



SMAGRINET

POWERING SMART GRID
EXPERTISE IN EUROPE



his project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 837626

CONTACT US
info@smagrinet.eu

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DELIVERABLE 3.6

MODULES' EVALUATION AND UP-DATED MODULES

DELIVERABLE TYPE

Report

MONTH AND DATE OF DELIVERY

Month 20 | November 2020

WORK PACKAGE

WP3

LEADER

TU Berlin

DISSEMINATION

Confidential

AUTHORS

Christine Michalek
Kai Strunz

PROGRAMME
H2020

CONTRACT
837626

DURATION
30 Months

START
April 2019

Contributors

Name	Organisation
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Peer Review

Name	Organisation
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Revision History

Version	Date	Reviewer	Modifications
0.1	30/11/20	-	Initial Version

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1. Executive Summary

Work package 3 (WP3) – in particular T3.6 – in the SMAGRINET project is the focus of this deliverable. It shows the result of the evaluation for the first implementation phase of the developed modules. WP3 aims at developing, evaluating, and adjusting three teaching modules for the master level engineering students.

This document outlines:

- Context, mission, and objective of WP3
- First evaluation of the modules:
 - Participation of consortium universities
 - Evaluation approach
 - Evaluation results

2. Introduction to Work Package 3

Work Package 3 of the SMAGRINET project aims at developing three challenge and case-based modules. They are linked to European university programs in order to teach students about operational problems of modern power grids and are aiming at combining the social, technological and industrial dimensions. The modules are implemented at master level and besides piloting, evaluating, and adjusting the developed modules, students traineeships at companies, and a simulation session are also part of WP3. These activities prepare the next generation of engineers and researchers with interdisciplinary operational and problem-oriented skills. The imparted mind-set supports solving ongoing and emerging challenges of the energy transition.

This section first explains the context and piloting phase of the three developed modules. Next, mission and purpose of WP3 are introduced. At last, the objectives are defined and described in detail.

2.1. Context

This deliverable is focusing on T3.6 and the first evaluation of the modules. For the sake of completeness, all other work package topics are described briefly as well.

2.1.1. T3.1 Development of Three Challenge and Case-based Modules

Three challenge and case-based master level modules are developed. The modules build on the needs and challenges identified under work package 2 – the competence hub. The set of modules is designed to be implemented within one academic year. SMAGRINET university partners collaborate and bring in their specific area of expertise.

2.1.2. T3.2 Piloting of the Developed Modules

The piloting of the three developed modules is structured in two phases and all six consortium universities are participating. During both phases, the modules are implemented and aiming at involving 20 students per consortium university. In total, $6 \cdot 20 \cdot 2 = 240$ students will be educated. The modules can be completed during one phase, which represents one academic year, which makes them flexible and easily replicable.

2.1.3. T3.3 International Mobility at Enterprises

A complementary mobility program is offered in parallel with the modules. Five students from each consortium university are provided with scholarships for international internships at European hosting enterprises. The duration of the mobility varies from one to three weeks. The attending students afterwards prepare a knowledge sharing seminar for all fellow students.

2.1.4. T3.6 Evaluation of the Pilots and Adjustment of the Modules

After each academic year the modules will be evaluated by students. The first round of evaluation before entering the second implementation cycle allows to identify potential for improvement. These adjustments can be made before teaching the modules for the second time. The second evaluation after the second implementation phase should only discover minor changes to be made.

2.2. Mission

Energy transition and smart grid implementation require training of the next generation of electrical engineers. Replacing the current electrical grids with smart grids calls for knowledge how to implement new technologies and how to manage them effectively in the future. Education and training initiatives in the right fields are crucial to assist this transition.

Mission and purpose of the three master level modules in WP3 are to educate future engineers. They have to be able to respond to emerging operational problems and urgent challenges. Key principles for this purpose are:

- Joint use of top-level expertise from European universities and knowledge sharing
- Close collaboration between industry, academia and societal stakeholders
- Interdisciplinary and involving topics besides engineering competences and develop skills like communication, teamwork, critical thinking, and problem solving

2.3. Objectives

As a long-term objective, the SMAGRINET project aims at preparing a generation of researchers and engineers to meet the challenges of the energy transition.

WP3 in particular aims at developing three challenge and case-based master level modules that are linked to European university programs to teach students about operational problems and combining social, technological and industrial dimensions. The modules are driven from the needs of the industry and bring together top-level expertise from European universities, enhance industry-academia collaboration and are interdisciplinary. Simulation sessions and a mobility program complete the modules. In total, 240 master students are educated in two implementation phases over two years.

3. Evaluation of the Modules

This chapter starts by introducing the modules and participating universities in Section 3.1. Next, the evaluation methodology, including the evaluation form and information on the experimental group, is explained in Section 3.2. All evaluation results, covering pedagogical approach, lecture materials, exercise sessions, and the overall experience, are presented in Section 3.3.

3.1. Participating Universities

In total, six universities participate and implement the developed modules within the SMAGRINET project. Consortium partner universities include:

- Kaunas University of Technology (KTU)
- Tallinn University of Technology (TalTech)
- Technische Universität Berlin (TUB)
- Technische Universität Dresden (TUD)
- Université de Lorraine (ULOR)
- University of Ljubljana (ULJUB)

Three challenge and case-based modules were developed and presented in deliverable D3.1. The modules have to be implemented twice during the duration of the project. The timeline for the first piloting phase at each university is depicted in Figure 1¹. The piloting phase is subject of deliverable D3.2.

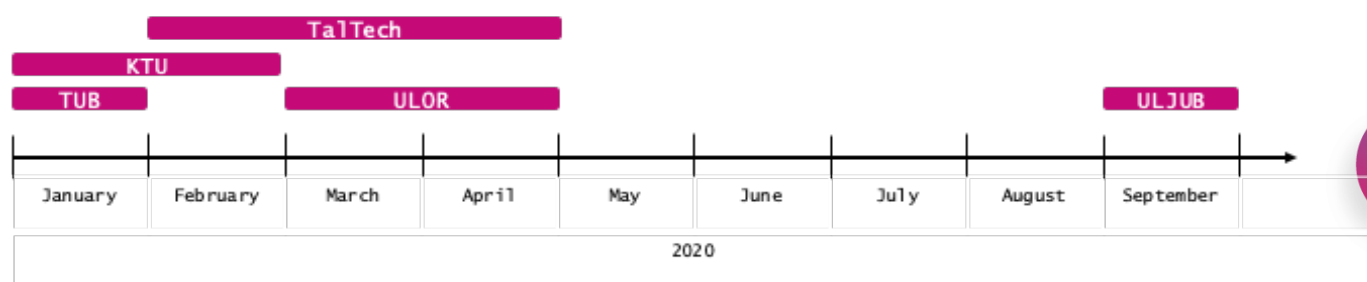


Figure 1: Timeline first piloting phase

As the consortium lists six participating universities, each module is taught at two universities. Module 1 “Artificial Intelligence in a Smart Grid with Prosumers” is allocated with KTU and TUD. Module 2 “Economic Operation and Societal Challenges” is taught by TalTech and ULOR. Module 3 “Connection Planning in Smart Grids” is assigned to TUB and ULJUB. Whereas TUB and ULJUB chose to teach the module as a one-week intensive course, all other consortium universities decided on a class over the time period of a few weeks.

3.2. Evaluation Methodology

In order to explain the evaluation methodology, design and content of the questionnaire is first explained in Section 3.2.1. Section 3.2.2 in the following shows statistical facts concerning the students who participated in this evaluation and constitute this experimental group.

¹ Due to administrative issues, TUD was not able to implement the module before this deliverable’s due date.

3.2.1. Evaluation Form

All universities used the same questionnaire to get evaluation results. The questionnaire was designed using evaluation questionnaires that are used at KTU, TalTech, TUB, ULOR, and ULJUB. It focuses on the pedagogical approach, lecture materials, exercise sessions, and the overall experience. An extract showing these topics is depicted in Figure 2.

	- 50 %	+ 50 %	80 %	100 %
I have attended ... of the sessions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	not at all	rather no	rather yes	definitely
Pedagogical Approach				
My pre-existing level of knowledge was sufficient to understand the course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good division between lectures and exercises.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Theoretical Part				
The material is presented in a clear and structured manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Slides are easy to understand.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lecture and exercise materials establish understanding of the course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Exercise Part				
The exercise topics illustrate the content of the course.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The exercise tasks are understandable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The knowledge transferred in lectures and exercise sessions is sufficient to complete the exercise tasks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Students are invited to participate during the exercise sessions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overall				
The content of this course is interesting for me personally.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The course motivates me to learn more about the topic.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The content of this course is useful for my aspired profession.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 2: Multiple-choice questionnaire

Moreover, these four open-ended questions were asked on the second page of the questionnaire:

- Can you identify strong elements of the course?
- Can you identify weak elements of the course?
- Do you see any areas for improvement?
- Do you have any constructive general comments and specific remarks on the teaching?

Designing an evaluation form with multiple-choice as well as open-ended questions offers the possibility to gain quantitative as well as qualitative evaluation results. The questionnaire was well accepted by the students, giving them the possibility to assess the module and give their opinion.

3.2.2. Experimental Group

In total, 71 students participated in the first implementation phase of the modules. 54 of these 71 students participated in the evaluative survey afterwards, filled in the questionnaire and hence, compose the experimental group for the presented results in the following. This equals 76 % of all participants.

Figure 3 shows the distribution of participating students per university. KTU was teaching Module 1 “Artificial Intelligence in a Smart Grid with Prosumers” – referred to as “Module AI” in the following. ULOR and TalTech were teaching Module 2 “Economic Operation and Societal Challenges” – referred to as “Module Economics” in the following. TUB and ULJUB were teaching Module 3 “Connection Planning in Smart Grids” – referred to as “Module Planning” in the following.

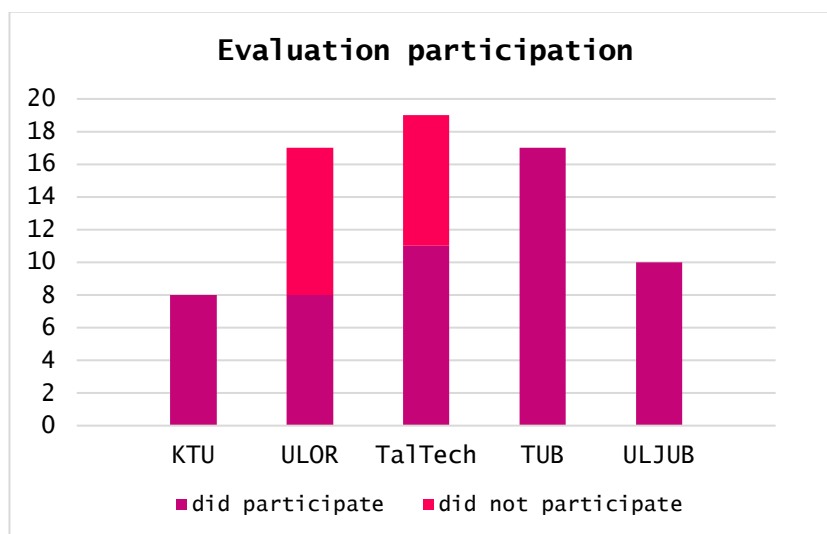


Figure 3: Participating students per university

Another important parameter in evaluating the impact of the results, is the total class attendance of the students. Only feedback from students who have attended the class most of the time is valuable for this analysis. Figure 4 depicts the attendance key per module. During “Module AI”, 88 % of the experimental group attended at least 80 % of the classes. During “Module Economics”, 63 % of the experimental group attended at least 80 % of the classes and 97 % of the experimental group attended at least 50 % of the classes. During “Module Planning”, 96 % of the experimental group attended at least 80 % of the class.

In summary, 65 % of the experimental group attended at least 80 % of the classes and 96 % of the experimental group attended at least half of the classes. In conclusion, the results presented in the following section are significant.

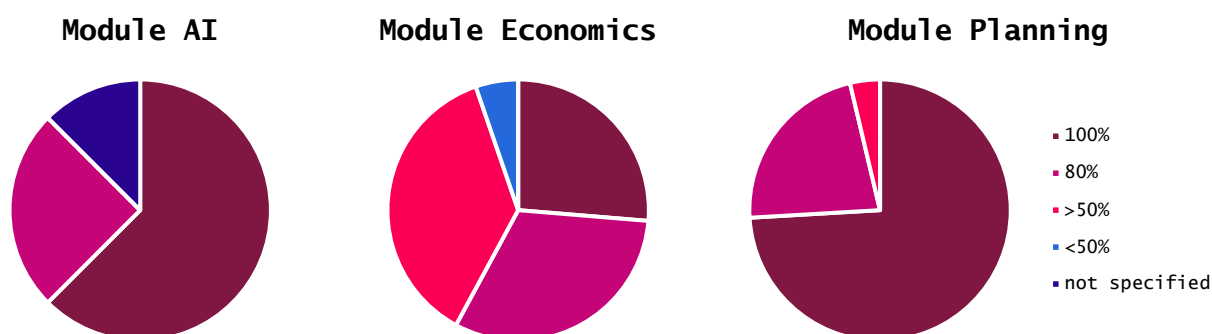


Figure 4: Attendance of participating students at classes

3.3. Results

The presentation of the results is guided by the structure of the evaluation form in Figure 2. First, the results concerning the pedagogical approach are analyzed in Section 3.3.1, followed in Section 3.3.2 by the results showing the students' opinion on the lecture materials. Section 3.3.3 presents the results for the exercise sessions and Section 3.3.4 summarizes the overall experience. Results from the open-ended question are summarized in Section 3.3.4 as well.

3.3.1. Pedagogical Approach

Students were asked to rate the following two statements on a scale from “not at all”, to “rather no”, to “rather yes”, to “definitely”, and the results are depicted in Figure 5 and Figure 6:

- My pre-existing level of knowledge was sufficient to understand the course.
- Good division between lectures and exercises.

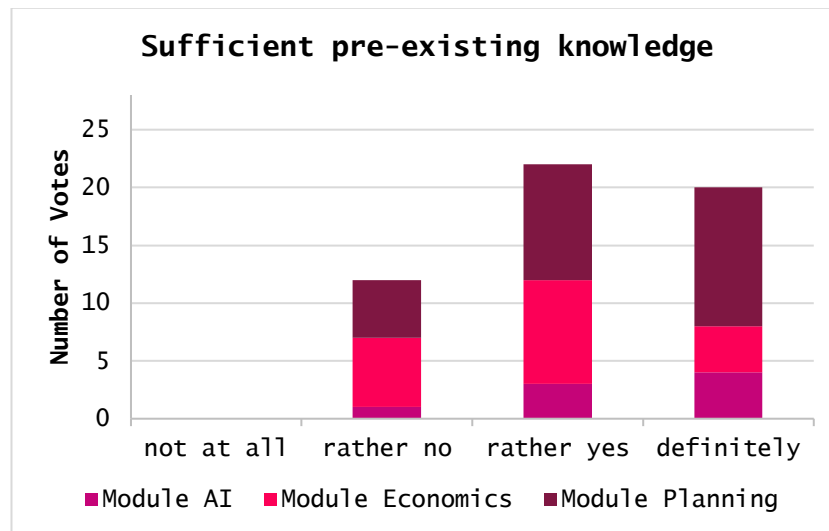


Figure 5: Results for “My pre-existing level of knowledge was sufficient to understand the course.”

The majority of the experimental group stated that their pre-existing level of knowledge was sufficient to understand the course, as depicted in Figure 5. This is concluded by taking the bars for “rather yes” and “definitely” into account. Looking at the “rather no” bar it can be observed that mostly students who attended “Module Economics” rated their pre-existing knowledge as not sufficient for the course. Feedback gathered from ULOR, who were teaching this module, confirms that the module was taught within an engineering curriculum. These students mostly focus on technical and not economic topics. Hence, the absence of pre-existing knowledge. This needs to be taken into account before teaching the module again.

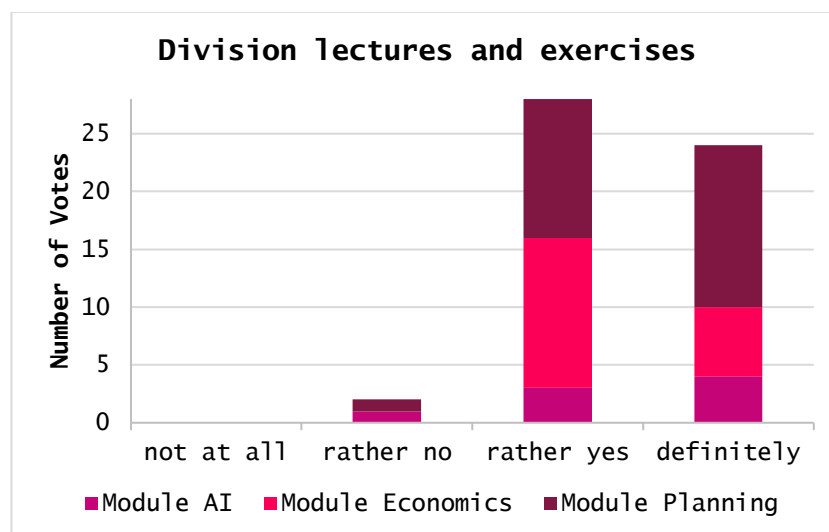


Figure 6: Results for “Good division between lectures and exercises.”

The results whether the division between lectures and exercises was well chosen are conclusive. Almost all students in the experimental group confirm this with choosing either “rather yes” or “definitely” as their answer in the questionnaire. The results are shown in Figure 6.

In conclusion, the pedagogical approach is a success, as the pre-existing knowledge of the students was sufficient for the modules and the division between lectures and exercises was well chosen.

3.3.2. Lecture Materials

Students were asked to rate the following three statements on a scale from “not at all”, to “rather no”, to “rather yes”, to “definitely” and the results are depicted in Figure 7, Figure 8, and Figure 9:

- The material is presented in a clear and structured manner.
- Slides are easy to understand.
- Lecture and exercise materials establish understanding of the course.

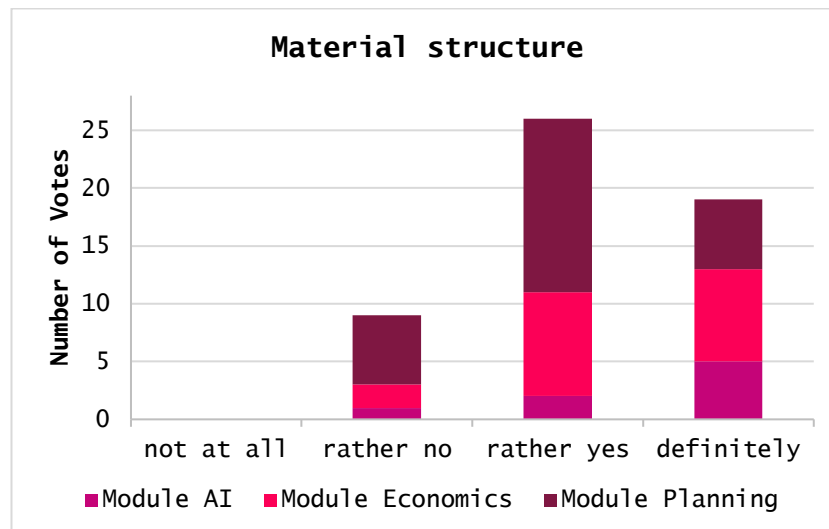


Figure 7: Results for “The material is presented in a clear and structured manner.”

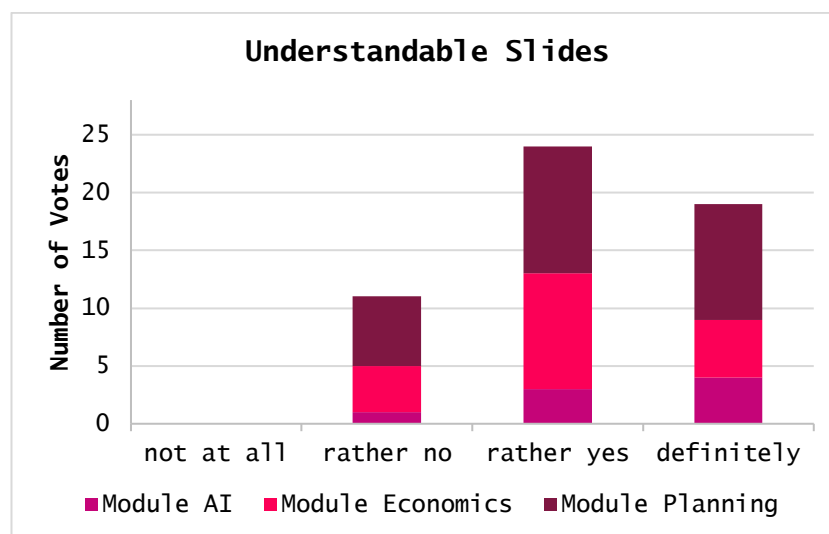


Figure 8: Results for “Slides are easy to understand.”

The material structure and that it is presented in a clear manner is mostly evaluated positive as well, as Figure 7 shows. The majority of the experimental group answers with “rather yes” or “definitely”. The greatest improvement potential for this evaluation aspect can be seen in “Module Planning”.

Figure 8 shows that the majority of the experimental group also thinks that the slides are easy to understand. As 20 % of the experimental group answer with “rather no”, this might be an area of improvement for all three modules before teaching them again.

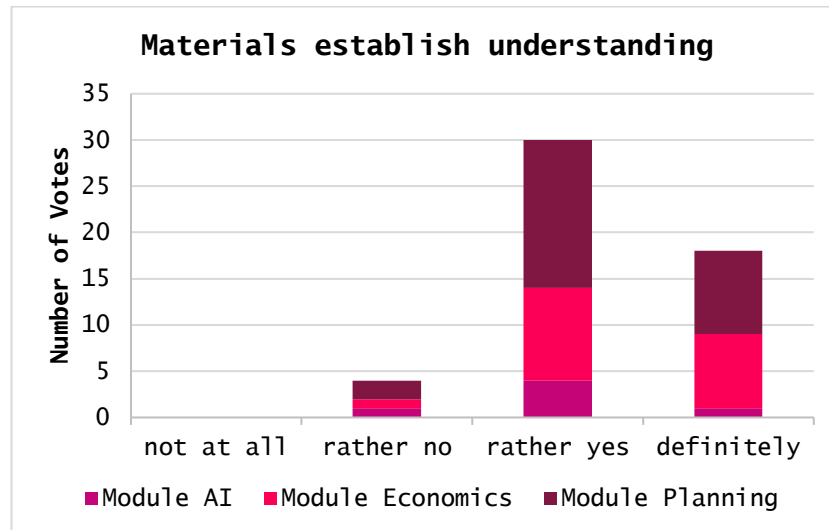


Figure 9: Results for “Lecture and exercise materials establish understanding of the course.”

Asking the experimental group to rate the lecture and exercise material and whether they establish an understanding of the course, the majority approves this hypothesis. Figure 9 shows that nearly all students rate the materials positive with either giving a “rather yes” or “definitely” answer.

In conclusion, lecture materials are well prepared for all three modules. In order to further improve the modules, some modifications concerning the understandability of the slides are advisable.

3.3.3. Exercise Sessions

Students were asked to rate the following four statements on a scale from “not at all”, to “rather no”, to “rather yes”, to “definitely” and the results are depicted in Figure 10, Figure 11, Figure 12, and Figure 13:

- The exercise topics illustrate the content of the course.
- The exercise tasks are understandable.
- The knowledge transferred in lectures and exercise sessions is sufficient to complete the exercise task.
- Students are invited to participate during the exercise session.

Figure 10 depicts the answers of the experimental group whether the exercise topics illustrate the content of the course. Negative answers are negligible due to their quantity and the majority rates the exercise topics as being illustrative for the course content.

In Figure 11 the results are shown whether the exercise tasks were understandable. The majority of the experimental group again voted for a positive result giving “rather yes” and “definitely” as answers. From the students who marked “rather no” as their answer, the majority belongs to “Module Economics”. This might relate to the findings of Figure 5 and the absence of pre-existing knowledge. It might be advisable that exercise tasks are described in more detail during the next implementation phase.

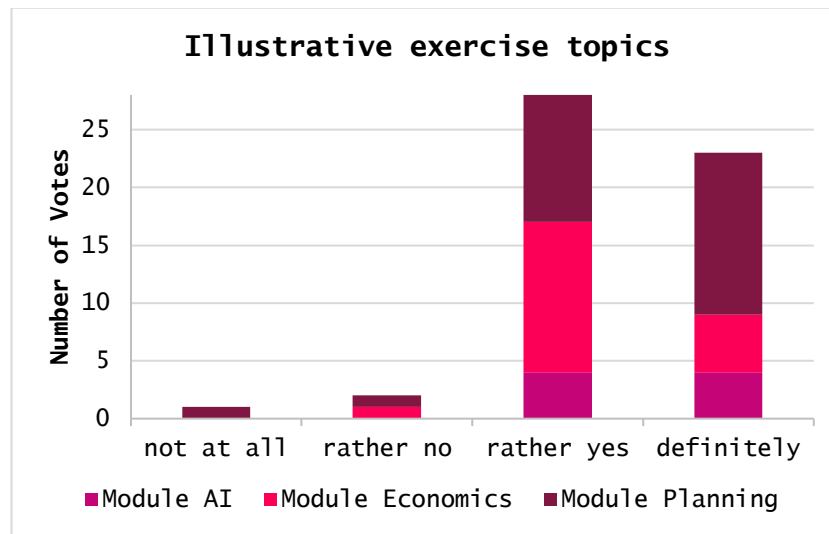


Figure 10: Results for “The exercise topics illustrate the content of the course.”

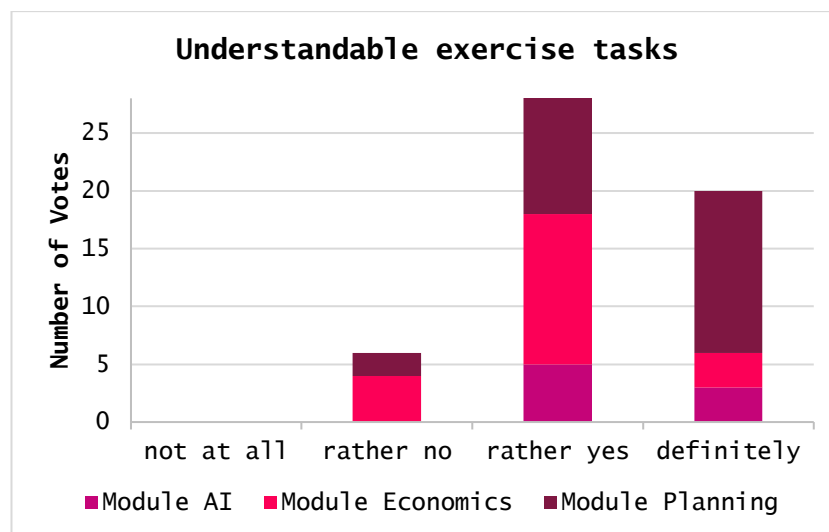


Figure 11: Results for “The exercise tasks are understandable.”

The knowledge transferred in lectures and exercise sessions is sufficient to complete the exercise tasks, as Figure 12 shows. The majority of the experimental group answers with “rather yes” or “definitely”. Also, some answers with “rather no” and “not at all” can be observed. This would need more feedback from the students for an informative evaluation and as the majority is capable of fulfilling the exercise tasks, these answers will be neglected.

Figure 13 depicts the possibility for students to get active and work on their own during exercise sessions. The majority of the experimental group confirms that an invitation to participate during the exercise sessions is expressed. Students are able to practice and consolidate their theoretical knowledge from the lectures.

In conclusion, the exercise sessions are well accepted by the students in this experimental group. Students are invited to participate, have gained the needed knowledge during lectures to fulfill the tasks, and the topics illustrate the content of the course. The exercise tasks are mostly understandable but might need some adjustment before implementing the modules for the second time.

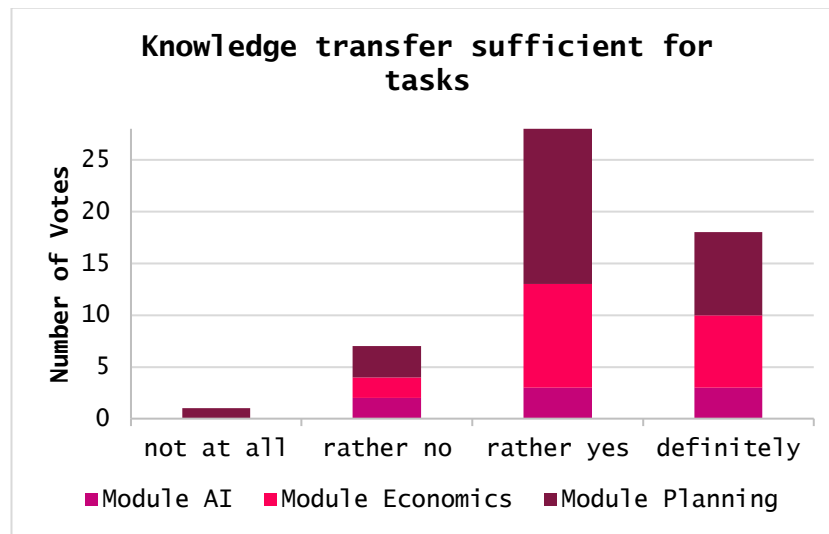


Figure 12: Results for “The knowledge transferred in lectures and exercise sessions is sufficient to complete the exercise task.”

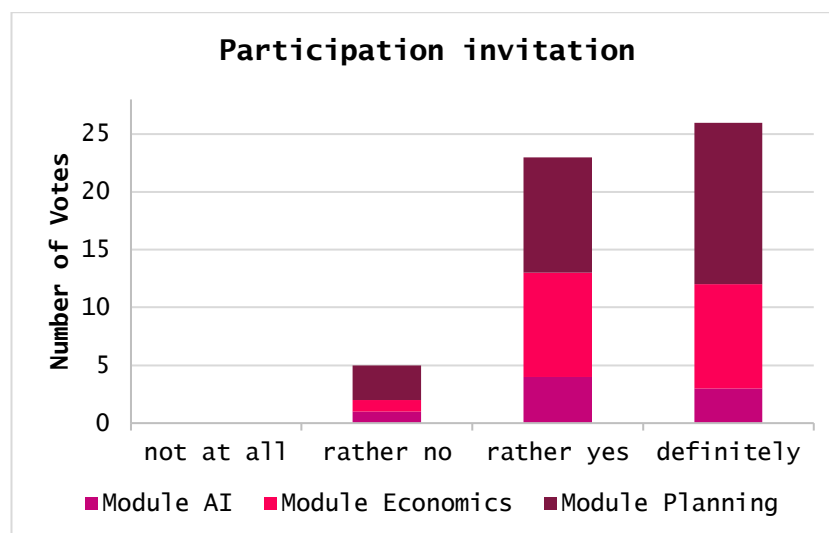


Figure 13: Results for “Students are invited to participate during the exercise session.”

3.3.4. Overall

Students were asked to rate the following three statements on a scale from “not at all”, to “rather no”, to “rather yes”, to “definitely” and the results are depicted in Figure 14, Figure 15, and Figure 16:

- The content of this course is interesting for me personally.
- The course motivates me to learn more about this topic.
- The content of this course is useful for my aspired profession.

Figure 14 focuses on the personal interest of the experimental group. 94 % of the students state that the content of the course is interesting for them personally. It is noticeable that the bar depicting the “definitely” bar exceeds the “rather yes” bar. All three modules consequently are suitable to prepare a generation of researchers and engineers to meet the challenges of the energy transition, as the topics of the modules correspond to their personal interest.

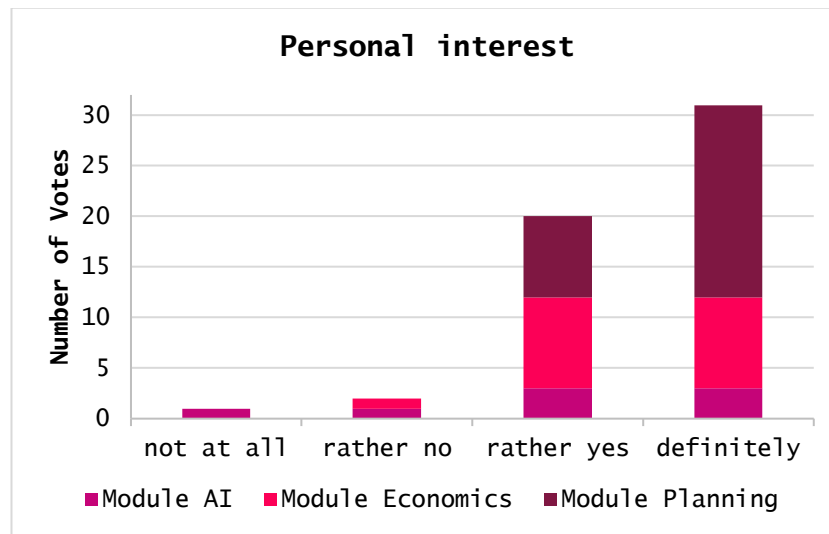


Figure 14: Results for “The content of this course is interesting for me personally.”

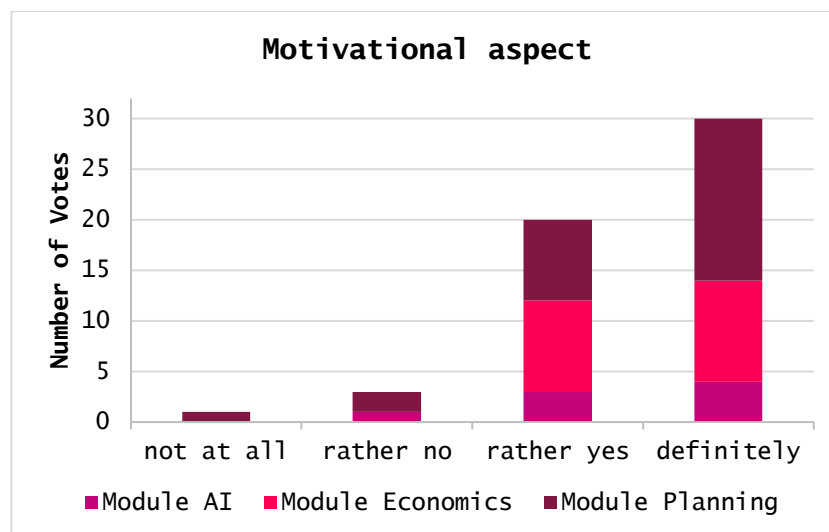


Figure 15: Results for “The course motivates me to learn more about this topic.”

Moreover, also the motivational effect of the modules is successful, as shown in Figure 15. 93 % of the experimental group credit the modules with motivating them to learn more about this topic. Hence, the modules serve as an incentive to sensitize students for the important topic of smart grids, the energy transition, and in gaining more knowledge about these topics.

Figure 16 depicts the last multiple-choice question from the questionnaire, aiming at the professional benefits of the modules. 89 % of the experimental group state that this course is useful for their aspired profession. 50 % of the students answered “definitely” and 39 % of the students chose “rather yes”. WP3 in particular aims at teaching students about smart grids and preparing them for their later profession. These results show the success of the effort to develop three challenge and case-based modules and preparing students for the emerging challenges.

Although the possibility to give qualitative feedback by using the open-ended questions was not used extensively, some arguments were written down repeatedly. On the positive side guest lectures and the up-to-date topics were mentioned. Moreover, the exercise sessions received very positive feedback associated with a request for even more exercise work. At the same time, students also suggested some areas of improvement. Some students mentioned to change the order of the lectures. As the order was often pre-defined by the

availability of the guest lecturers, this should be able to be implemented during the second teaching period. Also, some students think of the online classes to be unfortunate. As online classes are a consequence of the current covid19 situation, the issue hopefully will be resolved in an acceptable time frame.

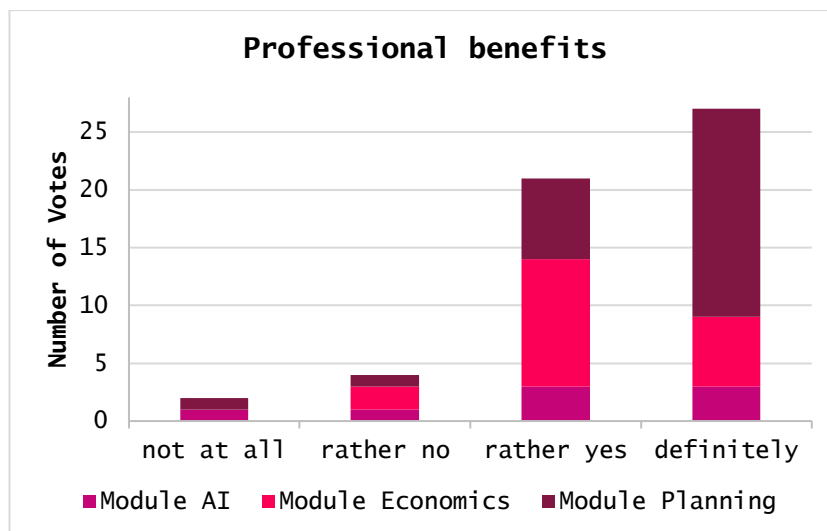


Figure 16: Results for “The content of this course is useful for my aspired profession.”

In conclusion, all three modules fulfill their objective and prepare a generation of researchers and engineers to meet the challenges of the energy transition. Students find the topics personally interesting, motivational, and useful for their aspired profession.

4. Conclusion

Energy transition and smart grid implementation require training of the next generation of electrical engineers. Replacing the current electrical grids with smart grids calls for knowledge how to implement new technologies and how to manage them effectively in the future. Education and training initiatives in the right fields are crucial to assist this transition. WP3 aims at developing three challenge and case-based master level modules that are linked to European university programs. The modules aim at preparing a generation of researchers and engineers to meet the challenges of the energy transition.

Evaluating the success of the developed modules is crucial to determine whether these objectives are reached. In total, 76 % of all educated students participated in this evaluation and only minor improvement options are noticeable. Some students comment that lecture slides are not always understandable and exercise tasks might need more details. Also, online classes are a negative aspect for some students. These remarks only appear in a very small quantity but have to be respected and taken into consideration before implementing the modules for the second time.

Overall, the pedagogical approach is a success, as the pre-existing knowledge of the students was sufficient for the modules and the division between lectures and exercises was well chosen. Also, lecture materials are well prepared for all three modules and the exercise sessions are well accepted. Students are invited to participate, have gained the knowledge during lecture to fulfill the tasks, and the topics illustrate the content of the course.

In conclusion, all three modules fulfill their objective and prepare a generation of researchers and engineers to meet the challenges of the energy transition. Students find the topics personally interesting, they find them motivational, and useful for their aspired profession.



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