

Nuclear Education – What Influence Does Online Teaching Have – A Cause Study In Austria

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ABSTRACT

The strong increase in the number of students in nuclear subjects at Austrian universities during the pandemic prompted the following research questions.

The last two years presented universities with big challenges. Due to Covid19 restrictions, conventional teaching methods had to be adapted and new approaches developed. Austria's nuclear education mastered the adjustment to the pandemic situation with the experience of the Young Generation Network (YGN). Courses were, if feasible, shifted towards online formats. The new approach was well accepted by students and the demand has risen. Nuclear (engineering) lectures and courses experienced a high number of participants during the online teaching format and also the assigned project- and bachelor-theses increased compared to the time before Covid.

To evaluate this strong increase, a survey was carried out, of which the results are presented in this paper. It also explains which challenges teachers' and students' had to face during that time and how this information can be used to maintain this positive development in Austria's nuclear education.

This paper looks at some general questions on the opinion of the students, and how the lectures have influenced their opinion and deepened their knowledge.

1 INTRODUCTION

The Covid crisis presented universities with a major challenge. Well proven teaching methods had to be adapted to the new hygiene regulations where face-to-face teaching was no longer possible. A new approach had to be developed to find a way to continue teaching online.

Nuclear education is taught at three universities in Austria. The most extensive offer is at the TUW¹ in Vienna, where Austria's only remaining research reactor is located. A smaller offer of courses is available at the Technical University Graz and University of Leoben (Montanuniversität).

This paper highlights how the pandemic and the accompanying online education has changed nuclear education in Austria. It will show the growth of numbers in students that was observed during that time, as well as an increased interest in scientific work (Bachelor and Project theses²). A survey was carried out to analyse the root causes of this rise. The results of

¹ Former University of Technology Vienna, now TUW

² During the Master program students have to carry out two project theses in preparation for their Master thesis. The length is equivalent to a Bachelor thesis.

the survey will be analysed and it will be discussed how this phenomenon/event can be a chance for the nuclear era in general but in particular for future teaching in favour of Austria's nuclear education.

2 NUCLEAR EDUCATION IN AUSTRIA

In Austria, nuclear courses are offered at three universities – the TUW, the University of Technology Graz and the Montanuniversity Leoben. The focus of the education is in Vienna, where the research reactor is also located. This reactor is a TRIGA MARK II reactor, operational since 1962. It is not only a facility for training local students, who profit from this institution as they get hands-on training in nuclear engineering but also plays a key role in international education for several universities and the IAEA. The courses at the reactor's institute (Atominstitut) range from basic courses in nuclear engineering to specified courses on reactor safety and practical exercises. Some of these courses are now held twice a year because the demand is almost double of what it was before the online classes started. In Graz, there is one introductory course for nuclear engineering. Each year up to 70 students take part in the course "Nuclear Energy and Environment" and over 40 interested students take part in the course "Introduction to Nuclear Energy" in Leoben [1].

3 PANDEMIC SITUATION AND ONLINE TEACHING

In Austria, the pandemic impacted the lecturers at the beginning of the term in March 2020. Courses had just started and students were eager to be introduced to nuclear subjects. The university guidelines were unclear, as well as the situation itself. It was quickly made apparent that lectures were cancelled, as well as all practical courses. However, the lecturer did not want to give up and started searching for alternatives. Video call systems were not yet well established in March 2020, and other solutions needed to be found. The lecturer addressed the students with the question – do you want to continue with the lecture? As the answer was a clear yes, a teaching solution had to be found. A simple VOIP solution was introduced – Discord³. It offered the basic teaching needs – a presenter mode and a viewer mode and a chat function for students.

In contrast to lectures, practical courses could not be shifted towards an online format and had to be completely cancelled until February 2021. Exams also needed a new format. Here as well, the lecturer searched for possible solutions together with local YGN fellows, who took several of the courses years before: They contributed to the discussion and had a first look at the new online exam format. The exam now consists of a short written online test and an additional homework. For the homework students have to do a small scientific 1,5 page work about Generation IV reactors or SMR.

In the following terms, four other lecturers started teaching with the help of ZOOM⁴ at the Atominstitut. Since the senior generation was not used to these tools, they struggled with some technical difficulties that could be solved together with the support of younger colleagues. Especially during the pandemic, the digital divide has led to inequalities across the board. Both for students and lecturers of older generations – digital immigrants – who have not had the chance to grow up with digital media. During this time, a technically complex conversion, with mostly insufficient resources about the familiar teaching method needed to take place very abruptly.

³ www.discord.org

⁴ www.zoom.us

4 INCREASING INTEREST – SURVEY DISTRIBUTION

Since the pandemic started, participants of nuclear courses and scientific works increased significantly. To evaluate the reason for this, two surveys were handed out to the students: The first one was for students attending the regular online lectures since March 2020, the second one was handed to all students that did a scientific work after the lecture. Especially since the number of scientific work form students increased by a factor of 5 – 10 (see [1]), the authors were interested if the online format of the lecture contributed to this effect, or if the current discussions regarding climate change or GenIV reactors were the main pushing factor. Hence, the authors were interested in the following questions:

Table 1: Questions of the online survey carried out in January 2022

Survey Students - Questions	Survey Scientific Work - Questions
The interest in lectures and courses in the nuclear field has increased strongly during the last months. Why did you decide to take a course in this field?	The interest in lectures and courses in the nuclear field has increased strongly during the last months. Why did you decide to do a scientific work in this area?
Do you think the online format of the lectures contributed to your decision? If yes, why?	Do you think the online format of the lectures contributed to your decision? If yes, why?
How have the courses changed your personal opinion about nuclear power? Why?	How have the courses changed your personal opinion about nuclear power? Why?
The use of nuclear power plants has been a hot topic of discussion for years and has been completely rejected in some countries, such as Austria. The topic has recently experienced an increased - mostly positive - media presence. How do you assess the nuclear situation in Europe the next few years and decades? Why?	The use of nuclear power plants has been a hot topic of discussion for years and has been completely rejected in some countries, such as Austria. The topic has recently experienced an increased - mostly positive - media presence. How do you assess the nuclear situation in Europe the next few years and decades? Why?

Answers could be given by a multiple-choice options (see Annex 1 for the detailed evaluation of all questions) and there was always the possibility to write individual comments.

The questionnaire was sent to students which showed already a basic interest in nuclear subjects. Austria is per definition an anti-nuclear country, and personal opinions can be biased due to this position. In addition, the survey was carried out during a pandemic with special circumstances regarding teaching. Nevertheless, we experienced this sudden increase in student numbers and scientific works and were eager to search deeper for root causes. The answers that will be analysed in the next chapter must be taken with regard to the technical background of all participants and can probably not be extended to any other group.

5 RESULTS

5.1 Lecture Survey

With the first question the authors searched for the motivation to take a course in the nuclear field. 59% stated that the personal interest and curiosity fostered the decision. 29% chose the course due to the current discussions. Details can be found in Annex 1.

The second question looked at the possible additional information for the motivation due to the online format. 73% stated that the online format did not influence the decision, 27% stated that the online format did. Individual responses showed that the possibility to listen to

the recorded sessions several times are a huge benefit (12 out of 15 individual answers), 3 stated that online lectures are not beneficial for them.

The third question inquired if the courses lead to an opinion change due to the course. 61% stated that their opinion shifted towards positive attitude, 2% towards a negative attitude, 38% stated, that their opinion was not influenced. In individual answers students stated that the lecture was able to deliver facts and figures and showed that there is new development in the nuclear industry.

The fourth question was answered the following: 42% of the students answered that they do see a rise in NPPs in Europe, 19% said it will stay consistent and 17% said that it will decline, the rest was not sure. The students' most indication for an increase in the next few years was the current discussion about climate change and the associated emission reduction. However, they do not believe that there will be a boom in current anti-nuclear countries, such as Austria.

5.2 Scientific work results

The first question was related to the aroused interest in scientific works after the lectures that the authors noticed since March 2020. Hence the authors inquired if among the students that wrote a scientific work this increase was only related to the current discussions regarding climate change, or also due to the lecture. The answers are shown in table 2, multiple answers were possible.

Table 2: Answers to question 1 of the survey

Answer	Total	%
Personal interest and curiosity	10	59%
Due to current discussions	7	41%
Aroused interest through lectures	6	35%
General interest	5	29%
Promising field of work	2	12%
Others	5	29%

The second question inquired if the online format had contributed to the decision of doing a scientific work in this area. 18 % stated yes, 82% stated no. So, there is a small influence from the online format.

The third question showed that there was either no influence (31%) or a shift towards a positive opinion (69%).

For the fourth questions 65% of the students doing a scientific work think that the number of nuclear power plants will Europe-wide increase within the next couple of years, 13% said it will stay consistent and 7% that it will decline, the rest was not sure.

6 DISCUSSION

Contrary to the expectations, the online teaching format has not had a subjective benefit for the students' and was not the particular reason to sign up for this course. (73 % no to 27% yes) Analysing the individual answers show a different picture though. The majority of the students answering the survey, indicated that the online teaching provided high flexibility and was also easier to follow for working students since all of the lectures were recorded and continuously available for all registered students.

The main reasons to sign up for the class were either personal interest or the current discussions regarding climate change and GenIV reactors. The online format of the lecture was not a main root cause for choosing the lecture for 2/3, still 27% stated that the format was a reason to sign up. The individual answers showed that lecturers should continue to have online

elements for their lectures, either through recorded lectures from previous years or hybrid format (streaming with recording and live sessions).

35% of the students writing a scientific work after the lecture stated that their interest was aroused from the lecture itself (multiple answers possible) and 41% stated that current discussions were the reason. 59% said that their personal interest was also a reason. However, these answers do not explain the sudden increase in scientific works by a factor of 5-10, with student numbers only increasing by a factor of 1,5- 2. Students writing a scientific work also stated that the online format did not contribute to their decision. (82%-18%). The third question of the opinion change was confirmed the findings of Rohan et. al. from 2011(see [2]). Providing information at the right level is crucial for the opinion influence of students, and could be extended to a broader public.

According to the survey, students assume a boom of the nuclear industry in Europe and in particular in pro-nuclear countries. These experiences could stem from the excessive media coverage, especially regarding climate change. The majority of the students think the best way of stemming the climate crisis is by reducing emissions significantly. Students state, that nuclear power will be needed as it is a low CO₂ emitting energy source, even though its inherent drawbacks according to the students. The results were divided in the students and scientific work surveys. Students that carried out a scientific work assumed a better performance of the nuclear industry in Europe then the average student.

7 CONCLUSION AND OUTLOOK

In summary, it can be said that both lecturers and students were confronted with some major changes during the pandemic. It took some time to adjust the teaching to the new hygiene concept and they had to contend with a lot of uncertainties. Since the entire teaching mode had to be changed due to the Covid situation, the students now have the opportunity to engage with the lesson content in a completely new way. The focus is now on active collaboration during the semester with an independent research paper on a particular topic, such as Gen IV reactor, rather than the traditional examination at the end of the semester. As more students attended the lectures, and significantly more students continued with a scientific work after the lecture, a survey was distributed to search for root causes of this increase.

The survey showed that the format of the lecture is not the most important factor when it comes to reasons for taking a course, but the online format provided several benefits for the students and lecturers should be aware of this demand. The information provided to the students through the lecture was able to influence their opinion, as already shown before in larger studies. This fact is important and can be used to further teach Austrians about nuclear power.

Lectures and practical works in the nuclear industry still experience high interest. The survey was handed out to students in January 2022. This was before the energy crises hit Austria. The survey should be handed out continuously to further identify root causes. It should also be inquired if the homework helps students to select a scientific work in that field. Regular surveys, tailored to the current political situation, could provide information about how the students are influenced by media and how their opinion is formed by scientific data and facts.

REFERENCES

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[2] A. Rohan (2011). "Der Nuklearskeptizismus"; (Nr. 13976). Arbeitsgemeinschaft Informations- und Medienforschung; 1090 Wien, Maria Theresien-Straße 9/5a

Annex 1

STUDENTS SURVEY

Question 1: The interest in lectures and courses in the nuclear field has increased strongly during the last months. Why did you decide to take a course in this field?

	# Answers	%
Personal interest and curiosity	65	59%
Due to current discussions	32	29%
Promising field of work	11	10%
Others	3	3%

Individual Answers:

- All the answers above
- It has been an interesting and promising technology since the discovery of the nuclear fission. More a (geo)political and social problem since
- A colleague recommended the course to me

Question 2: Do you think the online format of the lectures contributed to your decision?

If yes, why?

	# Answers	%
No	44	73%
Yes	16	27%
Individual	15	

Individual Answers:

- it is definitely easier to attend the online classes (and of course the to watch the recordings) if one takes a lot of other courses
- It's easier to attend online lectures than to travel to the Atominstitut everytime
- Can watch lectures anytime and everywhere i want
- Because I suffer from a chronic illness of the intestines which is is extremely stressful when I have to attend a course physically...
- I do not like online Format in General and cannot concentrate in Front of screen at all
- Freedom of choice when and how to learn the material, more flexibility due to online format
- normally lecture time would interfere with other lecture -> only lecture material used
- I don't think that the lectures being online changed anything at all but being able to watch the recorded lecture at any time is a huge plus.
- I don't like distance learning at all.
- Flexibility, i couldn't watch the lecture live but i watched the recordings
- could not go to university in person
- Possibility to rewatch certain lectures, rewind, watch at my preferred speed
- I work full time and it is easier for me to participate in online courses.
- Higher flexibility regarding time management
- Recording of the lectures is a great benefit

Question 3: How have the courses changed your personal opinion about nuclear power? Why?

	# Answers	%
Positive	34	61%
Not at all	21	38%
Negative	1	2%

Question 4: The use of nuclear power plants has been a hot topic of discussion for years and has been completely rejected in some countries, such as Austria. The topic has recently experienced an increased - mostly positive - media presence. How do you assess the nuclear situation in Europe the next few years and decades? Why?

	# Answers	%
Increasing number of NPP	20	42%
Not sure	11	23%
Consistent number	9	19%
Decreasing number	8	17%

Individual Answers:

- concerning climate change and the energy crisis nuclear power is a good alternative to fossil fuels
- Increasing in pro-nuclear States, Like France and Poland, further decrease in german-speaking countries
- Europe needs power and if coal power plants for example get shutdown we need alternatives
- I think people that are not scientists are slowly understanding that nuclear energy is one of the only solutions for limiting global warming
- Because politics does not rely on scientific discussion and really evaluating pros and cons in decision making.
- To combat further climate change
- Our demand of power is increasing
- Exit from coal and oil, missing energy, renewables can't meet all the energy demand
- For years now we have seen a steady increase in electric consumption that wasn't reduced or slowed by the also increasing efficiency of electronics.
- Consistent due to shift from fossil to renewable energy sources (->e.g. France consistent, D/AT big turning point for Green Party if NPP would be promoted
- Due to less fossil powerplants
- we need non-fossil consistent energy deliverers for the grid to compensate renewable energies
- we need non-fossil consistent energy deliverers for the grid to compensate renewable energies
- Of course there has been accidents and atomic waste but with enough experience both can be handled. In my eyes it's the best way to avoid a climate catastrophe

- I don't think (unfortunately) we will be able to change to renewable energies fast enough to reduce our emissions significantly.
- The lecture helped to clarify preconceptions about safety and risk
- Because still it brings a lot of danger with it and most people feel unsafe with it
- because we need more and more energy and new small NPPs are a good solution
- Replacement of old NPP
- With the rising demand of cars fuelled by electricity, and the overall power usage in the common household. The demand for electricity has to be met
- It is a technology with low carbon emissions, although it causes dangerous nuclear waste. Maybe in the future fusion Tomahawks replace NPPs.
- Sustainable energy source with high efficiency

SCIENTIFIC WORK SURVEY ANSWERS

Question 1: The interest in lectures and courses in the nuclear field has increased strongly during the last months. Why did you decide to take a course in this field?

	# Answers	%
Personal interest and curiosity	10	59%
Due to current discussions	7	41%
Aroused interest through lectures	6	35%
General interest	5	29%
Promising field of work	2	12%
Others	5	29%

Question 2: Do you think the online format of the lectures contributed to your decision? If yes, why?

	# Answers	%
No	14	82%
Yes	3	18%

Question 3: How have the courses changed your personal opinion about nuclear power? Why?

	# Answers	%
Positive	11	69%
Not at all	5	31%

Question 4: The use of nuclear power plants has been a hot topic of discussion for years and has been completely rejected in some countries, such as Austria. The topic has recently experienced an increased - mostly positive - media presence. How do you assess the nuclear situation in Europe the next few years and decades? Why?

	# Answers	%
Increasing number of NPP	10	67%

Not sure	2	13%
Consistent number	2	13%
Decreasing number	1	7%