SUPPORTING THE DEVELOPMENT OF TECHNICAL CREATIVITY AMONG ELEMENTARY EDUCATION STUDENTS DURING THE COVID-19 PANDEMIC

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Abstract The lockdown and the following closure of the University of Maribor created unequal working conditions among both students and staff in those areas of study where much emphasis is placed on practical work. In the Didactics of Science and Technics II course, the content of the course was adapted and designed to focus on technical creativity and monthly project activities instead of prefabricated exercises and products. The exercises consisted of four monthly projects, where students produced various products and reported and presented their results at the end of each project. An evaluation questionnaire was distributed to all participants in the course. The questionnaire was completed by 57 of the total 88 students. The results of the study show that the design of the course, based on technical creativity, fully met and exceeded the expectations of the students and, most importantly, compensated for inequalities and enabled each individual to successfully fulfil the course obligations.

Keywords:
science and technology,
technical creativity,
evaluation,
COVID-COVID-19 pandemic,
elementary education

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1 Introduction

An important fact of modern times is that the acquisition of certain competences necessary for a future teacher's work in the classroom depends on various forms of formal as well as informal learning. However, unpredictable situations can inhibit or even encourage the success of acquiring these competences. Faculties of education, as institutions for the training of new pedagogical staff, find themselves in a major gap in some situations. They are well aware of the fact that the goal of teacher education is actually to prepare students for successful performance in direct practice. However, events like the COVID-19 pandemic in 2020 can quickly change the quality of the process of future graduates acquiring the competences they need. We must not forget that the best time for future teachers, in terms of acquiring certain competences and developing favourable beliefs in various areas of their continued work, is the time of their studies (Haney et al. 1996; Hribar & Fošnarič, 2016).

In the context of shaping the character of a classroom teacher, the fact that the process of acquiring students' knowledge, skills and habits during their studies must be holistic across the entire vertical, is very important. In this regard, the mechanisms for acquiring certain specific competences, which are the subject of this study, are closely based on the generic competences, which in their essence form their foundation. For example, problem solving, logical thinking, technical creativity, motivation to work in a team, and the ability to search for, select and use relevant data and information with the help of information and communication technology (ICT). Although we know that the process of collaboration is important for the professional development of future teachers, as such a collaborative aspect affects both the development of the individual and the development of the institution as a whole (Fullan & Hargreaves, 2000), certain unexpected situations simply begin to hinder this.

Within the implementation of the pedagogical process of training future elementary school teachers at the Faculty of Education at the University of Maribor, basic technical-technological education is also an important element. In its primary context, it is closely related to the search for creative elements in students, which should be expressed in their applied dimension in direct pedagogical practice. Although creativity can usually be described as the production of useful solutions to problems or new and interesting ideas in various professional fields (Amabile 1996; Oldham & Cummings 1996; Zhou & George 2001; Mishra & Henriksen 2018), its promotion can be special, especially in the technical field. Therefore, at the Faculty of Education, when implementing technical and technological content in the classroom, we are constantly looking for ways to foster students' innovation and creativity. In fact, we try to follow the development of creativity in this field so that future teachers will be able to develop problem-solving skills in a new, original, diverse (divergent) way or focus on creating something new and unique, according to Pečjak (2013). We recognize that teaching takes place in a complex space where a high degree of flexibility is required to support learning practices. Therefore, technical creativity, as well as creativity in general, cannot be fostered in the educational system itself without the students, as only they bring it into practice later as teachers (Hall & Thomson, 2005).

The lockdown and closure of the Faculty of Education undoubtedly caused a major problem, especially in the practical field of implementing activities.

Thus, teachers and students had to quickly rely on their own ingenuity. This is reminiscent of the well-known "learning school" (Holly & Southworth, 1989).

This description of a "learning school" indicates that it is extremely important for the development of the future teachers that they are not left to themselves, but that they are given opportunities and incentives to participate. All of this was impaired by the COVID-19 pandemic and the closure of the university. In this case study, the authors wish to demonstrate certain elements of adaptation to the situation in the Didactics of Science and Technics 2 course from the Elementary education study program at the Faculty of Education at the UM. The adaptation and the modified implementation, including the conducted research, are based on a different approach to the acquisition of students' competences, focusing on the development of technical creativity with students' work adapting to the dynamics of project work, instead of conducting classic assembly exercises and products. In this way, an attempt is made to even out the inequalities and constraints among students resulting from the unforeseen COVID-19 pandemic. The authors are convinced that in this context they have even managed to take a step forward.

2 Insights Into the First COVID-19 Lockdown at the University of Maribor

In response to the COVID-19 outbreak most universities around the world transitioned to online environments (Usak et al., 2020). Hodges et al. (2020) referred to this transition, which began overnight and with much improvisation, as Emergency Remote Teaching (ERT). While teachers had at least some freedom to adapt their teaching to Online Distant Education (ODE), students only had the choice to follow their teachers. Therefore, the term Forced Online Distance Teaching (FODT) was introduced as a description of university teaching practices during the closure of the university, and the term Forced Online Distance Education (FODE) was introduced as a description of university education practices during the closure of the university. ERT caught teachers off guard, and they immediately responded by introducing FODT, which should be distinguished from Voluntary Online Distance Teaching (VODT) and Online Distance Teaching (ODT) (Ploj Virtič et al., 2021; Dolenc et al., 2021).

During the first COVID-19 lockdown, three comprehensive studies combining the topics of positive/negative side-effects and the students'/educators' preferences in engaging with FODE at the University of Maribor were conducted.

The first study, titled "Changes in online distance learning behaviour of university students during the coronavirus disease 2019 outbreak, and development of the model of forced distance online learning preferences" (Ploj Virtič et al., 2021), aimed to investigate the response of university students to the new situation. The research sample consisted of 750 university students from the University of Maribor, of which 448 student responses were considered complete. The highlights of the study were:

- The transition to ODE cannot be considered a transition to asynchronous learning because of the prevalence of synchronous and blended lectures. Even though ODE can be utilised anywhere and anytime, it was only used anywhere.
- The biggest jump during ERT occurred with the introduction of the MS Teams videoconferencing system, which was used the most during lockdown but had been hardly used by the students before.

- Student satisfaction with Online Distant Learning (ODL) has a statistically significant impact on their continued preference for ODL; however, student attitudes toward online learning do not have a statistically significant impact on satisfaction with ODL.
- There are major differences between large group and small group teaching. Working with small groups of students allows for more individualized teaching and learning experiences.
- Students desired more asynchronous activities that would be more meaningful than synchronous ones.

The second study, titled "Perspectives on lessons from the COVID-19 outbreak for post-pandemic higher education: Continuance intention model of forced online distance teaching" (Dolenc et al., 2022), aimed to investigate the response of university educators to the new situation. A call for participation was sent to all potential respondents (n = 914). The research sample consisted of 290 university educators from the University of Maribor, of which 74.4% were professors and 25.5% were teaching assistants. The highlights of the study were:

- Most of the teachers used the video conferencing system to transfer their lectures into an online "talking heads" format, which is a passive format from the students' perspective. Active methods involving active student participation were less common.
- Most teachers understood asynchronous teaching as the provision of course materials and instructions to be completed outside of lecture time.
- FODT helped many teachers to "get out of their comfort zone" and try new methods and forms of ODT, but many of them will return to traditional teaching when the university reopens.

The third study, titled "The difference in views of educators and students on Forced Online Distance Education can lead to unintentional side effects" (Dolenc et al., 2021), aimed to examine the difference between educators' and students' views on FODE during the first COVID-19 lockdown. This study was part of two previous studies and focused solely on the responses to two open-ended questions. The research sample consisted of 347 university students and 210 university educators. The results of the study were as follows:

- Students and educators shared most of the negative and positive views; however, there were unique views that were not shared between the two groups. The negative views outweighed the positive views.
- Although the educators were able to adapt or change the teaching environment, their views were more negative than those of the students, who could only adapt to the environment chosen by their educators.
- Even when students do not have a choice, they find positive aspects that are not based on learning experiences or technology, but on domestic comfort and prosperity.

The valuable insights and highlights from these studies were used to prepare and adjust courses during the second COVID-19 lockdown, which occurred shortly after the beginning of the new academic year.

The second COVID-19 lockdown was different from the first. It was longer and lasted the entire academic year and was also accompanied by severe restrictions. The academic year began with a hybrid teaching model with various constraints regarding the number of students in classrooms and live teaching. After only 14 days, the entire pedagogical process was transferred online, immediately following the restriction of movement between statistical regions and the restriction of free movement of people. A week later, this was followed by new restrictions on cross-border movement between municipalities and the prohibition of offering and selling goods and services to consumers, with the exception of grocery stores. Students were condemned to study in their own, generally confined space, with no ways to socialise or acquire the necessary materials and equipment for the areas of study where much emphasis is placed on practical work.

3 Case Study: The Didactics of Science and Technics II Course

The Didactics of Science and Technics II course is taught in the 4th year of the Elementary Education program. The course consists of 30 hours of lectures, 29 hours of exercises (tutorial), and 1 hour of another form of study (my.UM 2022). Students also complete 60 hours of individual work, which is part of the course. During lectures, all students are grouped, and during exercises, the students are divided into groups. Both lectures and exercises are scheduled for two hours per week.

The main goal was to dispel the myth that exercises performed in a workshop cannot be performed remotely. This myth was built up during the first COVID-19 lockdown, where these types of exercises were generally put on hold and performed in a compressed fashion after the lockdown ended. Based on the findings from the studies (Ploj Virtič et al. 2021; Dolenc et al. 2022), the exercises were transformed into asynchronous activities, so that the students had active control over the time and place of learning/working. Information and communication technology (ICT), which according to the study (Dolenc et al. 2021) had the most negative impact on students, owing to connectivity problems and weak hardware, was primarily used to document and submit their work.

The content of the course was also adapted and designed to focus on technical creativity and monthly projects (*Figure 1*) rather than pre-packaged exercises and products, which compensated for the inequalities and limitations among students.

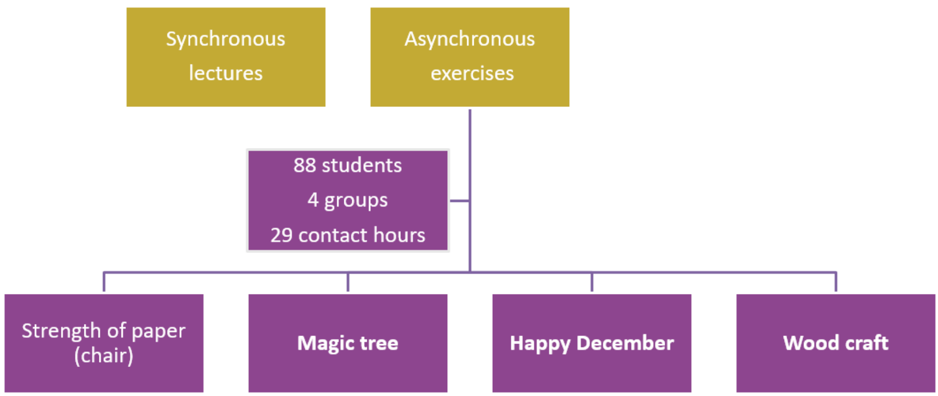

Figure 1: The organigram of the Didactics of Science and Technics II course
Source: own.

The lectures were synchronous, mainly because of student contact with the course. The asynchronous activities had monthly meetings and individual feedback through the instant response system on MS Teams. The activities consisted of four monthly projects, where the students made various products and reported and presented their findings at the end of each project. Following the course, a custom exam was given remotely, without cameras and with mandatory video conferencing presence. The students who attended the course came from all over Slovenia, from Murska Sobota to Nova Gorica and everywhere in between. Two students even attended the course while on an Erasmus exchange in Lisbon.

3.1 Project: The Strength of Paper (Paper Chair)

The Strength of paper project was a preparatory project and lasted only 14 days. The project consisted of two assignments. First, the students had to test and evaluate the strength of multiple paper profiles (*Figure 2*).

Figure 2: Example of testing the strength of paper profile legs
Source: own.

The students constructed tables, using a hardcover book as the table surface, paper profiles as the legs, and ordinary food as the weights. They calculated the mass before the table collapsed and then compared the data for different paper profiles.

In the second exercise, the students used what they had learned about paper profiles to design and make paper chair legs that could support their own mass (*Figure 3*).

An important goal of the project was also to test and evaluate the submitted project documentation, so that the students learned how to prepare and submit clear, complete, and accurate project documentation. Therefore, each student received personalised feedback on their project documentation. The most common errors were related to reading the instructions, following the instructions, and preparing the project documentation in a way that would allow the teacher to assess and evaluate their work. At the end of the project, the students discussed and evaluated the most common errors and problems in a group video conference.

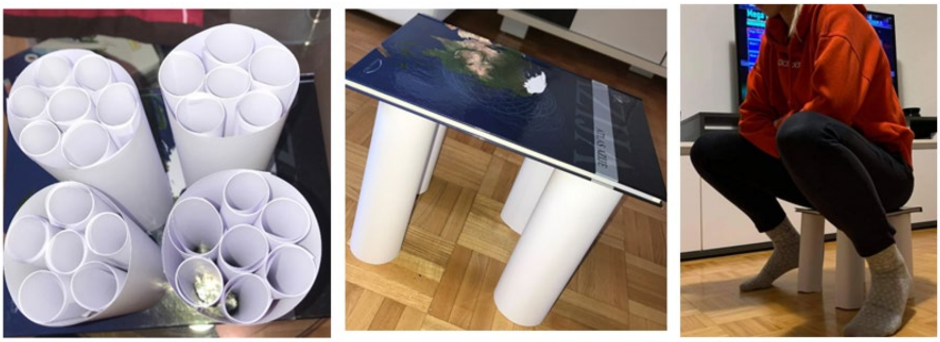

Figure 3: Example of constructing and testing paper chair legs
Source: own.

3.2 Project: Magic Tree

The Magic Tree project was designed in such way that the students first developed an idea and then used any material they could find. It was based on the idea that the Magic tree is a very special tree that allows one's imagination and creativity to run wild. It is a tree that can inspire, teach, tell stories, or simply spark the imagination. Because a project, based on such broad premises, could lose control and allow the imagination to run wild, the students were given the following limitations:

- The Magic tree should be a tree, at least in essence. It must have roots, a trunk, and a canopy.
- The magic tree should be free-standing and measure between 50 and 150 cm.
- The choice of material for the Magic tree is arbitrary. It may be constructed of trash (reuse), natural materials (collected on a long healthy walk), homemade materials (collected while cleaning a room), or all of the above plus something else. The choice is yours.
- The Magic tree must be meaningfully integrated into any content at the elementary level, it can be cross-curricular, it can be part of activity days,

part of a competition, a project that spans the whole school year, or any other part of the school curriculum.

The subject areas of the Magic trees designed and produced were mostly interdisciplinary, some were universal. Most of them were connected to the subject of Science and Technics (42), followed by Environmental and social studies (39), the Slovenian language (32), Art (28), Mathematics (9), Physical education (7), Social education (6), and Music (3).

The ideas for inclusion in the desired subjects were mostly unique. For example:

- Environmental and Social Studies (*Figure 4*, item 1): Family tree and naming of the family members.
- Environmental and Social Studies (*Figure 4*, item 2): Learning about the seasons and fruits that grow on trees.
- Science and Technics in fourth grade (*Figure 4*, item 3): Relating an animal's external appearance to its lifestyle and environment.

Figure 4: Examples of the students' Magic trees
Source: own.

Some innovative and unique Magic trees were designed to be interdisciplinary (*Figure 5*).

Figure 5: Examples of interdisciplinary Magic trees
Source: own.

The most common materials used were paper (80), natural materials (53), plastic (49), waste material (46), metal (33), wood (29), and textiles (11), but most trees consisted of a variety of materials (*Figure 6*).

Figure 6: Examples of the materials used in the Magic trees
Source: own.

Most of the Magic trees were intended for classroom use (61), while 26 magic trees were planned for activity days and 7 for long-term project work. Of the Magic trees, 58 were designed as learning tools and 44 as student products. Some were designed as both.

3.3 Project: Happy December

December is traditionally the most festive month of the year. Products made at school and at home are usually associated with Christmas and New Year. With lockdown, movement restrictions, closures, and FODE, December was also the most difficult month in terms of student motivation and well-being. Not only did they suffer from a lack of motivation to study, but also from social deprivation. From their perspective, these were the first holidays, during which they could not celebrate with friends and extended family. The design of the project was strongly influenced by the difficulties the students experienced. Therefore, the Happy December project was planned as a team effort in families with holiday-themed products.

The students were given the following instructions:
In the Happy December project, we will remember those who mean a lot to us and ease our loneliness, as well as those who cannot be with us because of the current measures.

We will be making four products, namely:

- A greeting card (for someone we cannot visit).
- Holiday decorations (to brighten the holidays for a loved one).
- Christmas tree ornaments (to remind us that we can do anything).
- A snowman (to awaken the child in you, or to cheer up your siblings. nephews and nieces, or children from your neighbourhood).

Your job is to have fun at work, make new memories, and spend the holidays in as carefree a manner as possible. There is nothing wrong with inviting your loved ones to create with you, in fact, it is desirable to do so.

The greeting cards were designed and made in a variety of ways (*Figure 7*). The students used various techniques and materials to create traditional greeting cards, and some students made greeting cards that were more in line with the pandemic situation.

Figure 7: Examples of the students' greeting cards
Source: own.

Most of the students designed and made indoor and outdoor Christmas decorations (*Figure 8*) related to Christmas.

Figure 8: Examples of the students' holiday decoration
Source: own.

Sewing was the preferrable option for making Christmas tree decorations. Most of the students designed and made hanging tree ornaments (*Figure 9*).

Figure 9: Examples of the students' Christmas decorations
Source: own.

The last activity allowed for some customization, mostly related to where they lived and the amount of snow available. Some students lived in areas with no snow or where there was just a dusting of snow. The materials used for the snowman were flexible (*Figure 10*). The students could use bread dough, pastry dough, modelling clay, or any other material that could be used to build a snowman.

Figure 10: Examples of the students' snowmen
Source: own.

The combination of teamwork with family members and Christmas-themed tasks was successful in motivating the students. In the project documentation, a large majority of students reported more than four products being necessary, and their creativity was at its peak.

3.4 Project: Woodcraft

The Woodcraft project was designed to require students to make a functional product out of wood. They could use any type of wood, from branches and sticks they found in the woods to semi-finished wood products, such as boards or plywood. The students also had to use at least four of the basic woodworking processes (drawing, measuring, clamping, cutting, sawing, drilling, sanding, joining – gluing, nailing, screwing, doweling – or surface protection) in making the product. They were advised that the complexity and function of the product would play an important role in evaluation.

The majority of the products were various types of chairs and footrests (*Figure 11*).

Figure 11: Examples of the students' chairs and footrests
Source: own.

Some products were designed to be used as functional objects in the students' living area (*Figure 12*).

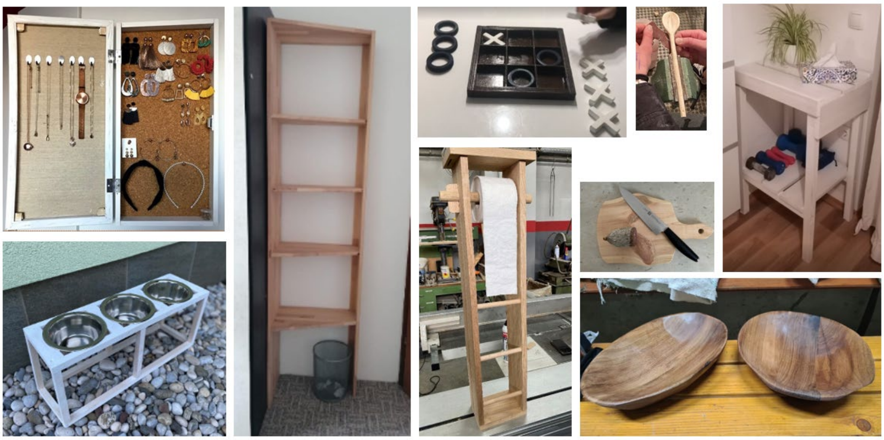

Figure 12: Examples of functional objects in the students' living areas.
Source: own.

Some of the products were also made out of a combination of materials, with wood as the main material (*Figure 13*).

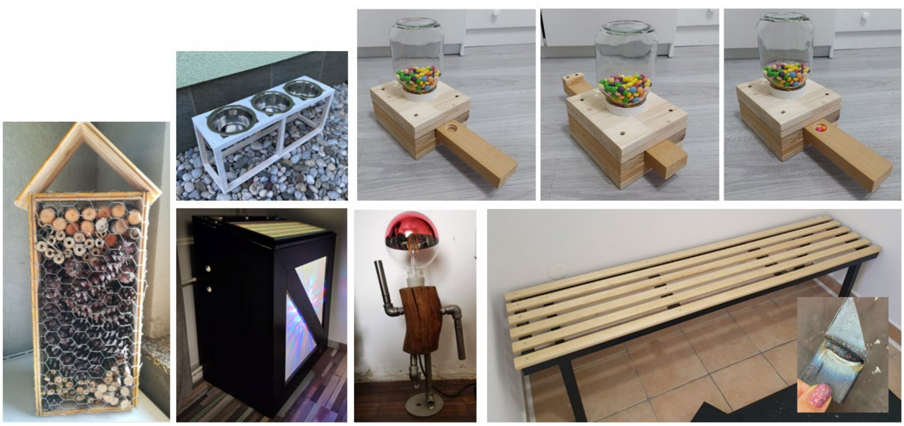

Figure 13: Examples of the students' products made of a combination of materials
Source: own.

The activity allowed the help of a family member who usually acted as an observer. Most often, the students described the role of the observer as an "instructor" who explained the use of machines and tools and oversaw their safety during the manufacturing process.

3.5 Evaluation of the Course

The students were asked to fill out an evaluation questionnaire after completing all of the course activities. Answering the evaluation questionnaire was voluntary.

Owing to the lockdown caused by COVID-19, an open-source web survey application 1Ka (University of Ljubljana, 2021) was chosen for data collection. The call for participation in the survey in the form of an evaluation questionnaire was sent to the course's MS Teams group. A reminder was sent one week after the initial call. After two weeks, data collection was completed. The survey was anonymous, and the responses were taken as consent. An opt-out option was recognized in that no fields were marked as mandatory, and no participant was subject to abuse or could take advantage of the response.

The sample consisted of 56 out of a total of 88 students, who had completed the course and were willing to participate in the survey.

The evaluation questionnaire consisted of five different parts, however for this case study, only the first two parts are relevant, wherein the authors asked for:

- The students' views on the course (7-point scale ranging from "Completely disagree" (1) to "Completely agree" (7));
- An evaluation of the course (10-point scale ranging from 1 for negative to 10 for positive); and
- An evaluation of the course (open-ended comments).

Data collected with the online system were stored in a spreadsheet file. Descriptive statistics were calculated using the IBM SPSS statistical program. Means and Standard Deviations (SD) were calculated based on frequency of responses and are shown in the tables below. The validity of the scales was ensured by using scales that had already been tested in previous studies.

3.5.1 Students' Views on the Course

The students' views regarding the usefulness of the subject of technics and product manufacturing in the educational process are presented in *Table 1*.

Table 1: The usefulness of the field of technics and the usefulness of product manufacturing

Statement	N	Mean	SD
Before taking the course, I had a good opinion of the usefulness of the field of technics in the educational process.	57	6.0	1.03
Before attending the course, I had a good opinion of the usefulness of making products in the educational process.	57	6.0	0.96
The contents of the exercises have positively changed my opinion about the usefulness of the field of technics in the educational process.	57	5.8	1.66
The contents of the exercises have positively changed my opinion about the usefulness of making products in the educational process.	56	6.0	1.66

The results show that the content of the exercises positively altered the students' already high opinion of the usefulness of the field of technics and the usefulness of making products in the educational process.

The students' opinions regarding content of the exercises and their implementation are presented in *Table 2*.

Table 2: Content of the exercises and their implementation

Statement	N	Mean	SD
I liked the way the exercises were conducted.	57	6.2	1.08
I think the manner in which the exercises were conducted was most suitable in the given situation.	57	6.8	0.45
I expected to gain more skills and knowledge during the exercises.	57	3.2	1.74
I think that I was able to express my creativity and originality in the exercises.	57	6.6	0.92

The results show that the students thought that the exercises were most suitable and suited them in the given situation. They thought that they were able to express their creativity and originality. However, some of them had expected to acquire more skills and knowledge during the process.

The students' opinions on the products and the product making process are shown in *Table 3*.

Table 3: Products and product making process

Statement	N	Mean	SD
I drew sketches of my ideas before I started making the products.	57	4.5	1.89
My idea for the design changed when I started collecting the materials for my product.	57	4.5	1.67
The products would be better if I had access to all the materials to make them.	57	5.2	2.02
The products would be better if I had access to tools and a workshop.	57	4.7	2.21
The products would be better if I had made them at the university.	57	3.8	1.73

The results show that most students sketched their ideas before making their products, but they changed the design when they started collecting materials for a product. They believe that the products would have been better had they had access to all the materials to make them. They also believe that the products would have been better had they had access to tools and a workshop, however, the majority of them believed that the products would not have been better if they had made them at the university.

In the second part, the students were asked to rate ten areas within the Didactics of Science and Technics 2 course using a 10-point system.

Table 4: Evaluation of the Didactics of science and technics 2 course

Areas	N	Mean	SD
Implementation of the lecture	56	9.2	1.57
Implementation of the exercises	57	9.8	0.58
Responsiveness during the lectures	56	9.3	1.42
Responsiveness during the exercises	56	9.8	0.59
Appropriateness of the products	56	9.6	0.8
Amount of work in the lectures	56	8.3	2.41
Amount of work in the exercises	56	8.9	1.58
Implementation of the Didactics of NIT 2 course as a whole	56	9.7	0.94
Implementation of the course in total	57	8.8	1.63
Exam difficulty	57	7.3	1.91

The results show that the students gave top marks to both the lectures and exercises and to the course as a whole. The same pattern is seen in the responsiveness during the lectures and the exercises, and the appropriateness of the products made in the exercises. The amount of work, exam implementation and exam difficulty were rated as appropriate and with high marks.

The authors received 36 open-ended comments from students. Analysis of the comments shows that the students had an overall positive experience with the course. All comments were positive, and the students' comments confirmed that the design and delivery of the course based on asynchronous activities fully met and exceeded their expectations.

"*With the exercises, I liked that we had an activity that included several exercises together and we could decide for ourselves when we wanted to make the product. We were not forced to make a product in a certain week if we happened to have a lot of other commitments that week.*"

The students' comments also confirmed that delivering the course based on asynchronous activities and adapting the content to focus on technical creativity compensated for inequalities and enabled each individual to successfully complete the coursework.

"I enjoyed the exercises. I already mastered my technical skills and use or work with different tools, so it did not cause me any major problems. However, it is true that I live in an apartment building, and I do not have all the tools or materials at home, so I had to make my own products at my grandparents' or my boyfriend's house, because luckily they had all the materials and tools I needed."

The course was successfully completed by all participants, including those who were abroad on an Erasmus exchange, which further strengthens the claim.

4 Conclusion

The realization of the program for acquiring teaching qualifications at elementary school level was undoubtedly put to the test during the pandemic period at the Faculty of Education at the University of Maribor. All of us involved in this process found ourselves in the unenviable position of putting our ingenuity and perseverance to the test. In the process, the authors also learned a great deal. They found that a specific project modification of an approach that emphasises a higher level of technical creativity can exceed student expectations and, most importantly, equalise inequities and allow everyone to successfully complete all coursework. In the context of what the authors have been doing, they have learned that it is possible to accomplish anything with a carefully planned work strategy. The strategy should not be based on "reproductive activities" or "dictation work", which has little to do with creative technical activity, but on problem-solving strategies that develop divergent thinking. At the same time, the product does not become an end in itself, but a means for the development of the students' comprehensive creative abilities.

In "Teaching in the Society of knowledge", Hargreaves (2003) points out the great demands and expectations of society on all those who will be or are already professionally involved in teaching. So, we find ourselves in a whole bundle of conflicting interests and demands. We expect ourselves to encourage and enable students to acquire quality knowledge so that later on they will be able to promote creativity through their work and contribute to the progress of society. At the same time, owing to increasing economic pressures and dwindling resources, we were expected to perform all these tasks as efficiently and with as few resources as possible during the pandemic. Well, we may actually have done it.

Finally, the analysis of the survey results, the complexity of the students' products, and the students' feedback from monthly meetings has shown that students spend significantly more time on technical activities in the home environment than is required by the current curriculum. The most common feedback during the monthly meetings was that the students transferred these activities to their free time. The reasons for this varied, but they all had a common theme: To get away from excessive computer work and to spend time with family members who were allowed to and even wanted to participate in the activities.

All these experiences remind us of how much we underestimated the creativity of students and their willingness to create, design, and produce during "normal" classes. The authors are convinced that in the future, the experience gained can be combined with project or problem-based learning (PBL) and regular exercises in a workshop at the university. PBL is often used as an educational strategy across a broad variety of disciplines and is referred to as a total approach to education (Wells et al., 2009). The PBL process should involve a systematic approach to resolving problems or meeting challenges that are encountered in real-life situations (Levine, 2001). A student's independence, self-direction, and autonomy are considered the hallmarks of PBL (Rideout et al., 2002). PBL is a beneficial learning style, as students acquire problem-solving abilities to deal with a variety of unique life situations (Norman, 2008). In the case study presented, the students were confronted with real-life situations in which they had to solve several problems related to the creation of a product (accessibility of materials, tools, machines, and work environment) in conjunction with the integration of the manufactured product into activities in the school environment. Although they had structured instructions and tasks, they were not guided, but were independent and autonomous because of the nature of the asynchronous activities.

Finally, the authors can say that they have learned and achieved the following:

- Exercises performed in a workshop in ODE are possible with a carefully planned approach or strategy.

- Project learning within the content framework of the subject area can also be problem-based learning on 'steroids', where students know how to look for and solve real-life problems.
- More time was spent solving problems on their own initiative than the contact hours in the curriculum. However, none of this placed any obvious additional burden on them, as they enriched their experience of the pandemic in their home environment through the creative cycles of their own work, and even derived a great deal of pleasure from it.

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