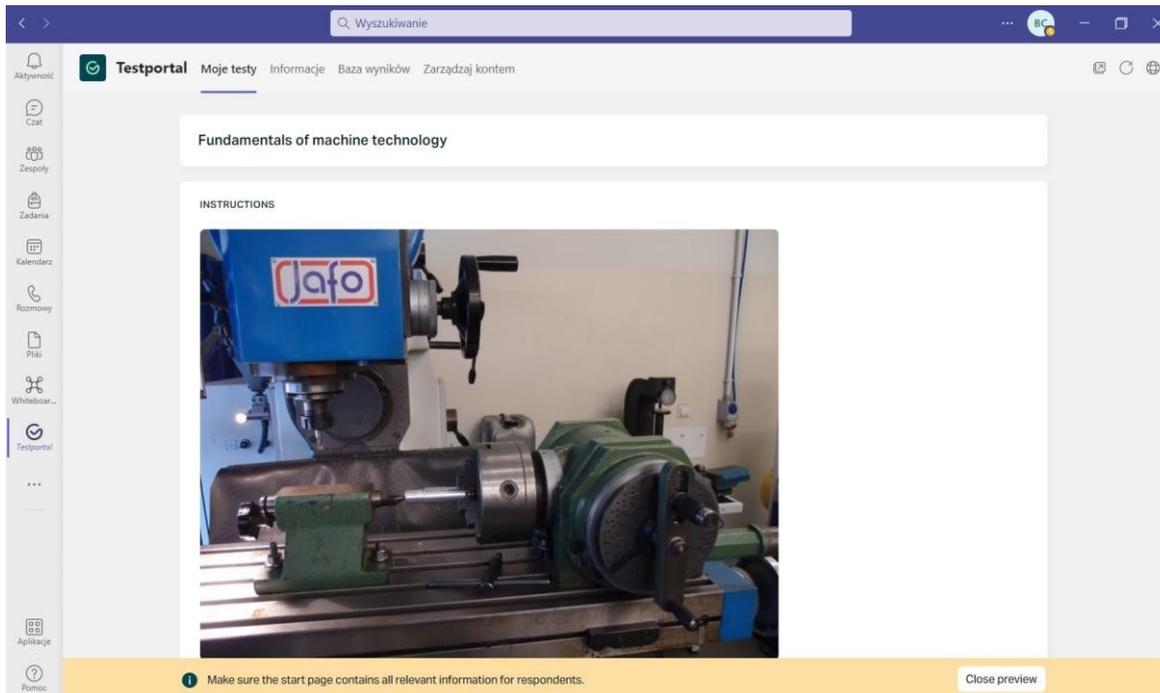
Fig.34. Editing the starting page of the test

The application offers the possibility to generate a .doc or .pdf file with the prepared test (Fig. 35). This can make it easier to check the correctness of the content (a hard copy is sometimes better) or allow the test to be taken in other than online conditions.

Fig. 35. Screen with exported test to .pdf file

✖ Whiteboard.Chat for Edu

The application is designed for teamwork, e.g. teacher with students or group of students. The data transfer is done in real time in the cloud as a digital classroom.

Teacher and students can type, pen, draw, add finished text, create tables and graphs, add images, sticky notes, etc. In this way, they work together creatively, immediately preparing notes on such activities. All group members can see these notes in real time.
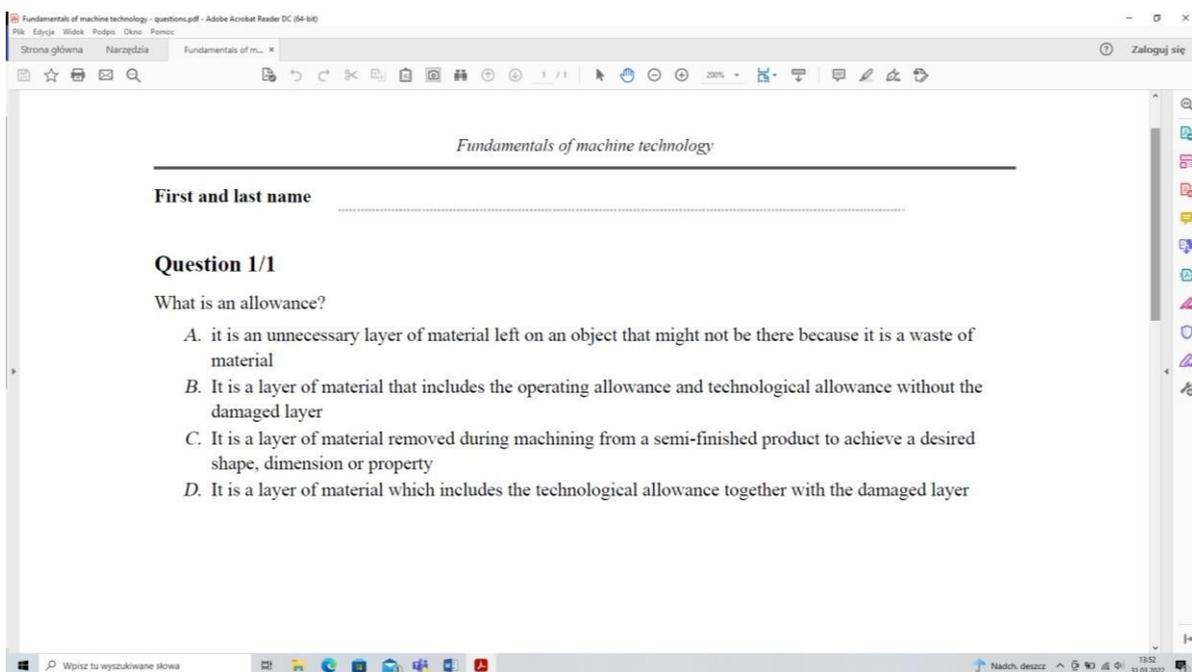
Getting started can be done using a ready-made template, or you can create your own diagram. The application also provides an extensive library of shapes for the flowchart.

The idea of working with Whiteboard is shown in Fig. 36, when different objects are placed on one whiteboard by multiple users at the same time.
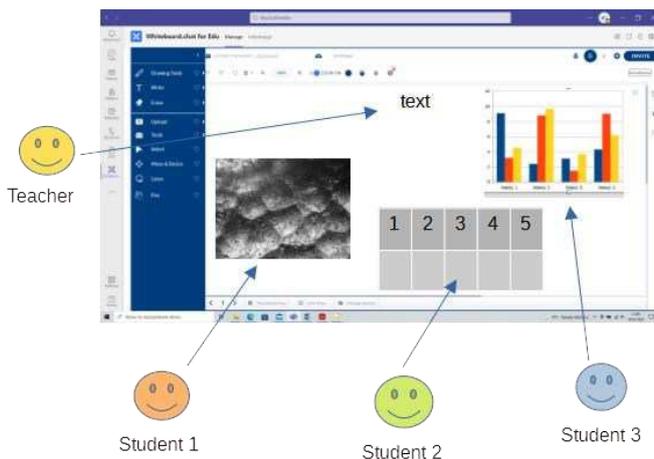
Fig. 36. Diagram of a common board for a team

A start with the application is easy, it automatically starts the tutorial showing the most important elements and their location on the whiteboard screen (Fig. 37). If the application is already well-known to us, it can be skipped.
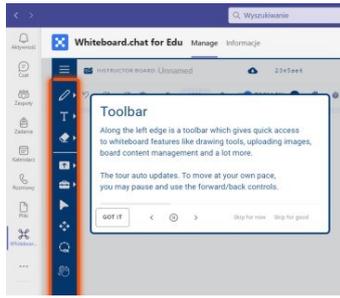
a)
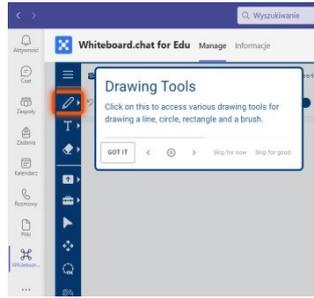
b)
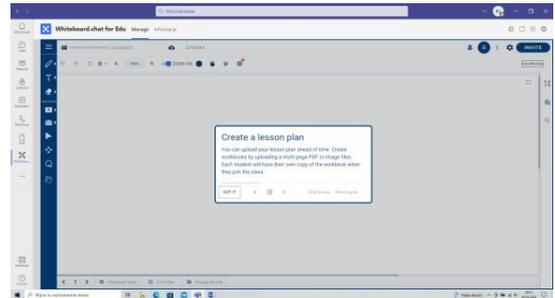
c)
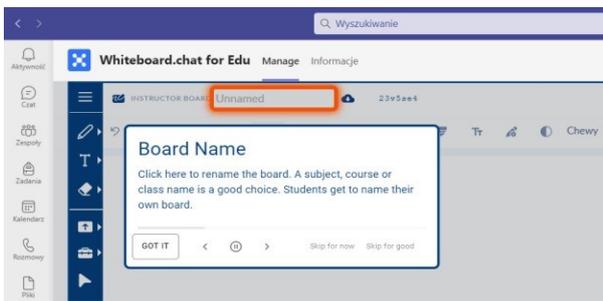
d)
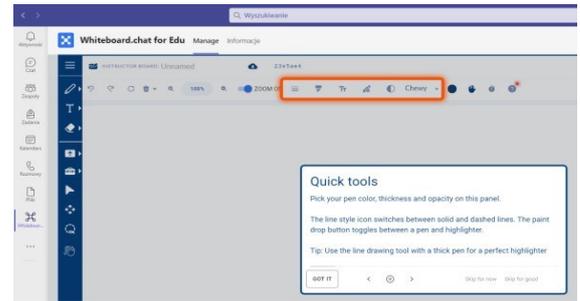
e)
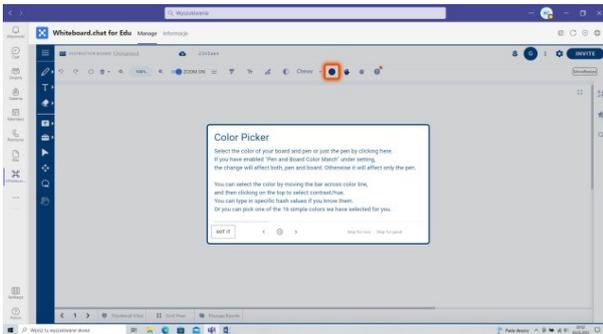
f)
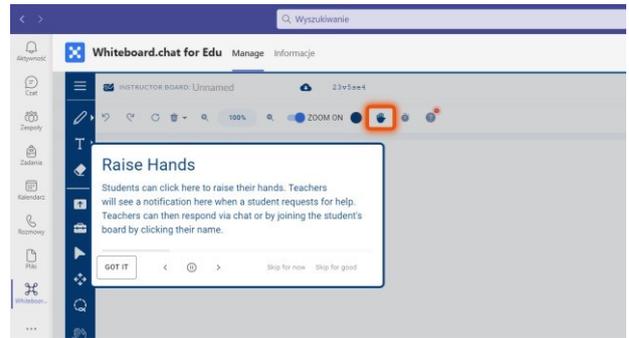
g)
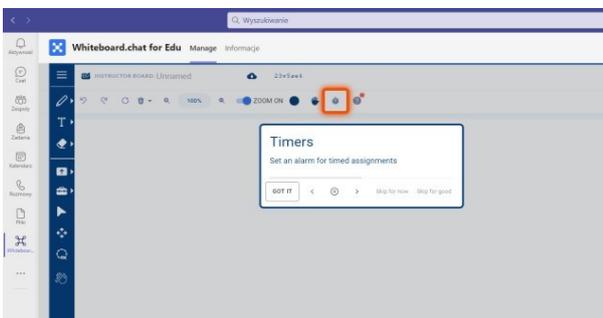
h)
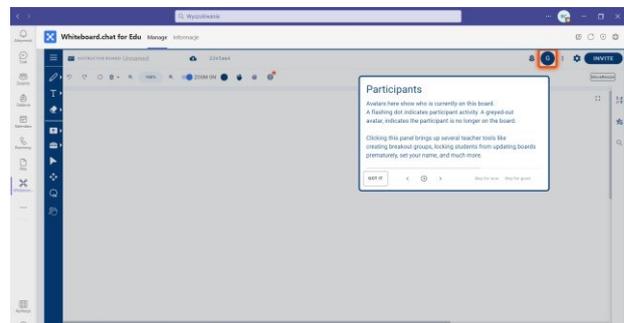
i)

Fig. 37. Examples of tutorial screens: a) toolbar on left, b) drawing tools, c) place for lesson materials, d) place for name, e) quick tools bar, f) color picker button, g) raise hands button, h) timer button, i) participants view

Case study

Topic – Laser cutting of plastics – laboratory

Whiteboard.Chat for Edu can be used for distance or hybrid classes, if some students are present in the college room and the remaining students are logging in online.

Once the application is launched and all participants have logged in, you can proceed with the class.

Step 1: Start of class - the teacher defines the topic, the purpose of the exercise and gives tasks to be done by students (Fig.38)
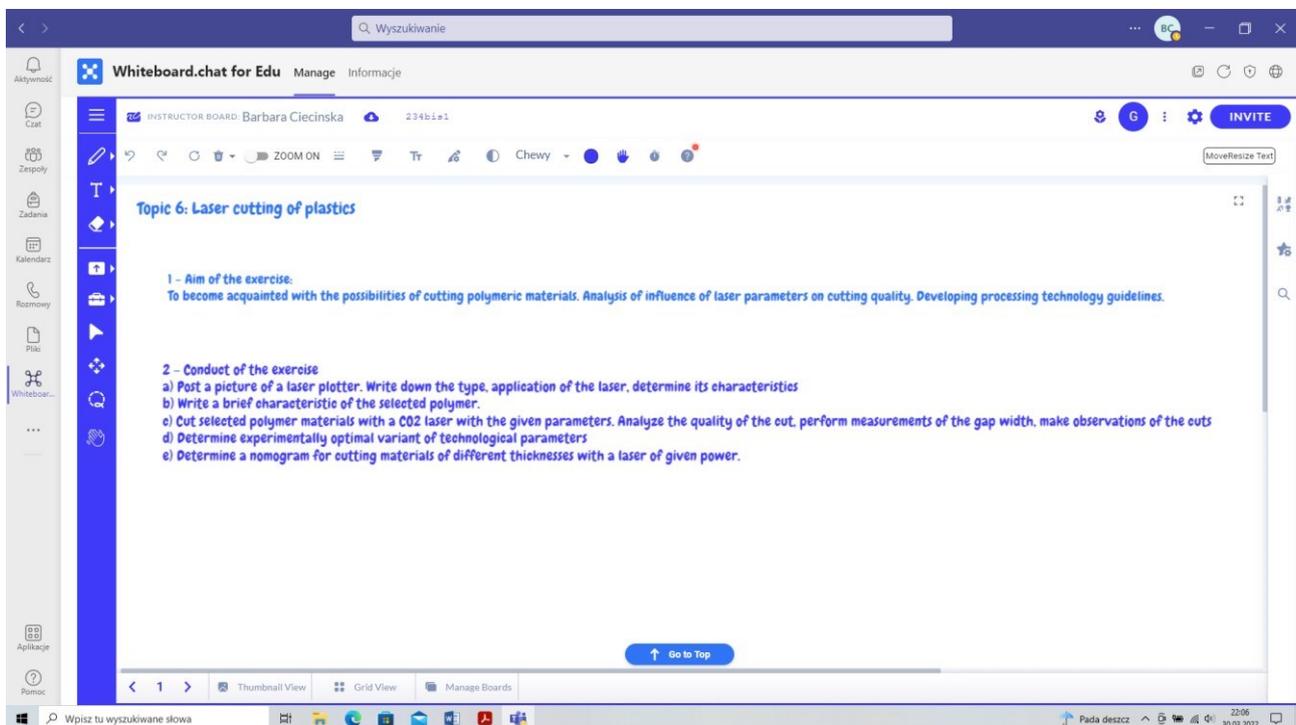
Fig. 38. A board with the topic of the lesson, the purpose and the tasks to be completed

Step 2: Define the tasks to be completed by the individuals. The teacher has selected 5 students and assigned names to each task (Fig. 39)
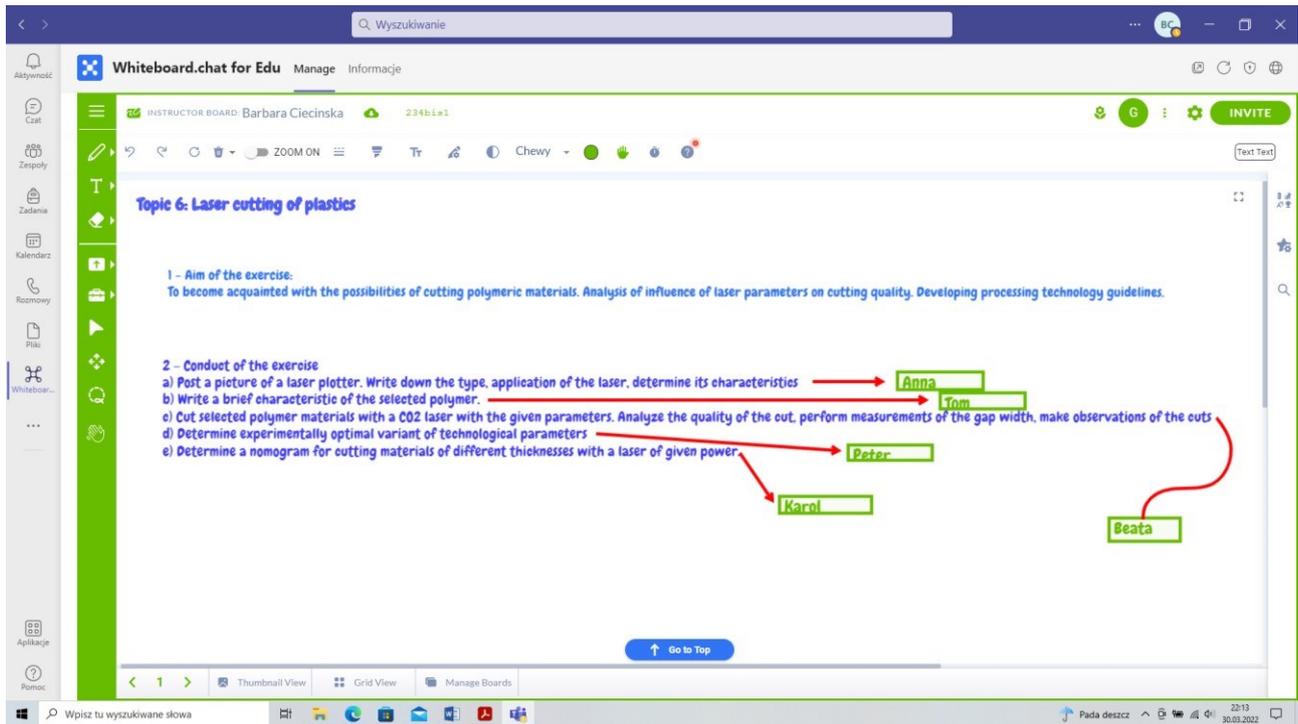
Fig. 39. Board screen with students assigned to tasks

Step 3: Students are asked one at a time to perform their task. Anna puts a picture of the device used to make the samples on the board (Fig. 40). At this stage she can also state the performance of the workstation, give its advantages and disadvantages. This part of the work the students were given before, where technical and operational documentation was given to study on their own in advance.
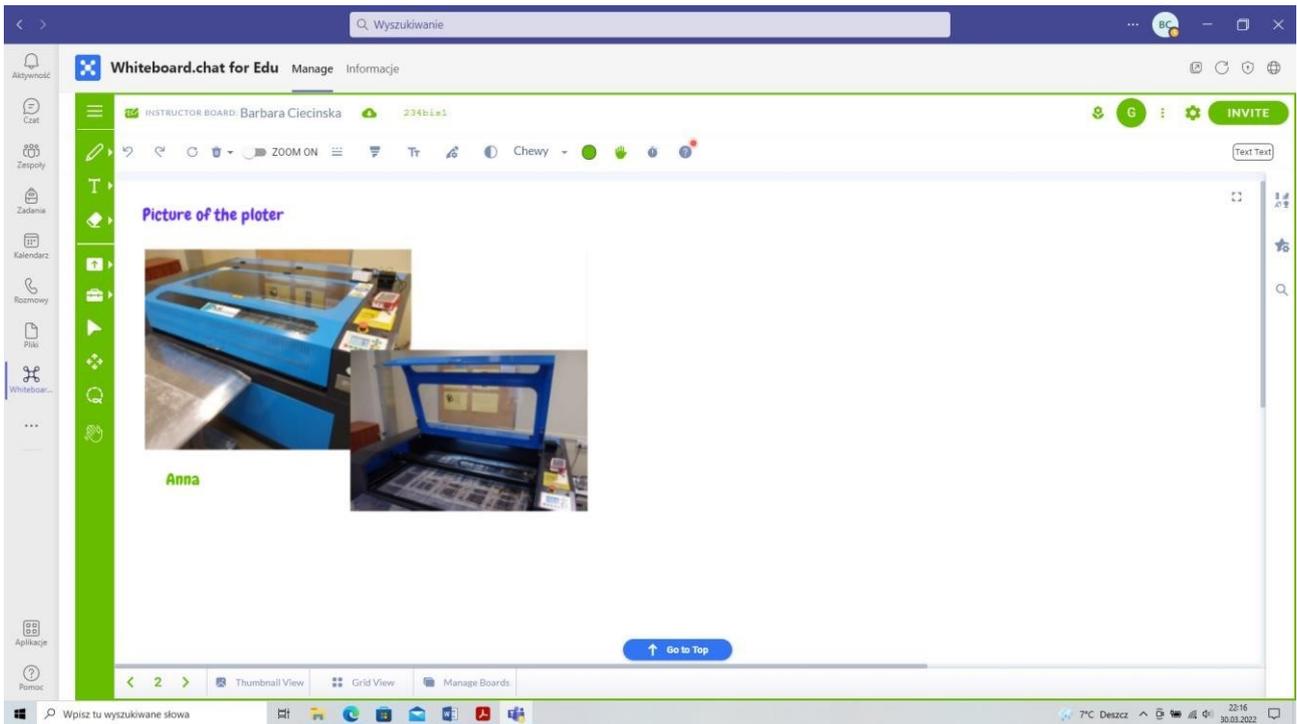
Fig. 40. Initial stage of working together with students

Step 4: Tom briefly characterized the polymer that was used to make the samples. He put the note on the board as an excerpt from the text (Fig. 41).
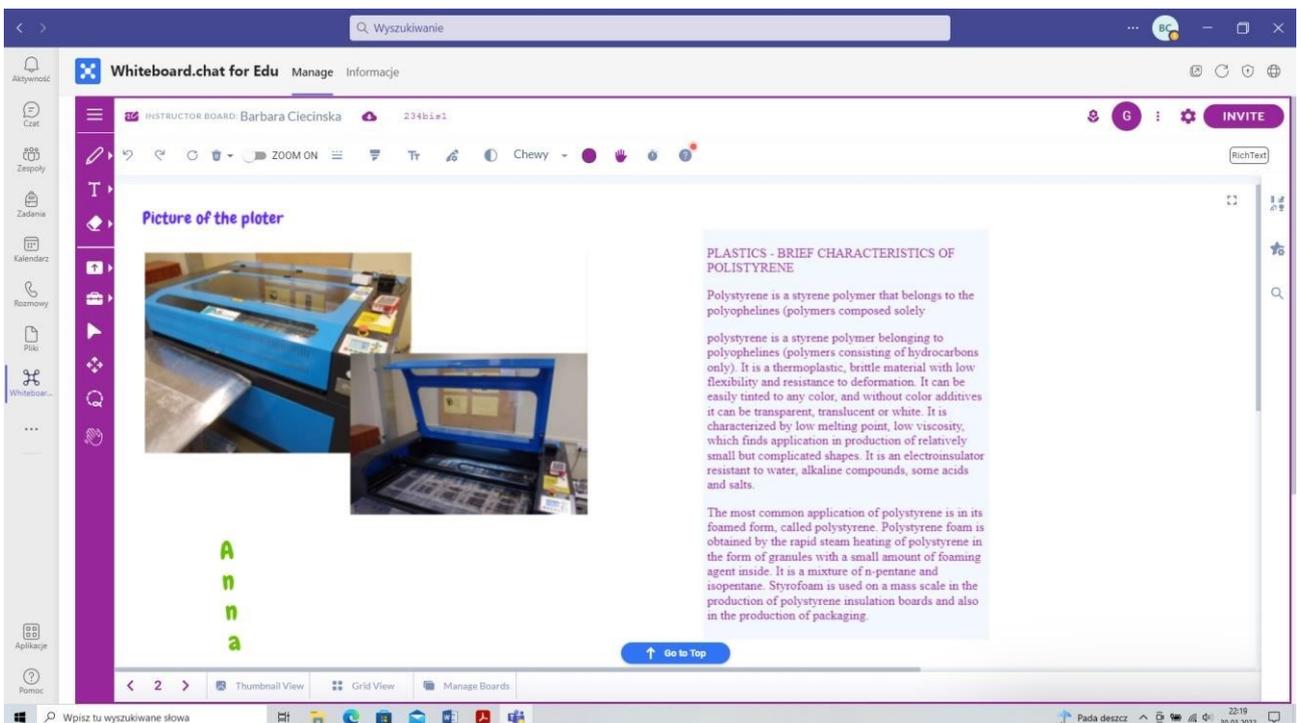
Fig. 41. Table with completed sample material characteristics

Step 5: Beata was the person who, along with the teacher, was present in the lab and helped make the samples. In real time, using an online camera, the students watched the processing (Fig. 42).
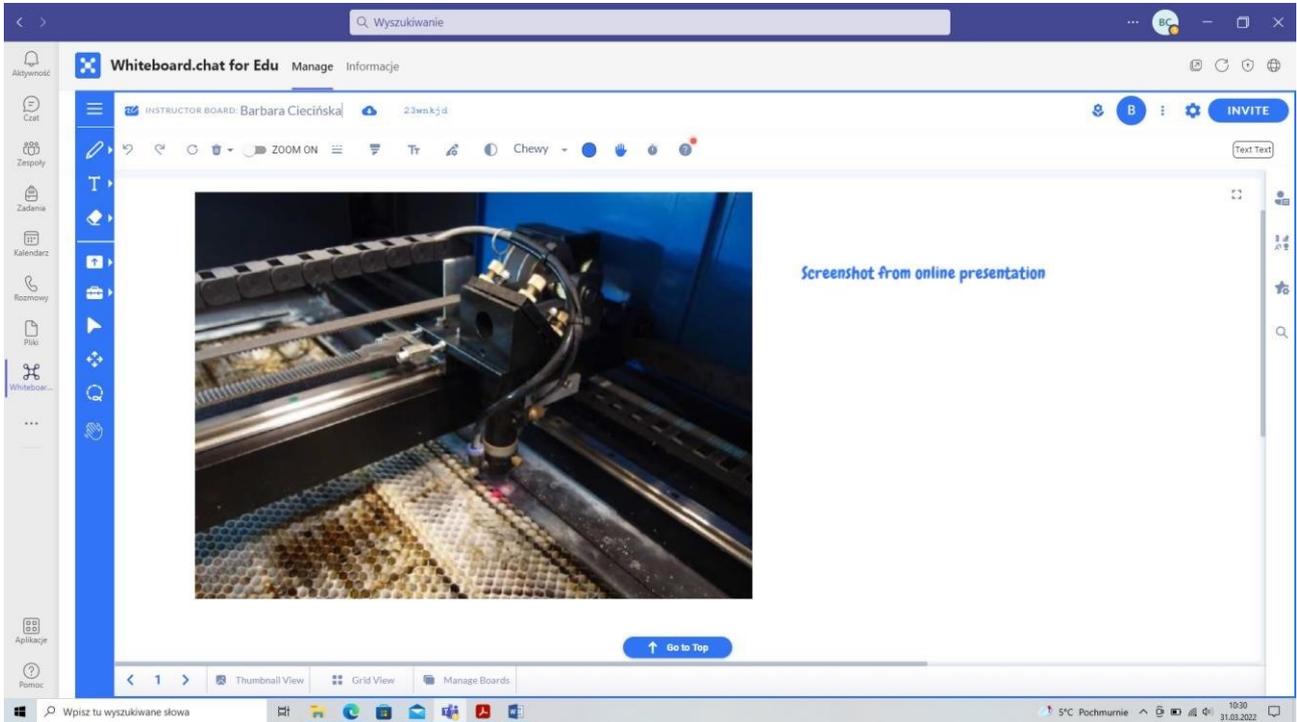
Fig. 42. Presentation online of use of the laser

After the samples have been made, a picture of the sample and a picture of the gap gauge used to measure the width of the cuts is placed on the board (Fig. 43).
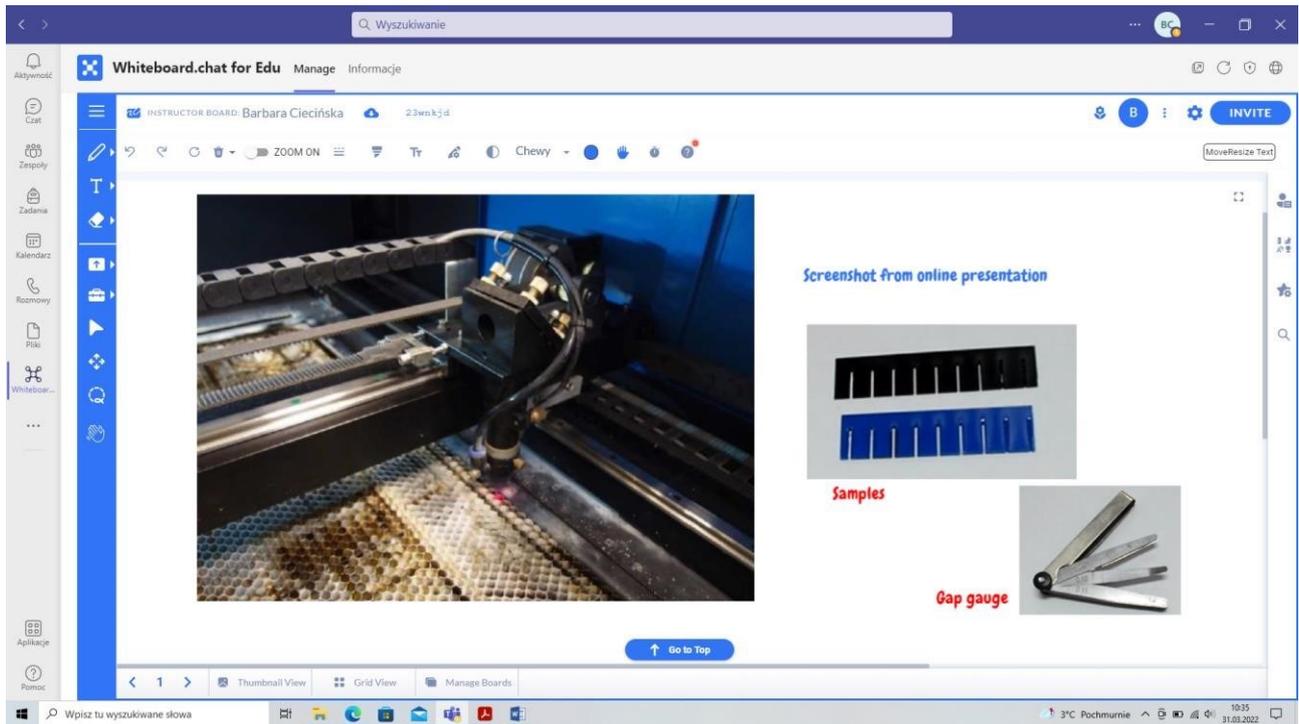
Fig. 43. Supplemental information with photo of samples and gap gauge

Step 6: Peter's task is to evaluate the quality of the cuts and choose the best processing option. By referring to the individual cuts on the whiteboard a table is made together, with which the processing results are marked. The best variants in terms of laser power and beam speed relative to the sample are selected and highlighted in red. These are also technological guidelines for the material variant adopted (Fig. 44).
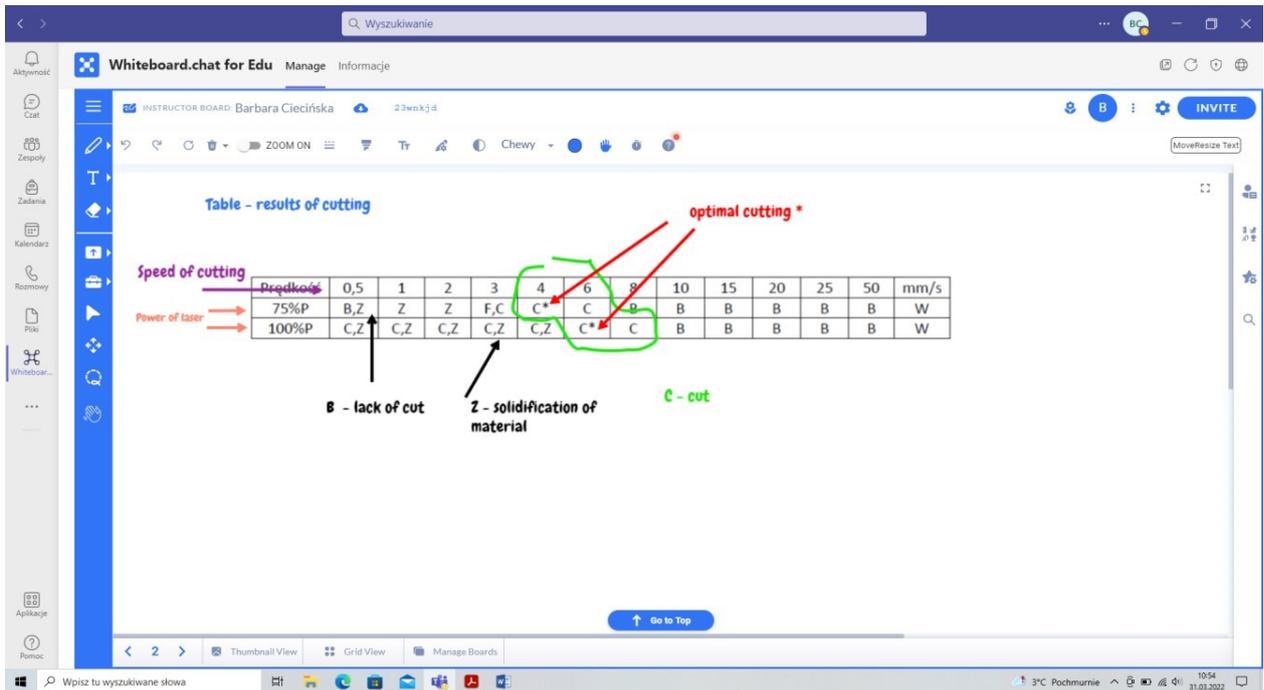
Fig. 44. Cooperative work of the speaker, teacher and other students

Step 7: Karol calculated parameters specific to laser cutting using handwriting possibilities (Fig. 45). The application runs an automatic text recognition mode, handwritten letters can be converted to typewritten letters. In the example the original style of the student is kept, it gives the impression of being in a classroom and writing on a classic blackboard.
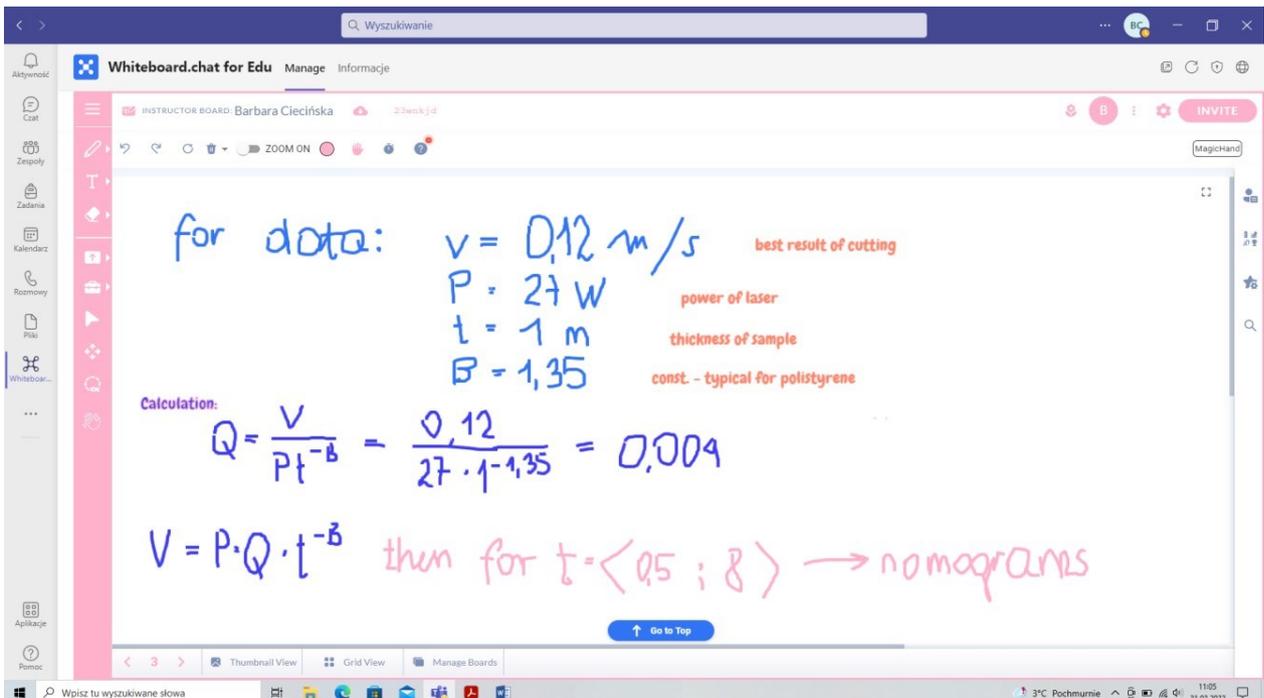
Fig. 45. Student calculations and teacher notes

Then, on the basis of the obtained results, graphs - nomograms were drawn (Fig. 46)
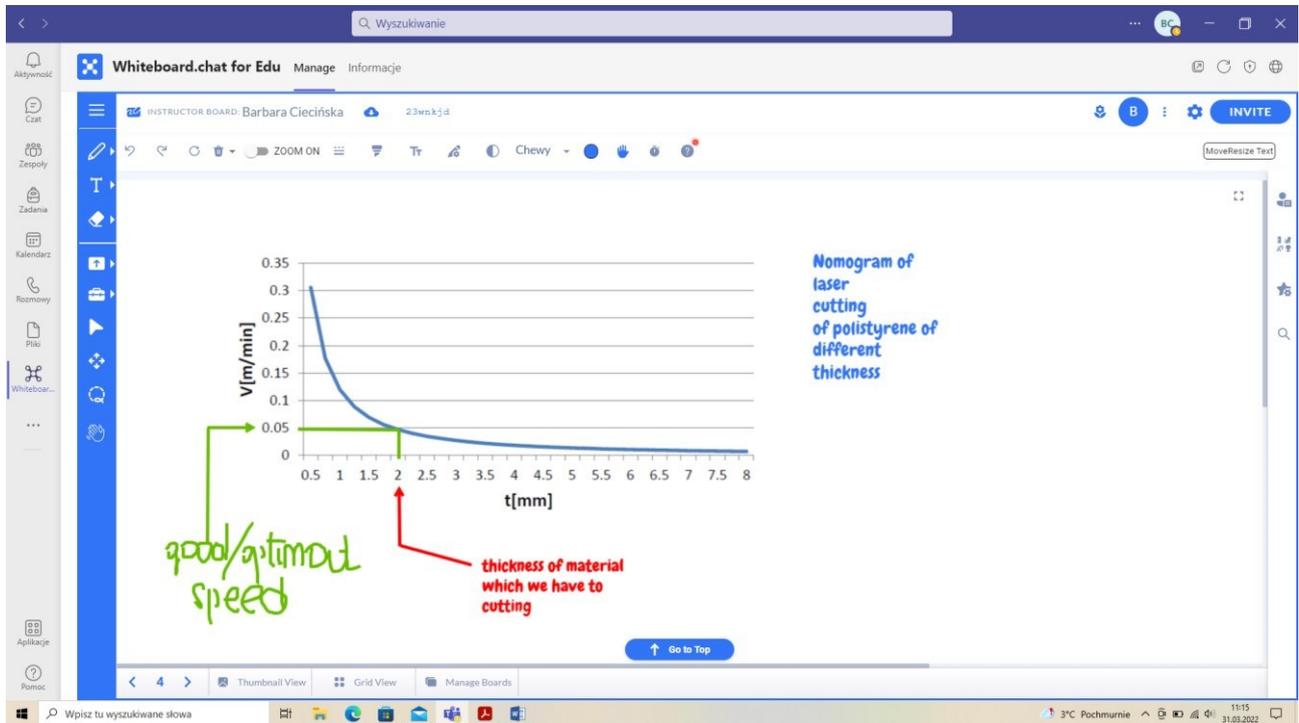
Fig. 46. Drawing graphs online

At the end of the class, the instructor can go back to all the arrays made, as they are available in the active application, and they can also be saved and played back as needed (Fig. 47).
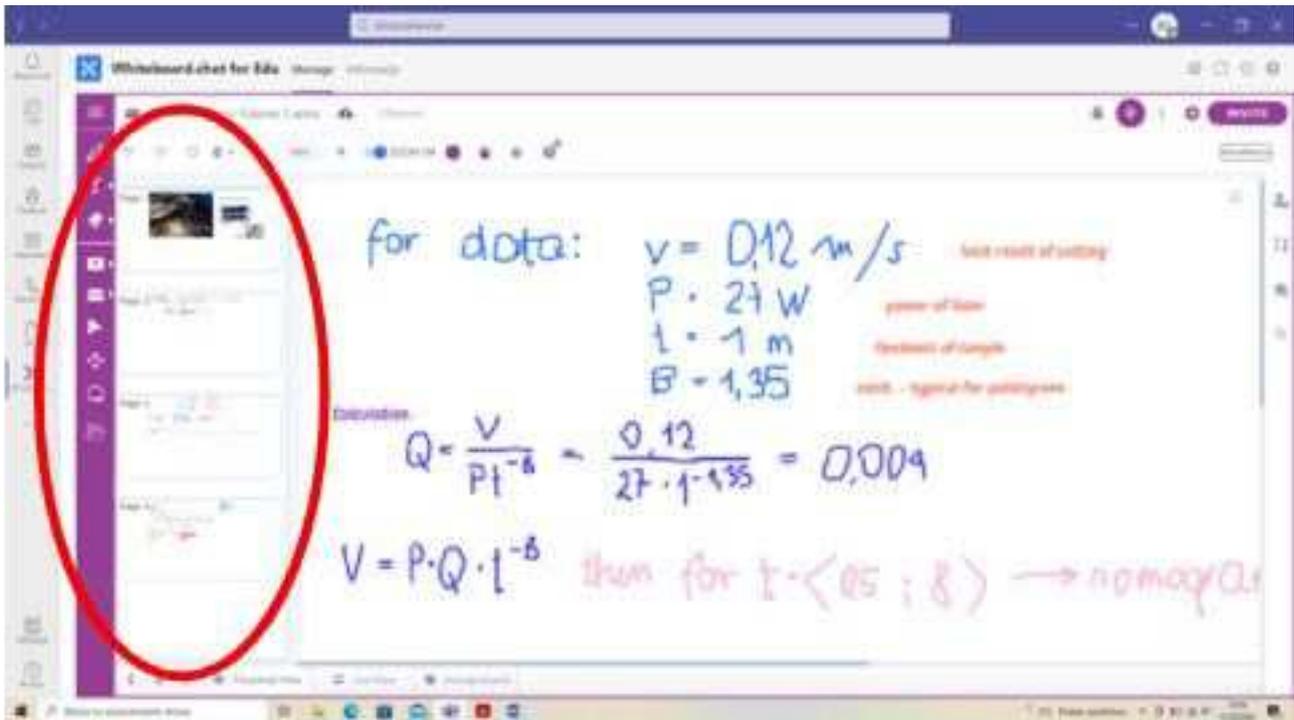
a)
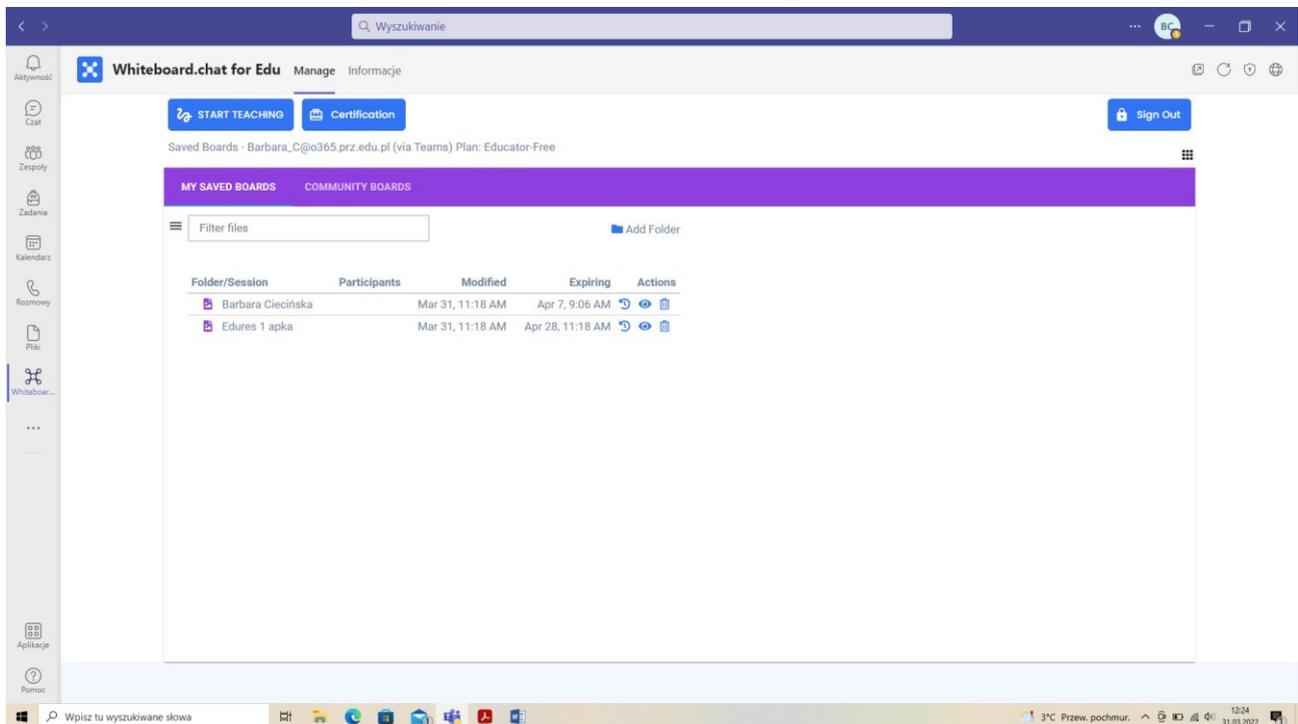
b)

Fig. 47. Completion of the application:

a) boards saved during the class, b) project saved and available in the future

Report of the National Technical University of Athens

Brief description of the example and research the example concerns

The example concerns the e-learning course, created by using the Moodle software and presenting the results of investigations conducted in the field of the surface topography evaluation after nonconventional machining and more specifically after Electrical Discharge Machining. The course was created based on the paper of Karmiris-Obratański, P., et al. "Surface texture and integrity of electrical discharged machined titanium alloy." in The International Journal of Advanced Manufacturing Technology journal (2020): 1-15.

Electrical Discharge Machining (EDM) is a non-conventional machining process, extensively applicable in the modern industry. Owing the non-contact nature of the process, any electrically conductive material can be machined in high quality, regardless its mechanical properties. Titanium alloys are commonly machined by EDM, as difficulties related with their low thermal conductivity and the high chemical reactivity can be overcome. As titanium alloys are utilized in quality demanding applications and industries, high machined surface quality is required, as well surface integrity. The current study, presents an experimental investigation of how ED machining parameters affect the MRR, the TWR and the SQ on machining Titanium Grade 2 by EDM. For pulse current 9/13/17/25A, and pulse on time 25/50/100/200μs a full-scale experiment has been carried out, using graphite electrode. The surface texture (ST) has been estimated in terms of arithmetic mean height (Sa), maximum height of scale-limited surface (Sz), and skewness of the scale-limited surface (Ssk), while also measurements of the surface waviness were conducted as well. For all the aforementioned parameters an Analysis of Variance (ANOVA) has been performed. Finally, the surface topography and integrity were evaluated through optical and SEM microscopy observation, through which the surface cracks and micro-cracks due to high pressure and temperature gradients can be distinguished and characterized.

1. Stages of creating an e-learning course with special attention to e-learning platform functions that are useful when creating a research-based course.
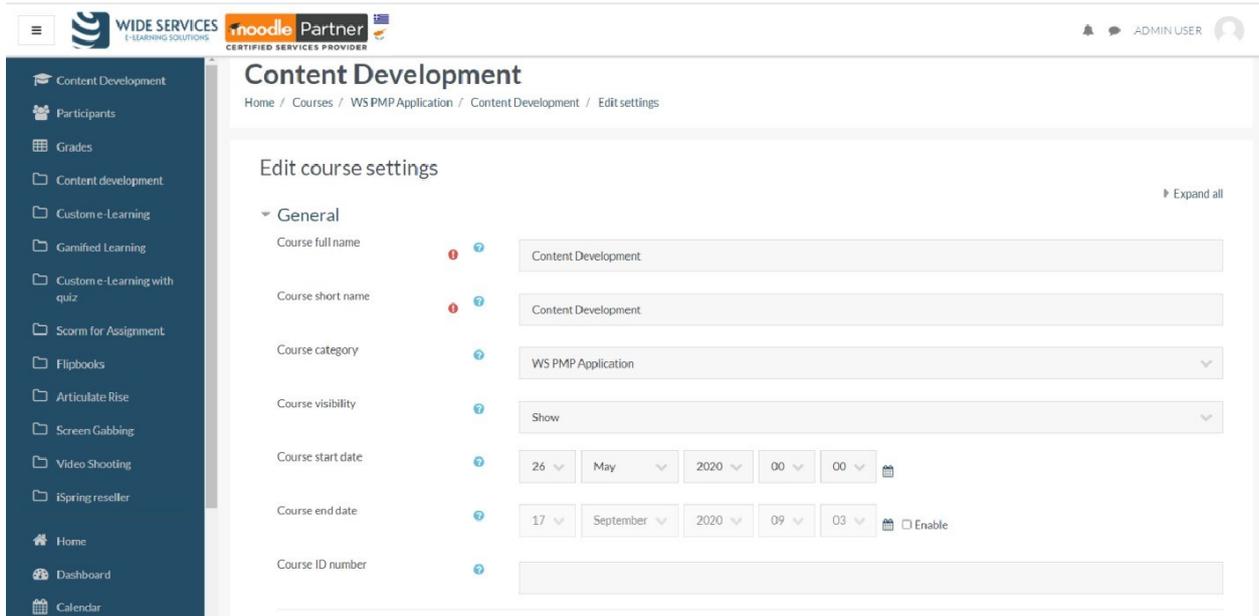
Fig. 1. Screenshot from the "Editing course settings"
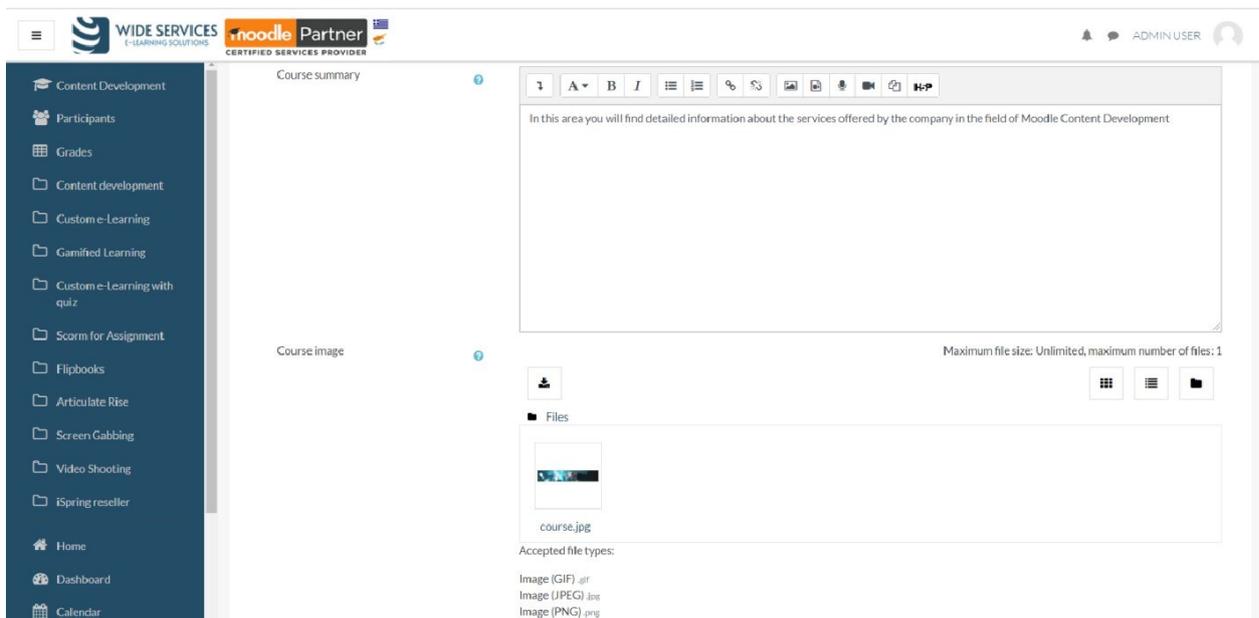
Fig. 2. Screenshot from the "Editing course settings-optional settings"

The current lecture has been created as part of the course Micro-Nanotechnology. When a new course is created, the course full name, short name, course category, course visibility, course start date and end date, as well the course ID number can and have to be set. Some additional editing options are the insertion of a course summary, a course representative image, the course format, and other organizational details like the topic formats, the weekly schedule format and the social format of the course. In Figures 1 and 2 the respective screenshots are presented. Nevertheless, the following

report will focus mainly on the editing and creating of the particular lecture and not of a hole course since this topic has been extensively presented and discussed by other consortium partners.

Fig. 3. Screenshot from the "Add topics"
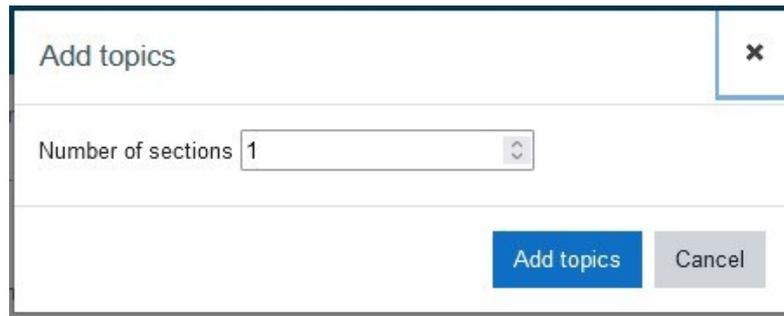
Fig. 4. Screenshot from the "Number of topics specification menu"

Fig. 5. Screenshot from the "Title of the topic editing"

To add a lecture on a specific course, the "Add topics" option has to be used, then, the number of topics has to be defined, and when the corresponding topics-lectures have been created the respective titles have to be specified. In Figures 3-5 the screenshots from the aforementioned steps are presented.

Now, we are ready to create and edit the lecture (see Figure 6).

Fig. 6. Screenshot from the "Editing screen"

As we can see the application interface is very familiar, and similar with a typical text editor. There are the main text editing options, namely, the selection of the main "Paragraph styles", between "Bold", "Italic" and "Underlined" writing styles, as well options regarding the font color and the insert of multilanguage content. Moreover, there are the typical options regarding the listing types (ordered list / unordered list), along with the options for the paragraphs indent. When the advanced options menu is activated, there are the options of "Strike through", "Subscript", "Superscript", "Background color" and the options regarding the text alignment. In Figure 7 the aforementioned options are depicted.
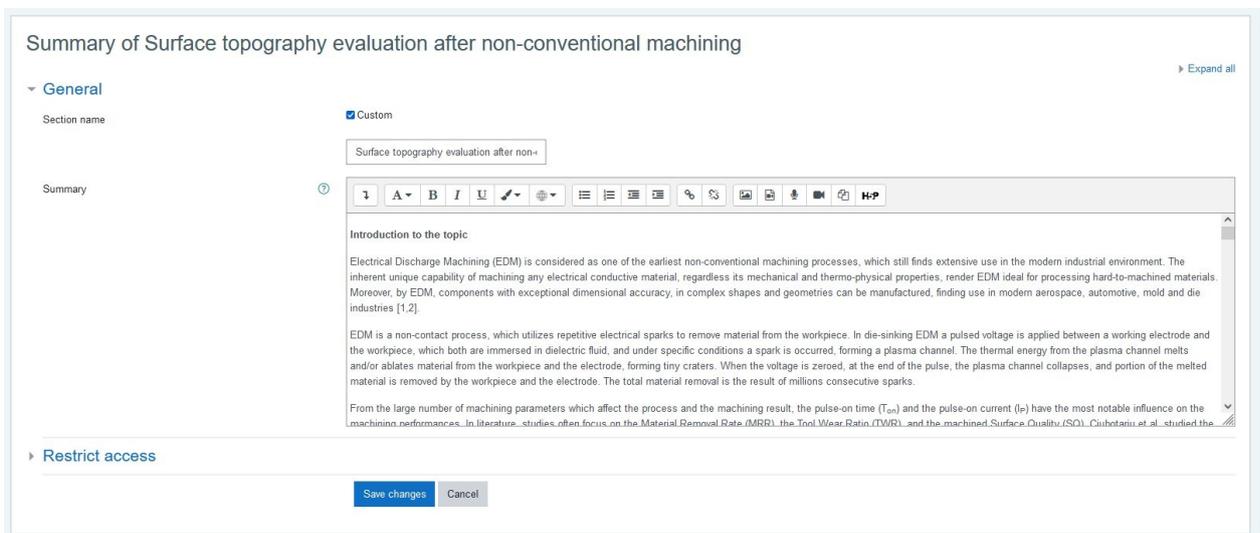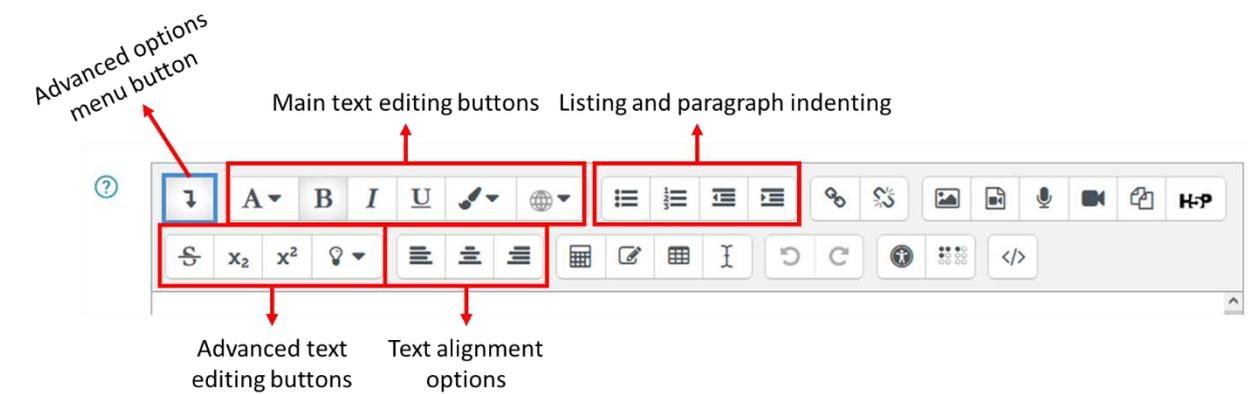
Fig. 7. Text editing options

Since the lecture pertains to a scientific topic, and especially in the field of engineering, the capability to easily insert equations, tables and special characters is very important. The corresponding buttons are depicted in Figure 8.
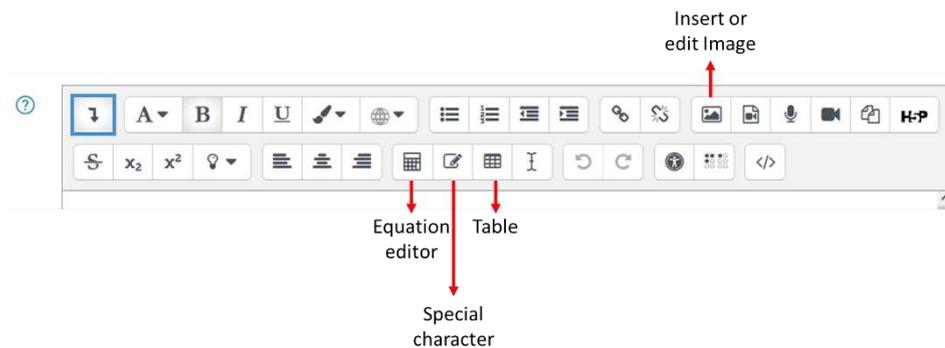
Fig. 8. Equations, tables, special characters and Image editing

The equation editing uses the TeX Notation, and through the popped-up menu the main "Operators", "Arrows", and "Greek Symbols" can be added. Additionally, there is special menu for the more advanced and complex mathematical formulas. In Figure 8 the Equation Editor is presented.
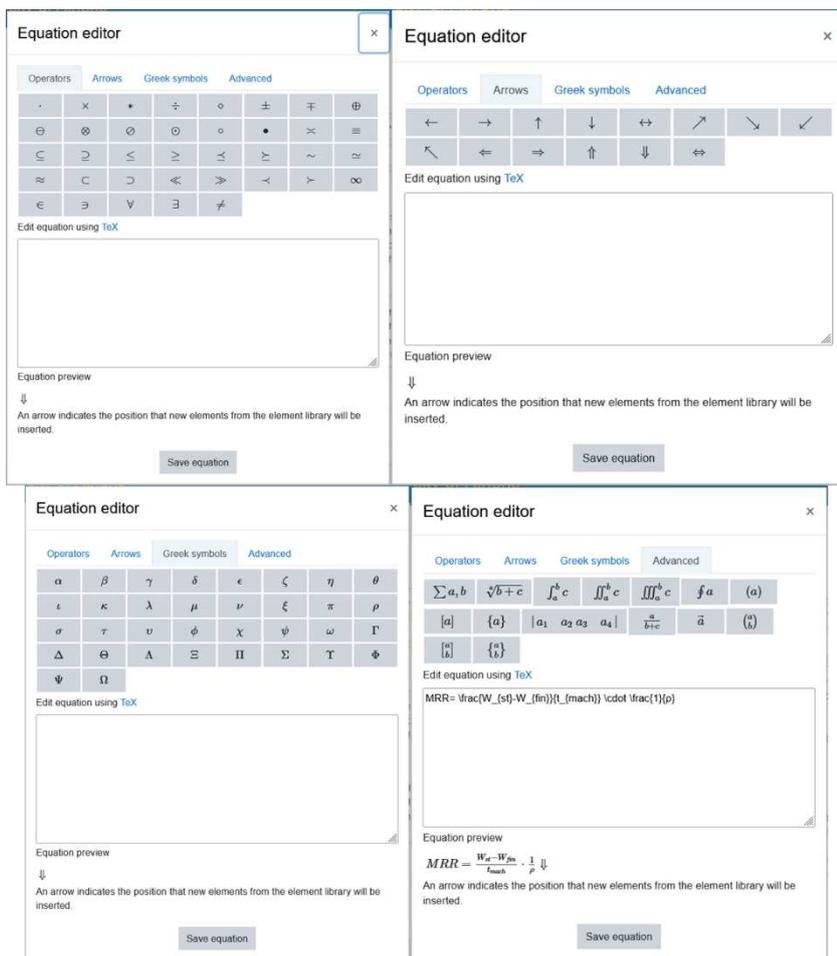
Fig. 9. Equation editor

To create a Table there are many different options, like the definition and the position of the caption, the number of rows and columns, along with some appearance choices regarding the border style, size, color, etc. In Figure 10 the corresponding Table Editor is presented.

Fig. 10. Table editor

The insertion of an Image can be done either with Copy-Paste or by using the corresponding button. The Image editing menu (Figure 11), provides access to manage and change the image properties like its size and its alignment. Moreover, a very useful option is the capability to describe the image for someone who cannot see it, by inserting a brief description in the corresponding frame. There are also similar options and menus to insert and edit video or audio, but since no video or audio are included in the current lecture these options are not further discussed.

Fig. 11. Image properties menu

Following the aforementioned steps and by utilizing the above-presented tools the lecture was created. Now, there are some options concerning any possible restrictions that we may want to add. These restrictions can be according to the "Cohort", "Date", "Grade", "Group", "User Profile" or "nested restrictions". More details are presented in Figure 12.
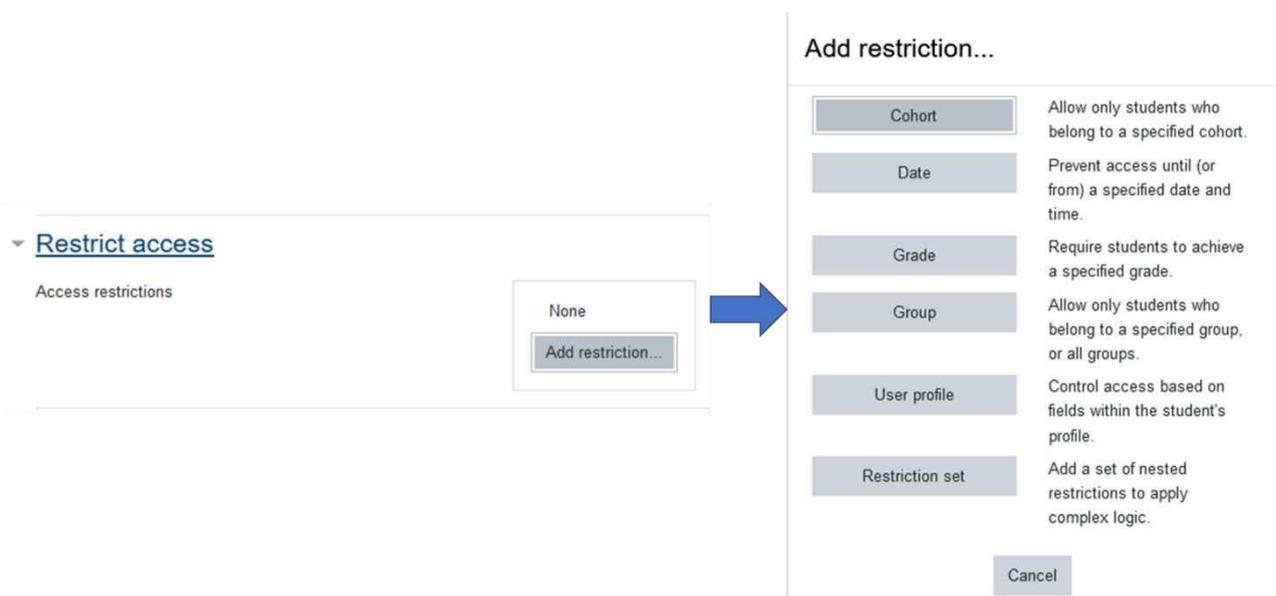
Fig. 12. Adding restrictions menu / options

Finally, there is the options to add activities and / or resources. Through this tool, Questionnaire, Quizzes, and Glossary can be added. Nevertheless, and since no such capabilities were used to create this lecture, there are only presented in Figure 13, and not further analyzed.
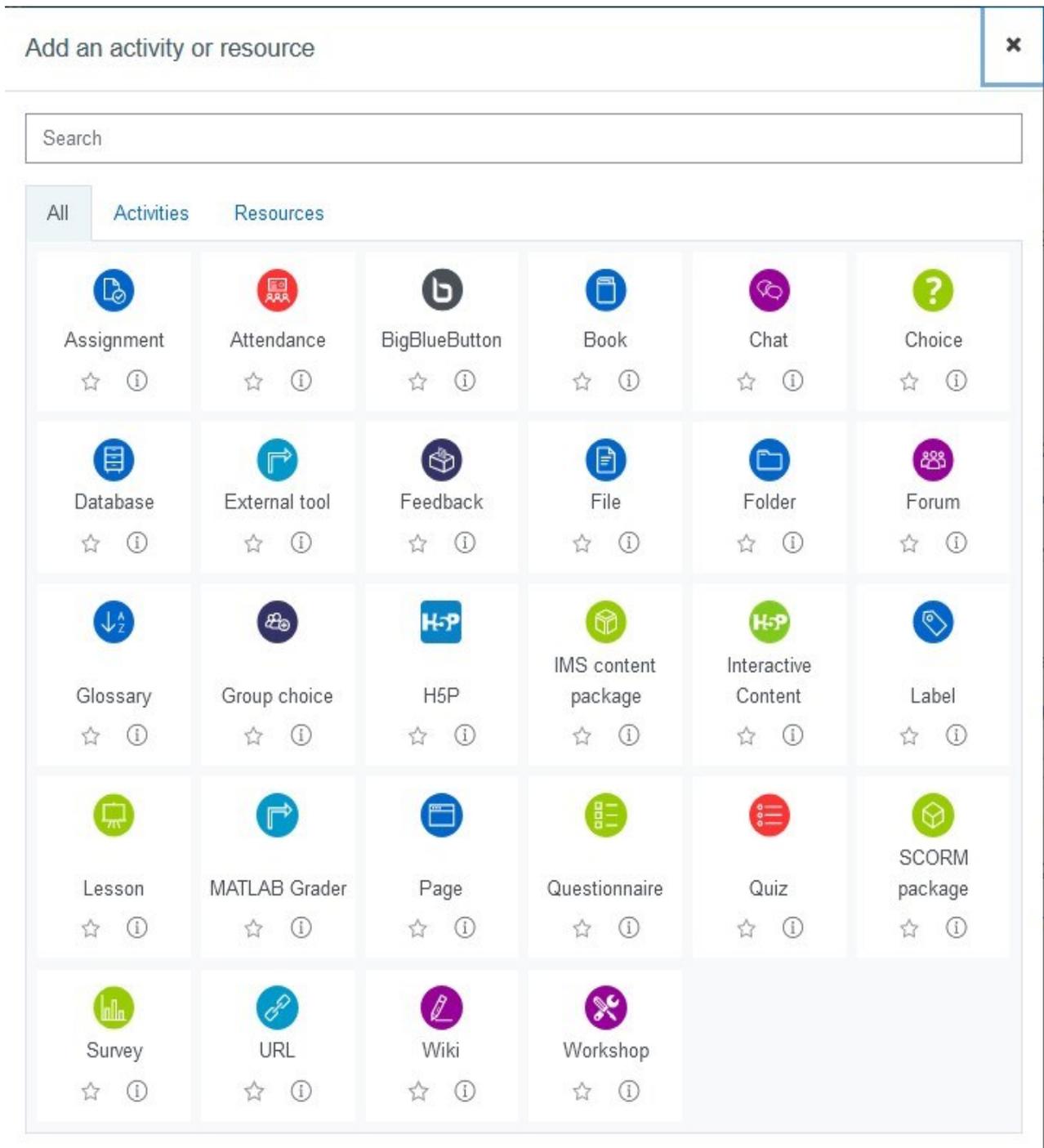
Fig. 13 Additional activities and resources options

Report of Hochschule Furtwangen University

FELIX stands for Furtwangen ELearning and Information eXchange and is the university's central learning platform. Students can find teaching materials related to events as well as important information and announcements from faculties and service facilities in FELIX. FELIX supports teachers in organizing their teaching and helps with communication between teachers and students. To use all functions, teachers have to apply for author rights via ticket. FELIX includes different sections: Digital groups, course, Author area, question pool, VidoCo and HFU service.

Digital groups: digital groups can exist within a FELIX course or independently of a course. Digital groups enable cooperation and collaboration between registered members.

Course: in the Courses tab students can find their courses. For students, this is the most important FELIX tab. Fig. 1 provides the list of faculties and teaching events.
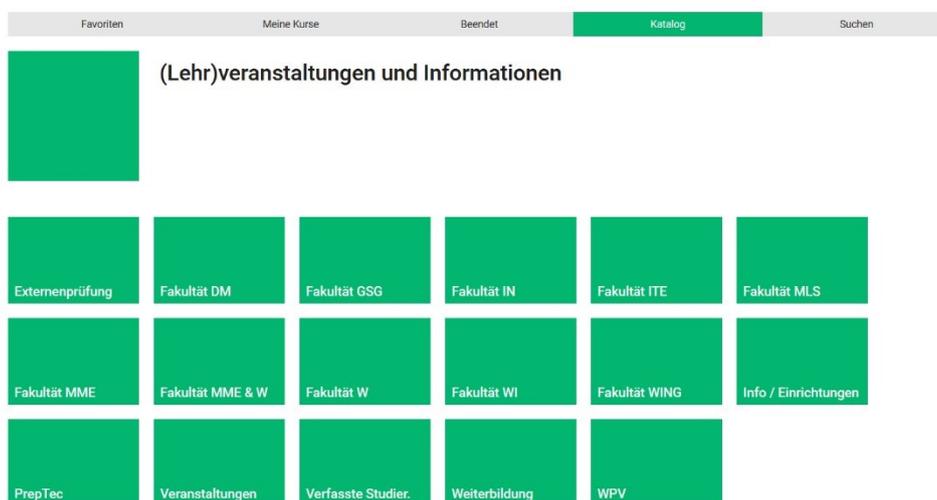
Fig. 1. Teaching events and faculties at Furtwangen University

By clicking on each icon, the list of teaching programs can be seen for each faculty. Each course at each teaching program has an individual page containing general information of course as shown in Fig. 2.

Fig. 2. Information page for course

Author area: in the Author Area tab, authors find their courses, which they have created or for which they are co-owners. For authors, this is the most important FELIX tab. Fig. 3 shows an exemplary page of Author Area.

Fig. 3. Author Area

Question pool: in the tab Question Pool, authors manage all FELIX questions for tests and e-exams. For creating the test, the following questions are available: single-choice, multiple-choice, Kprim, True/False, matrix, drag and drop, cloze (with/without

numerical solution), hot text, hotspot, free text, upload file, sequence and draw. After providing the questions, they can be integrated into the corresponding course.

VidoCo: in the VidCo tab, you will find information about the online conference systems in use at HFU.

- Alfaview: alfaview is the tool for synchronous distance learning at HFU. Online lectures are usually held via alfaview. For this purpose, corresponding rooms have been set up for all faculties.

- MEMEO: MEMEO stands for 'Meet Me Online' and is an online conference system at Furtwangen University based on Adobe Connect. MEMEO is available free of charge to all members of Furtwangen University. MEMEO works with the basic functions with any operating system or mobile device.

- BigBlueButton: BigBlueButton is the alternative on-premise service for online conferencing at HFU. Employees can use BigBlueButton to hold web conferences and presentations.

- Jitsi: this service can be used for smaller meetings with up to 10 participants that can get by without video and want to be conducted on an ad-hoc basis at short notice.

HFU service: in the HFU Services tab, you will find links to important HFU services (e.g. the Studi-Portal, the password change service, LINKEDIN Learning, etc.).

Report of Centoform srl

For the development and implementation of the e-learning courses, Centoform uses two primary platforms for e-learning, and one platform for the development of the didactic materials.

For the development of the IFTS Circular Society course uses the Moodle, open access platform. The platform is fully personalized and learning institutions can upload different types of learning materials, and resources. Moreover, the platforme offers P5H type of resources like: interactive videos, interactive presentations, quizzes, interactive timelines to be created. The organization of the resources is user friendly and easily understandable, moreover the menu with the learning pathways is easily comprehensible. The platform as itself is very known and used all around the world, which guarantees constant update and lack of bugs. Despite the fact that the platform has a lot of positive sides, we can also identify some negative aspects connected with the old-fashioned definition of the pathways and general definition of all learning units or materials as a course. The platform does not allow to structure the learning materials by modules and doesn't have any module assignments. Platform is organized in a hierarchical way and does not allow any peer to peer or peer to teacher connections. That limits the students' possibility to use the platform for the establishment of the learning networks.

The e-learning platform for the Start up Bio project was developed within the e-learning hub of the AKEP. Through the e-learning hub, it is possible to develop professional skills with up to date non formal training methods to support employability and personal development in the agricultural sector. This e-learning allows learners to attend classes from any location of their choice. Additionally, the online platform allows students to access the material any time they need and use it for future reference. The platform offert to the learners a variety of teaching and learning methods: interactive videos, online sessions, didactic materials, etc. Platform also allows short term peer to peer and peer to teacher relations. However it also has several cons. Platforms do not allow to build a more extensive network, and construct the long term peer to peer relation. The set of the live sessions that were performed, give of course, the possibility to interact, but once the session was finalized, no other communication channels are possible.

For the development of the didactic materials that are used during the different courses
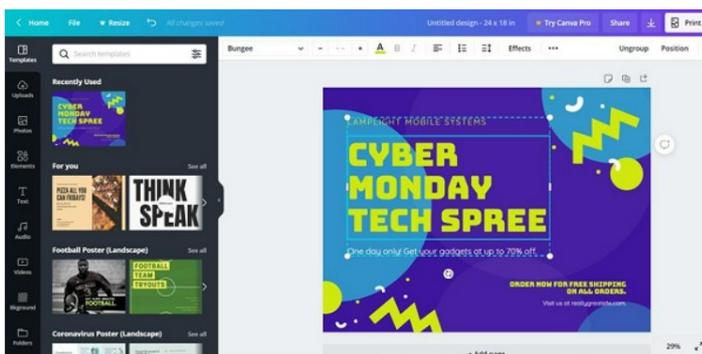
Centoform uses CANVA, the open access platform through which easily produced user -friendly and interactive didactic materials. Through it could be created compelling designs for the didactic materials, presentations, infographics and projects. The platform does not require any previous experience as a graphic

designer to use and with a variety of tools and layouts available, it is possible to swap fonts and images to create a professional design. Despite the variety of the profits and useful tools, it also has several limits that complicate the development of the resources. Canva does not have local file storage. This means if the website is down for some reason, you will need to wait to access your designs to make new changes. There is no possibility for the table creation which makes the description of some data more complicated than in the common excel or word.

To conclude, we could say that there are many pros and cons in the usage of one specific platform. Unfortunately despite the huge potentials and the user friendliness of the tools and platforms, several obstacles still exist that complicate the didactic resources creation or management.

2. Development of a set of tools/templates/procedures/ algorithms for utilization of research results into digital platforms

Politechnika Rzeszowska im. Ignacego Łukasiewicza

- **Algorithm that facilitates the development of the content of an e-learning course, created with the use of the Moodle software, related to scientific research.**

In most cases, scientific articles are published in the PDF format on websites of publishing houses, examples of which are Elsevier (elsevier.com), Springer (springer.com), and MDPI (mdpi.com). To quickly develop an e-learning course based on the results of scientific research presented in the above-mentioned articles the user of the Moodle software must change the file format of a scientific article from the PDF to an easier to edit format, which allows for quick extraction of fragments of the text of an article as well as its figures and tables presenting the results of scientific research.

For this purpose, commercial computer software or free programming environments, which are proposed as part of the algorithm presented in tab. 1, can be applied. An example of a commercial program that can be used to prepare the content of an e-learning course, ready to be used in the Moodle software, is the Microsoft Word. In the case of a free programming environment, the Python programming language with the additional PyPDF2 package can be used.

Tab. 1. Algorithm that facilitates the development of the content of an e-learning course created by using the Moodle software

1st stage
Scientific article saved in the PDF format
2nd stage

Selection of a research article processing tool	
Microsoft Word (commercial software)	Python + PyPDF2 (free programming environment)

Sample article saved in the PDF format and edited by using the Word software.
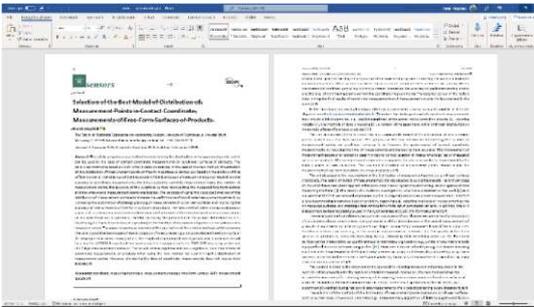 	
	Sample program code based on the PyPDF2 package.
	
	`import PyPDF2`
	
	`filename = 'path'`
	`pdfFileObj = open(filename,'rb')`
	
	`pdfReader = PyPDF2.PdfFileReader(pdfFileObj)`
	
	`num_of_pages =`
	`pdfReader.numPages`
	`count = 0`
	`text = ''`
	
	`while count < num_of_pages:`
	`    pageObj = pdfReader.getPage(count)`
	`    count +=1`
	`    text += pageObj.extractText()`
	
	`print(text)`

3rd stage

Developing the results of a processed scientific article

Advantages / disadvantages of commercial and free solutions

Advantages:	Advantages:
- quick conversion of a PDF file to a format that facilitates editing of a scientific article, - easy extraction of text fragments, figures, and tables, Disadvantages: - manual extraction of text fragments, figures, and tables, - long time to develop the content of an e-learning course.	- automated extraction of text fragments related to parts of a scientific article, e.g., abstract, results of experimental and simulation investigations, - the ability to create separate text files containing fragments of a scientific article, Disadvantages: - the PyPDF2 package does not enable the identification of figures and tables, - the necessity to prepare a computer program enabling the processing of a scientific article.

4th stage

Creating an e-learning course based on extracted parts of a scientific article

Inserting extracted parts of a research article available in the PDF format, which are the results of processing a scientific paper, into an e-learning course by using the Moodle software.
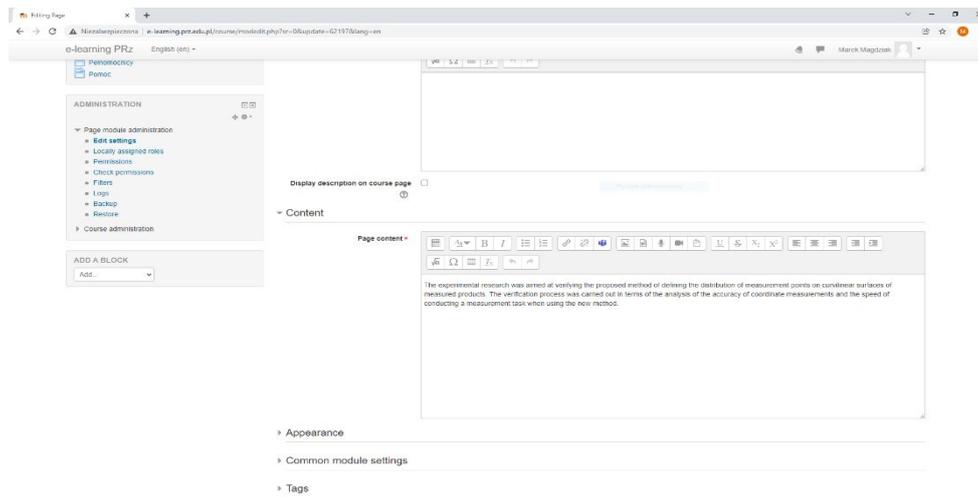
- **Sharing procedures**

Dissemination strategies at partner universities require standard steps which should be followed in order to share research results.

This standard steps have been developed by the EDURES project and are presented in the following figures 1-9.

The following should be considered while content is shared:

- Intellectual Property Rights must be obeyed

- Safety procedures must be respected

- Equal accessibility must be guaranteed

- Opinion of beneficiaries must be taken into consideration

- Sharing must be supported and appreciated by organisation

- Teachers must be obliged to be trained and qualified

- Computer science infrastructure must be delivered
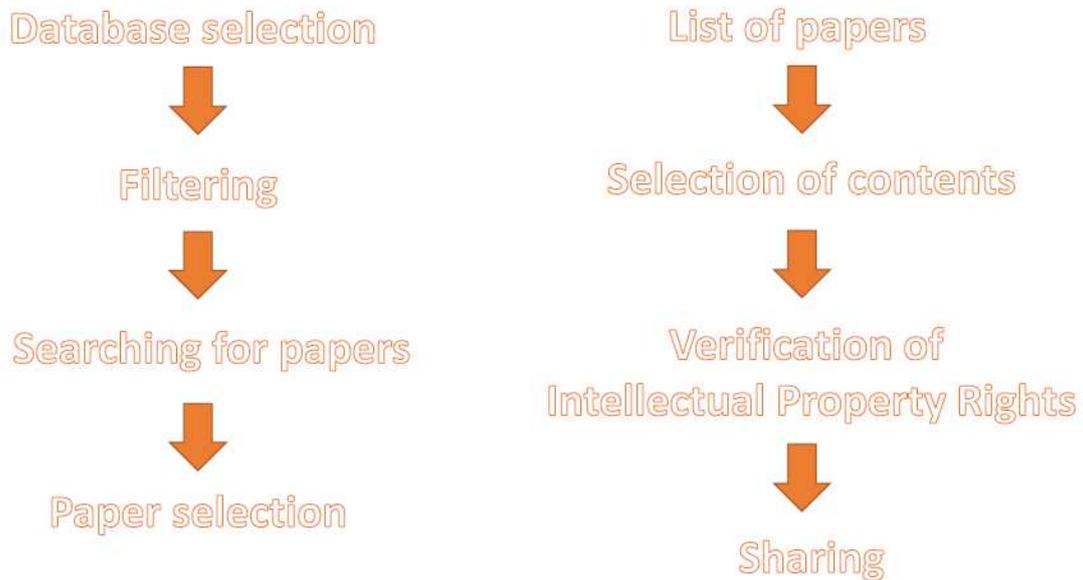
Paper sharing procedure

Database selection

↓

Filtering

↓

Searching for papers

↓

Paper selection

List of papers

↓

Selection of contents

↓

Verification of Intellectual Property Rights

↓

Sharing

Fig. 1

Paper sharing procedure

(continuation)

The choice of a platform/method

↓

The choice of a tool

↓

Content preparation

↓

Content publishing

Fig. 2

Book sharing procedure

Database selection

↓

Filtering

↓

Searching for books

↓

Book selection

List of books

↓

Selection of contents

↓

Verification of
Intellectual Property Rights

↓

Sharing

Fig. 3

Book sharing procedure

(continuation)

The choice of a platform/method

↓

The choice of a tool

↓

Content preparation

↓

Content publishing

Fig. 4

Photo sharing procedure

The choice of an research object

↓

The choice of a tool

↓

Taking a photo

↓

Verification of Intellectual Property Rights

↓

Photo sharing
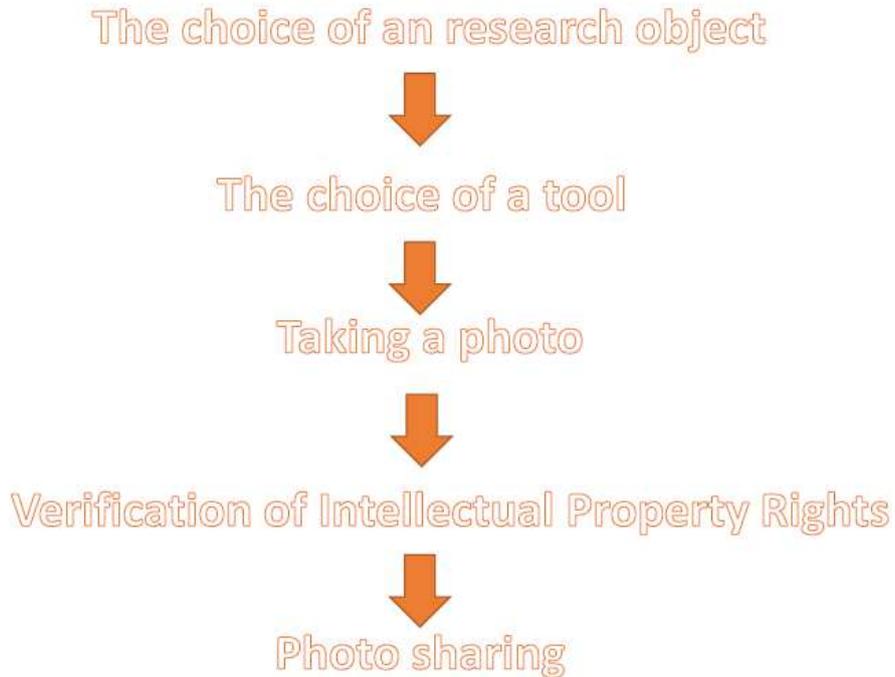
Fig. 5

Video sharing procedure

Recorded object selection

↓

Recording tool selection

↓

Recording

↓

Editing

List of videos

↓

Platform or method selection

↓

Verification of
Intellectual Property Rights

↓
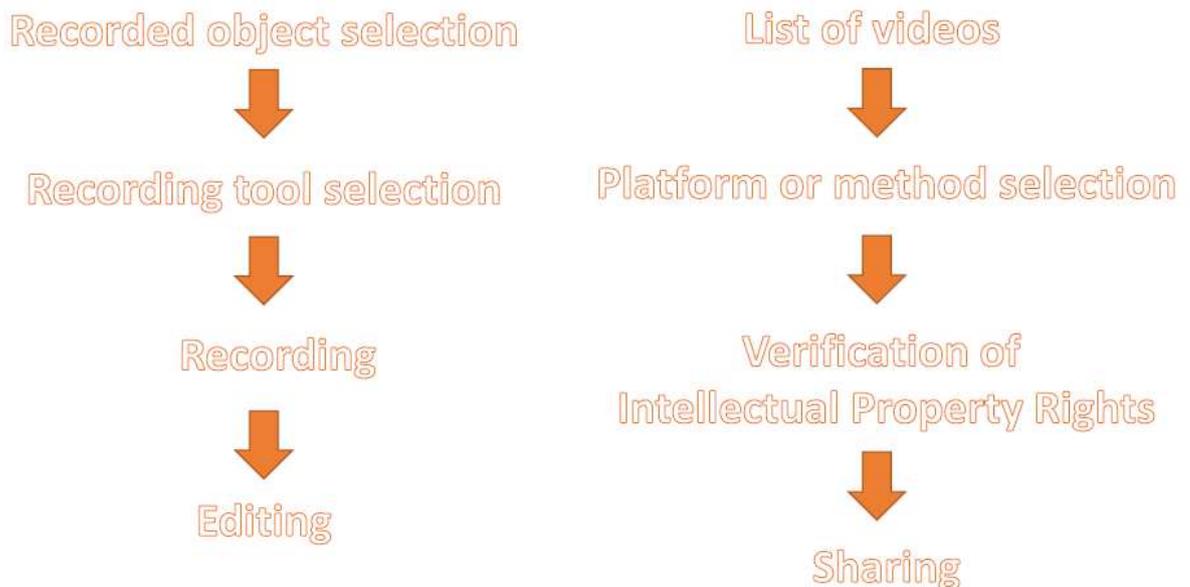
Sharing

Fig. 6

Algorithm sharing procedure

The choice of an research object

⬇

Algorithm preparation and final editing

⬇

Verification of Intellectual Property Rights

⬇

Algorithm sharing
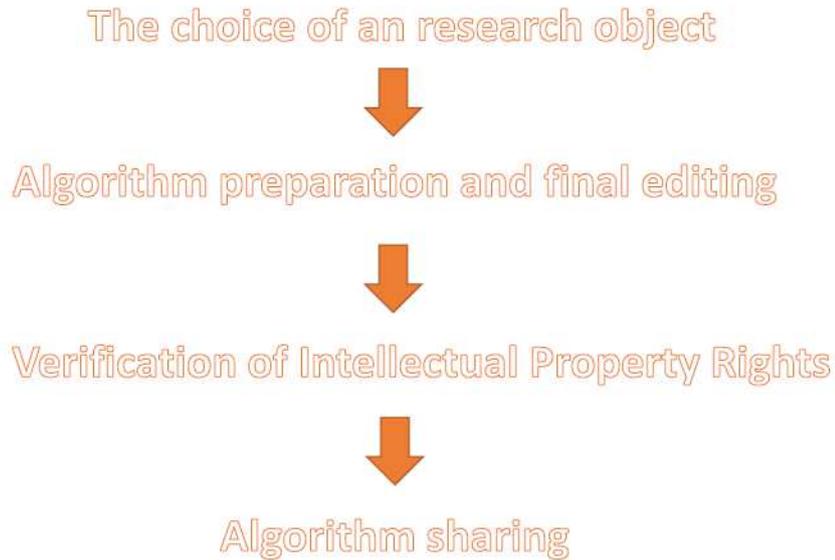
Fig. 7

E-learning materials sharing

The choice of materials

⬇

The choice of an e-learning platform

⬇

The choice of e-learning platform tools

⬇

Verification of Intellectual Property Rights

⬇

Materials sharing

Fig. 8

Infrastructure sharing

The definition of needs

↓

Serching for the existing infrastructure

↓

The choice of tools/devices/software/machines/etc.

↓
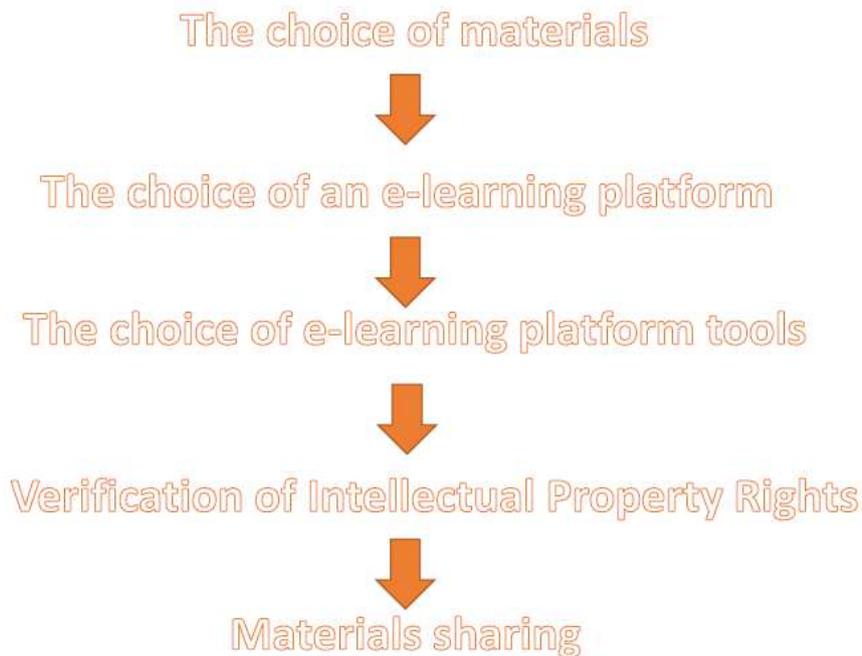
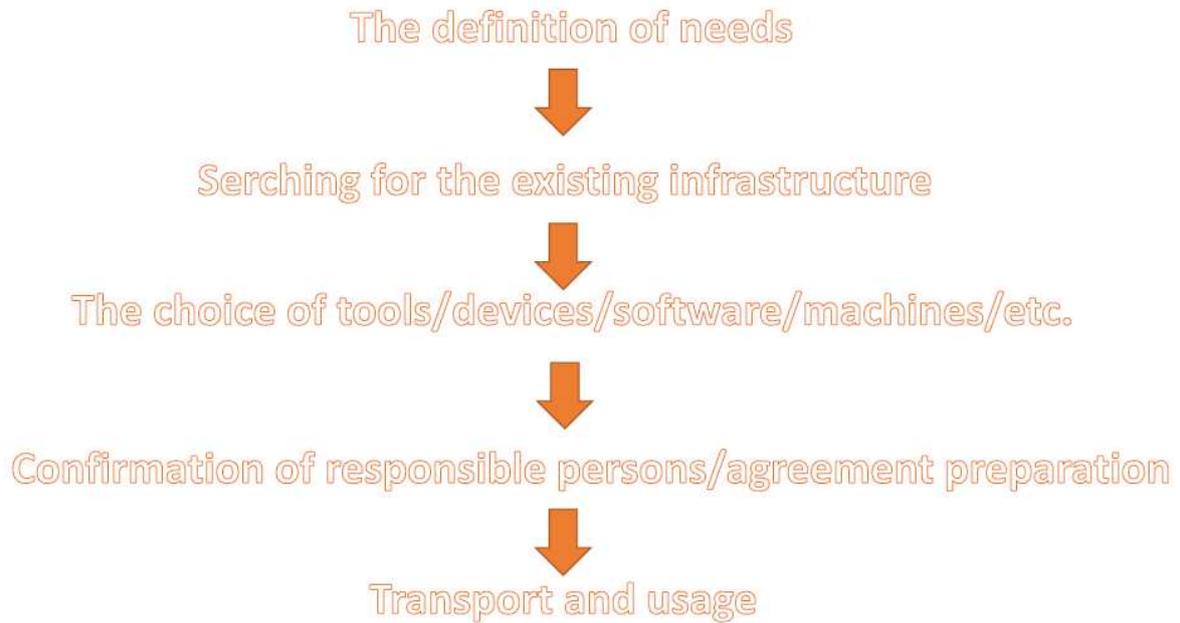Confirmation of responsible persons/agreement preparation

↓

Transport and usage

Fig. 9

National Technical University of Athens

The utilized software Moodle can, in general, be considered as a complete and very practical platform to create, present and communicate e-learning courses. It is very user-friendly, and at the same time, it provides numerous of options to enrich the course with additional helpful activities and/or resources. Thus, our suggestions for improvement do not pertain to the main "core" of the platform, but comprises some additional capabilities/options. More specifically, we consider that the capability of downloading the course in an editable format, the option to hyperlink a course element with multiple resources, and an add-on for "Reference management software" would be useful and enable us to upgrade the quality of the offered services.

E-books have, nowadays, gained remarkable popularity, hence, the classic books have been replaced by notepads and tablets to a large extend. Therefore, the capability of a student to download and save off-line a course would be very useful and in line with the modern technological and digital trends. The off-line save serves two main purposes: At first, the student will be able to have access to the course from anywhere, regardless the internet connection or any other limitations. At the same time, since the courses have mainly an educational scope, the student may "build" a digital library with unlimited and indefinitely access to the course's information. Another also significant aspect, is that the format of the downloading file must be editable, so that the student is able to take notes and study from this course. We should always have in mind that e-courses aim to replace, at a certain level, the classic books. Thus, they must facilitate the study in every level. Finally, copy-rights issues can be addressed by introducing some kind of watermark.

Our second suggestion is that some course elements could be hyperlinked with multiple resources. For example, a reference can be hyper-linked with a URL (e.g., of the respective publication). Additionally, it would be very practical if the same reference is also hyper-linked with some supplementary resources, like the abstract of the paper, and/or some characteristic images, or even many multimedia resources. As a result, the student can choose between being redirected to the publication site, reading the paper's abstract (which would be in the form of a brief side comment text), or being redirected to the relevant multimedia resources, simply by clicking on this reference. That way, additional information can be provided, rendering the study more interactive and flexible. Considering the previous suggestion, when someone downloads the course, any text-type hyperlinked resource will also be included in the downloaded file as a side comment.

Our final suggestion is to integrate a proper add-on of "Reference management software". Since the course creator probably owns a digital library of scientific publications, which may utilize to build the course, it would be very useful to the user to be able to directly insert the relevant references without the necessity of intermediate software or the need to insert them by hand.

3. Testing the developed tools/templates/procedures/ algorithms in platforms

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- **Editing two research papers by using the Microsoft Word software.**
  - Paper with one column.

Report on the e-learning platforms utilization

o Paper with two columns.

All information regarding text, figures, and tables of two considered papers can be easily exported from the Microsoft Word software to an e-learning course created by using the Moodle software.

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Suggestions

Our suggestions for improvement pertain to some additional capabilities/options of the Moodle Platforms. More specifically, we consider that:

- the capability for downloading the course in an editable format
- the option to hyperlink a course element with multiple resources • an add-on for "Reference management software"

would be useful and will upgrade the quality of the offered services.
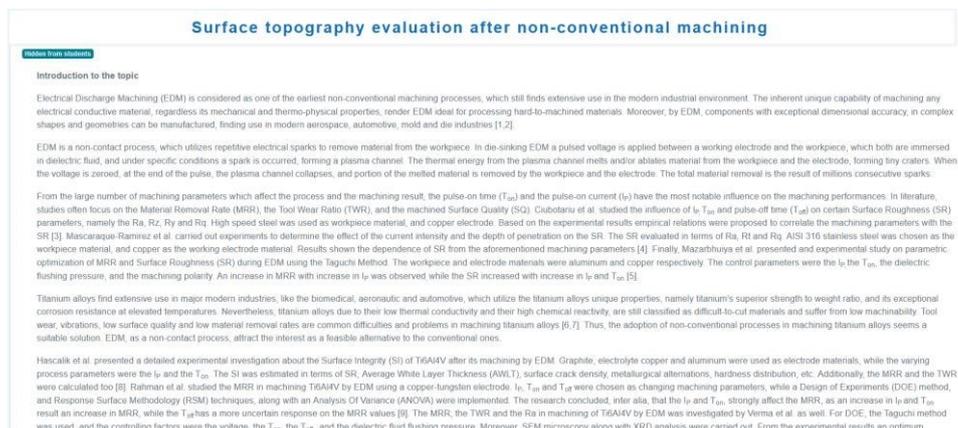
Fig. 1. Screenshot of the lecture in the format that students have access.

As we can see from the screenshot of Figure 1, there is no option and capability for the students to download the course in an editable format. Thus, we believe that it could be an improvement, and a significant facilitation for students if, by clicking on the course title they could have the option to download the lecture in an editable format (like .doc and/or .pdf).
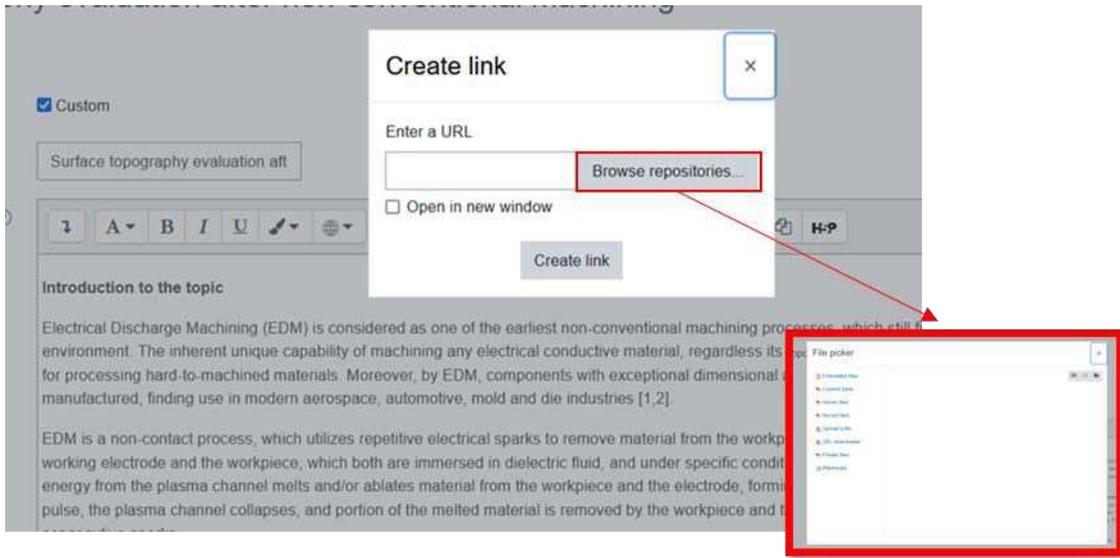
Fig. 2. Screenshot of the options for adding a hyperlink

As we can see from the screenshot of Figure 2, there is no option to add multiple supplementary resources, rather the option to enter an URL, or a file from the repositories. We believe that it would be very practical if, in the same reference, could be incorporated more than one hyperlinks, e.g., an URL and some supplementary resources, like the abstract of the paper, and/or some characteristic images, or even many multimedia resources. As a result, the student can choose between being redirected to the publication site, reading the papers abstract (which would be in the form of a brief side comment text), or being redirected to the relevant multimedia resources, simply by clicking on this reference and having the respective options. That way, additional information can be provided, rendering the study more interactive and flexible. Moreover, considering the previous suggestion, when someone downloads the course, any text-type hyperlinked resource will also be included in the downloaded file as a side comment.

Fig. 3. Screenshot of the editing options

As we can see from the screenshot of Figure 3, there is no option to automatically add the bibliographic references. Since the course creator probably owns a digital library of scientific publications, which may utilize to build the course, it would be very useful to the user to be able to directly insert the relevant references without the necessity of intermediate software or the need to insert them by hand. This can be implemented by integrating a plug-in, like the one that Mendeley provides for the text editors (see Figure 4).
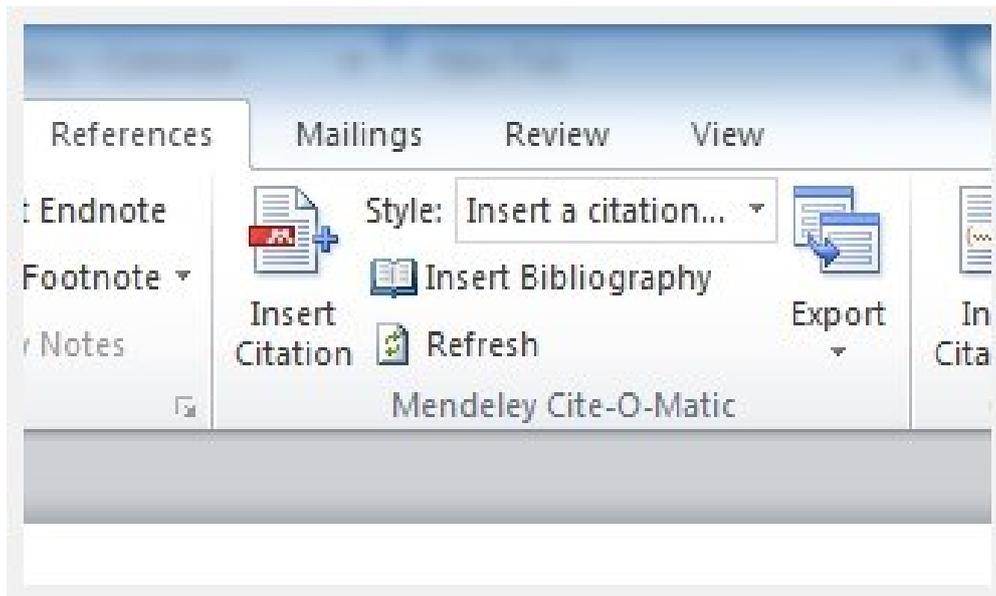
Fig. 4. Mendeley plug-in for word

Conclusion

Analysis of possibilities of the selected e-learning platforms indicates various areas of their utilization for the aims of research-based education.

Teachers may look for various existing tools within digital platforms and use them in the process supporting research results dissemination. Moreover, the research results may be obtained in some cases in a distance learning mode by students participating in i.e. laboratory classes. The new functionalities supporting research results implementation in the e-learning environments may significantly help teachers in obtaining better attention of students and accelerate innovative technologies transfer to the industry.

Notes