IO2

Joint Curriculum validation report

Project:
Boosting a novel and innovative tRAining approaCh of Key Enabling Technologies BRACKET

Table of Contents

Introduction

The Erasmus+ project “Boosting a novel and innovative training approach of Key Enabling Technologies – BRACKET” aims to transfer Key Enabling Technologies, concretely nanotechnology, biotechnology and advanced materials, to Vocational Education and Training (VET) through the development of innovative and open learning content.

After successful delivery of ‘Joint Curriculum Harmonized Units’ structure the Consortium needed to validate this product before the real content development.

This has been defined in the scope of the project and for this reason, stakeholders and associated partners were being consulted before the development of the training content for a new online course available for VET students who are interested in developing and fostering new skills on KET.

Methodology

The main objective of this validation phase was to receive the feedback on the future training course proposal. Such information would provide the answer on proposed Joint Curriculum, especially if it addresses the expectations of the industry or if there is any space for the improvement.

To provide a structured evaluation, stakeholders received the Validation questionnaire with 10 questions. These questions were reflecting the opinion on specific aspects of the 'Joint Curriculum Harmonized Units'. Most of these questions were using a Likert scale as the common approach for ranking responses in questionnaire-based research.

Project partners tried to reach different stakeholders (companies, professional associations, research institutes, etc.) by email, phone or face to face interviews in order to receive as many answers as possible. In addition, the participants were invited to have a look at a general overview of the Joint Curriculum drafted for this task.

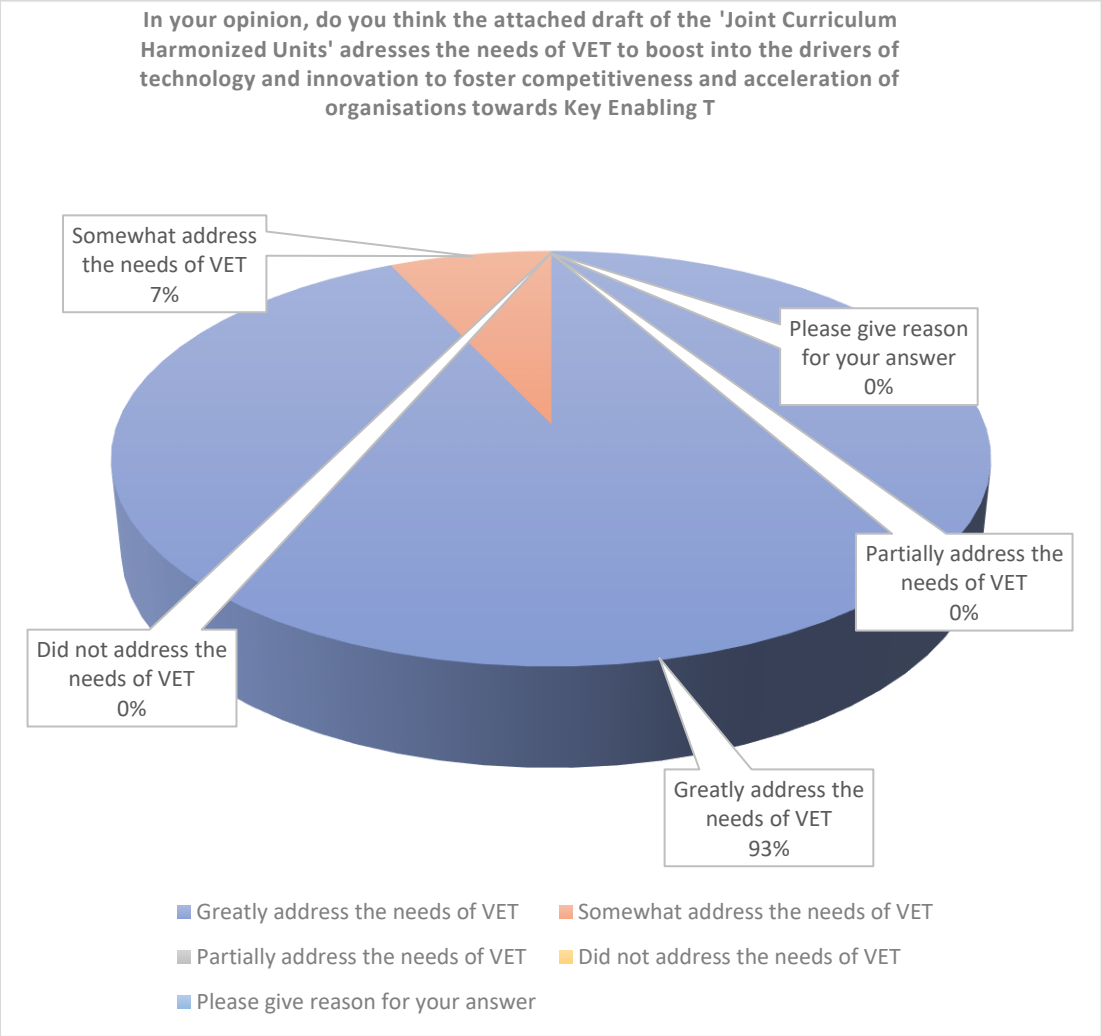
Both documents, the questionnaire and the 'Joint Curriculum Harmonized Units' structure can be found in the Annex section.

Bracket consortium is consisted of 7 partner organisations from 6 countries (Croatia, Slovenia, Spain, Greece, Poland and Latvia). Each partner organisation was expected to receive the feedback from 5 different KET experts, students or VET professionals interested in BRACKET project.

Finally, consortium partners collected 44 stakeholders' respondents, instead of 35 answers. The profile of respondents ensured that all types of stakeholders have been involved in the validation process.

Section 1: Mission

Question no. 1: **In your opinion, do you think the attached draft of the 'Joint Curriculum Harmonized Units' addresses the needs of VET to boost into the drivers of technology and innovation to foster competitiveness and acceleration of organisations towards Key Enabling Technologies (nanotechnology, biotechnology and advanced materials)?**

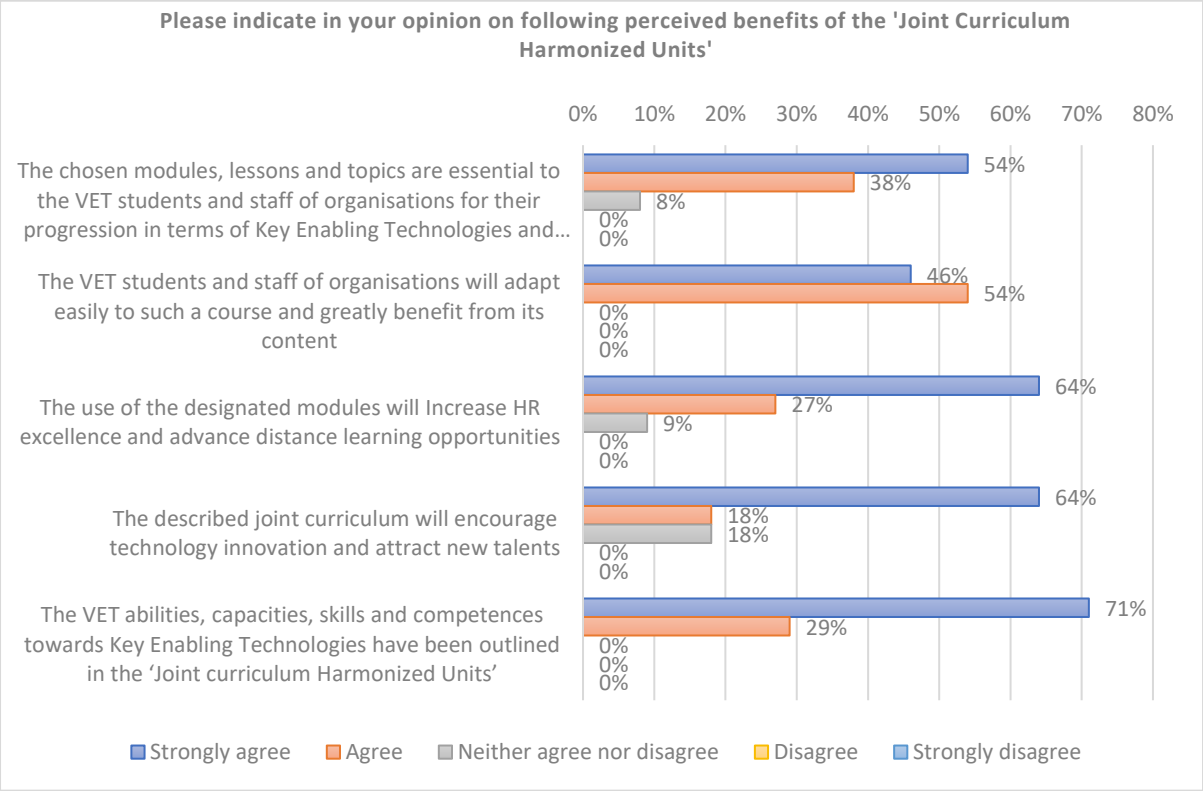


Greatly address the needs of VET	93%
Somewhat address the needs of VET	7%
Partially address the needs of VET	0%
Did not address the needs of VET	0%
Please give reason for your answer	0%

93 % of the respondents indicated that the 'Joint Curriculum Harmonized Units' addresses the needs of VET to boost the drivers of technology and innovation to foster competitiveness and acceleration of organisations towards Key Enabling Technologies. 7% of respondents see that the 'Joint Curriculum Harmonized Units' somewhat addresses the needs and there

wasn't any respondent who would see a partial addressing of the needs or who would think that the 'Joint Curriculum Harmonized Units' doesn't address the needs of the VET trainees. Because of the that we can confirm the 'Joint Curriculum Harmonized Units' structure is providing the expected content to the future users.

Question no. 2: **Please indicate in your opinion on the following perceived benefits of the 'Joint curriculum Harmonized Units'**



The experts were asked to evaluate the statements. The scale of 5 possible answers presented from highest to lowest score is following: strongly agree; agree; neither agree nor disagree; disagree; strongly disagree.

In the next paragraph you can see statements presented from the most beneficiary to the least beneficiary for the users.

1. The most positive feedback and the strongest benefit for the potential users of the project was received for the statement '' **The VET abilities, capacities, skills and competences towards Key Enabling Technologies have been outlined in the 'Joint curriculum Harmonized Units'** '' where more than 71% of respondents strongly agreed and 29% of respondents agreed. This means 100% of respondents see that the VET abilities, capacities, skills and the competences are really outlined in the 'Joint curriculum Harmonized Units'.
2. '' **The use of the designated modules will increase HR excellence and advance distance learning opportunities** '' was the second most agreed assertion with score

of 64% strongly agreed, 27% agreed and 9% neither agreed nor disagreed. This indicates 91% of the respondents agreed and just 9% were neutral, 0% of disagreement. This proves that the usage of modules will increase HR excellence and advance distance learning opportunities.

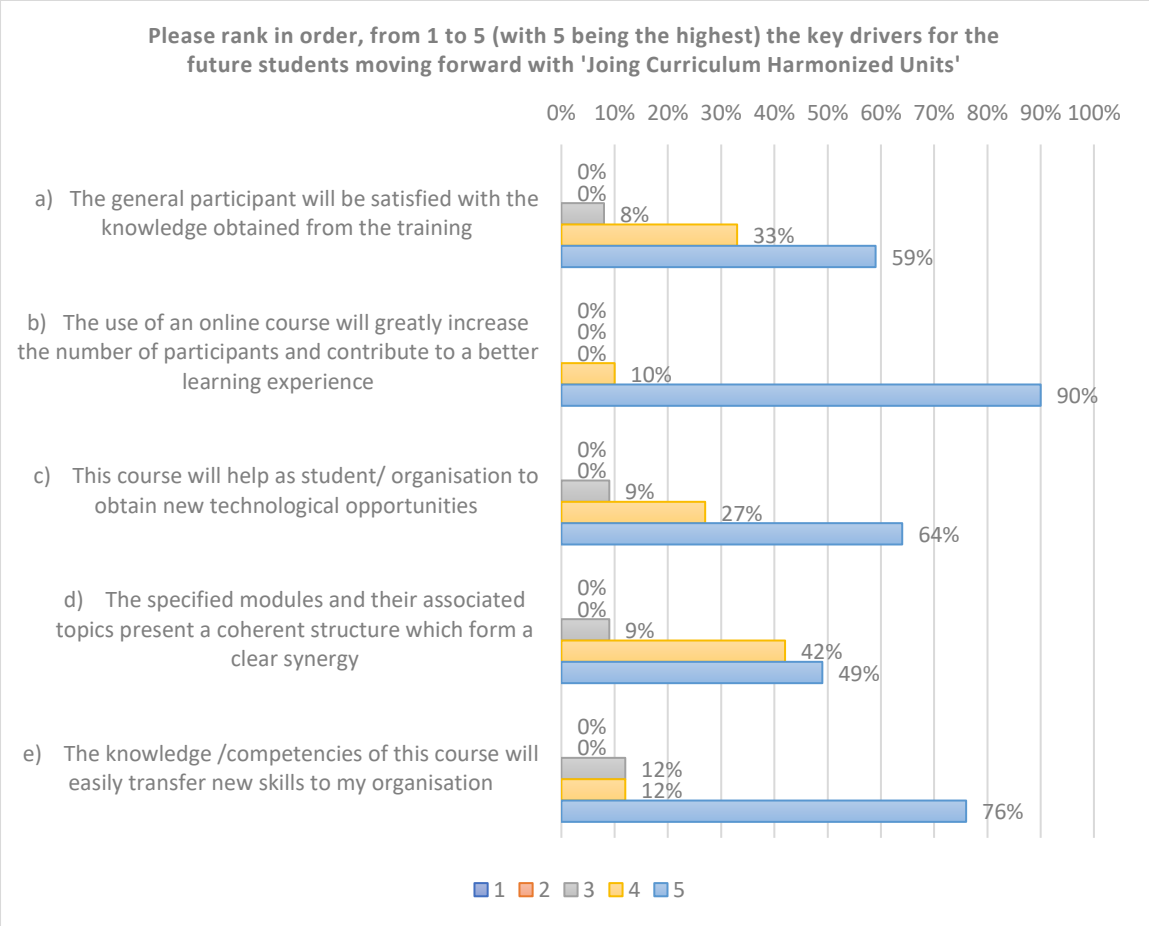
3. Third statement with the most positive feedback was '' **The described Joint Curriculum will encourage technology innovation and attract new talents** '' with score 64% strongly agreed, 18% agreed and 18% neither agreed nor disagreed. 82% of all responses were positive and 18% neutral. This means Joint Curriculum should encourage technology innovation and attract new talents. In fact, 3rd, 4th and 5th statements received the same cumulative score but in order to position them it was chosen to position them by the rating of the "strongly agree" answers.
4. '' **The chosen modules, lessons and topics are essential to the VET students and staff of organisations for their progression in terms of Key Enabling Technologies and technological innovation ''** received 54% of strongly agree, 38% of agree and 8% of neither agree nor disagree evaluation. 92% of all answers were agreed with the statement, 8% neutral, no disagreement. This result shows that the chosen modules, lessons and topics are essential to the VET students and staff. In fact, 3rd, 4th and 5th statements received the same cumulative score but in order to position them it was chosen to position them by the rating of the "strongly agree" answers.
5. '' **The VET students and staff of organisation will adapt easily to such a course and greatly benefit from its content** '' had 46% strongly agree and 54% agree feedbacks which shows that 100% of respondents agree and feel that the VET students and staff of organisation will adapt easily to such a course and greatly benefit from its content. In fact, 3rd, 4th and 5th statements received the same cumulative score but in order to position them it was chosen to position them by the rating of the "strongly agree" answers.

Please indicate in your opinion on the following perceived benefits of the 'Joint curriculum Harmonized Units'	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The chosen modules, lessons and topics are essential to the VET students and staff of organisations for their progression in terms of Key Enabling Technologies and technological innovation	54%	38%	8%	0%	0%
The VET students and staff of organisations will adapt easily to such a course and greatly benefit from its content	46%	54%	0%	0%	0%
The use of the designated modules will Increase HR excellence and advance distance learning opportunities	64%	27%	9%	0%	0%
The described joint curriculum will encourage technology innovation and attract new talents	64%	18%	18%	0%	0%
The VET abilities, capacities, skills and competences towards Key Enabling Technologies have been outlined in the 'Joint curriculum Harmonized Units'	71%	29%	0%	0%	0%

From general perspective 'Joint curriculum Harmonized Units' are expected to bring the benefits to the users. All answers were highly agreed by the respondents, every statement received at least 82% of agreement score and there was no disagreement.

The strongest benefit is the outline of VET abilities, capacities, skills and competences towards Key Enabling Technologies, but all other benefits are important for the users as the cumulative scores were almost identical.

Question no. 3: **Please rank in order, from 1 to 5 (with 5 being the highest) the key drivers for future students moving forward with 'Joint curriculum Harmonized Units'**



The experts were asked to rank in order the key drivers for future students moving forward with 'Joint curriculum Harmonized Units'. The ranking was from 1 (lowest) to 5 (highest).

The statements were lined up according to the key drivers for the future students and the relevance to them.

1. '' **The use of an online course will greatly increase the number of participants and contribute to a better learning experience** '' with 90% of highest ranking 5, and 10%

of ranking 4. In general, 100% of respondents scored 2 highest rankings proving that the online aspect the most important key driver element.

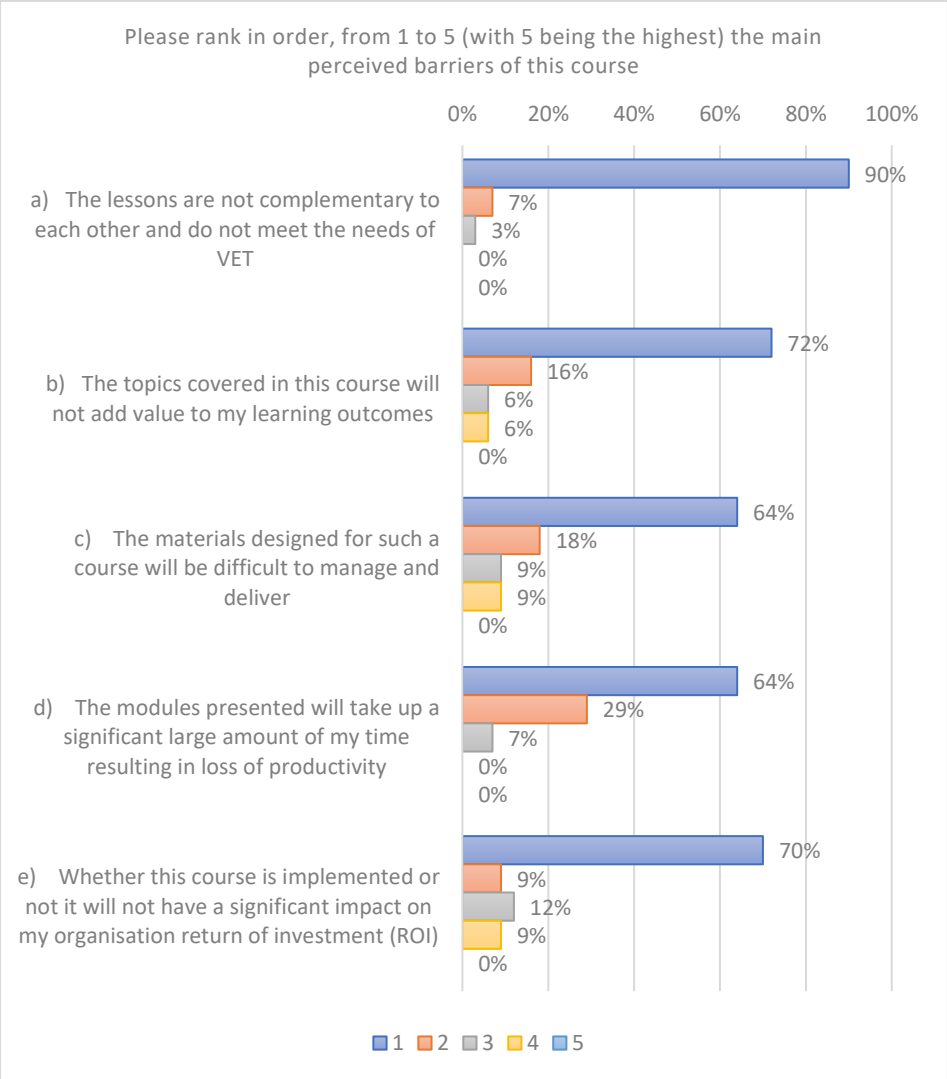
2. ‘’ **The knowledge/competencies of this course will easily transfer new skills to my organisation ’’** received 76% of highest ranking 5, 12% of ranking 4 and 12% of ranking no. 3. 88% of all scores ranking 5 and 4 and just 12% of moderate scores proved that is expected that this course is targeting real knowledge and competences which will be easily used and transferred into new skills needed for the organisations.
3. **“ This course will help as student/ organisation to obtain new technological opportunities** ‘’ was scored as the third most important key element – 64% of respondents ranked as 5, 27% as 4 and just 9% as 3. 91% of the respondents ranking for 5 and 4 and just 9% for the moderate ranking 3 shows that this course will help student/organisation to obtain new technological opportunities.
4. ‘’ **The general participant will be satisfied with the knowledge obtained from the training ’’** was evaluated with 59% of highest 5 ranking, 33% as 4 ranking and 8% of ranking no. 3. 92% of all respondents scored ranking 5 and 4 while just 8% of respondents ranked this topic as moderate. Such evaluation proves that participants are satisfied with the knowledge obtained from the course.
5. Lowest score from this perspective and the lowest level as the key driver received the statement ‘’ **The specified modules and their associated topics present a coherent structure which form a clear synergy** ‘’ where 49% of respondents scored highest score no. 5, 42% score 4 and 9% score no. 3. 91% of all responses targeted ranking 5 and 4 and just 9% was showing the moderate score. This all proves that the modules are coherent.

Please rank in order, from 1 to 5 (with 5 being the highest) the key drivers for future students moving forward with ‘Joint curriculum Harmonized Units’	**1**	**2**	**3**	**4**	**5**
a) The general participant will be satisfied with the knowledge obtained from the training	0%	0%	8%	33%	59%
b) The use of an online course will greatly increase the number of participants and contribute to a better learning experience	0%	0%	0%	10%	90%
c) This course will help as student/ organisation to obtain new technological opportunities	0%	0%	9%	27%	64%
d) The specified modules and their associated topics present a coherent structure which form a clear synergy	0%	0%	9%	42%	49%
e) The knowledge /competencies of this course will easily transfer new skills to my organisation	0%	0%	12%	12%	76%

From the general perspective all scores were very high. The summarized scores of ranking 5 and 4 were on the level of 100% for the best key driver (online learning aspect) and 88% - 92% for rest of the key drivers. The moderate results for ranking no. 3 were in level of 8% - 12%, no results with ranking 2 or 1.

These results prove that all the key drivers are very important part of the curricula and there are no drivers which would have the lower importance. However, the online learning aspect is the most important key driver.

Question no. 4: **Please rank in order, from 1 to 5 (with 5 being the highest) the main perceived barriers of this course**



The main aim of this question was to evaluate biggest barriers for the future students using the 'Joint curriculum Harmonized Units'. The respondents were asked to rank the statements in order, from 1 to 5 (with 5 being the highest).

1. **'' The lessons are not complementary to each other and do not meet the needs of VET ''** represents the area with the lowest level of barrier for the potential users with ranking 90% as no. 1, 7% no.2 and 3% no.3. Score of 97% for ranking 1 and 2 shows

that the participants don't see the problem of the lessons not being complementary for each other.

2. **'' The modules presented will take up a significant large amount of my time resulting in loss of productivity ''** shows that also the time is easy to handle, as the score for this statement was 64% no.1, 29% no.2 and just 7% no.3. In fact, 93% of respondents scored raking 1 or 2. The participants don't see the time spent on the modules as the problematic factor to handle their work activities.
3. **'' The topics covered in this course will not add value to my learning outcomes ''** was the third strongest with the score of 72% raking 1, 16% ranking 2, 6% ranking 3 and 6% ranking 4. Which represents that 88% of respondents scored raking 1 or 2. So the participants see the topics covered in the training as those bringing the value.
4. **'' Whether this course is implemented or not it will not have a significant impact on my organisation return of investment (ROI) ''** was evaluated as following - 70% no. 1, 9% no. 2, 12% no.3 and 9% no.4. That means 79% of respondents don't see that the course wouldn't have the significant impact, 12% are neutral and just 9% of respondents feels more pessimistic.
5. **'' The materials designed for such a course will be difficult to manage and deliver ''** appears to represent the biggest obstacle for the respondents with ranking 64% ranking 1, 18% ranking 2, 9% ranking 3 and 9% ranking 4. But despite the last place 82% of respondence don't see the difficulty to manage the course, 9% are rather neutral and just 9% see some difficulty.

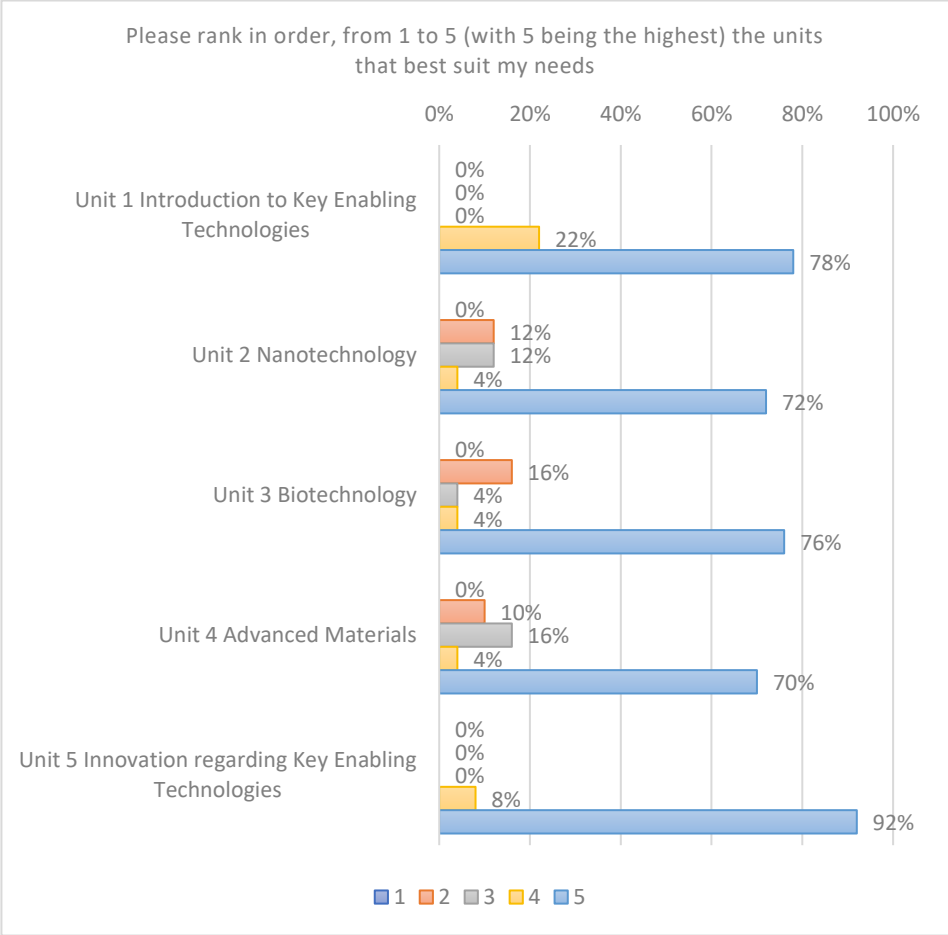
Please rank in order, from 1 to 5 (with 5 being the highest) the main perceived barriers of this course	**1**	**2**	**3**	**4**	**5**
a) The lessons are not complementary to each other and do not meet the needs of VET	90%	7%	3%	0%	0%
b) The topics covered in this course will not add value to my learning outcomes	72%	16%	6%	6%	0%
c) The materials designed for such a course will be difficult to manage and deliver	64%	18%	9%	9%	0%
d) The modules presented will take up a significant large amount of my time resulting in loss of productivity	64%	29%	7%	0%	0%
e) Whether this course is implemented or not it will not have a significant impact on my organisation return of investment (ROI)	70%	9%	12%	9%	0%

In general respondents did not see any significant barriers to the Joint Curriculum presented as all statements received a cumulated score in very similar level. In more detailed all statements received at least 79% to 97%.if to look at summarised scores of rankings 1 and 2. The moderate score no.3 had from 3 % to 12% and just in 3 cases raking 4 in level of 6% to 9% was needed.

According to these results there are no significant barriers or obstacles to pass the course. Even the lowest scored statement which represent the biggest obstacles **'' The materials designed for such a course will be difficult to manage and deliver ”** had really high score of 82% in summarised ranking 1 and 2 so despite of the last position still we can't consider this aspect as any barrier. The smallest barrier for the trainees is **'' The lessons are not complementary to each other and do not meet the needs of VET ''** with summarised score of 97% for rankings 1 and 2.

Section 2: Course overview

Question no. 5: **Please rank in order, from 1 to 5 (with 5 being the highest) the units that best suit my needs**



Participants were requested to rank in order, from 1 to 5 (with 5 being the highest) the five proposed units.

The following sequence of units' shows them based on ranking where the highest will be the first presented.

1. **" Unit 5 Innovation regarding Key Enabling Technologies "** proves that the general unit about innovation and KET is very much welcomed by all the respondents. The ranking for this unit was following – 92% scored ranking 5 and just 8% ranking 4. 100% of respondents ranked this unit with rankings 5 and 4 and just 8% were missing to the absolute score of 100% for the ranking no. 5. This proves that Unit 5 is seemed by all participants as the most needed.
2. **" Unit 1 Introduction to Key Enabling Technologies "** another general unit, this time introduction one was scored with the 2nd highest score - with 78% of score 5 and 22%

of score 4. Despite the second position 100% of the score was for ranking 5 and 4. Which also shows that this general unit '' Unit 1 Introduction to Key Enabling Technologies '' is very expected and needed.

3. **'' Unit 3 Biotechnology ''** was the first one from the specific units. 76% of the participants presented ranking 5, 4% ranking 4, 4% ranking 3 and 16% ranking 2. Result shows the reality of 80% scoring rankings 4 and 5 while 4% are moderate and just 16% are not too interested. For specific units it depends on which fields are the experts/participants coming from because not every specialised units they need to be necessarily interested in.
4. **" Unit 2 Nanotechnology ''** has also very high score. 72% of respondents ranked no. 5, 4% no. 4, 12% no. 3 and 12% no. 2. 76% of the participants presented ranking 5, 4% ranking 4, 4% ranking 3 and 16% ranking 2. Such result indicates that 76% of scoring reached ranking 4 and 5 while 4% are moderate and just 12% are not too interested. For specific units it depends on what fields are the experts/participants coming from because not every specialised units they need to be necessarily interested in.
5. **'' Unit 4 Advanced Materials ''** was evaluated as 70% ranking 5, 4% ranking 4, 16% ranking 3 and 10% ranking 2. That shows the reality of 74% scoring rankings 4 and 5 while 16% are moderate and just 10% are not too interested. For specific units it always depends on what fields are the experts/participants coming from because not every specialised units they need to be necessarily interested in.

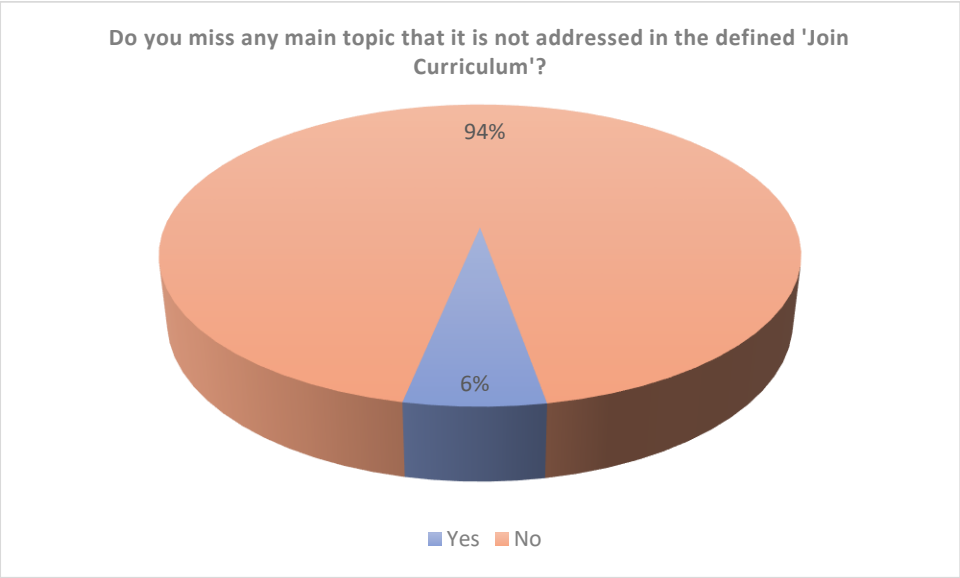
Please rank in order, from 1 to 5 (with 5 being the highest) the units that best suit my needs	**1**	**2**	**3**	**4**	**5**
Unit 1 Introduction to Key Enabling Technologies	0%	0%	0%	22%	78%
Unit 2 Nanotechnology	0%	12%	12%	4%	72%
Unit 3 Biotechnology	0%	16%	4%	4%	76%
Unit 4 Advanced Materials	0%	10%	16%	4%	70%
Unit 5 Innovation regarding Key Enabling Technologies	0%	0%	0%	8%	92%

The results have shown that both general units (**'' Unit 5 Innovation regarding Key Enabling Technologies '' and '' Unit 1 Introduction to Key Enabling Technologies '')** are easy to understand by all respondents. Both topics obtained the highest ranking. From the specific units the most prefered is **'' Unit 3 Biotechnology '',** after **" Unit 2 Nanotechnology''** and the **'' Unit 4 Advanced Materials ''** as the last**.** We can interpret it in a way that the general units are easy to understand for all participants while the specific units depend on the preference or the study direction/ work position of each single participant.

But from the general perspective all modules received very high ranking. General modules received 100% of all scores in ranking 5 and 4 while the specific units received from 74% to 80% in ranking 5 and 4 whereas from 10% to 16% of participants were not so much interested in these modules. Each specialist has its own needs and expectations and we can't expect that all experts are interetsed in all specific topics. Based on these factors the results of the

specific modules are very satisfactory and we can say all modules were ranked very high and they are well accepted by the participants.

Question no. 6: **Do you miss any main topic that it is not addressed in the defined "Joint Curriculum" ?**



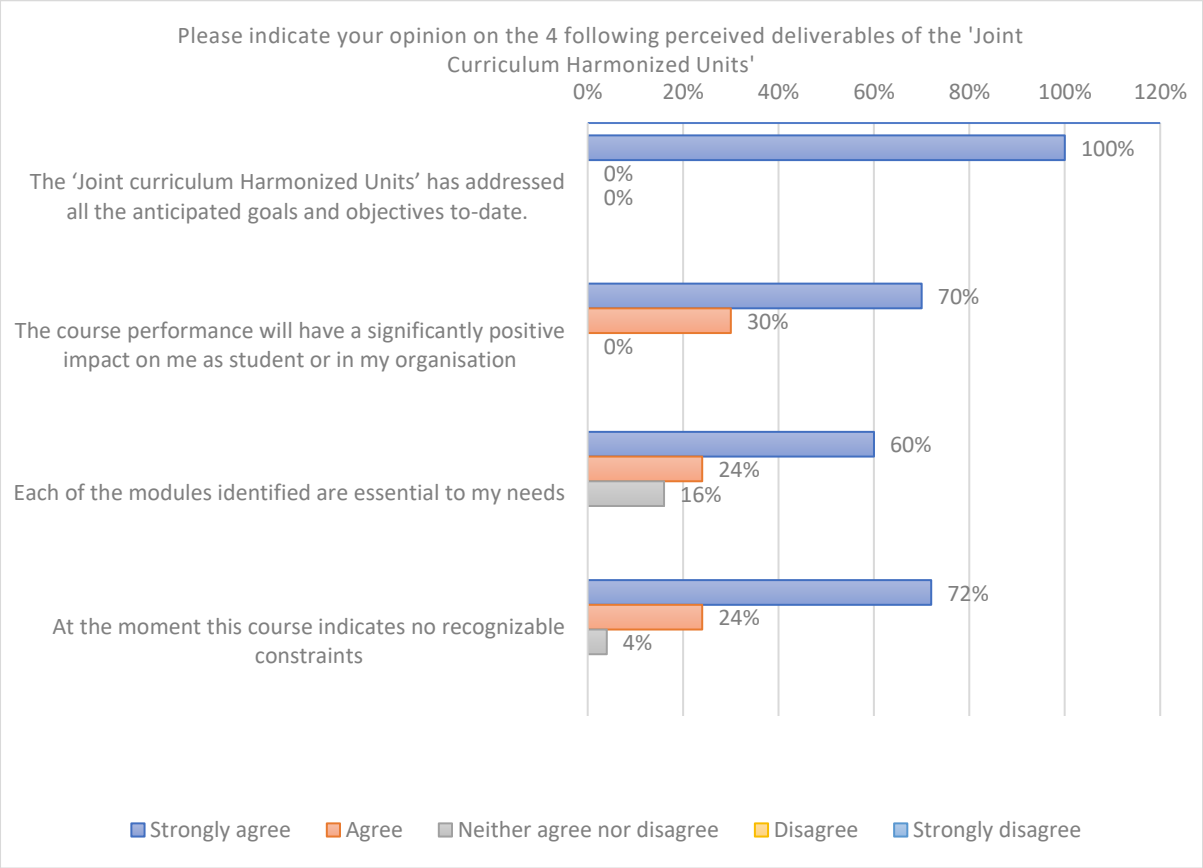
Answer	Rate
Yes	6%
No	94%

94% of the respondents showed the satisfaction with the proposed content structure of 'Joint Curriculum Harmonized Units'. Only 6% of respondents see that there is still some space for the improvement.

Additional feedback from our experts suggested that we could include more information about climate and environmental changes. Information about **Photonics** and **Micro-/Nano electronics** could also be better represented in the curriculum.

It was also recommended that VET should explicitly cover the limitations of taught materials and on the other hand should teach how to identify and utilize external support in order to enable trainees to implement solutions in all subunits of the curriculum. The respondent didn't explain deeper what the external support means but we can expect that there is a need to get the access to extra literature and publications, like www.shcolar.google.com, www.researchgate.com , www.academia.com, and www.scopus.com.

Question no. 7: **Please indicate your opinion on the 4 following perceived deliverables of the 'Joint Curriculum Harmonized Units'**



The experts were asked to evaluate the statements. The scale of 5 possible answers presented from highest to lowest score is following: strongly agree; agree; neither agree nor disagree; disagree; strongly disagree.

The statements are presented from the most agreed for users to the least agreed.

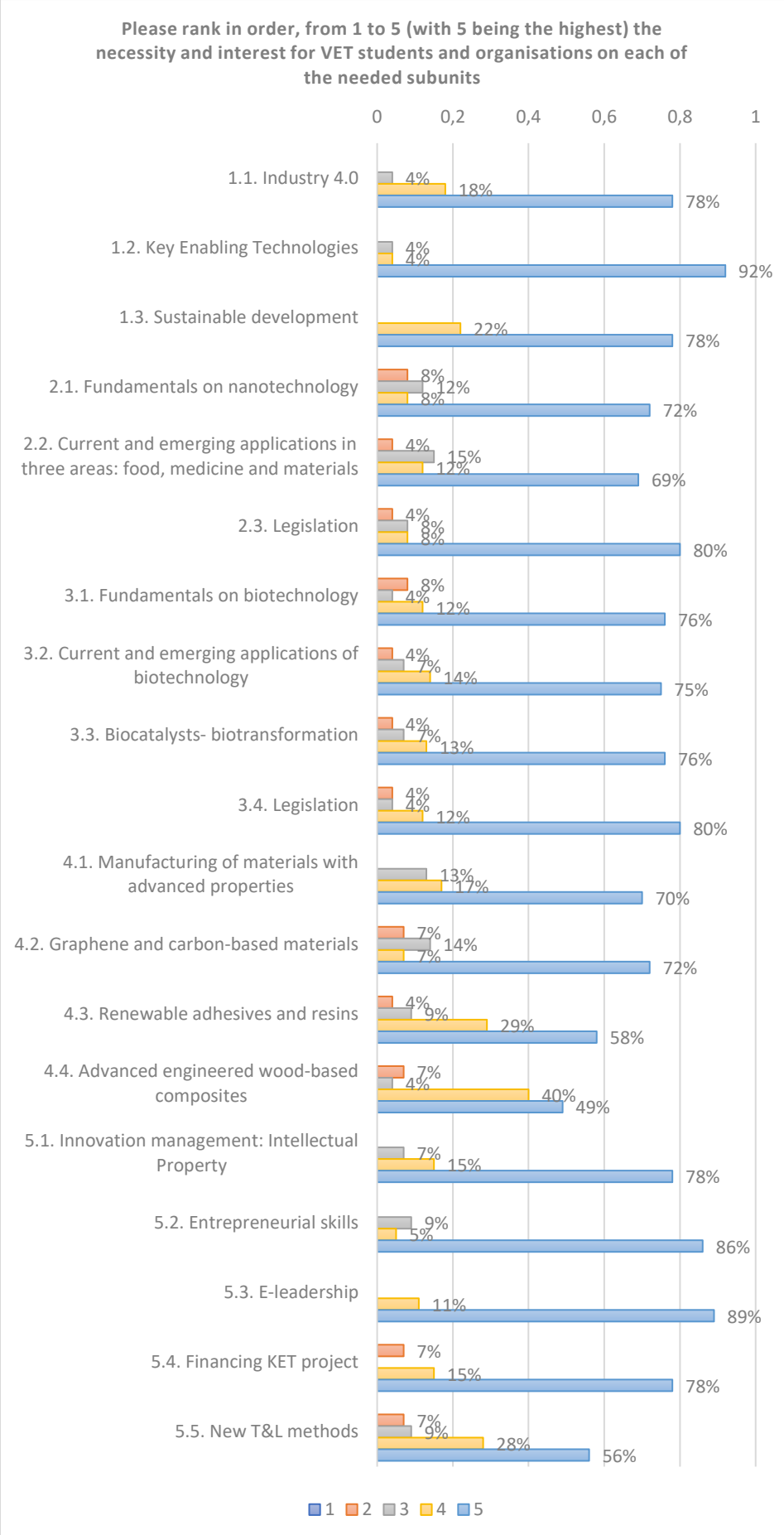
1. **'' The 'Joint curriculum Harmonized Units'' has addressed all the anticipated goals and objectives to-date.''** Received absolute score of 100% strongly agree feedback which proves that the 'Joint curriculum Harmonized Units' addresses the objectives and goals which are to-date.
2. **'' The course performance will have a significantly positive impact on me as student or in my organisation ''** received second highest rating feedback where 70% of experts strongly agreed and 30% agreed. Which also means that 100% of respondents agreed with the statement that the course performance will have the positive feedback on the students and the organisation.
3. **'' At the moment this course indicates no recognizable constraints ''** showed that 72% of the experts strongly agreed, 24% agreed and 4% neither agreed nor disagreed with the statement. In this case 96% of respondents agree that this course indicates no recognizable constrains.
4. **'' Each of the modules identified are essential to my needs ''** statement was evaluated by 60% of respondents as strongly agreed, 24% agreed, 16% neither agreed

nor disagreed. Also, in this least evaluated statement 84% of respondents agree with the statement and 16% are neutral which indicates that the modules identify the essential needs of the potential users.

Please indicate your opinion on the 3 following perceived deliverables of the 'Joint Curriculum Harmonized Units'	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The 'Joint curriculum Harmonized Units' has addressed all the anticipated goals and objectives to-date.	100%	0%	0%	0%	0%
The course performance will have a significantly positive impact on me as student or in my organisation	70%	30%	0%	0%	0%
Each of the modules identified are essential to my needs	60%	24%	16%	0%	0%
At the moment this course indicates no recognizable constraints	72%	24%	4%	0%	0%

From general perspective **'Joint curriculum Harmonized Units' is expected to bring the benefits to the users.** All answers were highly agreed by the respondents, every statement received at least 84% of agreement, in 2 cases only there was the neutral answer (from 4% - 16%) and there was 0% disagreement. We can present that the 'Joint curriculum Harmonized Units' has addressed to-date goals and objectives to-date, the course will have the significant impact on trainees and the organisations, there are no constraints and the course identify the real needs.

Question no. 8: **Please rank in order, from 1 to 5 (with 5 being the highest) the necessity and interest for VET students and organisations on each of the defined subunits**


Please rank in order, from 1 to 5 (with 5 being the highest) the necessity and interest for VET students and organisations on each of the needed subunits
0
0,2
0,4
0,6
0,8
1
1.1. Industry 4.0
4%
18%
78%
1.2. Key Enabling Technologies
4%
4%
92%
1.3. Sustainable development
22%
78%
2.1. Fundamentals on nanotechnology
8%
12%
8%
72%
2.2. Current and emerging applications in three areas: food, medicine and materials
4%
15%
12%
69%
2.3. Legislation
4%
8%
8%
80%
3.1. Fundamentals on biotechnology
8%
4%
12%
76%
3.2. Current and emerging applications of biotechnology
4%
7%
14%
75%
3.3. Biocatalysts- biotransformation
4%
7%
13%
76%
3.4. Legislation
4%
4%
12%
80%
4.1. Manufacturing of materials with advanced properties
13%
17%
70%
4.2. Graphene and carbon-based materials
7%
14%
7%
72%
4.3. Renewable adhesives and resins
4%
9%
29%
58%
4.4. Advanced engineered wood-based composites
7%
4%
40%
49%
5.1. Innovation management: Intellectual Property
7%
15%
78%
5.2. Entrepreneurial skills
9%
5%
86%
5.3. E-leadership
11%
89%
5.4. Financing KET project
7%
15%
78%
5.5. New T&L methods
7%
9%
28%
56%
1
2
3
4
5

The respondents were asked to rank in order, from 1 to 5 (with 5 being the highest) the interest of for VET students in subunits topics.

The following sequence shows the units based on ranking, with the highest ranked presented first.

1. **'' 5.3. E-leadership ''** is very important topic to everyone, not depending on any specialisation. The ranking for this subunit was following – 89% scored ranking 5 and just 11% ranking 4. Just 11 % was missed from the absolute score. The general subunit as the Leadership is a universal topic important to every person not depending on the specialisation.
2. **'' 1.2. Key Enabling Technologies ''** another more general unit, this time introduction to the Key Enabling Technologies was scored with the 2nd highest score - 92% of score 5 and 4% of score 4 and 4% ranking 3. The highest rankings 5 and 4 were together 96% and just 4% in moderate level. General units are easy to understand for every user not depending on his/her specialisation.
3. **'' 1.3. Sustainable development ''** another part of Unit 1, general subunit on sustainable development was third best ranked with score. 78% of replies with ranking 5, and 22% ranking 4. The highest rankings 5 and 4 were together 100%. General units are easy to understand for every user not depending on his/her specialisation.
4. **'' 5.2. Entrepreneurial skills ''** was evaluated as ranking 5 with 86%, 5% ranking 4, 9% ranking 3. The highest rankings 5 and 4 were together 91% and just 9% in moderate level showing that entrepreneurial skills are transversal unit important for every user not depending on his/her specialisation.
5. **'' 1.1. Industry 4.0 ''** was the last from Unit 1 but still on 5th place in total ranking with score of 78% no. 5, 18% no. 4, 4% no. 3. The highest rankings 5 and 4 were together 96% and just 4% in moderate level. Industry 4.0 is new direction which is transversal for all users not depending on his/her specialisation.
6. **'' 5.1. Innovation management: Intellectual Property ''** another subunit from unit 5 with general content was ranked as the 6th best. The score for this unit was following – 78% scored for ranking 5, 15% ranking 4 and 7% ranking 3. 93% were ranked 5 and 4, just 7% with moderate ranking. Again, the transversal topic which suits to everyone.
7. **'' 3.4. Legislation ''** was the highest ranked subunit of unit three with score - 80 % of score 5 and 12% with score 4 and 4% with score 3 and 4% of score 2. 92% were ranked 5 and 4, just 4% with moderate ranking and 4% of lower score. Again, the transversal topic which suits to everyone.
8. **'' 5.4. Financing KET project ''** was ranked as 8th best subunit and proved how important are general parts of the curricula and dominating position of units one and five. Score was 78% of the experts presented ranking 5, 15% ranking 4 and 7% ranking 2. 93% were ranked 5 and 4, just 7% with lower ranking. The transversal topic which suits to everyone as the financing is needed for everyone.
9. **'' 2.3. Legislation ''** was the highest scored subunit of unit two with following evaluation – 80% ranking 5, 8% ranking 4, 4% ranking 3 and 4% ranking 2. 88% were ranked 5 and 4, just 4% with moderate ranking and 4% of lower score. Again, the legislation is a transversal topic which suits to everyone.

10. **'' 3.3. Biocatalysts - biotransformation ''** was ranked with 76% no. 5, 13% no. 4, 7% no. 3 and 4% no. 2. This was a highest ranked specific subunit where 89% of respondents ranked the highest scores 5 and 4, 7% moderate and 4% lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
11. **'' 3.2. Current and emerging applications of biotechnology ''** is another subunit of unit three with following score – 75% scored ranking 5, 14% ranking 4, 7% ranking 3 and 4% ranking 2. This specific subunit was ranked by respondents with 89% of the highest scores 5 and 4, 7% moderate and 4% lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
12. **'' 4.1. Manufacturing of materials with advanced properties ''** on 12th place was positioned the best evaluated subunit of unit four with score of - 70% of score 5 and 17% of score 4 and 13% score 3. This specific subunit was ranked by respondents with 87% of the highest scores 5 and 4 and 13% of moderate score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
13. **'' 3.1. Fundamentals on biotechnology ''** was the last from subunits of unit three. Its score was following – 76% of respondents ranked 5, 12% ranked 4, 4% ranked 3 and 8% ranked 2. This specific subunit was ranked by respondents with 88% of the highest scores 5 and 4, 4% ranked moderate ranking 3 and 8% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
14. **'' 2.2. Current and emerging applications in three areas: food, medicine and materials ''** was evaluated as 14th with score 69% ranking 5, 12% ranking 4, 15% ranking 3 and 4% ranking 2. This specific subunit was ranked by respondents with 81% of the highest scores 5 and 4, 15% ranked moderate ranking 3 and 4% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
15. **'' 2.1. Fundamentals on nanotechnology ''** last subunit of unit two was ranked on 15th place with score as 72% no. 5, 8% no. 4, 12% no. 3 and 8% no. 2. This specific subunit was ranked by respondents with 80% of the highest scores 5 and 4, 12% ranked moderate ranking 3 and 8% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
16. **'' 4.2. Graphene and carbon-based materials ''** were following with score of 72% scored ranking 5, 7% ranking 4, 14% of ranking 3 and 7% of ranking 2. This specific subunit was ranked by respondents with 79% of the highest scores 5 and 4, 14% ranked moderate ranking 3 and 7% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar,

and it depends how many specialists/people interested in specific fields were evaluating the curricula.

17. **'' 4.3. Renewable adhesives and resins ''**were ranked with third lowest valued score as 58% score 5 and 29% score 4, 9% score 3 and 4% score 2. This specific subunit was ranked by respondents with 87% of the highest scores 5 and 4, 9% ranked moderate ranking 3 and 4% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.
18. **'' 5.5. New T&L methods ''** was the exception among subunits of unit five with second lowest score - 56% of the experts presented ranking 5, 28% ranking 4, 9% ranking 3 and 7% ranking 2. This general subunit was the exception for the general units ranked by respondents with 84% of the highest scores 5 and 4, 9% ranked moderate ranking 3 and 7% of lower score. But in general, all scores for all modules are very high.
19. **'' 4.4. Advanced engineered wood-based composites ''** was evaluated as the last with 49% ranking 5, 40% ranking 4, 4% ranking 3 and 7% ranking 2. This specific subunit was ranked by respondents with 89% of the highest scores 5 and 4, 4% ranked moderate ranking 3 and 7% of lower score. It' s quite unfair to evaluate which specific module is more needed and which less while the evaluation is very similar, and it depends how many specialists/people interested in specific fields were evaluating the curricula.

Please rank in order, from 1 to 5 (with 5 being the highest) the necessity and interest for VET students and organisations on each of the defined subunits	**1**	**2**	**3**	**4**	**5**
1.1. Industry 4.0	0%	0%	4%	18%	78%
1.2. Key Enabling Technologies	0%	0%	4%	4%	92%
1.3. Sustainable development	0%	0%	0%	22%	78%
2.1. Fundamentals on nanotechnology	0%	8%	12%	8%	72%
2.2. Current and emerging applications in three areas: food, medicine and materials	0%	4%	15%	12%	69%
2.3. Legislation	0%	4%	8%	8%	80%
3.1. Fundamentals on biotechnology	0%	8%	4%	12%	76%
3.2. Current and emerging applications of biotechnology	0%	4%	7%	14%	75%
3.3. Biocatalysts- biotransformation	0%	4%	7%	13%	76%
3.4. Legislation	0%	4%	4%	12%	80%
4.1. Manufacturing of materials with advanced properties	0%	0%	13%	17%	70%
4.2. Graphene and carbon-based materials	0%	7%	14%	7%	72%
4.3. Renewable adhesives and resins	0%	4%	9%	29%	58%
4.4. Advanced engineered wood-based composites	0%	7%	4%	40%	49%
5.1. Innovation management: Intellectual Property	0%	0%	7%	15%	78%
5.2. Entrepreneurial skills	0%	0%	9%	5%	86%

5.3. E-leadership	0%	0%	0%	11%	89%
5.4. Financing KET project	0%	7%	0%	15%	78%
5.5. New T&L methods	0%	7%	9%	28%	56%

In general respondents were satisfied with the subunits and the structure. Majority of them were evaluating the subunits with the top scores of highest and second highest rankings. In fact no subunit received a score lower than 79% for ranking 5 and 4 summarized. In addition just few of subunits were around this score, while majority of them were around 90% score for ranking 5 and 4.

The survey allowed to identify the differences between popularity of each unit. All subunits of Unit no.1 had a very high score, where the worst subunit was scored as the 5th most interesting for VET students. The second highest evaluation received unit was Unit no. 5 where all of subunits were evaluated very high with one small exception of subunit 5.5. But despite the fact 5.5 was evaluated lower nevertheless for ranking 5 and 4 summarized the subunit reached score of 84% .

The general units and their subunits are transversal, needed and aplicable for all experts, students and all interested people. That's why its easier for them to evaluate the general subunits high.

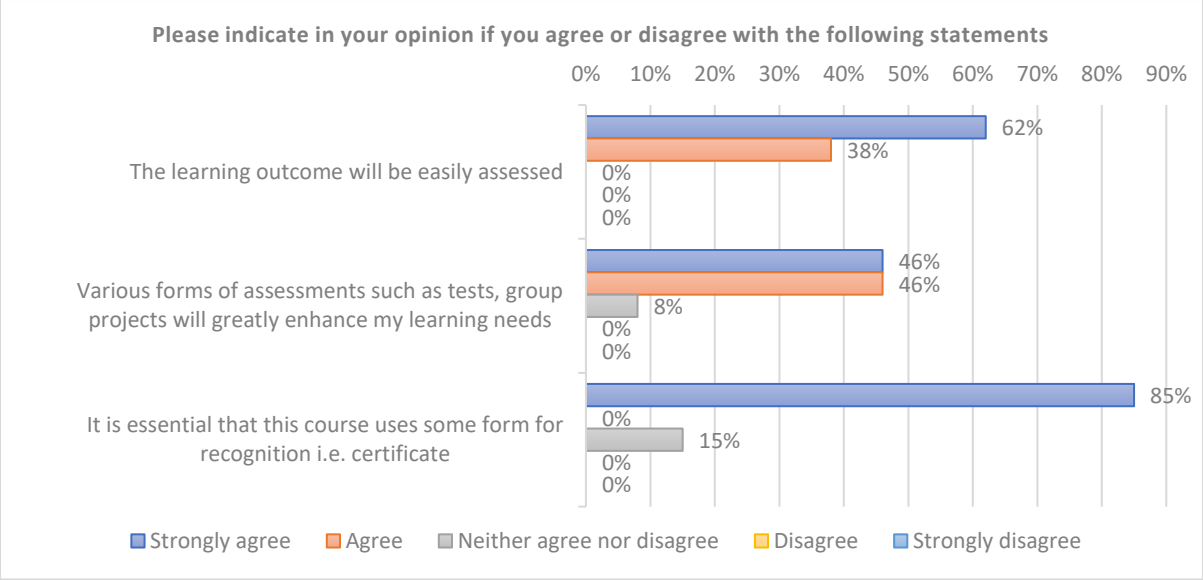
All the units about the new technologies were ranked with the lower importance than the general units. But as it was mentioned earlier even the worst subunit received the score 79% for rankings 5 and 4. That means for every subunit 4/5 of all respondents see such subunits as very important and we shouldn't look just at the positions between all subunits, as the percentual difference can be ignored due to very small difference, but we should concetrate more on the real score of each unit. Another factor that played role in scoring for the specific units is that these subjects are very various and for the specialists from different field seemed their specific units more important than other specific units they don't specialise in. So because of all these factors we shuld see all units and subunits as a complete course and we shouldn't diferentiate between each subunit.

Subunits of Unit three (Biotechnology) were the best scored new technology subunits followed by the subunits of Unit two (Nanotechnology). On the last place were ranked subunits from unit four (Advanced technologies) while the best subunit of unit four was 4.1. Manufacturing of materials with advanced properties.

Question no. 9: **Do you miss any main topic that it is not addressed in the defined "Joint Curriculum?**

In general, the experts are satisfied with the provided structure and the content. There were no further comments on this topic.

Question no. 10: **Please indicate in your opinion if you agree or disagree with the following statements**



The respondents were asked to evaluate the statements. The scale of 5 possible answers presented from highest to lowest score is following: strongly agree; agree; neither agree nor disagree; disagree; strongly disagree.

The following sequence of shows the units based on ranking, with the highest ranked (most agreed) presented first.

1. **" It is essential that this course uses some form for recognition i.e. certificate "** Statement received very high score as 85% strongly agree and 15 % of neither agree nor disagree. This shows the respondents wish to receive the certificate at the end of the course.
2. **" The learning outcome will be easily assessed "** received second highest feedback where 62% of experts strongly agreed and 38% agreed. Which means that all 100% of respondents agree with this statement and they believe the learning outcome will be assessed easily.
3. **" Various forms of assessments such as tests, group projects will greatly enhance my learning needs "** showed that 46% of the experts strongly agreed, 46% agreed and 8% neither agreed nor disagreed. Which means 92% of the respondents agree and just 8% are neutral. Yes, various forms of assessment are expected by the participants.

Please indicate in your opinion if you agree or disagree with the following statements	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The learning outcome will be easily assessed	62%	38%	0%	0%	0%

Various forms of assessments such as tests, group projects will greatly enhance my learning needs	46%	46%	8%	0%	0%
It is essential that this course uses some form for recognition i.e. certificate	85%	0%	15%	0%	0%

From general perspective, the assessment side of the curricula was evaluated with highly positive feedback from 85% - 100% and only in minimal cases there was a neutral feedback (8 -16%) while 0% of disagreement. According to the results obtained, consortium confirm that there should be a certificate at the end of the course, the learning outcomes will be easily assessed and the respondents agree with the various types of the assessment.

Conclusion

The Joint Curriculum within the BRACKET Project was validated through a series of questionnaires with stakeholders of the industry sector. Stakeholders and associated partners provided their feedback about it, with the aim to identify the potential weaknesses and areas for improvement.

The survey consisted of 10 questions divided into two parts. Survey conducted was completed by 44 participants – different KET experts, students or VET professionals. Participants were invited to check a general overview of the Joint Curriculum drafted for this task. This document is annexed in this report.

The respondents were evaluating different aspects of the 'Joint Curriculum Harmonized Units'.

First section of the questionnaire was dedicated to the mission of the course and the participants were evaluating:

1. Innovation and technology drivers
2. Benefits of the course
3. Barriers of the course

From all three aspects the 'Joint Curriculum Harmonized Units' passed the evaluation very successfully.

Joint Curriculum Harmonized Units' address the needs of VET to boost into the drivers of technology and innovation to foster competitiveness and acceleration of organisations towards Key Enabling Technologies as all respondents agreed (93% responded that greatly addresses the needs and 7% that somewhat addresses).

The strongest benefit is the outline of VET abilities, capacities, skills and competences towards Key Enabling Technologies, but all other benefits are important for the users as the cumulative scores were almost identical.

results prove that all the key drivers are important part of the curricula and there are no drivers which would have the lower importance. However, the online learning aspect is the most important key driver.

There are no significant barriers or obstacles to pass the course. Even the lowest ranked statement which represent the biggest obstacles ''The materials designed for such a course will be difficult to manage and deliver" had really high score of 82% in ranking 1 and 2 together. However, the smallest barrier for the trainees is the fact that the lessons are not complementary to each other.

Second section of the validation questionnaire was dedicated to the course overview and the participants were evaluating:

1. Needs of participants (Units evaluation)
2. Missing topics
3. Deliverables of the Units
4. Interest in subunits
5. Missing main topics
6. Assessment and certification

All units of the training curricula were well accepted by the respondents. Both general units (''Unit 5 Innovation regarding Key Enabling Technologies'' and ''Unit 1 Introduction to Key Enabling Technologies '') are easy to understand for all respondents. and they presented the highest interest in them. From the specific units the most prefered is ''Unit 3 Biotechnology'', after" Unit 2 Nanotechnology'' and the ''Unit 4 Advanced Materials'' as the last. We can interpret it in a way, that the general units are easy to understand to all participants while the specific units depend on the preference or the study direction/ work position of each single participant. But from the overall perspective all modules received in strongest ranking no.5 at least 70% and 74% if to calculate ranking 5 and 4 together. That's why we can say all modules were ranked very high and they are well accepted by the participants.

If to discuss the missing topics and the main topics 94% of the respondents presented the satisfaction with the proposed content structure of 'Joint Curriculum Harmonized Units'. Only 6% of respondents see that there is some space for the improvement. Respondents are satisfied with the provided structure and the content. There were no further comments on the main topics just some slight suggestions on topics as more information about climate and environmental changes, information about Photonics and Micro-/Nano electronics or usage of external resources.

Review of questionare results have shown that both general units (''Unit 5 Innovation regarding Key Enabling Technologies'' and ''Unit 1 Introduction to Key Enabling Technologies

‘’) are easy to understand to all respondents so they presented the highest interest in them. From the specific units the most prefered is ‘’Unit 3 Biotechnology’’, after ”Unit 2 Nanotechnology’’ and the ‘‘Unit 4 Advanced Materials’’ as the last. We can interpret it such that the general units are common and easy to understand for all participants while the specific units depend on the preference or the study direction/ work position of each single participant. Each specialist has its own needs and expectations and we can’t assume that all experts are interetsed in all specific topics. Based on these factors the results of the specific modules are very satisfactory and we can say all modules were ranked very high and they are well accepted by the participants.

‘Joint curriculum Harmonized Units’ is expected to bring the benefits to the users. We can present that the ‘Joint curriculum Harmonized Units’ has addressed to-date goals and objectives to-date, the course will have the significant impact on trainees and the organisations, there are no constraints and the course identifies the real needs.

The participants are interested in all subunits while the general units and their subunits are transversal, needed for all experts, students and all interested people. That’s why its easier for them to evaluate these subunits high.

The units about the new technologies were ranked with the lower position than the general units. But as it was mentioned earlier even the worst subunit received high the score 79% of rankings 5 and 4. That means for every subunit 4/5 of all respondents see such subunits as very important and we shouldn’t look just at the positions between all subunits but we should concetrate more on the real score of each unit. Another factor for the specific units is that these subjects are very various so for the specialists from some field seems their specific units more important than other specific units they don’t specialise in. So because of all these factors we shuld see all units and subunits as a complete course and we shouldn’t diferentiate between each subunit.

Subunits of Unit 3 (Biotechnology) were the best scored new technology subunits followed by the subunits of Unit two (Nanotechnology). On the last place were ranked subunits from unit four (Advanced technologies) while the best subunit of unit four was 4.1. Manufacturing of materials with advanced properties.

The assessment side of the curricula was evaluated with highly positive feedback from 85% - 100% and only in small amount of cases there was a neutral feedback (8 -16%) while 0% of disagreement. According to the results obtained, consortium confirm that there should be a certificate at the end of the course, the learning outcomes will be easily assessed and the respondents agree with the various types of the assessment.

From the overall feedback on BRACKET project ‘Joint Curriculum Harmonized Units’ we can see that all aspects of the project were validated with very high scores. There was no single element which would receive the moderate or even negative feedback. The scores were very high and the ‘Joint Curriculum Harmonized Units’ received a real prove and recommendation to continue the product development in the direction as planned.

The structure of the Joint Curricula is well prepared, and the experts agreed with the topics covered, as well as with the key drivers and the assessment options. Its visible that experts are satisfied and welcoming the future product.

Because of this overwhelming support of the curriculum, there was no need to change the curriculum structure.

Annex I : Joint Curriculum validation : questionnaire

Dear participants,

Key Enabling Technologies (KETs) are considered one of the most relevant areas for scientific innovation within Horizon 2020 program. KETs are a basic source for innovation that provide indispensable technological elements for the development of a wide range of new materials, products, processes and services with greatest added value.
However, one of the major weakness of Europe lies in its ability to transfers the knowledge base into specific goods and services. In order to solve this inconvenient, BRACKET project born with the main objective of transferring KETs to Vocational Educational and Training (VET) trough the development of an innovative and open learning training content.
At this point of the project, the Consortium aims to validate the Joint Curriculum, which has been defined in the scope of the project. For this reason, stakeholders and associated partners are being consulted before the development of the training content for a new online course available for VET students who are interested in developing and fostering new skills on KET.

Section 1: Mission

Q1. In your opinion do you think the attached draft of the 'Joint Curriculum Harmonized Units' address the needs of VET to boost into the drivers of technology and innovation to foster competitiveness and acceleration of organisations towards Key Enabling Technologies (nanotechnology, biotechnology and advanced materials).

a)	Greatly address the needs of VET	
b)	Somewhat address the needs of VET	
c)	Partially address the needs of VET	
d)	Did not address the needs of VET	
e)	Please give reason for your answer	

Q2. Please indicate in your opinion on the following perceived benefits of the 'Joint curriculum Harmonized Units'

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The chosen modules, lessons and topics are essential to the VET students and staff of organisations for their progression in terms of Key Enabling					

Technologies and technological innovation					
The VET students and staff of organisations will adapt easily to such a course and greatly benefit from its content					
The use of the designated modules will Increase HR excellence and advance distance learning opportunities					
The described joint curriculum will encourage technology innovation and attract new talents					
The VET abilities, capacities, skills and competences towards Key Enabling Technologies have been outlined in the 'Joint curriculum Harmonized Units'					

Q3. Please rank in order, 1 to 5 (with 5 being the highest) the key drivers for future students moving forward with 'Joint curriculum Harmonized Units'

	1	2	3	4	5
a) The general participant will be satisfied with the knowledge obtained from the training					
b) The use of an online course will greatly increase the number of participants and contribute to a better learning experience					
c) This course will help as student/ organisation to obtain new technological opportunities					
d) The specified modules and their associated topics present a coherent structure which form a clear synergy					
e) The knowledge /competencies of this course will easily transfer new skills to my organisation					

Q4. Please rank in order, 1 to 5 (with 5 being the highest) the main perceived barriers of this course

	1	2	3	4	5
a) The lessons are not complementary to each other and do not meet the needs of VET					
b) The topics covered in this course will not add value to my learning outcomes					

c) The materials designed for such a course will be difficult to manage and deliver					
d) The modules presented will take up a significant large amount of my time resulting in loss of productivity					
e) Whether this course is implemented or not it will not have a significant impact on my organisation return of investment (ROI)					

Section 2: Course overview

Q5. Please rank in order, 1 to 5 (with 5 being the highest) the units that best suit my needs

	1	**2**	**3**	**4**	**5**
Unit 1 Introduction to Key Enabling Technologies					
Unit 2 Nanotechnology					
Unit 3 Biotechnology					
Unit 4 Advanced Materials					
Unit 5 Innovation regarding Key Enabling Technologies					

Q6. Do you miss any main topic that it is not addressed in the defined "Joint Curriculum? Yes or Not. In case of "Yes", what topic do you consider is not addressed?

Q7. Please indicate in your opinion on the following perceived deliverables of the 'Joint curriculum Harmonized Units'

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The 'Joint curriculum Harmonized Units' has addressed all the anticipated goals and objectives to-date.					
The course performance will have a significantly positive impact on me as student or in my organisation					
Each of the modules identified are essential to my needs					
At the moment this course indicates no recognizable constraints					

Q8. Please rank in order, 1 to 5 (with 5 being the highest) the necessity and interest for VET students and organisations on each of the defined subunit

	1	**2**	**3**	**4**	**5**
1.1. Industry 4.0					
1.2. Key Enabling Technologies					

1.3. Sustainable development					
2.1. Fundamentals on nanotechnology					
2.2. Current and emerging applications in three areas: food, medicine and materials					
2.3. Legislation					
3.1. Fundamentals on biotechnology					
3.2. Current and emerging applications of biotechnology					
3.3. Biocatalysts- biotransformation					
3.4. Legislation					
4.1. Manufacturing of materials with advanced properties					
4.2. Graphene and carbon-based materials					
4.3. Renewable adhesives and resins					
4.4. Advanced engineered wood-based composites					
5.1. Innovation management: Intellectual Property					
5.2. Entrepreneurial skills					
5.3. E-leadership					
5.4. Financing KET project					
5.5. New T&L methods					

Q9. Do you miss any main topic that it is not addressed in the defined “Joint Curriculum?
Yes or Not
In case of “Yes”, what topic do you consider is not addressed?

Q10. Please indicate in your opinion if you agree or disagree with the following statements

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The learning outcome will be easily assessed					
Various forms of assessments such as tests, group projects will greatly enhance my learning needs					
It is essential that this course uses some form for recognition i.e. certificate					

Thank you for your time!

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Annex II : Joint Curriculum

1: Introduction to Key Enabling Technologies		Learning outcomes		
Subunit	**Sections**	**Knowledge**	**Skills**	**Competences**
Industry 4.0	What is Industry 4.0 Industrial sector transformation thanks to I4.0 New technologies for communication and data treatment. What is IoT?	- Describe the concept of Industry 4.0 and its current status - Describe the current state (2017-2019) of industrial sector regarding digital transformation - Describe the existence of technologies that allow hybridisation between the physical and digital worlds - Describe the existence of technologies for communication and data treatment - Describe the existence of tools for management of the business and collaborative platforms	- Identify possible Key Enabling Technologies (KETs) of the Industry 4.0 - Use of HADA tool for digital transformation in automatic diagnosis - Identify technologies that allow hybridisation between the physical and digital worlds - Identify technologies for communication and data processing - Identify tools for management of the business and collaborative platforms	- Move to next steps to go deeper in concepts of Industry 4.0 and its Key Enabling Technologies (KETs) - Move to next steps for digital transformation in the industrial sector. - Have excellent communications tools - Have persuasion techniques and leadership strategies - Have organisational skills and time management
Key Enabling Technologies	Key Enabling technologies What are KETs? Connection between KETs and I4.0	- Identify sustainability risks and prospects - Reproduce a fundamental understanding of relevant aspects of the natural,	- Identify alternatives ways to promote sustainable development in different settings and sectors	- Demonstrate problem-solving skills - Be able to perform critical analysis of facts and figures

		environmental and social sciences - Identify moral and social issues relating to sustainability - Understand relevant political and economic factors related to sustainability	- Interpret and analyse data related to sustainability - Identify some relevant political, economic factors related to sustainability - Identify moral and social issues related to sustainability	
Sustainable development	Introduction to sustainable development and sustainable development goals Economic growth and sustainable development goals Climate change for sustainable development goals Moral, ethical and social issues for sustainable development goals	- Describe Key Enabling Technologies (KETs) - Identify what KETs are	- Identify KET and its different types	- Outlet what KET are - Analyse and compare the different KETs identified

2: Nanotechnology		**Learning outcomes**		
Subunit	**Sections**	**Knowledge**	**Skills**	**Competences**
Fundamentals on nanotechnology	Introduction to Nanotechnology History and evolution of nanotechnology	- Describe the basic concept and definition of nanotechnology	- Identify the physical phenomena at the nanoscale, as well as the	- Have a basic general understanding of challenges of

	Nanotechnology vs classical science Risks, challenges and limitations of nanotechnology	- Define the history and evolution of nanotechnology - Define the physical phenomena at the nanoscale, as well as the limitations of classical science and technology - Enumerate the differences between dominant physical processes and effects at the nanoscale and those at the macroscale - State why nanotechnology is an enabling technology - Describe the risks, challenges and limitations that nanotechnology is confronted	limitations of classical science and technology - Identify the differences between nanoscale and macroscale - Identify the major milestones in the historical development of nanotechnology - Identify nanotechnology risks, challenges and limitations	nanotechnology in a wider context - Build capacity for generating new ideas related to nanotechnology applications - Be able to reflect in a holistic way on the pros and cons of nanotechnology - Be sensitized to potential risks relating to the use of nanotechnology - Show interest and initiative in nanotechnology-related matters
Current and emerging applications in three areas: food, medicine and materials	Technological applications of nanotechnology: general overview Technological applications of nanotechnology in food Technological applications of nanotechnology in medicine Technological applications of nanotechnology in materials	- Enumerate the main current and future technological applications of nanotechnology, especially in the fields of food, medicine and materials	- Identify the current and future technological applications of nanotechnology, especially in the fields of food, medicine and materials and be able to place them in the general	- Develop new goods or ideas for current and future technological applications of nanotechnology, especially in the field of food, medicine and materials

			context of research and industry	
Legislation	Intellectual property of nanotechnology applications Standards related to nanotechnology Ethical principles of nanotechnology applications	- Describe and the legislation on intellectual property in the field of knowledge and application of nanotechnology - Identify ethical principles and legislative standards in the field of nanotechnology	- Identify the legislation on intellectual property in the field of knowledge and application of nanotechnology - Identify the ethical principles and legislative standards in the field of nanotechnology	- Demonstrate familiarity with governance, policy and legislation of nanotechnology - Apply the legislation on intellectual property in the field of nanotechnology (knowledge and application) - Apply ethical principles and legislative standards to the field of nanotechnology

3: Biotechnology		**Learning outcomes**		
Subunit	**Sections**	**Knowledge**	**Skills**	**Competences**

Fundamentals on biotechnology	History and evolution of biotechnology and its competitive advantages compared to other non-biological processes Introduction to the basic concept and definition of biotechnology and the utilisation of microbial, plant, animal and human cells	- Describe the basic concept and definition of biotechnology and the utilization of microbial, plant, animal and human cells - Define the history and evolution of biotechnology and its competitive advantages cooperated to other non-biological processes	- Describe the science of biotechnology and identify its product domains and their advantages - Outline the steps in producing and delivering a product made through a biotechnological process - Outline how scientific methodologies are used to conduct research	- Demonstrate knowledge that gives the basis or opportunity to be original in the development and/or application of ideas in the field of biotechnology
Current and emerging applications of Biotechnology	Main aspects, scopes and applications of Food and Agricultural Biotechnology Main aspects, scopes and applications of Medical Biotechnology Main aspects, scopes and applications of Environmental Biotechnology Main aspects, scopes and applications of energy production Biological and biochemical principles and technical limitations for some of the most important industrial biotechnological process	- Identify the main aspects and scopes of Food Biotechnology, Agricultural Biotechnology, Medical Biotechnology, and Environmental Biotechnology - Enumerate the use and applications of microorganisms in Environmental Biotechnology and biodiremediation	- Apply innovative biotechnological approaches in industrial production in the agro-food, medicine, chemical industry - Outline current and potential applications and uses of biotechnological products	- Demonstrate the capacity of integrating the knowledge and tools of biotechnology and biocatalysis in order to apply them to the different industrial sectors (agro-food, pharmaceuticals, energy and chemicals production, or environmental bioremediation) - Be able to design protocols for the safety and quality control of biotechnological products

		- Describe the biological and biochemical principles and technical limitations for some of the most important industrial biotechnological process, emphasizing in microbial bioprocess - Enumerate the main industrial products of biotechnology in the agro-food sector, in medicine and in energy production - Describe the biotechnological processing stages of diverse processes in a research or an industrial environment		in compliance with safety regulations (e.g. regarding genetically modified organisms) and bioethics (e.g. in animal or human studies) - Demonstrate ability to use tools, systems or processes in order to conduct research or an solve practical problems in the field of biotechnology, biocatalysis and biotransformation
Biocatalysts – Biotransformations	Fundaments of biocatalysis and its applications to the food, chemicals, energy and pharmaceuticals industry	- Describe the fundaments of biocatalysis and its applications to the chemicals industry, to pharmaceuticals and to food - Describe the biocatalytic stages of diverse	- Describe the meaning and industrial applications of biocatalysis using enzymes or immobilized cells	- Demonstrate ability to use tools, systems or processes in order to conduct research or an solve practical problems in the field of biotechnology, biocatalysis and biotransformation

		processes in a research or an industrial environment - Describe the biological and biochemical principles and technical limitations for some of the most important industrial biotechnological process, emphasizing in microbial bioprocess - Enumerate the main industrial products of biotechnology in the agro-food sector, in medicine and in energy production		
Legislation	Intellectual property of biotechnology applications Standards related to biotechnology Ethical principles of biotechnology applications	- Describe how to disseminate the advantages and innovations of biotechnological products - Define the legislation on intellectual property in the field of knowledge and application of biotechnology - Identify the ethical principles and legislative	- Identify and get familiar with the legislation on intellectual property in the field of knowledge and application of biotechnology - Identify and apply the ethical principles and legislative standards in the field of biotechnology	- Demonstrate the ability to utilise intellectual property outputs and disseminate innovation in the field of biotechnology

		standards in the field of biotechnology		
4: Advanced Materials		**Learning outcomes**		
Subunit	**Sections**	**Knowledge**	**Skills**	**Competences**
Manufacturing of materials with advanced properties	Introduction to types of advanced materials Uses and future trends for advanced materials Productions of advanced materials	- Describe what qualifies a product as fitting the criteria of an advanced material - Recall the manufacturing steps and processes of specific materials to achieve advanced properties - Identify the applications and markets for advanced materials (i.e. advanced engineering wood composites)	- Identify the advantages and disadvantages of different manufacturing processes used to produce materials with advanced properties - Determine possible methods and technology to create materials with more advanced properties - Implement product design methodology to fit efficient material use	- Employ the use of manufacturing processes to produce materials with advanced properties - Assume responsibility in the preparation of product design according to the type of material to be used - Use advanced manufacturing principles to discover new advanced materials
Graphene and carbon-based materials	Overview of graphene and carbon-based materials Manufacturing process for graphene and carbon-based materials Composite related applications Electronic related applications	- Describe the types of graphene and carbon-based materials used in producing advanced materials - Recognise the important properties of graphene and carbon-based materials	- Identify the advantages and disadvantages of various graphene and carbon-based materials for use in advanced materials applications - Differentiate between the types of graphene	- Employ the use of the appropriate graphene and/or carbon-based materials in advanced material applications - Develop potential advanced materials that include graphene and/or carbon-based materials

		- Identify the production processing steps for various graphene and carbon-based materials	and carbon-based materials - Describe the material properties of graphite and carbon-based properties	- Illustrate how graphene and carbon-based materials are used in advanced materials
Renewable adhesives and resins	Overview of adhesive and resin types Production of adhesive and resins Applications of adhesive and resins in advanced composites	- Describe the types of renewable adhesives and resins used in the production of advanced materials - Recognise the important properties of renewable resins and adhesives - Identify the production processing steps for various renewable adhesives and resins	- Identify the advantages and disadvantages of using each type of renewable adhesives and resins in advanced material applications - Differentiate between the types of renewable adhesives and resins - Describe the material properties renewable adhesives and resins	- Employ the use of the appropriate renewable adhesive and/or resin in advance material applications - Develop potential uses for renewable adhesives and resins in advanced composite applications - Illustrate where renewable adhesives and resins are used in advanced materials
Advanced engineered wood-based composites	Introduction to use of advance engineering wood-based composites (EWC) EWC for building applications EWC for transportation and infrastructure EWC production and manufacturing technology	- Recognize various types of advanced engineered wood composite products made from bio-materials (i.e. wood) - Identify the main uses of various wood composites - List the raw materials that are used to manufacture	- Identify the advantages and disadvantages of each type of advanced engineered wood-based composite products, as compared to competing products - Explain the uses and limitations for each type	- Employ the use of the appropriate advanced engineered wood-based composite products in a design situation - Develop potential uses for appropriate advanced engineered wood-based composite products

		different advanced engineered wood-based composites	of advanced engineered wood-based composite products - Explain the manufacturing steps for producing advanced engineered wood-based composite products	- Lead the development of product which use advanced engineered wood-based composites

5: Innovation regarding Key Enabling Technologies		**Learning outcomes**		
Subunit	**Sections**	**Knowledge**	**Skills**	**Competences**
Innovation management: Intellectual Property	Introduction to IPR Types of IPR and procedures to reach it Patents and procedures to reach its protection IPR agreements License agreements	- Enumerate categories of IPR and the differences between them - Describe procedures for the protection of intellectual property - Define the structure of patent procedure and the importance of patent claims - Describe the basic structure and aims of IPR agreements and how to implement them	- legislation and types of IPR - Be able to apply for a patent protection - Identify trade secrets - Use patent databases - Use licensing	- Illustrate patents as assets, think proactive and be sensitized to IPR protection in the early stage of KET R&D - Be able to analyse patents and draft IP strategies and/or commercialisation strategies based on IPR - Be capable of using patent databases as important tools for technological information and novelty search

		- Describe the structure of license agreements		- Develop communication and negotiation skills (licensing)
Entrepreneurial skills	Spin-off Technology commercialisation Type of commercialisation Market opportunities for KETs products: real examples	- Reproduce the principles behind the commercialisation process - Identify critical milestones in the research-to market process - Identify commercialisation strategies and how to adapt them to KETs research-to-market processes. - Identify market characteristics and market opportunities	- Identify the procedure behind building competitive advantage of a modern enterprise - Identify the stages of research-to-market process for the commercialisation of R&D goods - Use innovation and commercialization strategies - Use management competences in the area of technology commercialisation - Identify Academic entrepreneurship - Identify corporate Entrepreneurship - Identify innovation processes and IPR in the context of public and private organisations	- Develop a systematic and general understanding of the complexity of KET research-to-market processes. - Be able to detail the process of commercializing R&D output from different angles (researcher, company manager, investors, etc.) - Develop analytical competences and creativity - Build social competences and communication skills - Develop entrepreneurial thinking - Develop capabilities relating to conflict-solving and decision-making - Develop communication skills - Demonstrate networking capabilities

			- Identify spin-off as a form of technology commercialisation	
E-leadership	Introduction to e-leadership Needs and opportunities regarding implementing ICT tools that improve business processes Digital trends to innovate strategic business and operating models Innovating digital marketing trends	- Identify opportunities and limitations in initiating digital marketing in own business context - Recognise needs and opportunities regarding implementing ICT tools that improve business processes in leading employees toward innovation	- Describe key success factors for efficient digital marketing - Define general steps in planning, implementing and improving digital marketing - Describe ICT tools and concepts supporting collaboration towards innovation and business processes driven by technology - Create concepts of implementing and improving business analyses and strategy planning	- Exploit and innovate digital marketing trends - Exploit digital trends to innovate strategic business and operating models - Enhance creativity - Be able to instigate innovative processes driven by technology
Financing KET project	Inclusion of KETs in National and European documents Public and private funds for KET-related projects	- State the inclusion of KETs to European and National documents - Identify the most important grants from	- Identify the documents which includes KETs at national and European level	- Be able to apply for KET funding in public and private sector - Be able to detail the integration of KETs at

	Stages of development and innovation funding Investors: types of investors, search for investors	public and private funds for KETs-related projects	- Identify the most suitable opportunities for public and private funding of KETs	national and European level - Improve own knowledge and skills in the area of KETs by attending online curses
New T&L methods	Collaborative platforms for education OERs and MOOCs Collaborative platforms for businesses Cases studies: new technologies in the XXI century	- Describe both need for and potential advantages of using new learning methods exploiting e-learning, formal and non-formal training - Identify the objectives and benefits from using MOOCs	- Use search engines for detecting online courses; find with multiple criteria MOOC and Free Online Courses from Coursera, edX, FutureLearn and other providers and Universities - Describe main advantages and disadvantages of e-learning and online courses - Use examples of available online free MOOC for the purpose of self-development	- Improve own knowledge and skills in the area of KETs by attending online curses - Enable co-workers to exploit online courses and e-learning - Express interest in using available online free MOOC for the purpose of self-development