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SEA CHANGE

OUR OCEAN | OUR HEALTH

Meta-analysis of the consultation reports

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Prior to Sea Changed P.McHugh and C.Domegan were involved in Sea for Society (SFS), a European Community FP7 funded project. Their expertise and previous experience in leading and reporting on SFS Collective Intelligence consultations greatly underpins the methodology, structure, wording and reporting format used in this deliverable (see D2.4 Global Analysis of the SFS Consultation Process from a Social Sciences Perspective by Domegan *et al*., 2014 for more information).

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Executive Summary

Sea Change is a three-year, EU funded, Horizon 2020 project with 17 partners in nine European countries (Belgium, Denmark, Greece, Sweden, France, Ireland, Portugal, Spain and UK). During April and May 2016, eight of these countries (except France) carried out consultations with education stakeholders (classified as incumbents, regulating agencies and challengers, see p. xii) for the purpose of gaining deeper insights into the barriers to teaching 12-19 year olds about the ocean, and to identify options for overcoming these barriers. The Sea Change partners used the method Collective intelligence (CI) to consult with the education stakeholders. The CI method used facilitation and problem solving to harmonise input from education stakeholders from different backgrounds and perspectives. This report was built on the Collective Intelligence consultation work completed and reported in Sea For Society (D2.4 Global Analysis of the SFS Consultation Process from a Social Sciences Perspective), as reported in Domegan *et al*., 2014.

A key outcome of Sea Change efforts is that for the first time there has been data gathered about the comprehensive and complex challenges to teaching about the ocean making the work particularly unique and innovative. The consultations revealed barriers to teaching 12-19 year olds about the ocean but also how the education stakeholders viewed the barriers to be linked and interrelated. The consultations also identified options considered by stakeholders "as the most feasible and impactful actions" (Domegan *et al*., 2015) for teaching 12-19 year olds about the ocean. The results from the CI consultations may advise on the Sea Change mobilisation design. This is due to the revelation of the stakeholders views on "***what*** to mobilise on and ***how*** to mobilise - how best to move forward" (Domegan *et al*., 2014) with ocean education. This understanding is drawn from the experiences and expertise held by the education stakeholders and how they collaborate in the CI consultations, thus developing a "holistic understanding of the problem, addressing problem complexity, and formulating a set of feasible options matched to the complexity of the problem" (Domegan *et al*., 2014).

Sea Change's Consultation Process

The content and the processes are clearly defined in the CI methodology and includes the participants being responsible for presenting barriers or ideas, which they identify as of importance in relation to the trigger question: What are the barriers to teaching 12-19 year olds about the ocean. The consultation facilitator is responsible for giving instructions to participants on how to generate and clarifying barriers. The barriers were categorized by internal working groups in each participating country and were achieved prior to the consultation. Categorisation means that barriers with shared commonalities were grouped together into categories. The 1-day consultation involved stakeholders voting on the most important barriers, across all categories. The barriers deemed most important were taken forward for structuring by using a software package (Interpretive Structural Modelling, ISM). The facilitator leads the structuring and interpretation of the graphical output (the structural maps), while the participants are asked to explore how the barriers aggravate each other. The end-result is a picture of how the barriers are linked and interrelated, which at the same time displays the participant's perception of barrier influence structure. Finally, the stakeholders are asked to generate options to overcome the barriers, which are followed by voting for the "most feasible and highest impact actions" (Domegan *et al*., 2014) to remove barriers to teaching 12-19 year olds about the ocean.

Sea Change Numbers

A total of 257 participants were involved in eight Sea Change stakeholder consultations. The stakeholder consultations resulted in 657 barrier statements to teaching 12-19 year olds about the ocean and 316 options to overcome these barriers. The barriers from each country structural barrier map highlighted

pathways of aggravation between barriers (McHugh *et al*., 2016). In this context, 'significantly aggravating' means to make it significantly worse, e.g. rubbing salt into a burn wound. During the meta-analysis, the 657 stakeholder barriers were grouped into 26 meta barrier categories and eight higher-order barriers themes. The choice of content-based names given to the higher-order themes were based on evidence-based reasoning for their grouping (barriers having similar meanings), according to education and science communication literature (Appendix 2). This analysis revealed the key barrier themes that are most influential to teaching 12-19 year olds about the ocean. The Sea Change multistage EU influence map of stakeholder barrier themes was generated to show the aggravating influence across the eight higher-order barrier themes.

Sea Change Consultation Key Outcomes

The eight higher-order barrier themes are displayed as highest (stage 1) to lowest influence (stage 6) in the Sea Change EU multistage influence map of barriers to teaching 12-19 year olds about the ocean (Fig. 1). The map should be read from left to right – with barrier themes to the left having more overall aggravating influence, in comparison to the barrier themes to the right (Domegan *et al*., 2014). This means the Awareness and perceived knowledge barrier theme (stage 1) exercises the highest level of overall influence to teaching 12-19 year olds about the ocean. Table 1 below further describes the eight higher-order barrier themes and their respective stakeholder descriptions in relation to each stage of the EU influence map of barrier themes. While Connections between humans and the ocean and Blue economy (stage 6), exercises the lowest level of influence for teaching 12-19 year olds about the ocean.

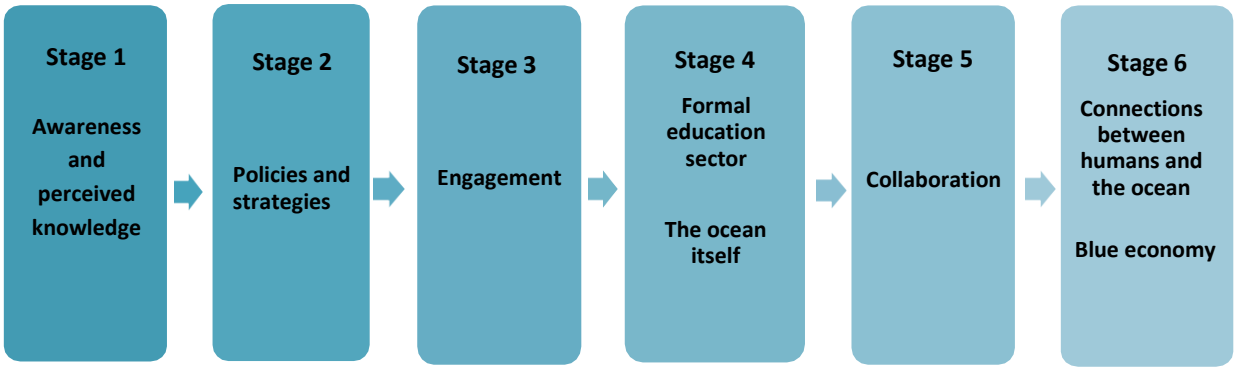

Fig. 1. Sea Change multistage EU influence map of stakeholder barrier themes.

Table 1. Stakeholder meta barrier themes and stakeholder descriptions

Stage	Higher-order barriers themes	Stakeholder description
1	Awareness and perceived knowledge	Barriers that relate to the concept of Ocean Literacy (OL): either lack of understanding of the concept or some of the elements of OL.
2	Policies and strategies	Policies and strategies affect how schools are run and the school budgets.
3	Engagement	Barriers relating to the importance of engaging students and speaking their language to increase interest and awareness of the ocean.
4	Formal education sector	All of the barriers that originate from the formal education sector.
	The ocean itself	The very nature of the ocean makes it difficult to experience or understand.
5	Collaboration	Collaboration between different marine education actors.
6	Connections between humans and the ocean	It is about how the ocean matters to both individuals and society.
	Blue economy	The barriers all relate to Blue Society, which is the long-term strategy to support sustainable growth in the marine and maritime sectors as a whole.

In terms of successful mobilisation action, the themes to the left of the map (Fig. 1) are more likely to have a stronger impact on "the overall system of barriers" (Domegan *et al*., 2014), while at the same time relieving pressure on the barriers belonging to the themes on the right. Thus, mobilisation actions taken to have an impact on barriers in the Awareness and perceived knowledge theme, that is, to focus on "The concept of Ocean Literacy (OL): either lack of understanding the concept or some of the elements of OL" could have considerable impact on more 12-19 year olds being taught about the ocean and may have a positive effect on barriers located in themes towards the right of the map, such as Policies and strategies. It is important to be aware that this influence map is not to be considered an action plan, since other factors may come into play when deciding on actions to be taken (Domegan *et al*., 2014). It is not necessary to address Awareness and perceived knowledge first, if there is an immediate opportunity, for example, to address the Policies and strategies theme (stage 2). The map suggests, however, that chance of successful policies might be greater if Awareness and perceived knowledge actions was implemented at the same time. No matter where the initial action is taken, the map can advise us on the possible impact of mobilisation actions, as well as barriers that will have an effect on their success. This map, which "portrays a complex, dynamic, and mutually interrelated set of barriers, reflecting pluralistic values, knowledge, experiences, and expertise, is an invaluable planning tool" (Domegan *et al*., 2014).

As mentioned above, the most influential higher-order barrier theme to teaching 12-19 year olds about the ocean was found to be Awareness and perceived knowledge, since it was located in stage 1 of the influence map but the meta barrier categories within in the higher-order category theme (Ocean Literacy and Ocean knowledge, Table 2) did not score highly in stakeholder importance. This was in contrast to the overall most important meta barrier category – Governance, which is both a driver and receiver of influence and part of the Policies and strategies higher-order theme (stage 2 of the influence map).

In addition, the education stakeholders generated 316 options to overcome the barriers to teaching 12-19 year olds about the ocean. The "most feasible and highest impact options" (Domegan *et al*., 2014) were arranged into one or more meta barrier categories. It is advised, however, that the generated options are

not used as custom-made mobilisation action plans. Although, used in combination with the Sea Change multistage EU influence map of stakeholder barrier themes, these options can be very significant and effective whilst designing a mobilisation strategy. As an example, the five most impactful and feasible options in the Awareness and perceived knowledge higher-order barrier theme included the following ideas: "spreading the marine topic over the curriculum," "Ocean Literacy subjects to be included in teacher training," "build a personal relationship with the ocean through interactive learning; connecting education with real projects," and "link World Ocean Day with a 1-day school event." A European mobilisation challenge might not include all of the Awareness and perceived knowledge options, in all of the European countries. But any mobilisation that includes these options may engage the stakeholders better. For example, if "connecting education with real projects" was selected as a mobilisation challenge then the objective could be to identify ocean outreach projects and citizen science initiatives at universities or research centres and disseminate them to teachers. Such a strategy would address "Limited or no links between schools and research centres," which is a barrier within the Governance category (stage 2 of the Influence map, Fig. 1). When the Sea Change mobilisation challenge "happens at a region or a country level, it can be adapted to reflect the local context and people" (Domegan *et al*., 2014).

How Sea Change is already addressing some of the barriers

Sea Change's consultations have identified barriers and solutions to teaching 12-19 year olds about the ocean in formal education across eight European countries. The urgency of the matter is due to a widespread lack of Ocean Literacy among the public (Belden Russonello & Stewart and American Viewpoint, 1999; Ocean Project, 2009 and 2011; Steel *et al*., 2005). This lack of Ocean Literacy described by several researchers is further confirmed by this report with one of the identified barriers being "Lack of awareness in schools and wider society of the relevance and importance of our ocean." This is an important barrier to consider, as without awareness it is difficult to engage in ocean responsible behaviour (Cava *et al*., 2005; Dupont & Fauville, 2016) or to see the ocean as a potential future career (Guest *et al*., 2015). Barriers need to be identified in order to be able to take efficient and expedient action to address them. Therefore, the barrier statements and the options (solutions to the barriers envisioned by participants) in this report could be useful to the ocean education community in their future collective action plans.

The EU influence map (Fig. 1), coupled with stakeholder barriers and options, provide robust support for actions already taken within Sea Change. Sea Change is already addressing some of the barriers by implementing some of the options that were identified in the consultation workshops. For example, "Lack of educational material/hands-on activities related to the ocean," through designing an interactive e-learning book on Harmful Algal Blooms, which is aligned with relevant science education methodologies. In addition, five marine modules are also under development to be distributed through the Foundation for Environmental Education (FEE) and Sea Change networks. These five modules will each focus on a topic:

1. The ocean is planet Earth's life support system
2. Seafood and human health
3. Marine pollution and human health
4. The ocean - a treasure trove for human medicine
5. The sea and our physical and mental wellbeing.

Furthermore, a Massive Open Online Course (MOOC) titled "From ABC to ABSeas: Ocean Literacy for All," aimed at helping teachers and students to incorporate Ocean Literacy into educational programmes,

addresses the above barrier ("Lack of educational material/hands-on activities related to the ocean") but also addresses another one, namely "Lack of suitable training available to teachers." One of the options that were identified in the consultation workshops ("Organize a platform to share educational materials with a forum to discuss ideas about the educational materials") is addressed through the Sea Change public launch of the Ocean EDGE platform. Ocean EDGE is an online inventory of both formal and informal educational resources and activities that are either available as downloadable products or serve as an inspiration. The European Marine Science Educators Association (EMSEA), through its conference and its network, also promotes sharing educational materials between members of the Ocean Literacy community.

Sea Change recommendations

Sea Change suggests a number of potential actions that could be taken into consideration by education stakeholders:

Teachers

The barrier "Lack of interest in individuals in the target group" can be addressed by using the solution "Use real examples to work with - the education should be connected to real projects." Ocean science educators can support teachers to introduce an element of fieldwork into their curriculum and also give students time to reflect on their experiences. This will create a more profound understanding and an opportunity to realise its relevance to the world outside the school (Ballantyne *et al.*, 2010). This would also address another barrier "Lack of opportunities for students to feel, touch, experience the sciences rather than read and imagine." Teachers can find relevant projects in the Ocean EDGE database. A number of the hands-on projects in Ocean EDGE have been contributed by universities and research centres. The fact that research institutions develop and test marine education material addresses another barrier revealed during the consultation ("Limited or no links between schools and research centres").

There is potential for teachers working as teams to share time and resources ("Lack of time" and "A lack of working interdisciplinary" were two identified barriers). If several teachers are involved, each using their allocated teaching time, it could mean that students can focus on learning about the ocean for a longer period of time. Also, since the school curriculum in many EU countries does not include the subject ocean, it is hoped that teachers find ocean projects among Sea Change resources that will fulfil their regular curricular needs.

Teacher training organisations/University teachers

During their training, teachers could become more familiar with both the content and the pedagogy required to teach about the ocean in their future classrooms. This would address two identified barriers, namely "Ocean Literacy ignored in curriculum of teacher training" and "Shortage of suitable training available to teachers." Professional development available for teachers on marine topics would help teachers to expand their own capacity and to foster their network of colleagues teaching marine science. This would also be an efficient way for scientists and teachers to connect and collaborate (identifying on-going science projects that can be adapted to be used in a school setting). This kind of partnership would address the "Limited or no links between schools and research centers" barrier.

Partnerships

Building partnerships between scientists and educators is not a new effort. Beginning in 2002, the US National Science Foundation-funded Centers for Ocean Sciences Education Excellence (COSEE) support scientist/educator partnerships that promote improving Ocean Literacy among the public. Still more efforts are needed, as evidenced in the identified barrier "Limited or no links between schools and research

centers." A key element in building partnerships is visibility, and it is suggested that parties join communities or networks (e.g. EMSEA, COSEE, national science conferences, etc..) to get exposure and get to know like-minded colleagues across Europe and the world for further collaboration and partnerships.

Policy makers

As identified during the consultations, there is a "Lack of a national strategy plan to implement Ocean Literacy" in Europe. There is worldwide concern about the protection and the health of the ocean, which can be tackled better with an ocean literate society. Indeed, Ocean Literacy is important for Europe's quest for a more marine-based economy and society based on sustainable management of marine resources. This should also address the barrier "Lack of interest from ministry of education to implement OL in national curriculum," as the issue of Ocean Literacy concerns us all and the future of this planet.

Moving forward

The current report presents a milestone in Ocean Literacy as for the first time an in-depth study of the barriers encountered by education stakeholders to teach marine science is released. This document will be made available to European policymakers (and beyond) to move toward a more ocean literate form of education. We recommend that this report be used to inform and guide future policy decisions concerning education and the role of the ocean in the curriculum experienced by any young European citizen.

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Key terms defined

Higher-order barrier theme: The Sea Change stakeholder meta barrier analysis generated 26 Sea Change categories, which were divided into eight higher-order barrier themes (Table 1).

Sea Change stakeholder categories: The 657 barrier statements created by the stakeholders were grouped into 26 categories during the Sea Change stakeholder meta barrier analysis.

Stakeholders: The stakeholder classifications used in the Sea Change consultations were:

Incumbents "are the dominant firm within the Sea Change defined system context, they are happy with the way things are and wish to preserve the status quo" (Domegan *et al*., 2015).

Challengers "are less privileged than the incumbents. They often conform to the prevailing order, but are awaiting new opportunities to challenge the structure of the existing system" (Domegan *et al*., 2015).

Regulating agencies "are in the system to defend the status quo and to facilitate the smooth running of it" (Domegan *et al*., 2015).

Structural maps: The structural maps of the eight stakeholder consultations showed pathways of aggravation between the barriers.

Structured barriers: These barriers were selected by the education stakeholders and included in the structuring step of the eight Sea Change stakeholder consultations. In total, 95 out of the 657 barrier statements were structured.

Position score: The structural map "places barriers in stages" (Broome & Albright, 1995). "Barriers in the rightmost stage are assigned the lowest score and those in the leftmost stage are assigned the highest score. In the Sea Change structural maps the barriers to the right receive a position score of 1, the position scores of the barriers to the left varies from 2-7. Barriers in the stages between the left and right receive a score between 2-6, depending on the number of stages in the map" (Domegan *et al*., 2014). "Position scores are rough measures" (Broome & Albright, 1995).

Antecedent score: "The antecedent score is the number of barriers lying to the left of a particular barrier. This score signifies the number of barriers that aggravate that barrier" (Domegan *et al*., 2014).

Succedent score: "The succedent score is the number of barriers lying to the right of a particular barrier. This score signifies the number of barriers that it aggravates" (Domegan *et al*., 2014).

Activity score: "The activity score is the sum of the antecedent and succedent scores" (Domegan *et al*., 2014). "The activity score can provide a measure of how active an item or category is in receiving and dispensing aggravation, because it is often the case that items with the highest activity scores are located in the middle of the map. Such items can be viewed as conduits through which aggravation passes" (Broome & Albright, 1995).

Net succedent/Antecedent score: "The net succedent/antecedent (Net SA) score is the succedent score minus the antecedent score" (Domegan *et al*., 2014). "If the Net SA score is positive, it means that the item or category is a net source of aggravation. If the Net SA score is negative, it means that the item or category is a net receiver of aggravation" (Broome & Albright, 1995).

Influence score: "The influence score is the sum of the position score and the net SA score" (Domegan *et al*., 2014). "The influence score reflects both actual and potential influence" (Broome & Albright, 1995).

1. Introduction and purpose

The goal of the Sea Change project is to bring about a fundamental "Sea Change" in the way European citizens view their relationship with the sea, by empowering them – as Ocean Literate citizens. To gain deeper insights into stakeholder's perceived barriers to teaching 12-19 year olds about the ocean, eight of the partner countries (Sweden, Ireland, Belgium, Denmark, Greece, Spain, UK and Portugal) carried out consultations with education stakeholders between April and May 2016. A total of 257 participants were involved in eight Sea Change stakeholder consultations. In total, 257 people contributed to the online component, while 108 from this group attended and participated in the stakeholder consultation workshops (McHugh *et al*., 2016).

The Sea Change partners used the method Collective intelligence (CI) to consult with the education stakeholders. The CI method used facilitation and problem solving to harmonise input from education stakeholders from different backgrounds and perspectives (Domegan *et al*., 2014; McHugh *et al*., 2016). The education stakeholders in each participating country identified a set of barriers which they identified as of importance in relation to the trigger question: What are the barriers to teaching 12-19 year olds about the ocean. This was followed by internal working groups arranging the barriers into categories based on shared commonalities. The categorisation was achieved by internal working groups in each participating country and was done prior to the consultation. During the 1-day consultation, the education stakeholders voted for the most important barriers, which were entered into the Interpretive Structural Modelling (ISM) software. This was followed by the facilitator asking a set of relational questions (Does barrier A significantly aggravate barrier B) exploring inter-relationships between the structured barriers. In this context, 'significantly aggravating' means to make it significantly worse, e.g. rubbing salt into a burn wound. Once all of questions had been answered, graphical outputs (structural maps) were presented showing the paths of aggravation of the structured barriers. The barrier to the left significantly aggravating barriers to the right. The end-result is a picture of how the barriers are linked and interrelated, which at the same time displays the participant's perception of barrier influence structure. Finally, the stakeholders are asked to generate options to overcome the barriers, which are followed by voting for the "most feasible and highest impact actions" (Domegan *et al*., 2014) to remove barriers to teaching 12-19 year olds about the ocean.

Deliverable 3.3 presents a meta-analysis, which is an analysis that combines the results of the eight consultation reports and their generated 657 barrier statements. A subset of the barriers (in total 95 barriers) were included in the structuring process, as they received the highest number of votes by the education stakeholders in each country (McHugh *et al*., 2016). Deliverable 3.3 does not present all of the stakeholder barriers and options, for a comprehensive list of the stakeholder barriers and options please see McHugh *et al*., 2016.

2. The Sea Change stakeholder influence map analysis

In order to create the Sea Change multistage European influence map of barriers to teaching 12-19 year olds about the ocean (Fig. 1), each of the 26 Sea Change meta barrier stakeholder categories were jointly grouped into eight higher-order barrier themes. The analysis of the structural maps was based on a series of scores (position, antecedent, succedent, activity, net SA and influence scores; p. xii), which were computed for the 95 structured barriers in the eight Sea Change stakeholder structural maps. The eight higher-order barrier themes scores (Appendix 1), which contained the 26 meta barrier Categories (Table 2) were also computed. The choice of content-based names given to the higher order themes were based on evidence-based reasoning for their grouping (barriers having similar meanings), according to education and

science communication literature (Appendix 2). In addition, the 26 meta barrier categories were ranked from highest to lowest influence score, depending on which higher-order theme they belonged to (Appendix 3).

Table 2. Higher-order barrier themes and their respective meta-barrier categories

Awareness and perceived knowledge	Ocean Literacy	Ocean knowledge			
Policies and strategies	Funding	Governance			
Engagement	Distraction	Communication	Interest	Hands-on	
Formal education sector	Interdisciplinary	Fieldtrip	Time	Equipment	Teaching
	Curriculum	School culture	Teaching material		
The Ocean itself	Access	Complexity			
Collaboration	Informal education	Partnerships	External programmes		
Connections between humans and the ocean	Personal experience	Everyday life	Culture		
Blue economy	Industry	Mareer (marine career)			

The Sea Change multistage EU influence map of stakeholder barrier themes represents paths of influence. The map should be read from left to right – with barrier themes to the left having more overall influence, in comparison to the barrier themes to the right (Domegan et al., 2014) influence on teaching 12-19 year olds about the ocean. This structural maps, on the other hand, produced paths of aggravation but were also read from left to right (McHugh et al., 2016).

This means the **Awareness and Perceived Knowledge** barrier theme (stage 1) exerts the highest level of overall influence to teaching 12-19 year olds about the ocean. Awareness and Perceived Knowledge according to stakeholders is described as “Barriers that relate to the concept of Ocean Literacy (OL): either lack of understanding of the concept or some of the elements of OL”. The second highest level of overall influence adheres to the **Policies and Strategies** barrier theme and is perceived by education stakeholders as “Policies and strategies affect school how schools are run and the school budgets”. The stage 3 higher-order barrier theme, **Engagement**, is described as “Barriers relating to the importance of engaging students and speaking their language to increase interest and awareness of the ocean”. In stage 4, **Formal education sector**, is labelled as “All of the barriers originate from the formal education sector”, while **The Ocean Itself**, is expressed as “The very nature of the ocean makes it difficult to experience or understand”. In stage 5, the higher-order barrier theme **Collaboration** is illustrated as “Collaboration between different marine education actors”. The stage 6 barrier themes of **Connections between humans and the ocean**, described as “It is about how the ocean matters to both individuals and society” and **Blue Economy**, “The barriers all relate to Blue Society, which is the long term strategy to support sustainable growth in the marine and

maritime sectors as a whole" differ from the previous barrier themes and stages, as they have influence, but it's at the lowest level for teaching 12-19 year olds about the ocean.

In the following sections, the eight higher-order barrier themes together with the 26 meta barrier categories, which were placed within the themes, and its respective structured barriers will be presented. This is followed by a list of options perceived by education stakeholders as the "most feasible and impactful" (Domegan *et al.*, 2015) for the meta-barrier category in question. Finally, individual structural maps for the eight countries will be displayed for each meta-barrier.

3. Higher-order themes and categories

3.1. Awareness and perceived knowledge

As can be seen in stage 1 of the multistage influence map, Awareness and perceived knowledge emerged as the most influential set of barriers to teaching 12-19 year olds about the ocean (Fig. 1). The barriers within this category received an average influence score of 7.0 (Appendix 3), which means that these barriers are significant influencers on all of the remaining categories within the six stage influence map. Awareness and perceived knowledge is made up of two categories, Ocean Literacy and Ocean knowledge. Each will be discussed in detail below.

3.1.1. Ocean Literacy

A total of 10 Sea Change stakeholder barriers were placed within the Ocean Literacy category. These barriers refer to a lack of awareness of the definition of Ocean Literacy and its relevance. The structured barriers within this category received 0 votes, making it the one of the least important category to the stakeholders (Appendix 3). However, it is seen as the most influential category to the stakeholders, along with Ocean knowledge. Of these 10 barriers, one was chosen by the stakeholders in various consultations to be included in the structuring phase (Table 3).

Table 3. Structured barriers within the Ocean Literacy category

Inability to recognise the importance and value of teaching students about the ocean

The positioning of Ocean Literacy in stage 1 of the multistage influence map suggests that the barriers structured in the Ocean Literacy category should lie to the left of their structural map and is both a receiver and driver of influence. In the **UK** structural map (Fig. 2), however, “Inability to recognize the importance and value of teaching students about the ocean” is placed in the third stage of the map, more to the right. This confirms Ocean Literacy is also a receiver of aggravation. This barrier goes on to aggravate two other barriers: “Lack of confidence when taking students out of the classroom (in regards to health and safety, logistics)” and “Competition and lack of clarity/coordination between providers”.

The most feasible and impactful options for Ocean Literacy are listed below:

- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)
- Build a personal relationship with the sea through interactive learning where does the fish finger come from (16 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- Promote risks / benefits (15 votes)
- National media (all) campaign for all aquatic interests and activities – commercial + leisure (14 votes)
- Create space and time and flexibility or a new scholar schedule organization in order we can work the ocean topic in a multidisciplinary way (14 votes)

- Empower teachers to manage curricula and to value Ocean Literacy issues/topics (even when not obvious) (14 votes)
- Dedicated self-funded marine department [with Secretary General from worldwide human resources market] (13 votes)
- Policies, Global Citizen Programme! 3 world days (1 per term, including the World Ocean Day), or off curriculum, or all (12 votes)
- The institutions must have mandatory time and budget assigned to outreach projects about the ocean (12 votes)
- Certificate for T.Y. students from National Governing Body (NGB) in Ocean Literacy. This should lead on to more work experience in the maritime industries (11 votes)
- Meaningful stories that the students can relate to (developed for the target group) (11 votes)
- Create attention about the sea via media/lobbyists (11 votes)
- Organize a platform to share educational materials with a forum to discuss ideas about the educational materials (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)
- External teaching can make the class more alive (10 votes)
- Teaching 12-19 year olds about the ocean should be more prioritized on a political level (education ministry) in common goals/teaching plans (interdisciplinary dimension)(10 votes)
- Design and development of a thematic educational program with the cooperation of HCMR, Universities, Environmental Education Centers and the Environmental Education Department of the Ministry of Education (10 votes)
- Evaluation of the already existing educational material with the aim of enriching it and/or creating new teaching methods in the framework of interactive educational teaching (10 votes)
- Design vocational workshops to inform and educate youth on sea-related jobs (8 votes)
- Lobby with Ministry of Education (Julia Crevits) for one or more curriculum goals on the ocean *(number of votes not reported)*
- Develop an overall ocean campaign to get more attention of the media for the ocean *(number of votes not reported)*

Fig. 2. UK structural map (Ocean Literacy barrier encircled).

3.1.2. Ocean knowledge

A total of 33 stakeholder barriers were placed within the Ocean knowledge category during the Sea Change stakeholder meta barrier analysis. These barriers suggest that there is some perceived knowledge of the ocean and also a lack of knowledge about the ocean. This category is made up of two subcategories: Some perceived knowledge; No perceived knowledge. The barriers in this category received 15 votes, making the category the ninth most important to the stakeholders (Appendix 3). The category also has a high level of influence on the remaining categories that lie to the right of it in the influence map. Of these 33 barriers, two were chosen by the stakeholders to be included in the structuring (Table 4).

Table 4. Structured barriers within the Ocean knowledge category

The sea is considered as an inexhaustible and unalterable resource for its use. It is only considered superficially, but its internal processes are unknown.
Lack of knowledge of our policy makers, teachers and lecturers

As Ocean knowledge is located in the first stage of the multistage influence map, we would expect to find the structured Ocean knowledge barriers within the first stages of the country structural maps. The **Spanish** stakeholder structural map confirms the placement of Ocean knowledge in stage 1 of the multistage influence map. The structured barrier "The Sea is considered as an inexhaustible and unalterable resource for its use. It is only considered superficially but its internal processes are unknown" (Fig. 3) goes on to aggravate six barriers: "Inability to convey the importance of the oceans for life on the planet, in an attractive way and adapted for young people", "Lack of explicit references linked to knowledge of the oceans at the school curriculum", "Lack of means to support knowledge and marine conservation environment, information, awareness and education on this subject", Difficulty in establishing a link between our daily lives and the benefits that the ocean provides to us or how our actions generate impacts on it", "Lack of systemic vision of the ocean" and "Lack of social awareness of the importance of the oceans in the development of humans". The **Irish** structural map (Fig. 4) places the Ocean knowledge barrier "Lack of knowledge of our policy makers, teachers and lecturers" in the second stage, which means that it is aggravated by "Lack of political will – Ireland's government is slow to act and implement on marine-related issues and marine education".

The most feasible and impactful options for Ocean knowledge are listed below:

- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- Bank on environmental dissemination (related with the oceans) in prime-time, even if were just a brief spot (19 votes)
- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)
- Build a personal relationship with the sea through interactive learning where does the fish finger come from (16 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- Promote risks / benefits (15 votes)
- Create space and time and flexibility or a new scholar schedule organization in order we can work the ocean topic in a multidisciplinary way (14 votes)

- National media (all) campaign for all aquatic interests and activities – commercial + leisure (14 votes)
- Dedicated self-funded marine department [with Secretary General from worldwide human resources market] (13 votes)
- The institutions must have mandatory time and budget assigned to outreach projects about the ocean (12 votes)
- Policies, Global Citizen Programme! 3 world days (1 per term, including the World Ocean Day), or off curriculum, or all (12 votes)
- Organize a platform to share educational materials with a forum to discuss ideas about the educational materials (11 votes)
- Certificate for T.Y. students from National Governing Body (NGB) in Ocean Literacy. This should lead on to more work experience in the maritime industries (11 votes)
- Meaningful stories that the students can relate to (developed for the target group) (11 votes)
- Create attention about the sea via media/lobbyists (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)
- Teaching 12-19 year olds about the ocean should be more prioritized on a political level (education ministry) in common goals/teaching plans (interdisciplinary dimension)(10 votes)
- Design and development of a thematic educational program with the cooperation of HCMR, Universities, Environmental Education Centres and the Environmental Education Department of the Ministry of Education (10 votes)
- Design vocational workshops to inform and educate youth on sea-related jobs (8 votes)
- Lobby with Ministry of Education Crevits for one or more curriculum goals on the ocean *(number of votes not reported)*
- Develop an overall ocean campaign to get more attention of the media for the ocean *(number of votes not reported)*

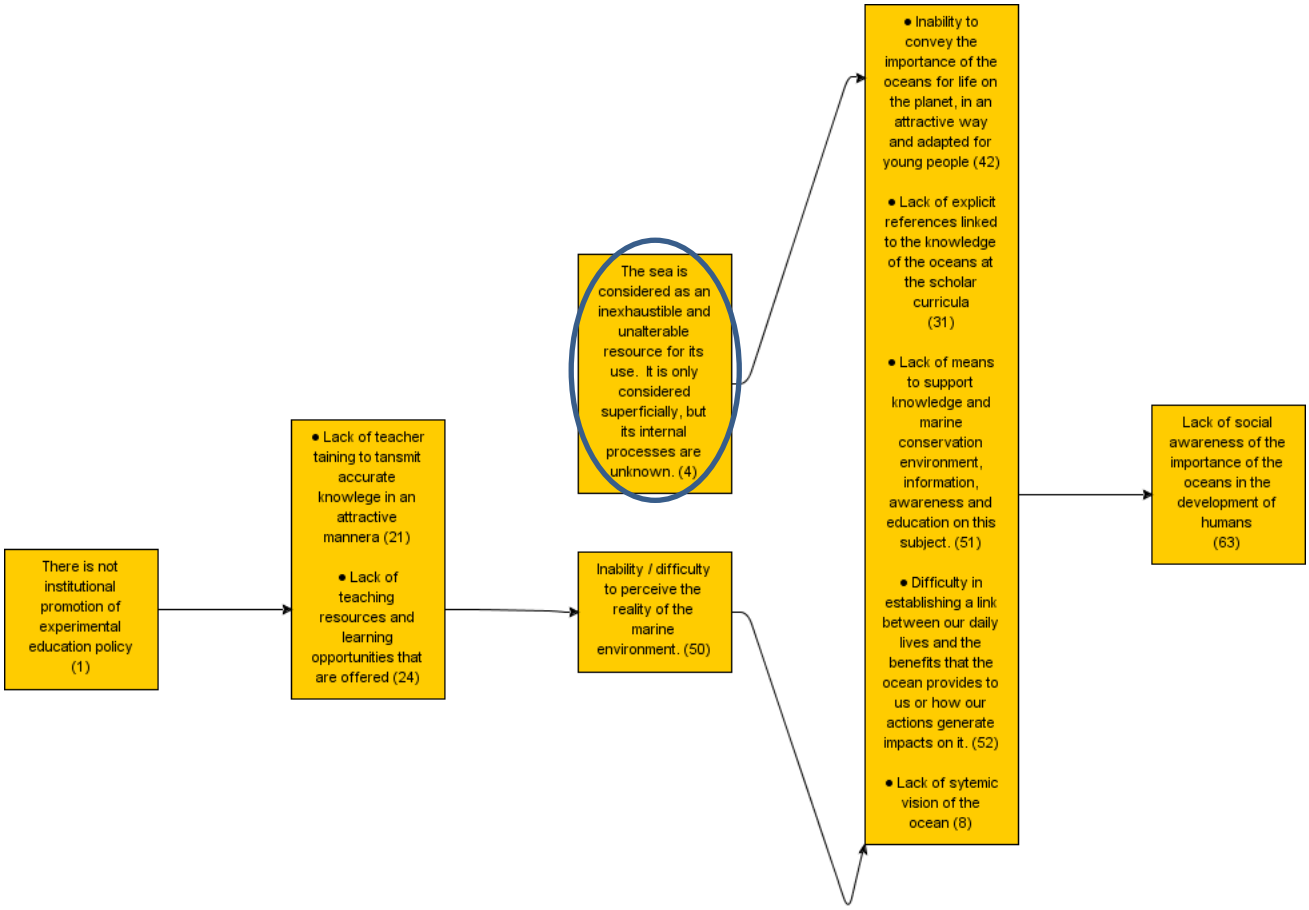

Fig. 3. Spain structural map (Ocean knowledge barrier encircled).

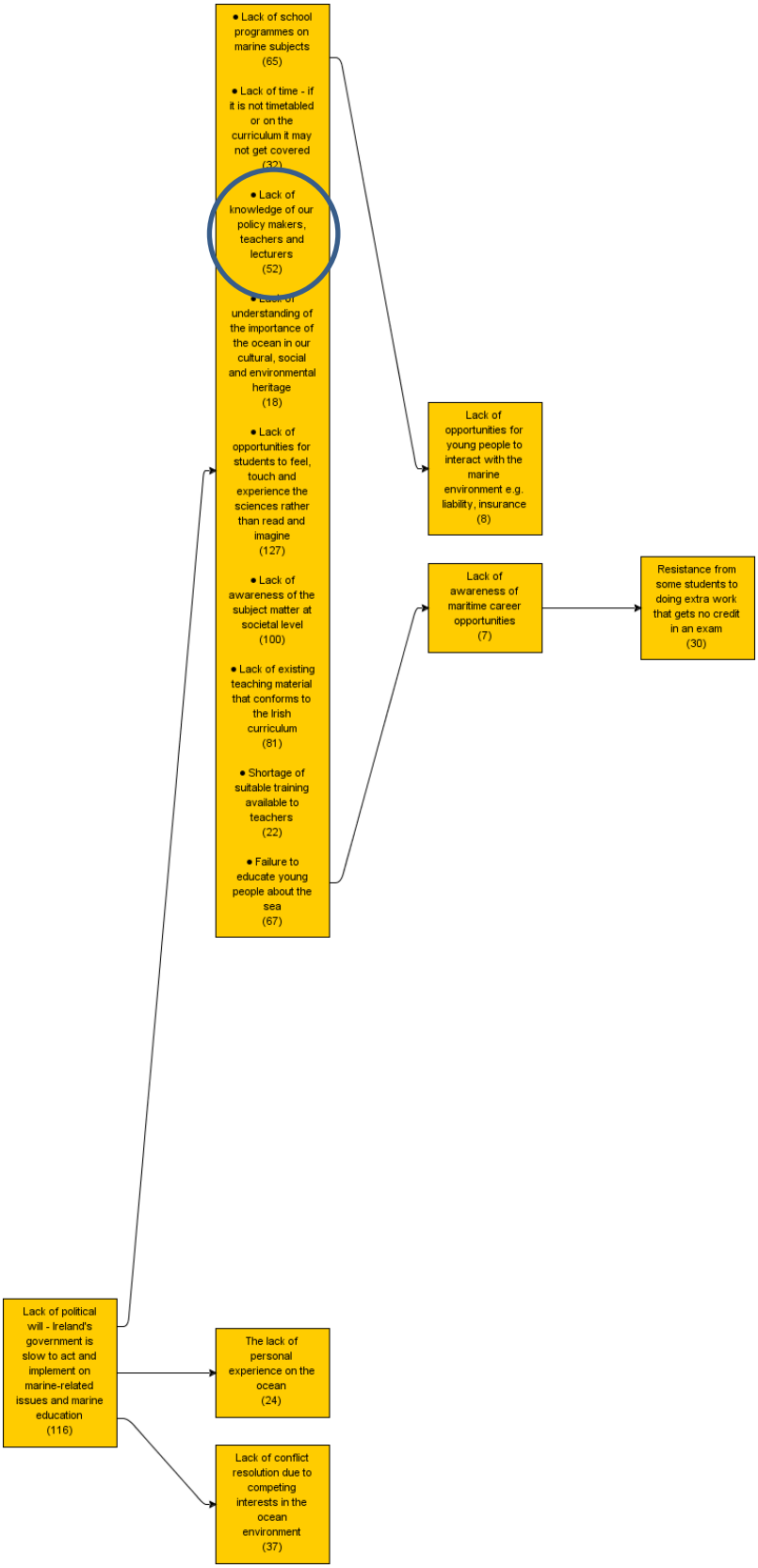

Fig. 4. Ireland structural map (Ocean knowledge barrier encircled).

3.2 Policies and strategies

Policies and strategies emerged as the next set of most influential barriers (Fig. 1). The barriers within this category received an average influence score of 6.31 (Appendix 3). There are two categories within Policies and strategies; these are Governance and Funding. Each of these categories will be discussed below.

3.2.1. Governance

These Governance barriers refer to a lack of support from regional and local authorities. In addition, there are no national strategies to incorporate ocean issues in the school curriculum. The category was divided into two sub-categories: Regional/Local matters and National priorities. A total of 34 barriers were generated within Governance. They received 102 votes, making it the most important category to the stakeholders (Appendix 3). This category is therefore seen as both important and influential to the stakeholders. Nine of the Governance barriers were involved in the structuring phase in various consultations (Table 5).

Table 5. Structured barriers within the Governance category

The municipality's inability to collaborate on opportunities that allow students to be taught about the sea as part of their education
Demand for the application of new teaching methods for which time and resources are needed
Limited or no links between schools and research centres
Lack of a national strategy plan to implement the OL
Lack of obvious connections with the school curricula
Lack of political focus on marine teaching
Lack of political will – Ireland's government is slow to act and implement on marine-related issues and marine education
Lack of interest from ministry of education to implement OL in national curriculum
National Curriculum / Government support – top down approach

The Governance category was seen as an influential category, as it is located in stage 2 of the influence map. Therefore, we may assume that the structured Governance barriers are located to the left of the individual country structural maps. We can see from the **Danish** structural map (Fig. 5) that "Lack of political focus on marine teaching" is placed within the first stage of the map. In the **Swedish** map (Fig. 6) "The municipality's inability to collaborate on opportunities that allow students to be taught about the sea" is also placed in the first stage. Also in the **Irish** map (Fig. 7) the barrier "Lack of political will – Ireland's government is slow to act and implement on marine-related issues and marine education" is placed in the first stage of the map. However, the **Portuguese** map (Fig. 8) displays barriers "Lack of interest from ministry of education to implement OL in national curriculum"; "Lack of a national strategy plan to implement the OL", "Lack of obvious connections with the school curricula" at different stages (2, 3 and 4, respectively). The **Greek** map (Fig. 9) sees the barriers "Limited or no links between schools and research centres" "Demand for the application of new teaching methods for which time and resources are needed" in the second and the final stages. While the **UK** map (Fig. 10) displays the barrier "National Curriculum / Government support – top down approach" towards the right. The barrier is considered both a driver and a receiver of influence.

The most feasible and impactful options for Governance are listed below:

- Create an Ocean Steering Group to coordinate project ideas + develop feasible funded projects (15 votes)
- Dedicated self-funded marine department [with Secretary General from worldwide human resources market] (13 votes)
- Teaching 12-19 year olds about the ocean should be more prioritized on a political level (education ministry) in common goals/teaching plans (interdisciplinary dimension)(10 votes)
- Promote the investigation and use of resources to amplify government subsidies (9 votes)

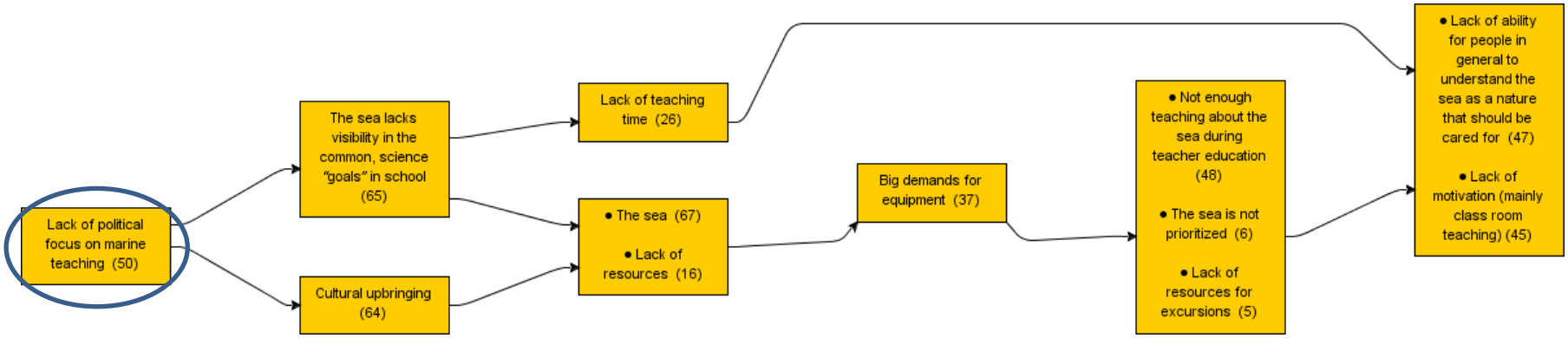

Fig. 5. Denmark structural map (Governance barrier encircled).

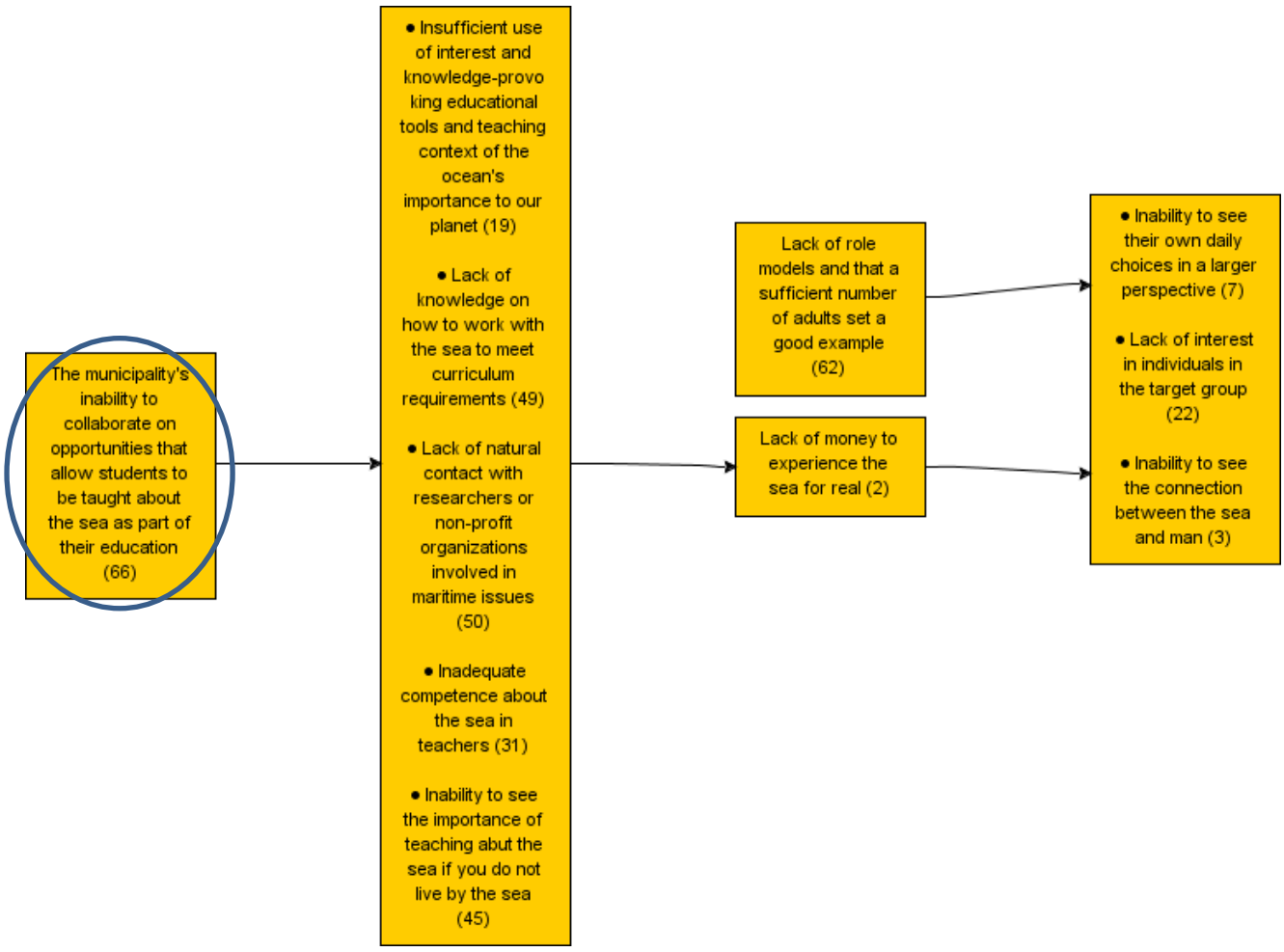

Fig. 6. Sweden structural map (Governance barrier encircled).

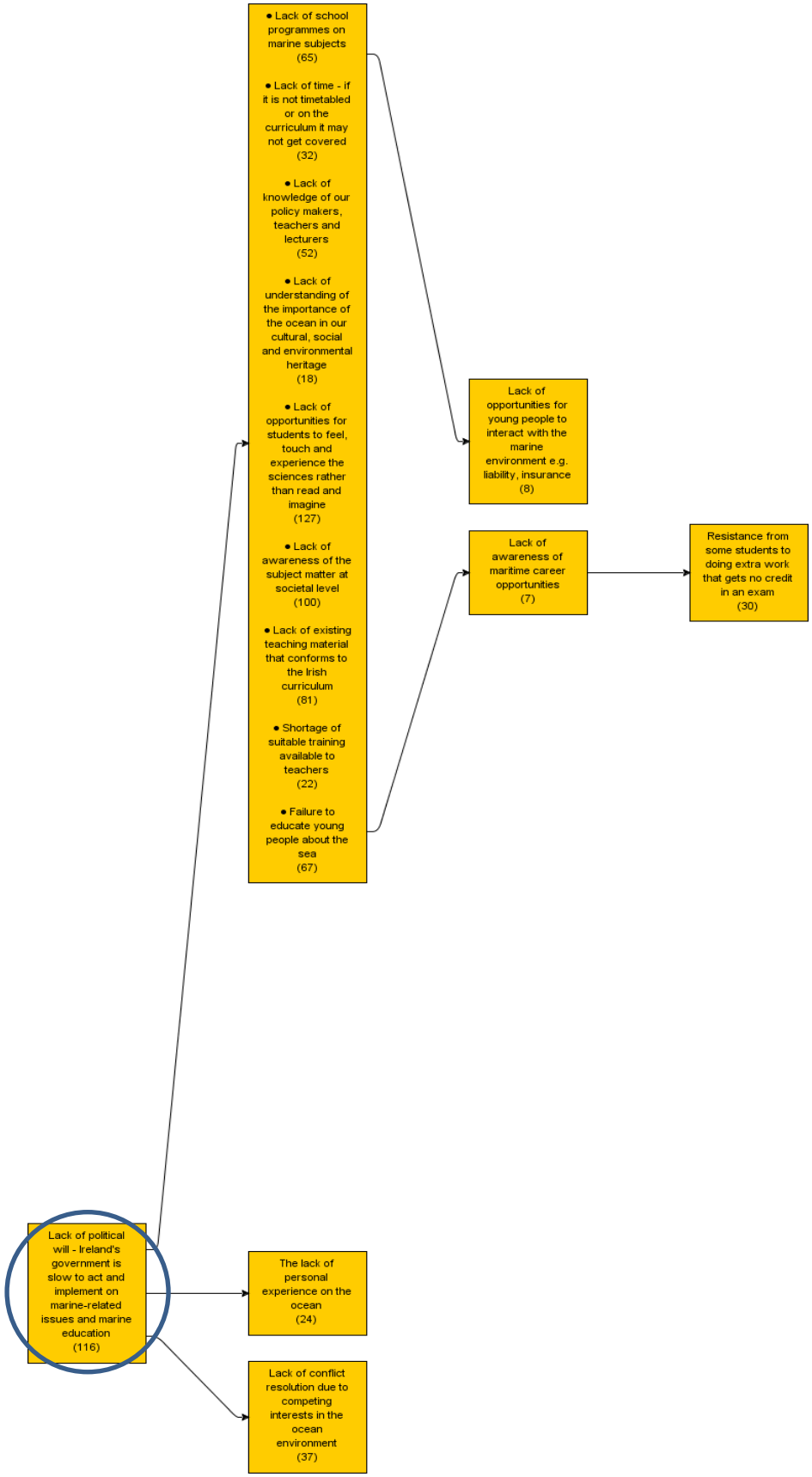

Fig. 7. Ireland structural map (Governance barrier encircled).

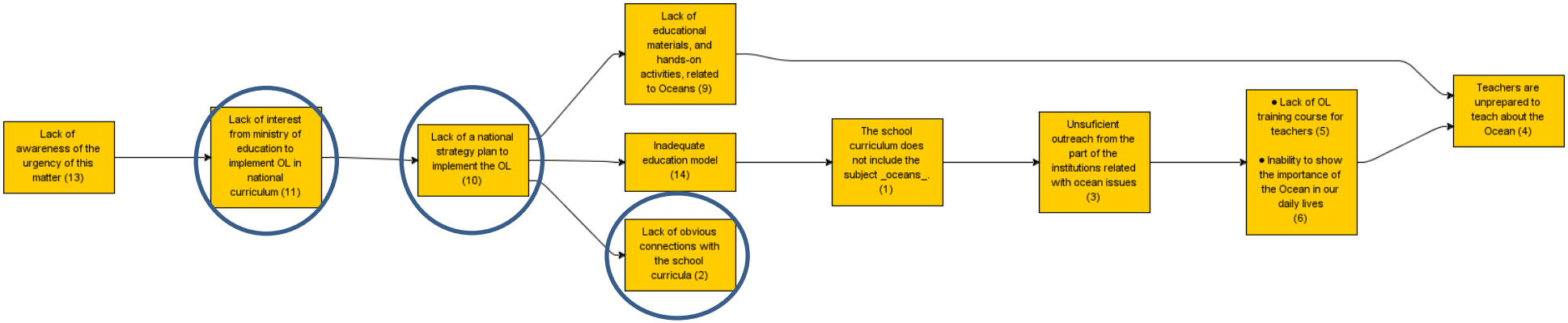

Fig. 8. Portuguese structural map (Governance barriers encircled).

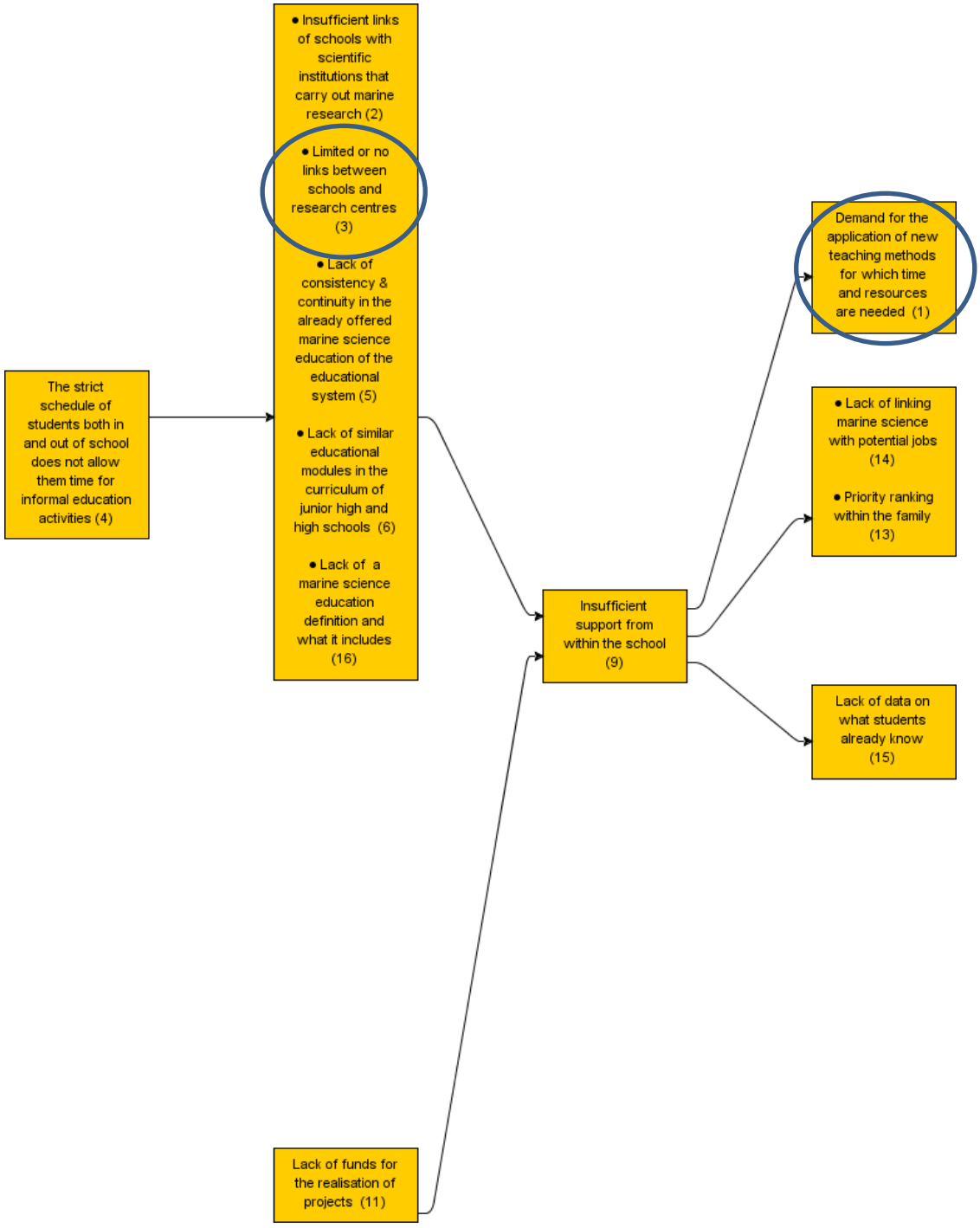

Fig. 9. Greece structural map (Governance barriers encircled).

Fig. 10. UK structural map (Governance barrier encircled).

3.2.2. Funding

A total of 20 barriers were structured within the Funding category. These barriers relates to lack of money for resources and funds to experience the marine environment. The Funding barriers received 32 votes, seventh place (Appendix 3), making it relatively important and influential to the stakeholders. Of the 20 Funding barriers, four were chosen by the various Sea Change stakeholders to be included in the structuring phase (Table 6).

Table 6. Structured barriers within the Funding category

Lack of resources for excursions
Stretched budgets within schools
Lack of money to experience the sea for real
Lack of resources

Funding appeared in stage 2 of the influence map, as an influential category. We would therefore assume that many of the Funding barriers are placed towards the left of the individual country structural maps. In the **UK** structural map (Fig. 11), the barrier "Stretched budgets within schools" is structured in the first stage (to the left). However, the barrier "Lack of money to experience the sea for real" which was generated in the **Swedish** consultation is placed towards the final stage of the structural map (Fig. 12). In addition, the **Danish** structural map (Fig. 13) barriers "Lack of resources for excursions" and "Lack of resources" were in the Centre and towards the right, respectively. The barrier is both a driver and a receiver of influence.

The most feasible and impactful options for Funding are listed below:

- Use real examples to work with - the education should be connected to real projects (16 votes)
- Create an Ocean Steering Group to coordinate project ideas + develop feasible funded projects (15 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- Dedicated self-funded marine department [with Secretary General from worldwide human resources market] (13 votes)
- The institutions must have mandatory time and budget assigned to outreach projects about the ocean (12 votes)
- External teaching can make the class more alive (10 votes)
- Design and development of a thematic educational program with the cooperation of HCMR, Universities, Environmental Education Centres and the Environmental Education Department of the Ministry of Education (10 votes)
- Design vocational workshops to inform and educate youth on sea-related jobs (8 votes)

Fig. 11. UK structural map (Funding barrier encircled).

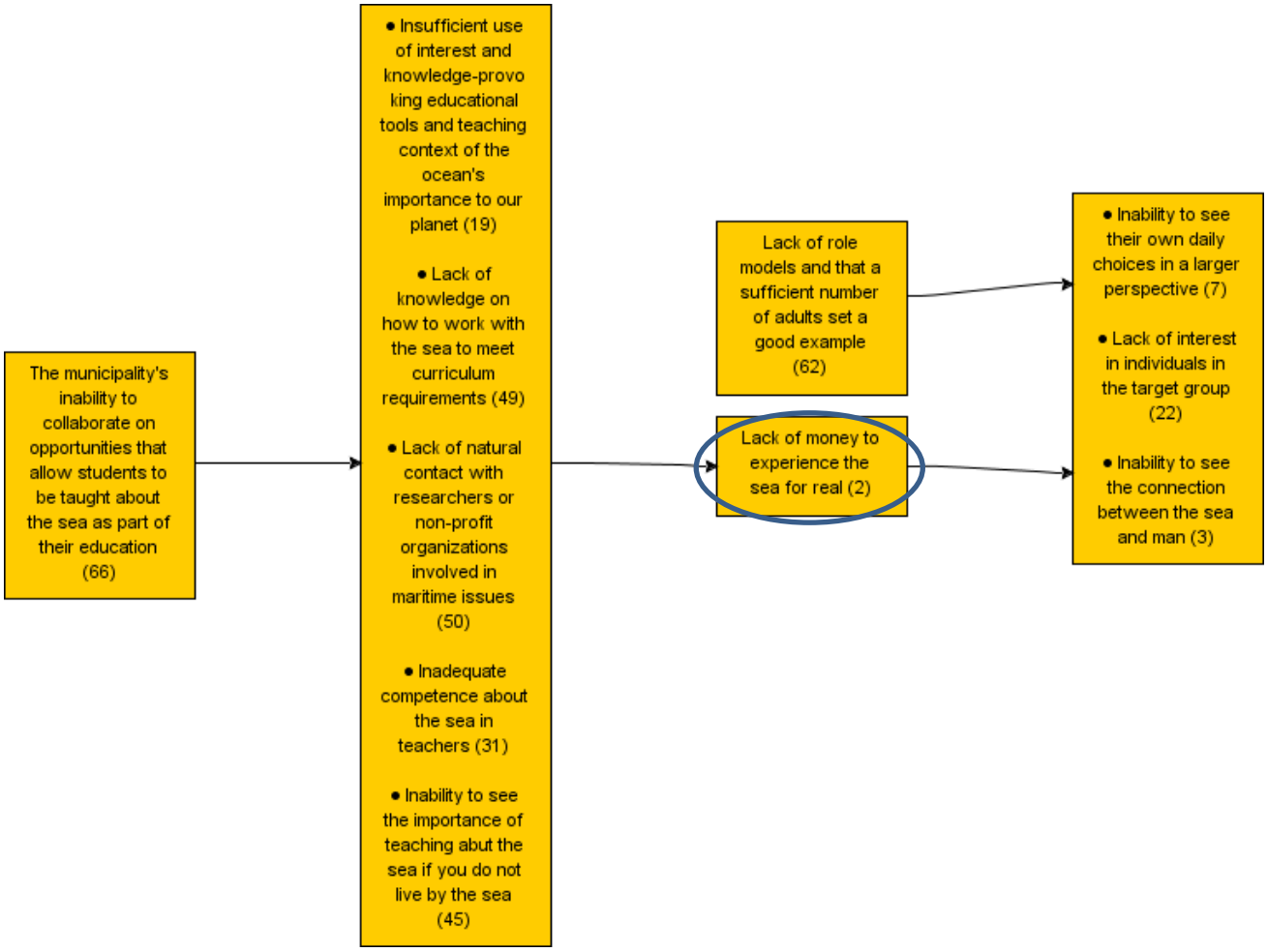

Fig. 12. Sweden structural map (Funding barrier encircled).

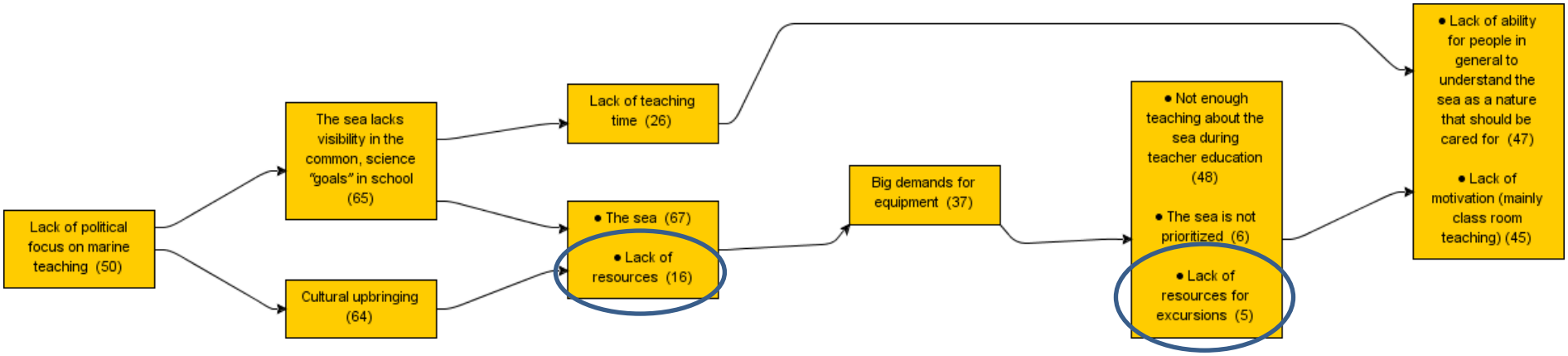

Fig. 13. Denmark structural map (Funding barriers encircled).

3.3. Engagement

Engagement emerged as the next set of most influential barriers (Fig. 1). The barriers within Engagement received an average influence score of 5.2 (Appendix 3). Engagement is made up of four categories; Interest, Distractions, Communication and Hands-on. Each will be discussed below.

3.3.1. Interest

The Interest barriers relate to a lack of interest and awareness of ocean topics by both teachers and students. A total of seven barriers were generated. These seven barriers received a total number of 0 votes, making it one of the least important categories to the Sea Change stakeholders (Appendix 3). Out of the seven barriers that were generated one was chosen by the stakeholders to be included in the structuring (Table 7).

Table 7. Structured barriers within Interest category

Lack of awareness of the urgency of this matter

As Interest is placed in stage 3 of the influence map, we would assume the majority of the Interest barriers to be situated to the left of the individual structural maps or in the middle of the maps. The **Portuguese** structural map (Fig. 14) highlights this with “Lack of awareness of the urgency of this matter” situated in stage 1 of the map, aggravating all the other barriers.

The most feasible and impactful options for Interest are listed below:

- Develop educational programs to be experiential and relevant for the students (24 votes)
- Further development for teachers and principles in "desire to create" activities (20 votes)
- Bank on environmental dissemination (related with the oceans) in prime-time, even if were just a brief spot (19 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- National media (all) campaign for all aquatic interests and activities – commercial + leisure (14 votes)
- Introduce outdoor pedagogy and intersectoral teaching in teacher training programmes (14 votes)
- Develop collaboration with other schools, universities and non-profit organisations (14 votes)
- Dedicated self-funded marine department [with Secretary General from worldwide human resources market] (13 votes)
- Meaningful stories that the students can relate to (developed for the target group) (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)
- External teaching can make the class more alive (10 votes)
- Evaluation of the already existing educational material with the aim of enriching it and/or creating new teaching methods in the framework of interactive educational teaching (10 votes)

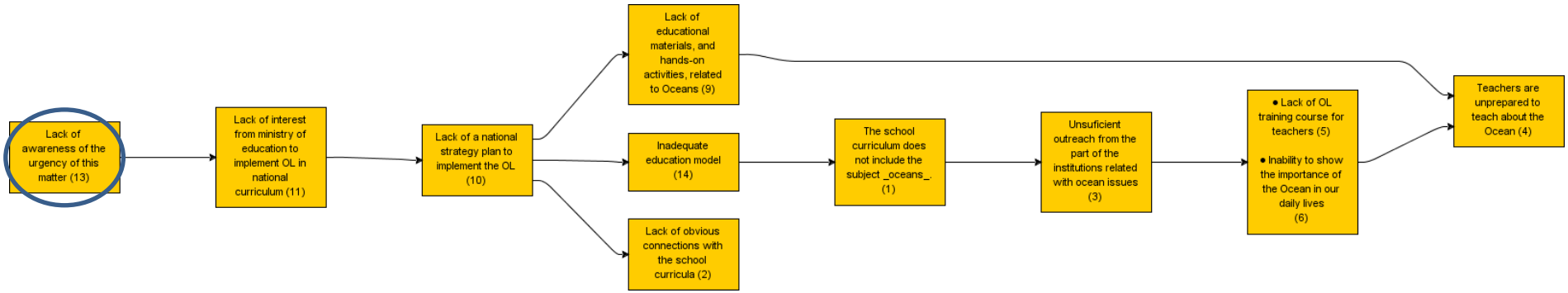

Fig. 14. Portugal structural map (Interest barrier encircled).

3.3.2. Distractions

22 barriers were generated in relation to Distractions. These barriers are concerned with interferences from external environments, which distract students and affects their engagement. The barriers received 9 votes from the stakeholders, ranking it 15th out of 26 categories (Appendix 3). Of the 22 Distractions barriers that were generated, three were chosen by the stakeholders to be included in the structuring phase (Table 8).

Table 8. Structured barriers within the Distractions category

Lack of linking marine science with potential jobs
Lack of interest in individuals in the target group
Priority ranking within the family

The Distractions barriers are situated in stage 3 of the influence map. We would again expect to find the structured barriers towards the left of the individual maps or in the middle of the maps. The **Greek** structural map (Fig. 15) presents “Lack of linking marine science with potential jobs” and “Priority ranking within the family” in the final stage of the structural map (furthest to the right). In the **Swedish** structural map (Fig. 16), the barrier “Lack of interest in individuals in the target group” is also towards the right (final stage). The barrier is a receiver of influence.

None of the top voted for options are feasible and impactful for the Distractions category.

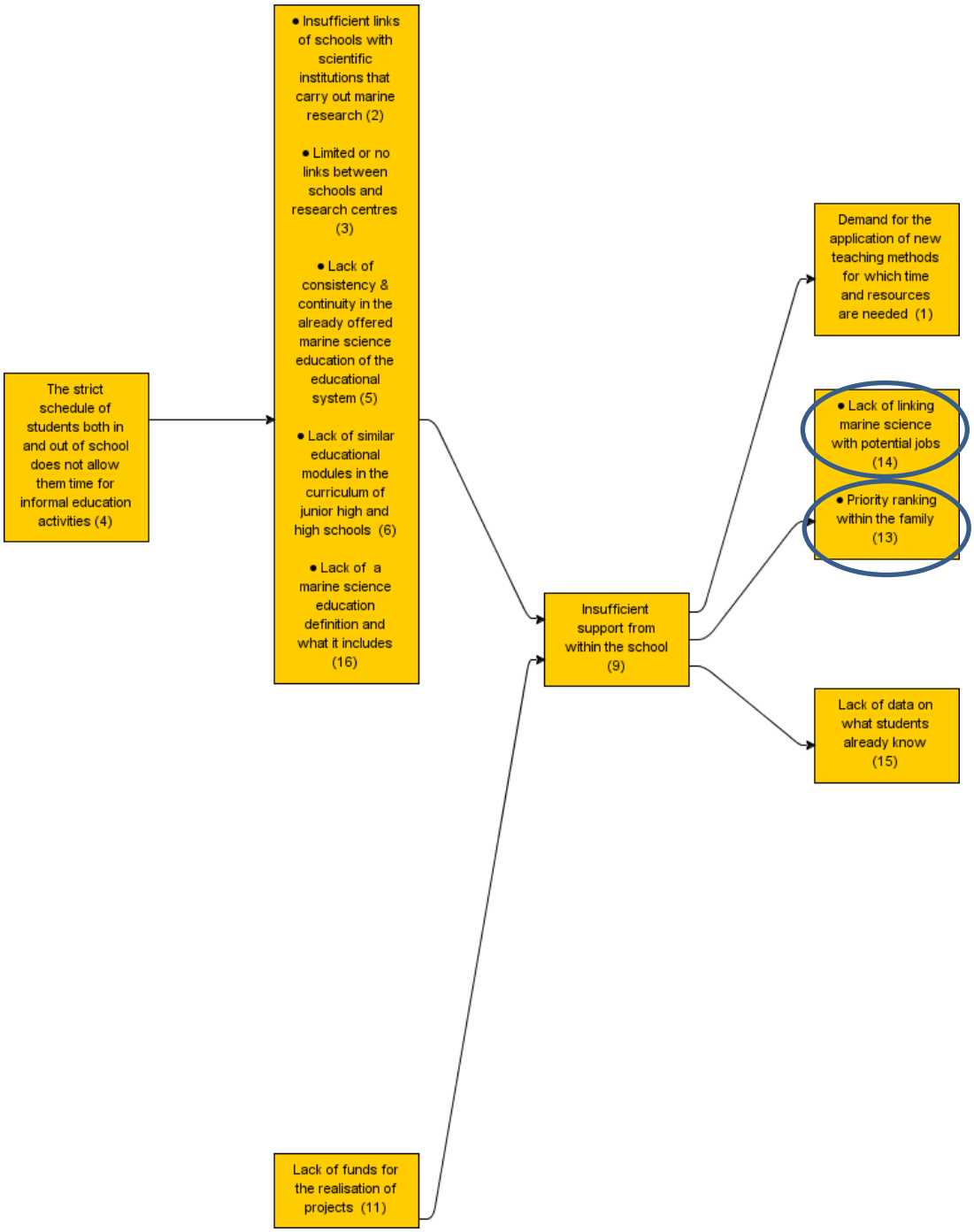

Fig. 15. Greece structural map (Distractions barriers encircled).

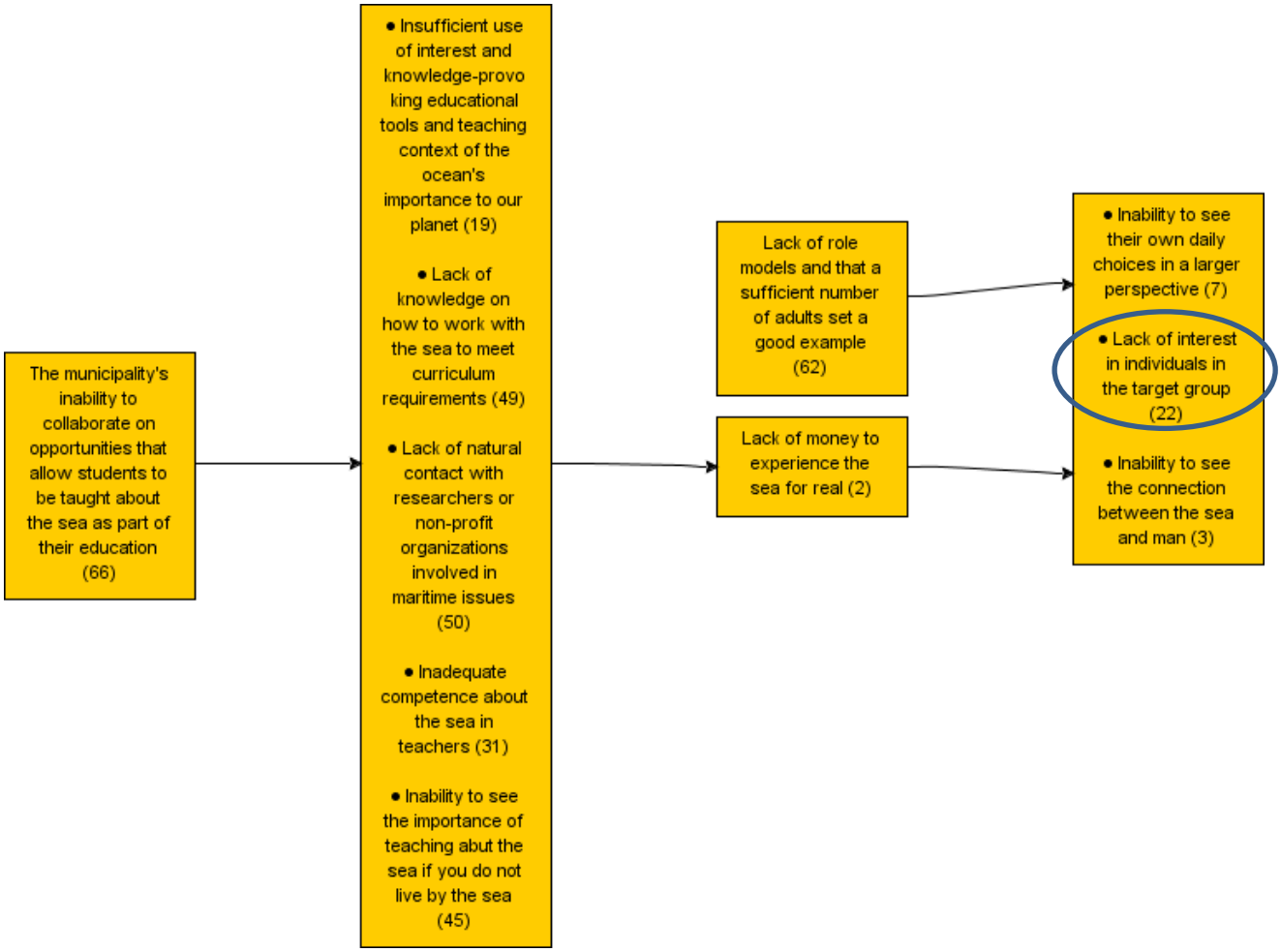

Fig. 16. Sweden structural map (Distractions barrier encircled).

3.3.3. Communication

A total of 22 barriers were generated in the Communication category. These barriers relate to reaching out to the audience in their own language and through the "right" channels. The Communication barriers received 49 votes, making it the fourth most important and influential category to the stakeholders (Appendix 3). Of the 22 Communication barriers three were included in the structuring phase (Table 9).

Table 9. Structured barriers within the Communication category

Lack of role models and that a sufficient number of adults set a good example
Inability to convey the importance of the oceans for life on the planet, in an attractive way and adapted for young people
Lack of attention from the media for the ocean

As Communication was placed in stage 3 of the influence map, it would be expected that the majority of structured Communication barriers would be to the left of the maps or in the middle of the maps. This is the case in the **Belgian** (Fig. 17) “Lack of attention from the media for the ocean” and **Swedish** structural maps (Fig. 18) “Lack of role models and that a sufficient number of adults set a good example”. As can be seen in the **Spanish** Structural map (Fig. 19), the structured barrier “Inability to convey the importance of the oceans for life on the planet, in an attractive way and adapted for young people” is in stage 2.

The most feasible and impactful options for Communication are listed below:

- Develop educational programs to be experiential and relevant for the students (24 votes)
- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- Further development for teachers and principles in "desire to create" activities (20 votes)
- Bank on environmental dissemination (related with the oceans) in prime-time, even if were just a brief spot (19 votes)
- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)
- Build a personal relationship with the sea through interactive learning where does the fish finger come from (16 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Create an Ocean Steering Group to coordinate project ideas + develop feasible funded projects (15 votes)
- Introduce outdoor pedagogy and intersectoral teaching in teacher training programmes (14 votes)
- National media (all) campaign for all aquatic interests and activities – commercial + leisure (14 votes)
- Dedicated self-funded marine department [with Secretary General] (13 votes)
- Create attention about the sea via media/lobbyists (11 votes)
- Organize a platform to share educational materials with a forum to discuss ideas about the educational materials (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography. (10 votes)
- External teaching can make the class more alive (10 votes)
- Evaluation of the already existing educational material with the aim of enriching it and/or creating new teaching methods in the framework of interactive educational teaching (10 votes)
- Design vocational workshops to inform and educate youth on sea-related jobs (8 votes)

- Develop an overall ocean campaign to get more attention of the media for the ocean *(number of votes not reported)*

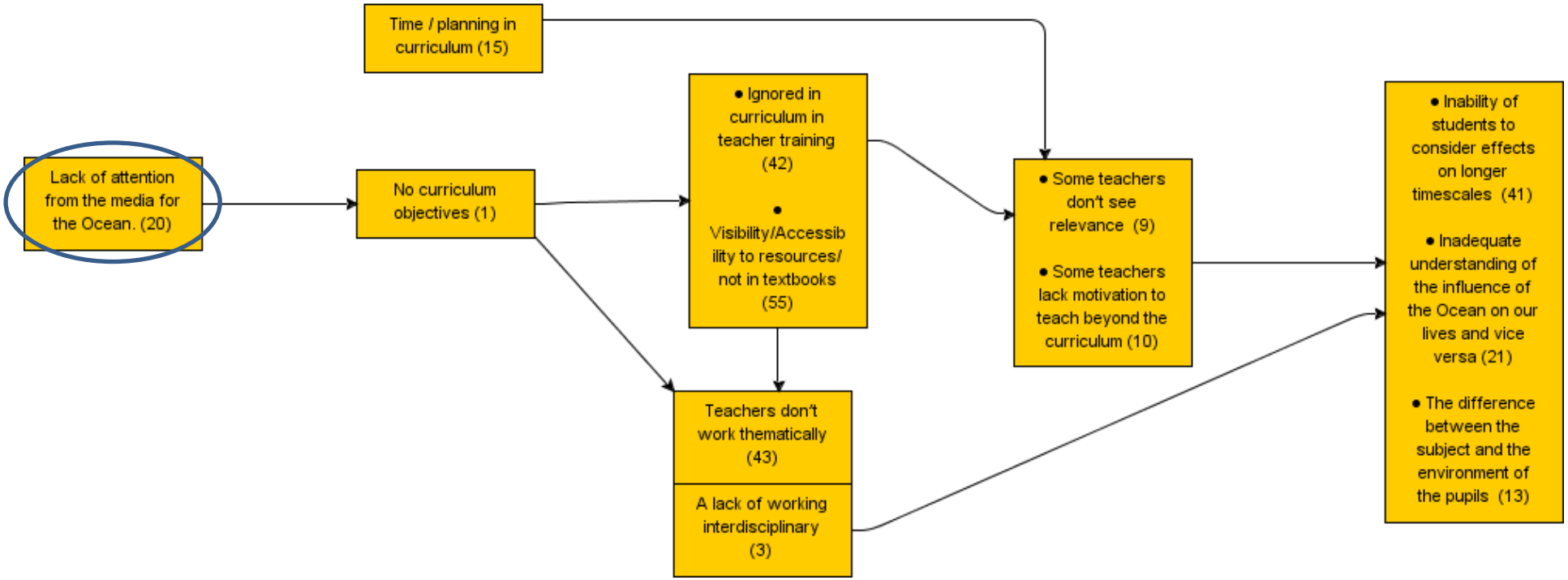

Fig. 17. Belgium structural map (Communication barrier encircled).

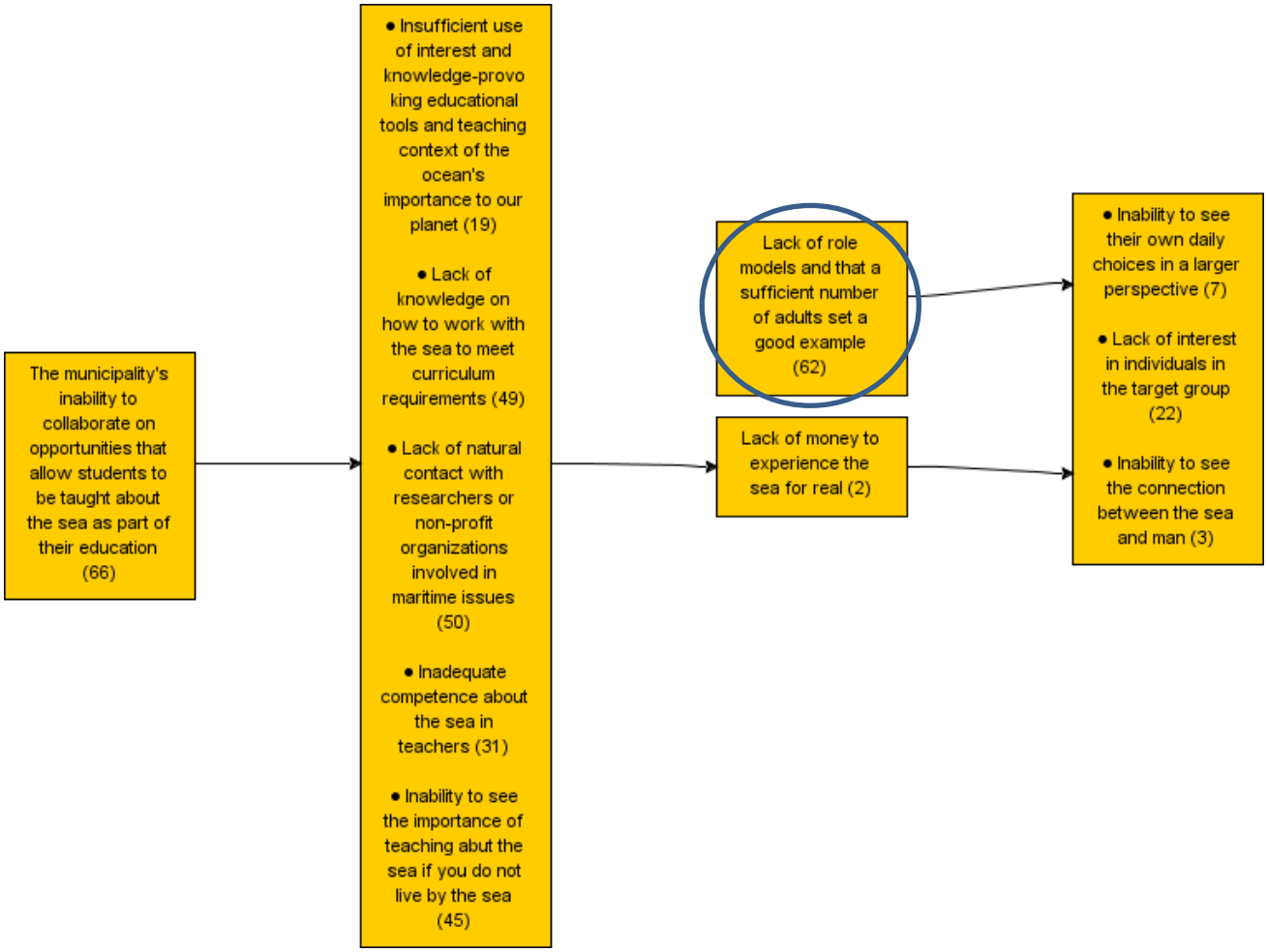

Fig. 18. Sweden structural map (Communication barrier encircled).

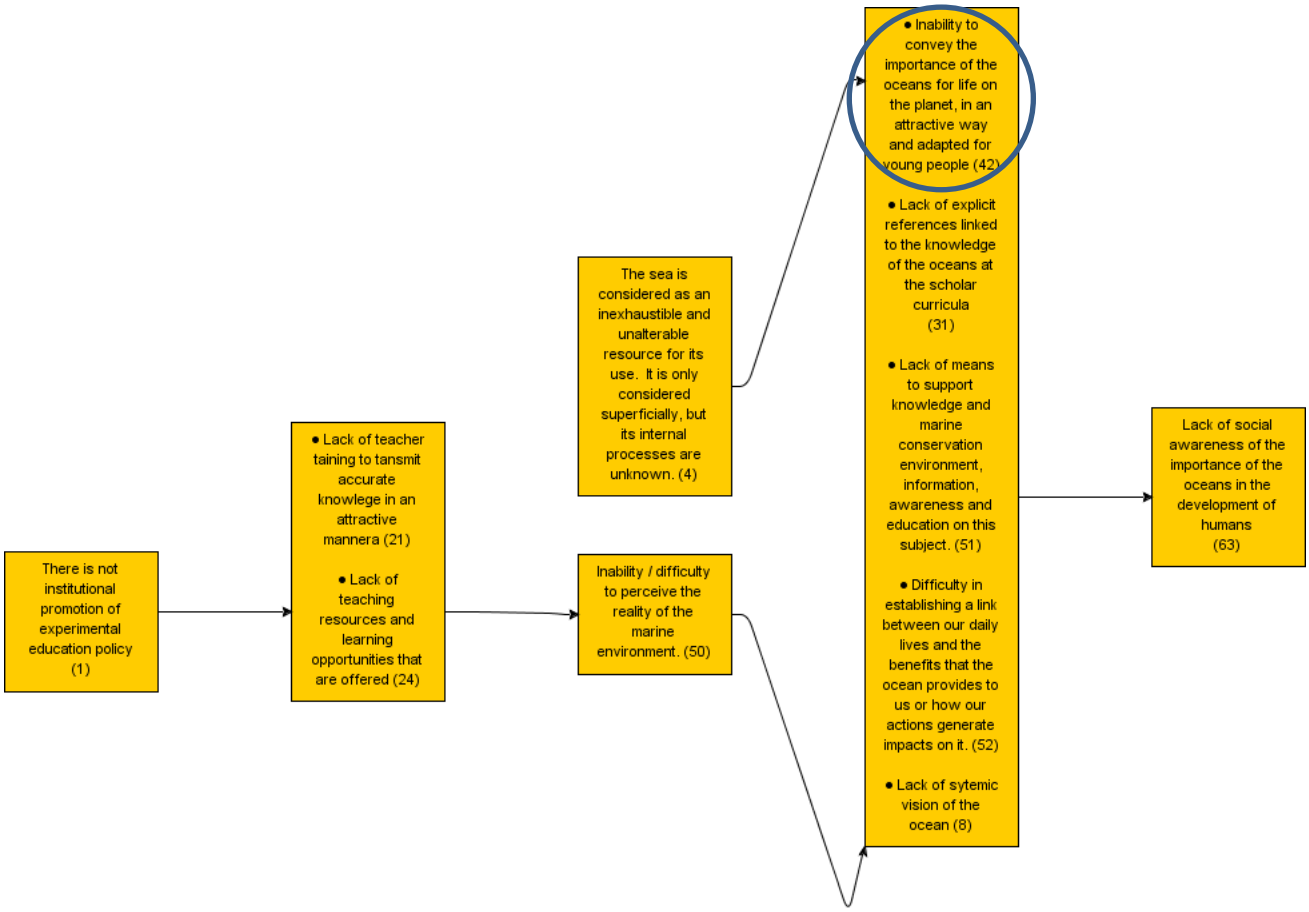

Fig. 19. Spain structural map (Communication barrier encircled).

3.3.4. Hands-on

A total of 15 barriers were generated in the Hands-on category. These barriers relate to the lack of hands-on activities, related to the ocean and sciences, given to the students. The Hands-on barriers received 0 votes, making it the one of the least important category to the stakeholders (Appendix 3). Of the 15 Hands-on barriers three were included in the structuring phase (Table 10).

Table 10. Structured barriers within the Hands-on category

There is not institutional promotion of experimental education policy
Lack of opportunities for students to feel, touch and experience the sciences rather than read and imagine
Lack of educational materials, and hands-on activities, related to oceans

As Hands-on was placed in stage 3 of the influence map, it would be expected that the majority of structured Hands-on would be to the left of the maps or in the middle of the maps. As can be seen in the **Spanish** map (Fig. 20), the structured barrier "There is not institutional promotion of experimental education policy" confirms this. The **Portuguese** map (Fig. 21), the structured barrier "Lack of educational materials, and hands-on activities, related to oceans" is found in the Centre of the map. In the **Irish** map (Fig. 22), the structured barrier "Lack of opportunities for students to feel, touch and experience the sciences rather than read and imagine" is placed towards the left (stage 2). The barrier is more a driver of influence.

The most feasible and impactful Hands-on options are listed below:

- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)

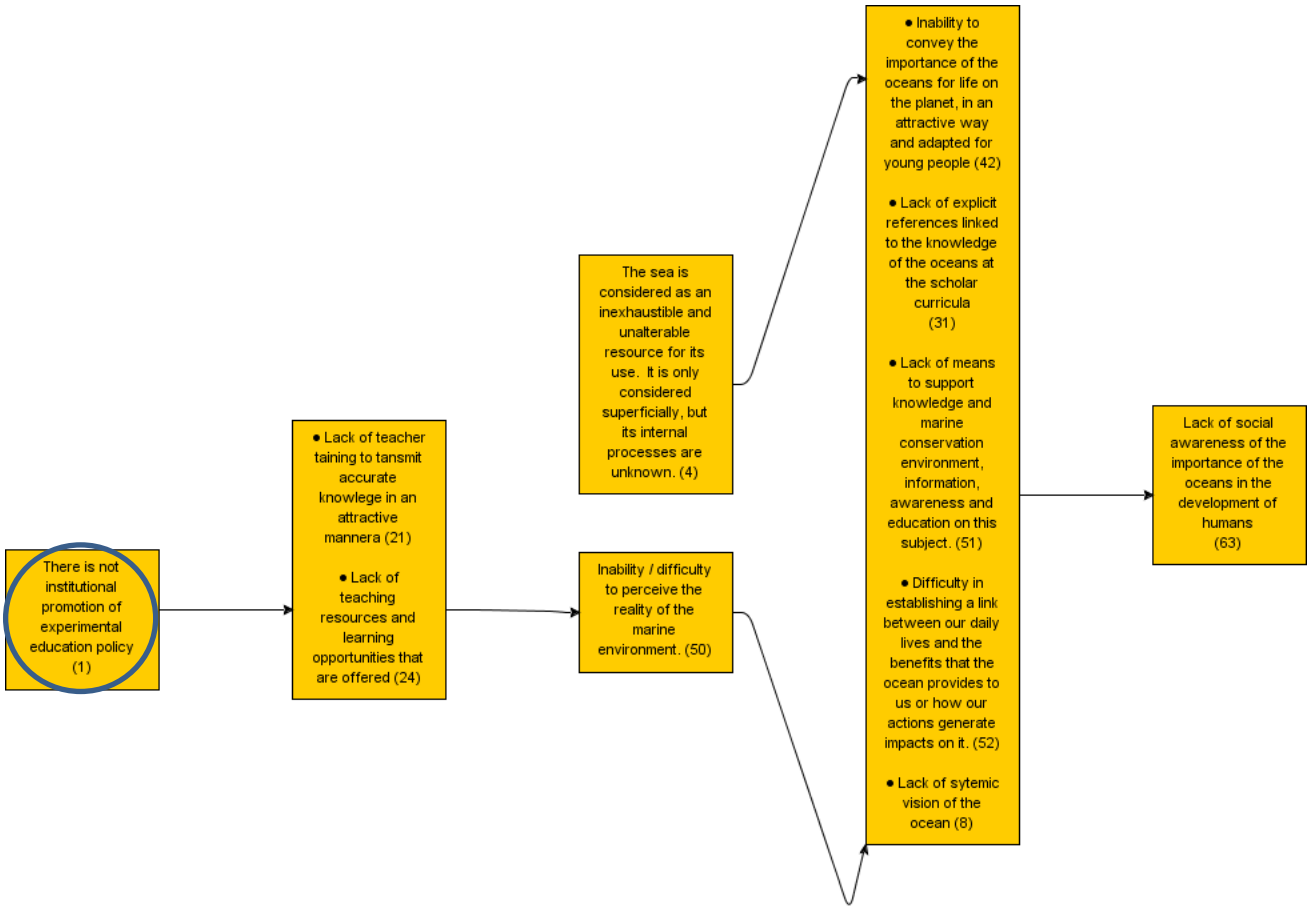

Fig. 20. Spain structural map (Hands-on barrier encircled).

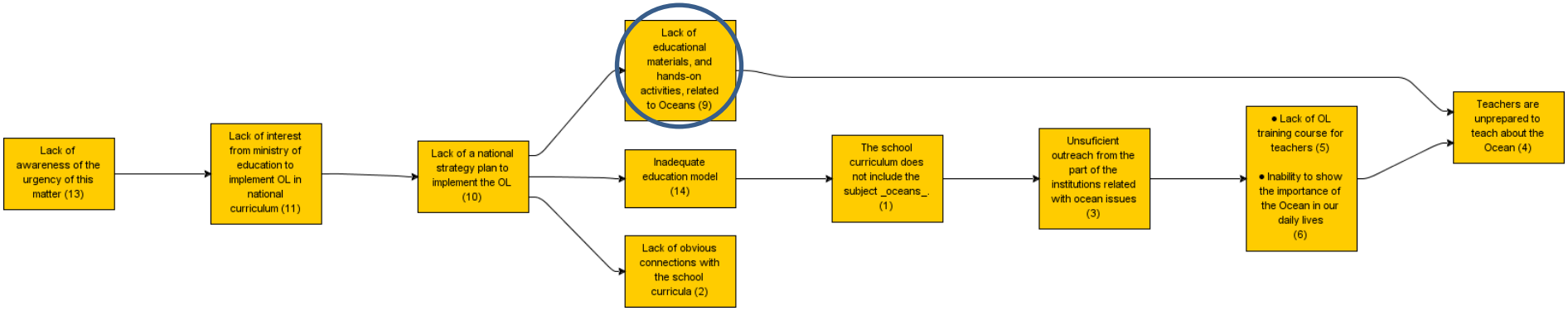

Fig. 21. Portugal structural map (Hands-on barrier encircled).

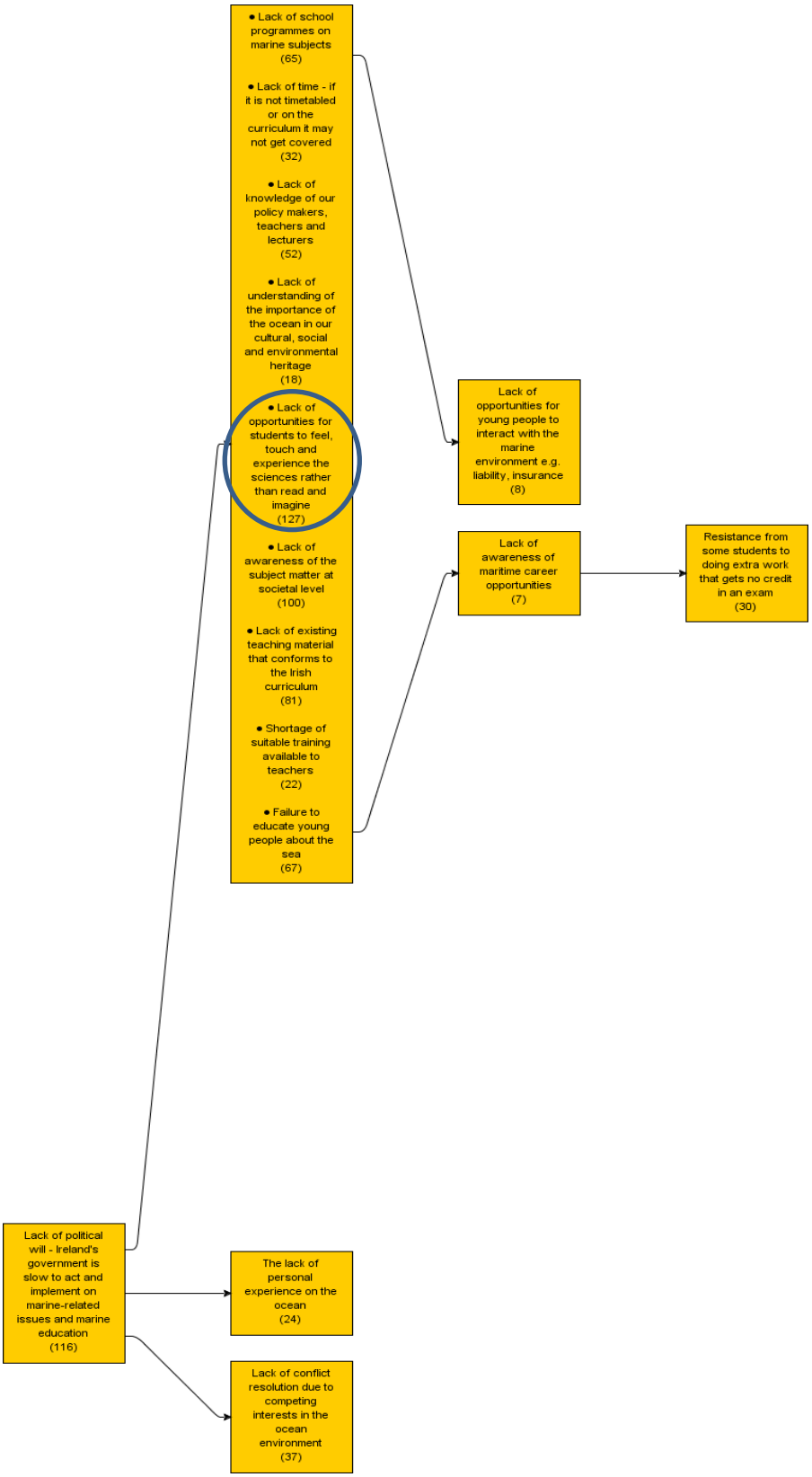

Fig. 22. Ireland structural map (Hands-on barrier encircled).

3.4. Formal education sector

Formal education sector emerged in the stage 4 of influential barriers (Fig. 1). The barriers within this category received an average influence score of 3.43 (Appendix 3), while the barriers within The Ocean itself received an average influence score of 3.33., a difference of 0.1. Due to the similar average influence scores, both of these categories were placed in stage 4 of the influence map. Formal education sector is made up of eight categories: Teaching, Fieldtrip, Interdisciplinary, Equipment, School culture, Curriculum, Time and Teaching material. Each will be discussed in detail below.

3.4.1.Teaching

A total of 75 Sea Change stakeholder barriers were placed within the Teaching category. This category has four subcategories: Teacher training; Motivation; Teacher marine knowledge; Teaching method. These barriers relate to teaching methods, shortage of teacher training courses and a lack of motivation and knowledge about the marine environment among teachers. The barriers within this category received 95 votes, making it the second most important and an influential category to the stakeholders (Appendix 3). Of these 75 barriers, 17 were chosen by the stakeholders in various consultations to be included in the structuring phase (Table 11).

Table 11. Structured barriers within the Teaching category

Shortage of suitable training available to teachers
Lack of OL training course for teachers
Not enough teaching about the sea during teacher education
Ignored in (curriculum of) teacher training
Professional development needed to address the lack of expertise and knowledge about the marine environment and oceans
Lack of teacher training to transmit accurate knowledge in an attractive manner
Inadequate education model
Lack of motivation (mainly class room teaching)
Some teachers don't see relevance
Inability to see the importance of teaching about the sea if you do not live by the sea
Some teachers lack motivation to teach beyond the curriculum
Teachers are unprepared to teach about the ocean
Lack of awareness of / expertise in Ocean Literacy (education) amongst teaching profession
Teachers don't work thematically
Insufficient use of interest and knowledge-provoking educational tools and teaching context of the ocean's importance to our planet
Lack of knowledge on how to work with the sea to meet curriculum requirements
Insufficient links of schools with scientific institutions that carry out marine research

The placement of Teaching in stage 4 of the multistage influence map suggests that the majority of the structured Teaching barriers will also be positioned in the Centre or to the right of the individual structural maps. In the **UK** structural map (Fig. 23), "Professional development needed to address the lack of expertise and knowledge about the marine" and "Lack of awareness /expertise in Ocean Literacy

(education) amongst teaching profession" are located in the Centre, confirming the influence map suggestion. As can be seen in the **Spanish** structural map (Fig. 24) "Lack of teacher training to transmit accurate knowledge in an attractive manner" is located in stage 2 (to the left). In the **Portuguese** map (Fig. 25) the barriers "Inadequate education model", "Lack of OL training course for teachers" and "Teachers are unprepared to teach about the ocean", are placed in the Centre, and in the final stages. However, in the **Greek** map (Fig. 26) the barrier "Insufficient links of schools with scientific institutions that carry out marine research" is located in stage 2. In the **Danish** map (Fig. 27), the barriers "Not enough teaching about the sea during teacher education" and "Lack of motivation (mainly class room teaching)" are placed in the final two stages. The **Belgian** structural map (Fig. 28) showed that barriers "Ignored in (curriculum of) teacher training", "Teachers don't work thematically", "Some teachers don't see relevance" and "Some teachers lack motivation to teach beyond the curriculum" are in the Centre stages. The **Swedish** barriers (Fig. 29) "Insufficient use of interest and knowledge-provoking educational tools and teaching context of the ocean's importance to our planet", "Lack of knowledge on how to work with the sea to meet curriculum requirements" and "Inability to see the importance of teaching about the sea if you do not live by the sea" are in the second stage. While the **Irish** barrier "Shortage of suitable training available to teachers" (Fig. 30) is also to the left in the structural map. The barrier is both a driver and driver of influence.

The most feasible and impactful Teaching options are listed below:

- Develop educational programs to be experiential and relevant for the students (24 votes)
- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- A better regulation to move forward in the competences and skills development, in order to overcome the actual dominant scheme of subjects and areas (20 votes)
- Further development for teachers and principles in "desire to create" activities (20 votes)
- Educate in complexity fostering a change on the methodology (19 votes)
- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)
- Promote the reshuffling of the official curriculum into a more flexible one, which will allow for a percentage of time to be allocated on new initiatives and will give teachers more freedom to select subjects for this time zone (17 votes)
- Build a personal relationship with the sea through interactive learning where does the fish finger come from (16 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- Introduce outdoor pedagogy and intersectoral teaching in teacher training programmes (14 votes)
- Develop collaboration with other schools, universities and non-profit organisations (14 votes)
- Create space and time and flexibility or a new scholar schedule organization in order we can work the ocean topic in a multidisciplinary way (14 votes)
- Empower teachers to manage curricula and to value Ocean Literacy issues/topics (even when not obvious) (14 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)

- Design and development of a thematic educational program with the cooperation of HCMR, Universities, Environmental Education Centres and the Environmental Education Department of the Ministry of Education (10 votes)
- Evaluation of the already existing educational material with the aim of enriching it and/or creating new teaching methods in the framework of interactive educational teaching (10 votes)
- External teaching can make the class more alive (10 votes)
- Lobby with Ministry of Education (Julia Crevits) for one or more curriculum goals on the ocean *(number of votes not reported)*

Fig. 23. UK structural map (Teaching barriers encircled).

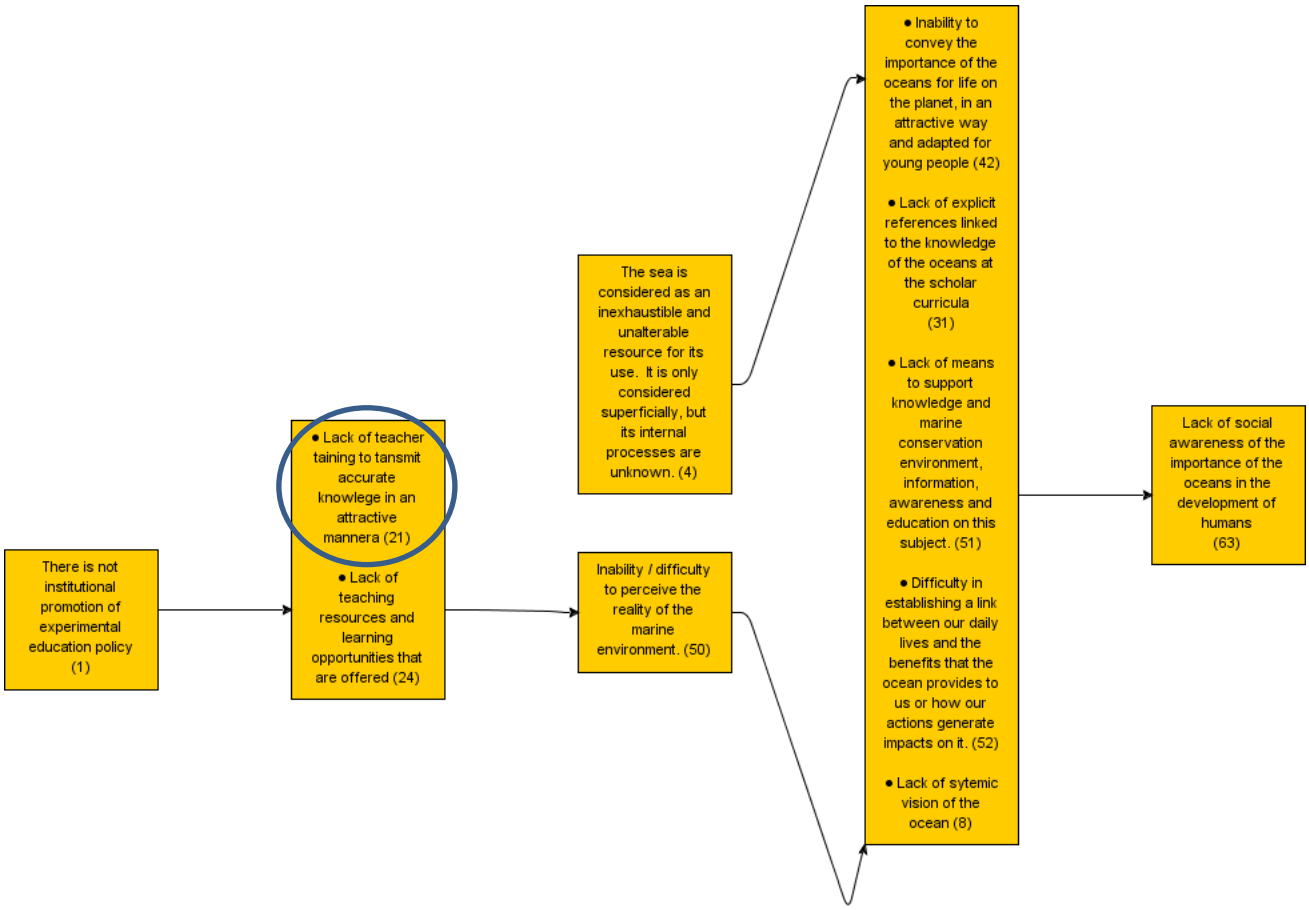

Fig. 24. Spain structural map (Teaching barriers encircled).

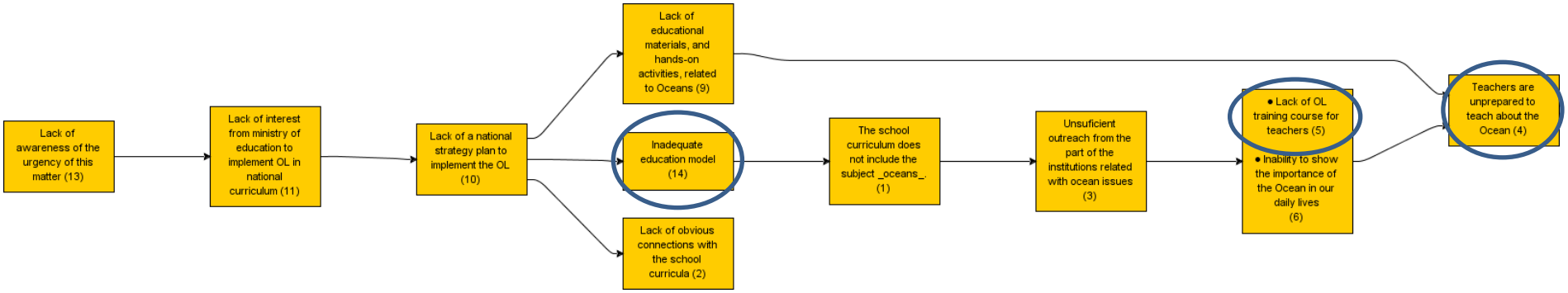

Fig. 25. Portugal structural map (Teaching barriers encircled).

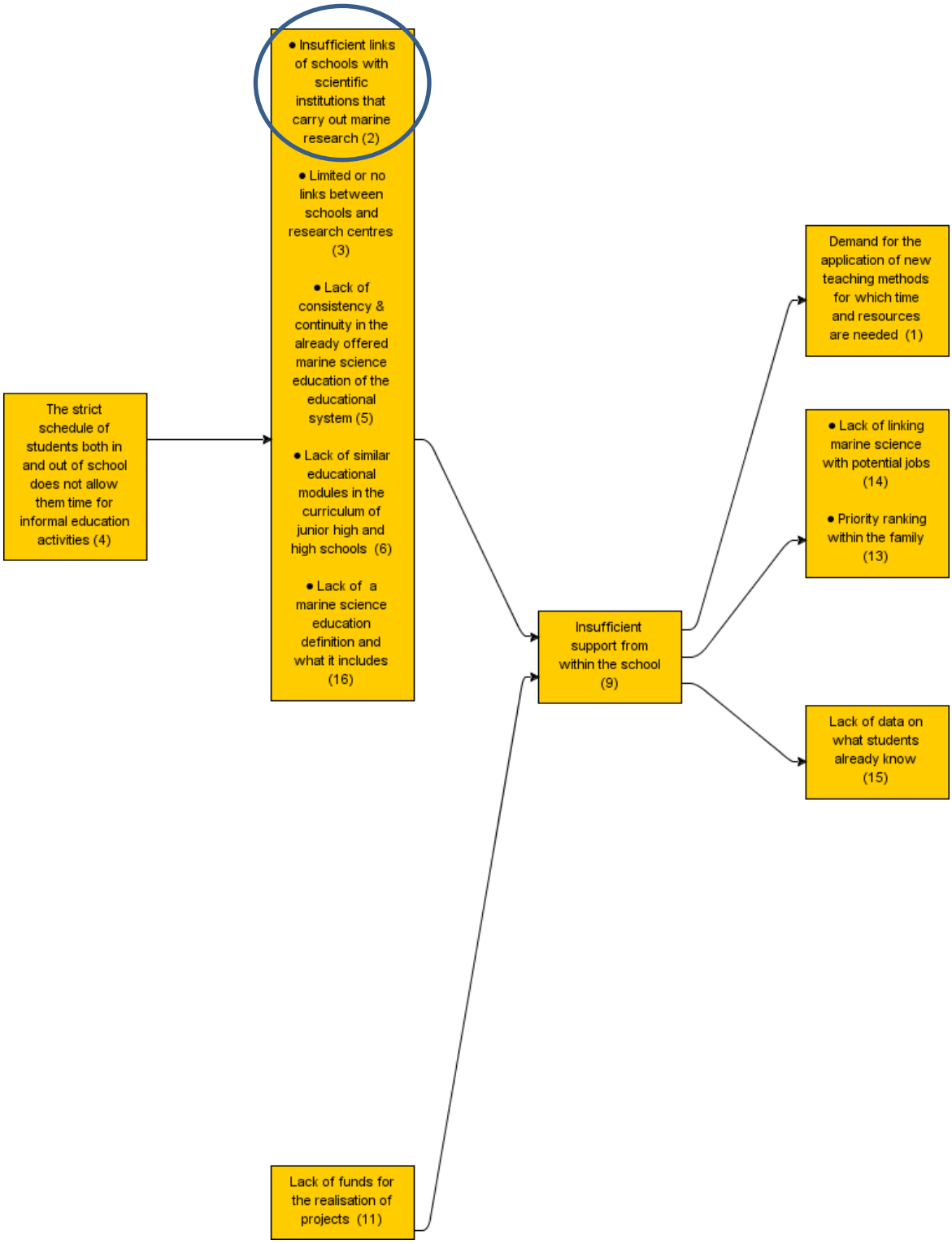

Fig. 26. Greece structural map (Teaching barrier encircled).

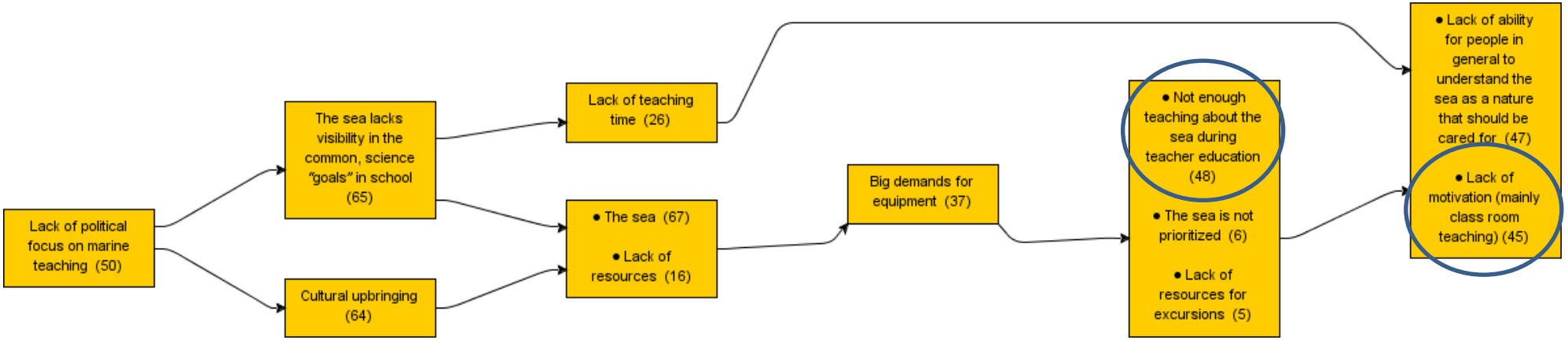

Fig. 27. Denmark structural map (Teaching barriers encircled).

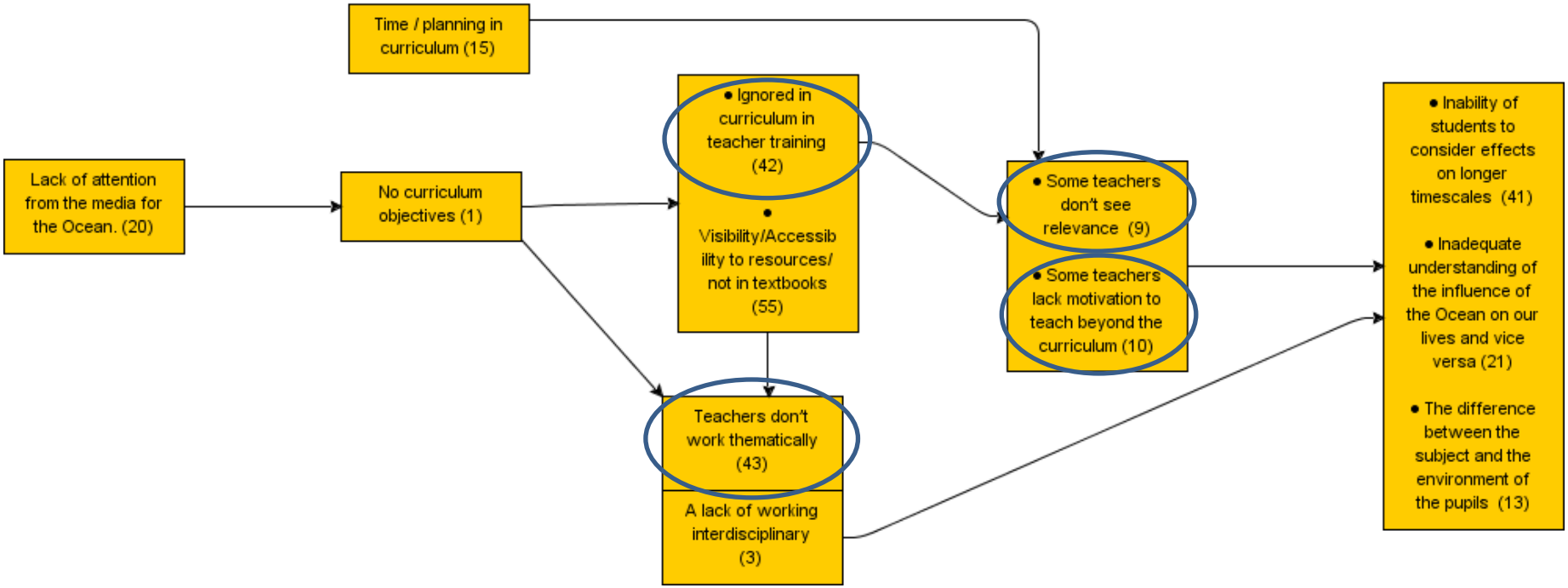

Fig. 28. Belgium structural map (Teaching barriers encircled).

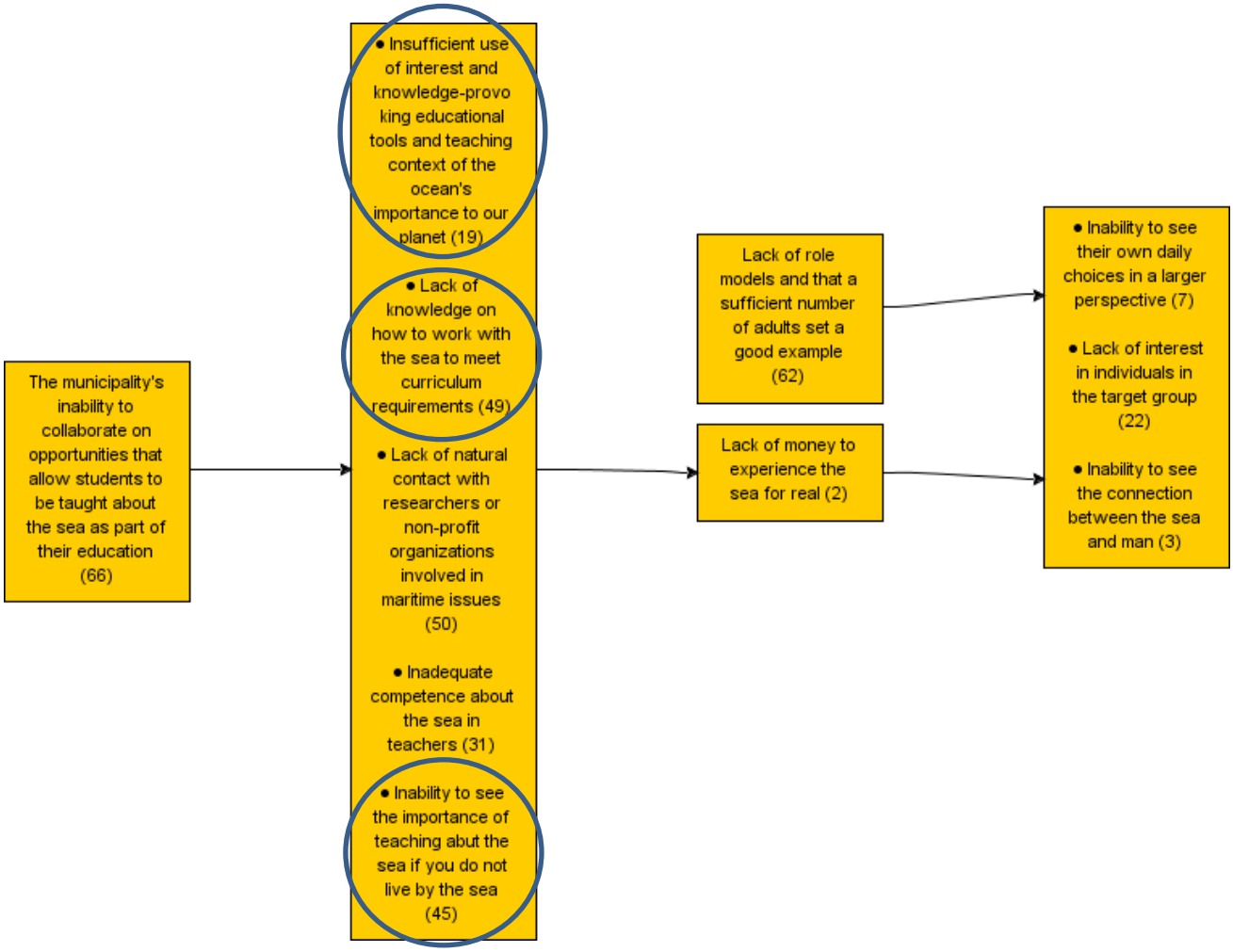

Fig. 29. Sweden structural map (Teaching barriers encircled).

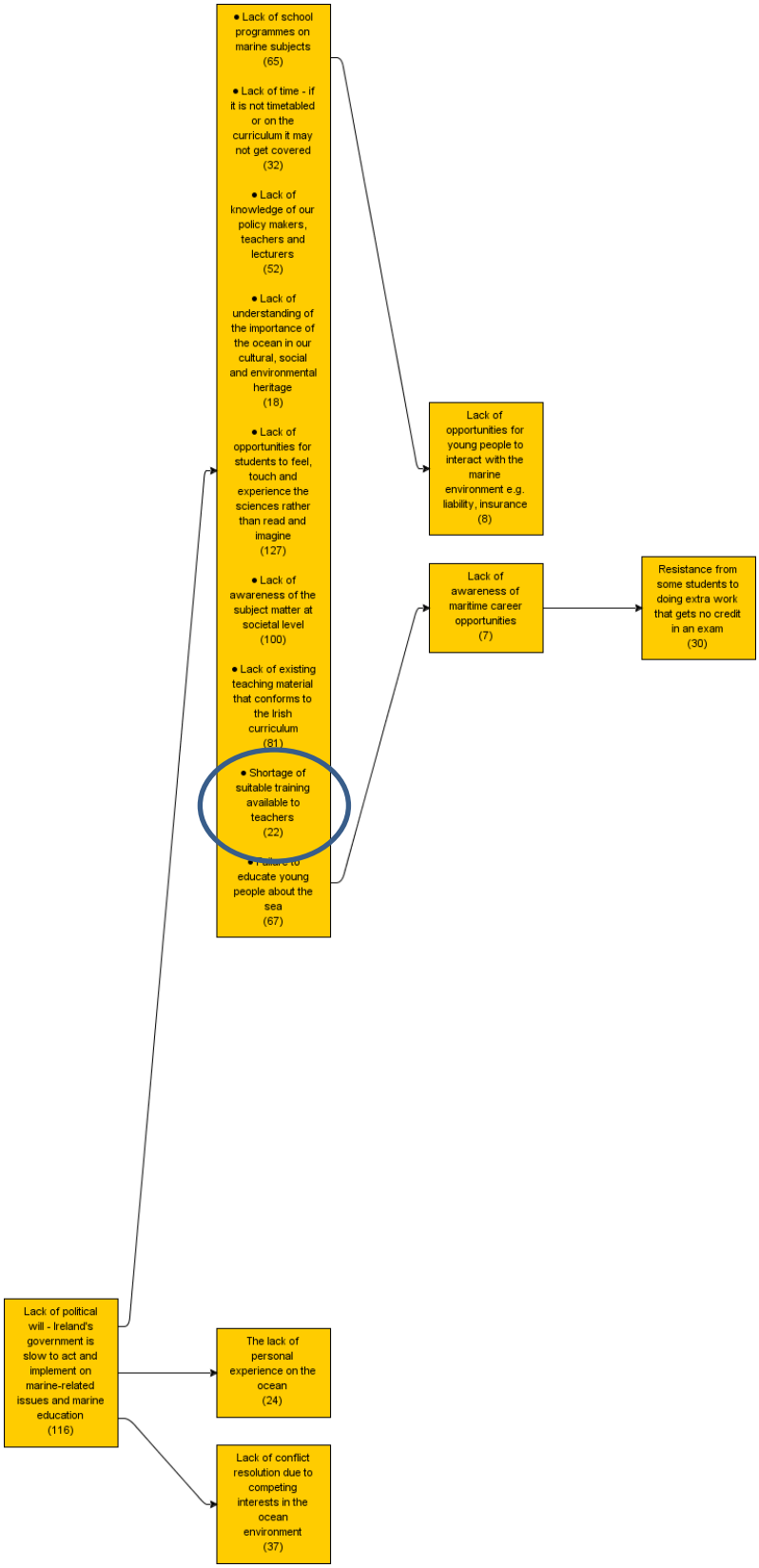

Fig. 30. Ireland structural map (Teaching barrier encircled).

3.4.2. Fieldtrip

A total of 26 stakeholder barriers were placed within the Fieldtrip category during the Sea Change stakeholder meta barrier analysis. This category contains two subcategories: Concerns; Schools. These barriers relate to concerns and difficulties experienced by teachers and students during fieldtrip activities. The barriers in this category received 0 votes, making it one of the least important by the stakeholders (Appendix 3). While this category was not seen as very important to the stakeholders, it has a reasonably high level of influence on the remaining categories that lie to the right of it in the influence map. Of these 26 barriers, three were chosen by the stakeholders to be included in the structuring (Table 12).

Table 12. Structured barriers within the Fieldtrip category

Lack of opportunities for young people to interact with the marine environment e.g. liability, insurance
Lack of a marine science education definition and what it includes
Lack of confidence when taking students out of the classroom

With Fieldtrip in stage 4 of the multistage influence map, this suggests that the majority of the structured Fieldtrip barriers will also be found in the Centre or to the right of the individual structural maps. The **UK** structural map (Fig. 31) barrier "Lack of confidence when taking students out of the classroom" is located towards the right. While the **Greek** barrier "Lack of a marine science education definition and what it includes" (Fig. 32) is towards the left. In the **Irish** structural map (Fig. 33), the barrier "Lack of opportunities for young people to interact with the marine environment e.g. liability, insurance" is located in the final stage, which confirms this suggestion. The barrier is both a driver and receiver of influence.

The most feasible and impactful option for Fieldtrips is listed below:

- External teaching can make the class more alive (10 votes)

Fig. 31. UK structural map (Fieldtrip barrier encircled).

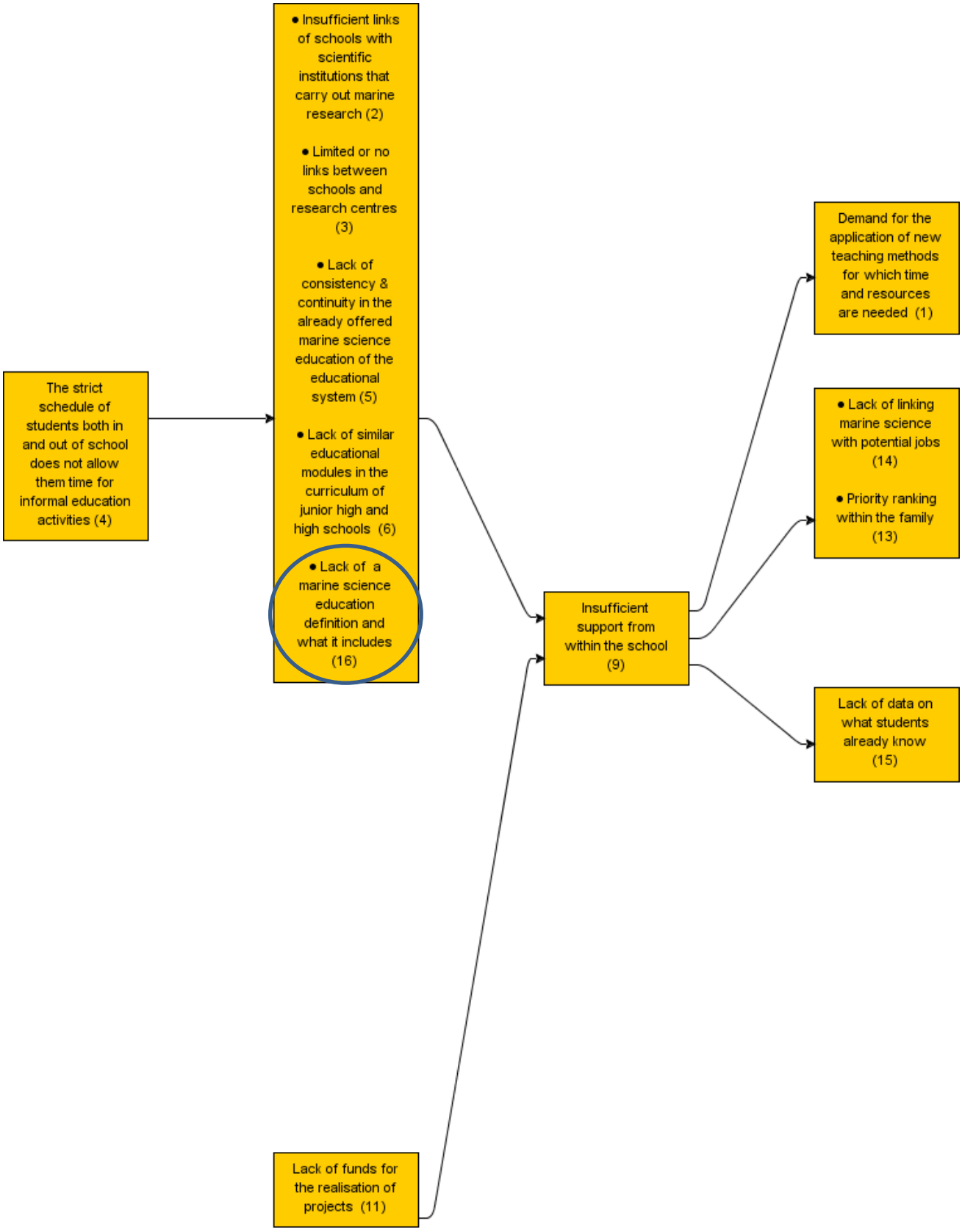

Fig. 32. Greece structural map (Fieldtrip barrier encircled).

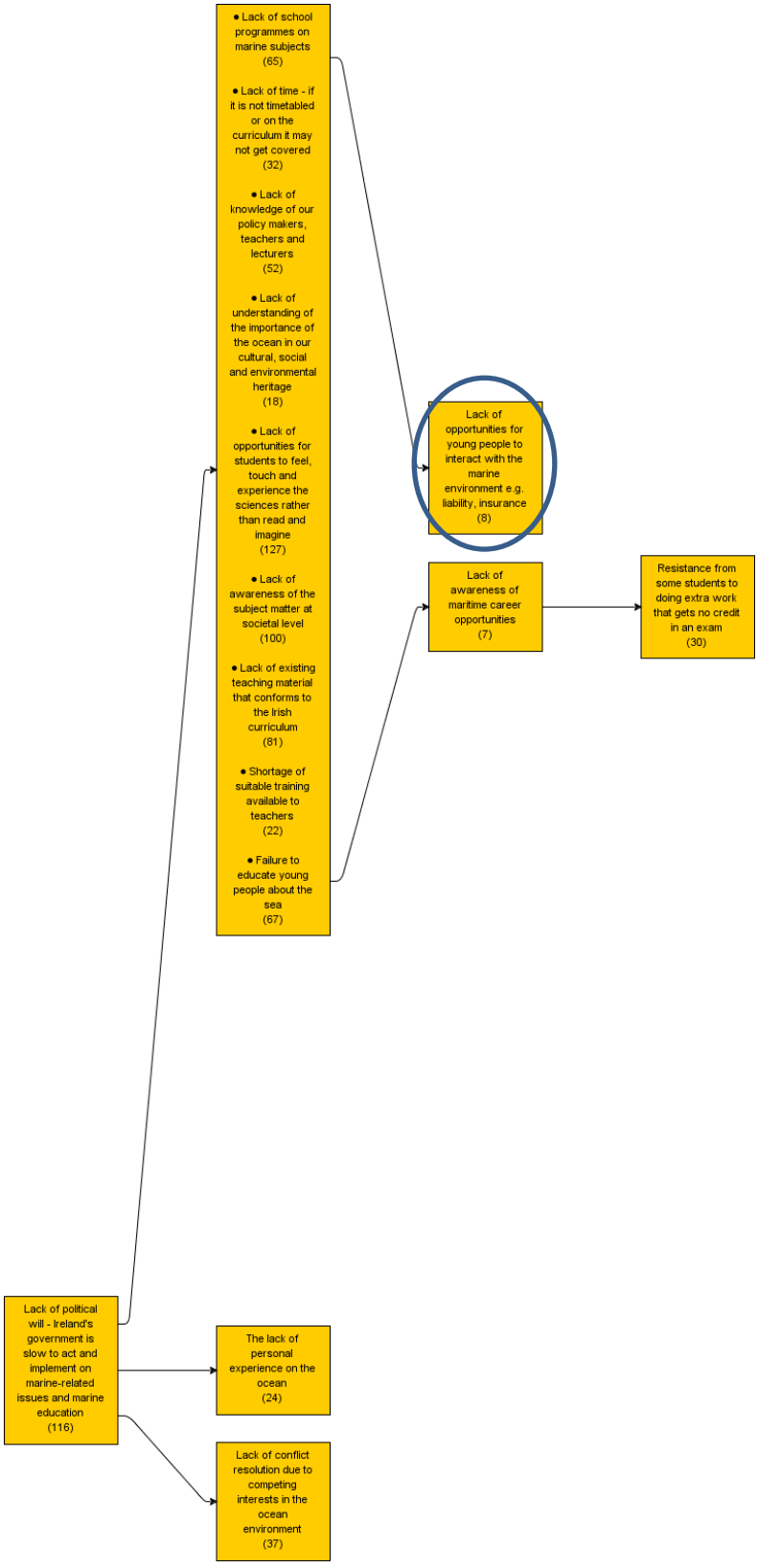

Fig. 33. Ireland structural map (Fieldtrip barrier encircled).

3.4.3. Interdisciplinary

A total of nine Sea Change stakeholder barriers were placed within the Interdisciplinary category. These barriers relates to there being a lack of interdisciplinary work among teachers. The barriers within this category received 0 votes, making it one of the least important categories to the stakeholders (Appendix 3). Of these nine barriers, two were chosen by the stakeholders in various consultations to be included in the structuring phase (Table 13).

Table 13. Structured barriers within the Interdisciplinary category

A lack of working interdisciplinary
Lack of similar educational modules in the curriculum of junior high and high schools

With Interdisciplinary in stage 4 of the multistage influence map, this suggests that the majority of the structured Interdisciplinary barriers will also be positioned in the Centre or to the right of the individual structural maps. In the **Belgian** structural map (Fig. 35), the barrier "A lack of working interdisciplinary" is located in the second stage (to the left), while the **Greek** barrier "Lack of similar educational modules in the curriculum of junior high and high schools" is located in the Centre (Fig. 34).

The most feasible and impactful Interdisciplinary options can be seen below:

- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- Create space and time and flexibility or a new scholar schedule organization in order we can work the ocean topic in a multidisciplinary way (14 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)

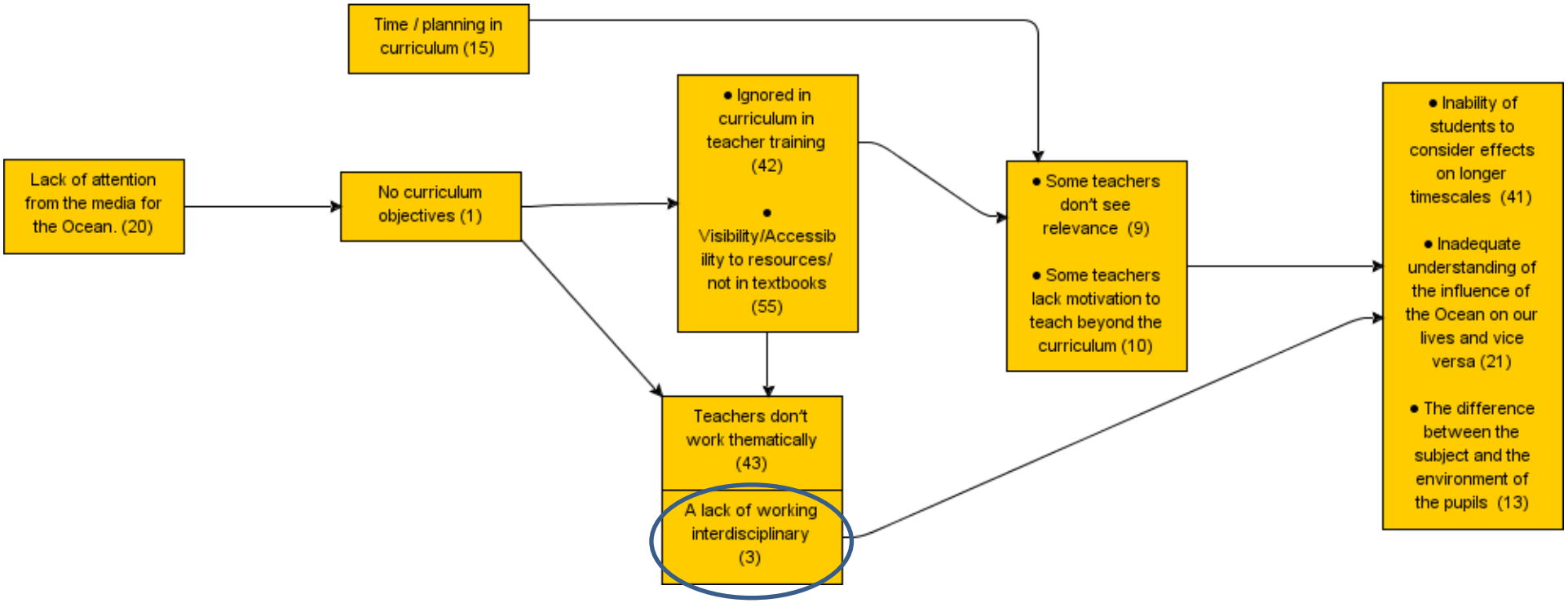

Fig. 34. Belgium structural map (Interdisciplinary barrier encircled).

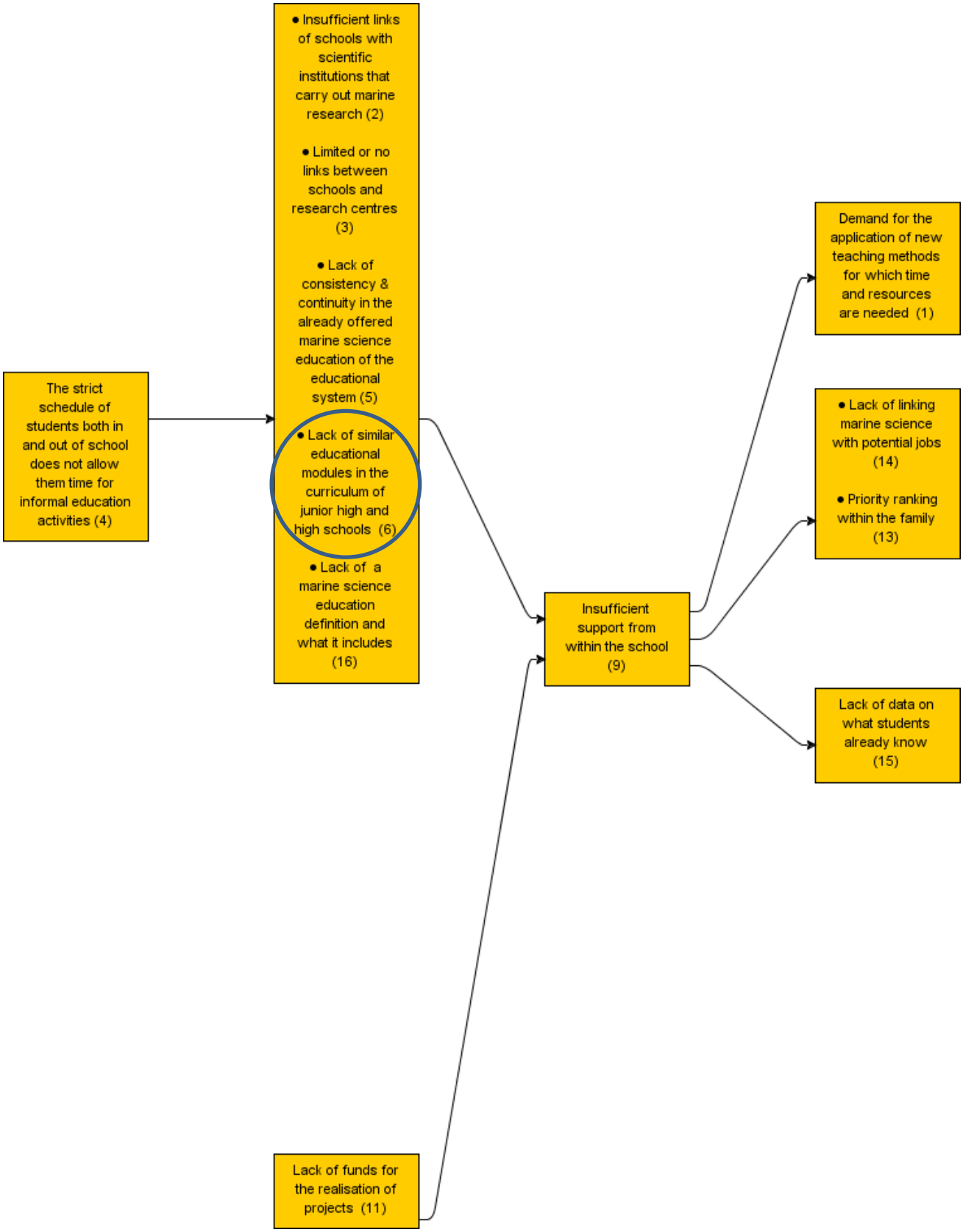

Fig. 35. Greece structural map (Interdisciplinary barrier encircled).

3.4.4. Equipment

A total of 10 Sea Change stakeholder barriers were placed within the Equipment category. These barriers refer to a lack of equipment in schools, despite the demand for it. The barriers within this category received 0 votes, making it one of the least important categories to the stakeholders (Appendix 3). Of these 10 barriers, one was chosen by the stakeholders in various consultations to be included in the structuring phase (Table 14).

Table 14. Structured barriers within the Equipment category

Big demands for equipment

Equipment is found in stage 4 of the multistage influence map and this suggests that the majority of the structured Equipment barriers will also be found in the Centre or to the right of the individual structural maps. This was confirmed in the **Danish** structural map, where the barrier "Big demands for equipment" was located in the Centre/towards the right.

None of the top voted for options are feasible and impactful for the Equipment category.

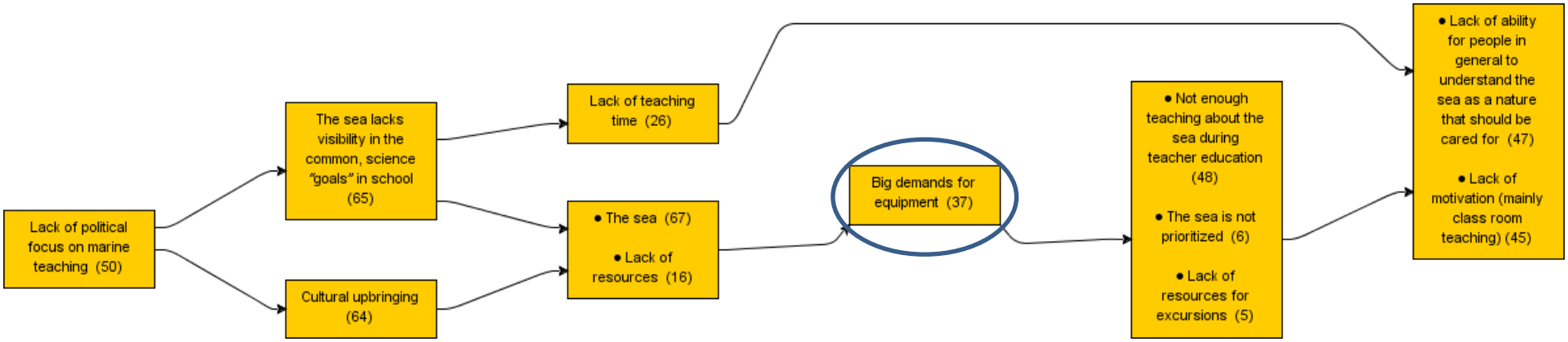

Fig. 36. Denmark structural map (Equipment barrier encircled).

3.4.5. School culture

A total of 13 Sea Change stakeholder barriers were placed within the School culture category. These barriers refer to obstacles from school management. The barriers within this category received 11 votes, making it the twelfth most important category to the stakeholders (Appendix 3). Of these 13 barriers, one was chosen by the stakeholders in various consultations to be included in the structuring phase (Table 15).

Table 15. Structured barriers within the School culture category

Lack of consistency & continuity in the already offered marine science education of the educational system

School culture is present in stage 4 of the multistage influence map, which suggests that the majority of the structured School Culture barriers will also be found in the Centre or to the right of the individual structural maps. In the **Greek** structural map (Fig. 37), the barrier "Lack of consistency & continuity in the already offered marine science education of the educational system" was placed towards the left. The barrier is a driver of influence.

None of the top voted for options are feasible and impactful for the Culture category.

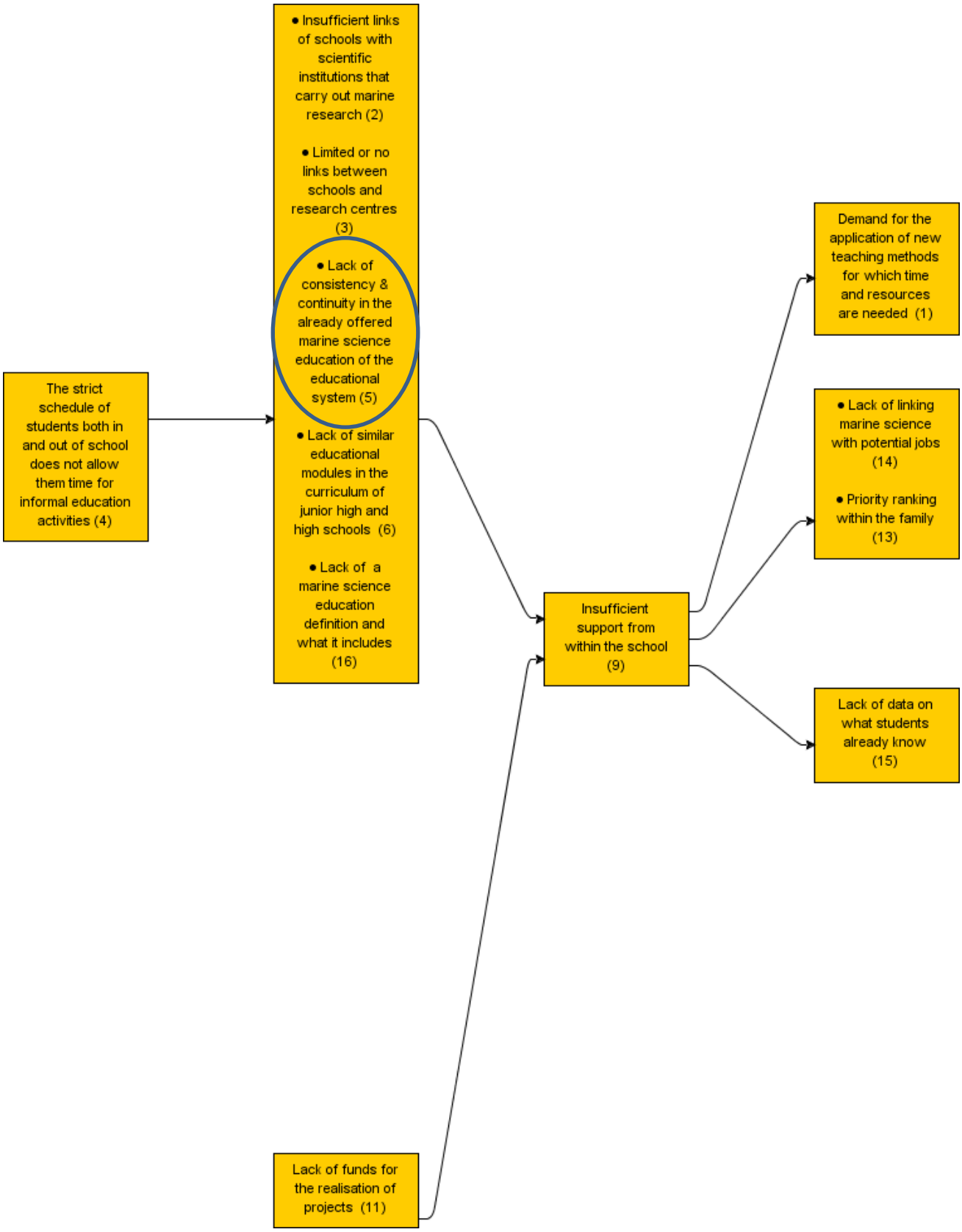

Fig. 37. Greece structural map (School culture barrier encircled).

3.4.6. Curriculum

A total of 63 Sea Change stakeholder barriers were placed within the Curriculum category. This category was divided into three subcategories: Tradition, Focus and Space. These barriers relate to the curricula being restricted, not including ocean subjects. The barriers within this category received 74 votes, making it the 3rd most important category to the stakeholders (Appendix 3). Of these 63 barriers, 10 were chosen by the stakeholders in various consultations to be included in the structuring phase (Table 16).

Table 16. Structured barriers within the Curriculum category

The school curriculum does not include the subject oceans
Lack of means to support knowledge and marine conservation environment, information, awareness and education on this subject
No curriculum objectives
The sea lacks visibility in the common, science "goals" in school
Lack of school programmes on marine subjects
Lack of explicit references linked to the knowledge of the oceans at the scholar curricula
Lack of opportunity within the current national curriculum
The strict schedule of students both in and out of school does not allow them time for informal education activities
Resistance from some students to doing extra work that gets no credit in an exam
Curriculum – Syllabus

Curriculum is found in stage 4 of the multistage influence map, which suggests that the majority of the structured Curriculum barriers will also be found in the Centre or to the right of the individual structural maps. In the **Greek** structural map (Fig. 38), the barrier "The strict schedule of students both in and out of school does not allow them time for informal education activities" is located in the first stage. While the **UK** barriers "Curriculum – Syllabus" and "Lack of opportunity within the current national curriculum" (Fig. 39) were placed in the first category and fourth category (out of five), respectively. The **Spanish** structural map (Fig. 40) showed the barriers "Lack of explicit references linked to the knowledge of the oceans at the scholar curricula" and "Lack of means to support knowledge and marine conservation environment, information, awareness and education on this subject" in the fourth stage (out of five). The **Portuguese** map (Fig. 41) placed the barrier "The school curriculum does not include the subject oceans" in the Centre. The **Danish** map (Fig. 42) placed the barrier "The sea lacks visibility in the common, science "goals" in school" towards the left. In the **Belgian** map (Fig. 43), the barrier "No curriculum objectives" was located towards the left. The **Irish** map (Fig. 44) placed the barrier "Lack of school programmes on marine subjects" in stage 2 and "Resistance from some students to doing extra work that gets no credit in an exam" in the final stage, to the right. The barrier is both a driver and receiver of influence.

The most feasible and impactful Curriculum options can be seen below:

- Consider spreading marine topic across the curriculum (not just science) to allow more time for it to be communicated to students (21 votes)
- A better regulation to move forward in the competences and skills development, in order to overcome the actual dominant scheme of subjects and areas (20 votes)
- Promote the reshuffling of the official curriculum into a more flexible one, which will allow for a percentage of time to be allocated on new initiatives and will give teachers more freedom to select subjects for this time zone (17 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Create space and time and flexibility or a new scholar schedule organization in order we can work the ocean topic in a multidisciplinary way (14 votes)

- Empower teachers to manage curricula and to value Ocean Literacy issues/topics (even when not obvious) (14 votes)
- Establish partnerships to jointly lobby govt. to change National Curriculum (13 votes)
- Policies, Global Citizen Programme! 3 world days (1 per term, including the World Ocean Day), or off curriculum, or all (12 votes)
- Certificate for T.Y. students from National Governing Body (NGB) in Ocean Literacy. This should lead on to more work experience in the maritime industries (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)
- External teaching can make the class more alive (10 votes)
- The season is short so e.g. move activities to the exam period (10 votes)
- Lobby with Ministry of Education (Julia Crevits) for one or more curriculum goals on the ocean *(number of votes not reported)*

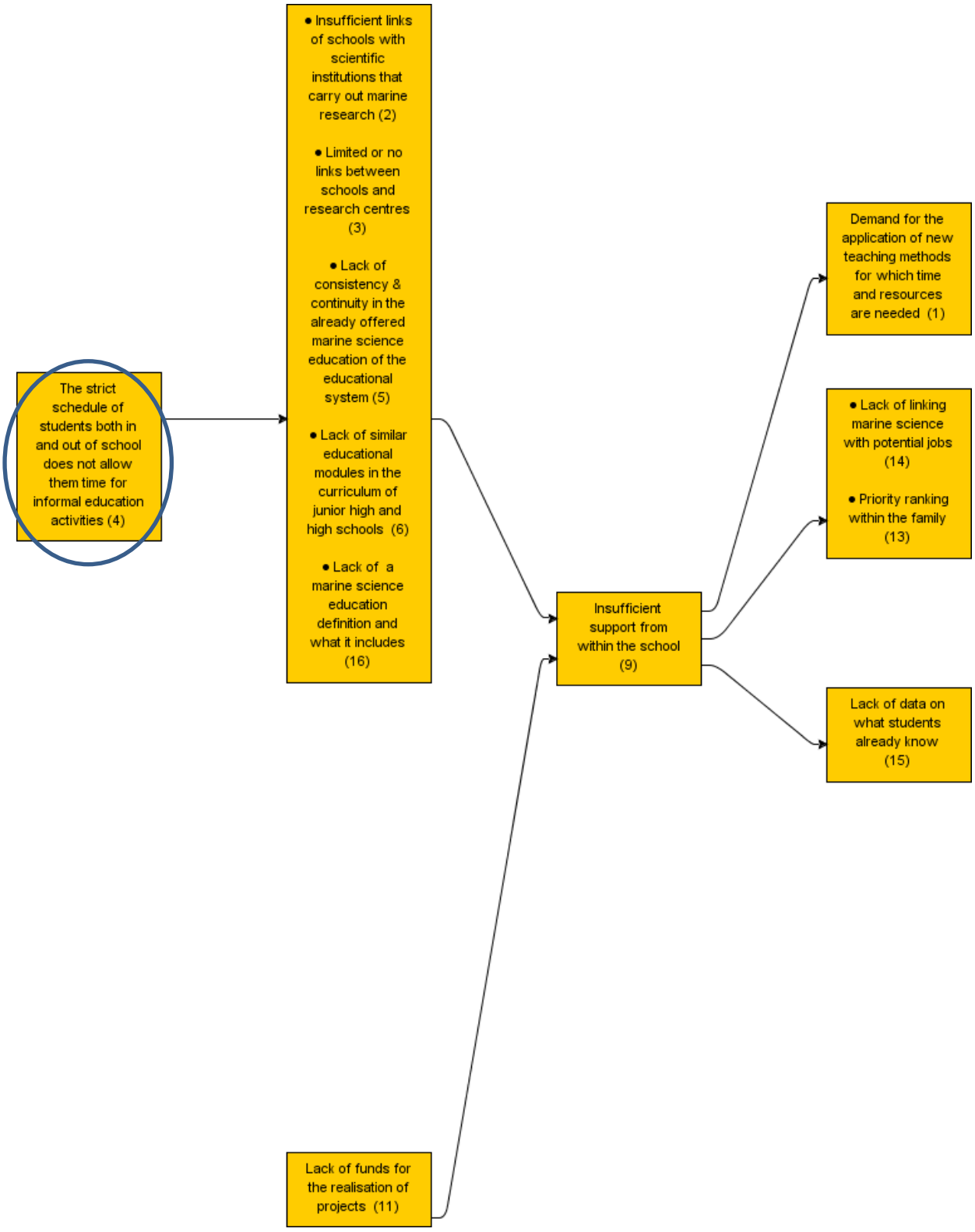

Fig. 38. Greece structural map (Curriculum barrier encircled).

Fig. 39. UK structural map (Curriculum barriers encircled).

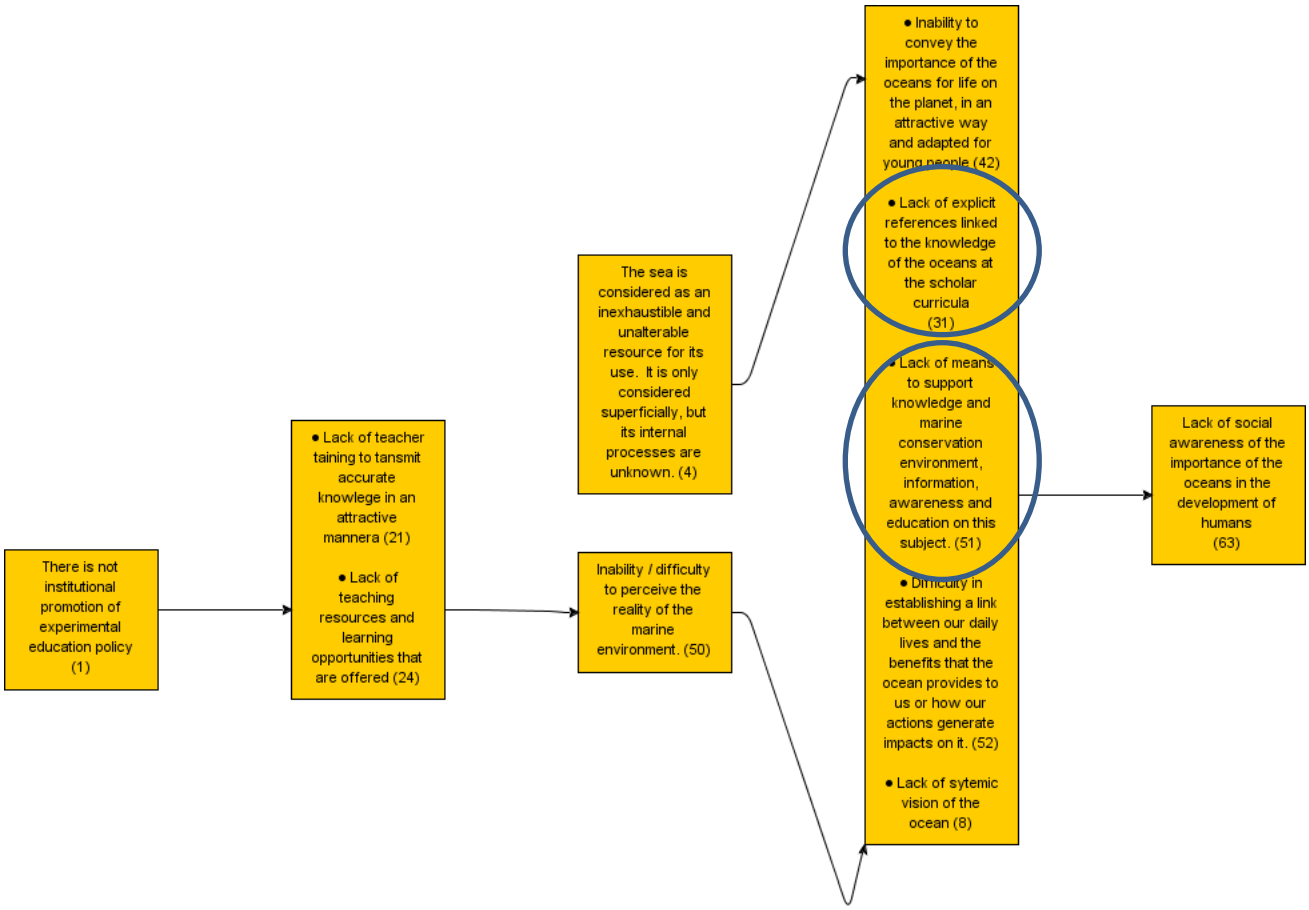

Fig. 40. Spain structural map (Curriculum barriers encircled).

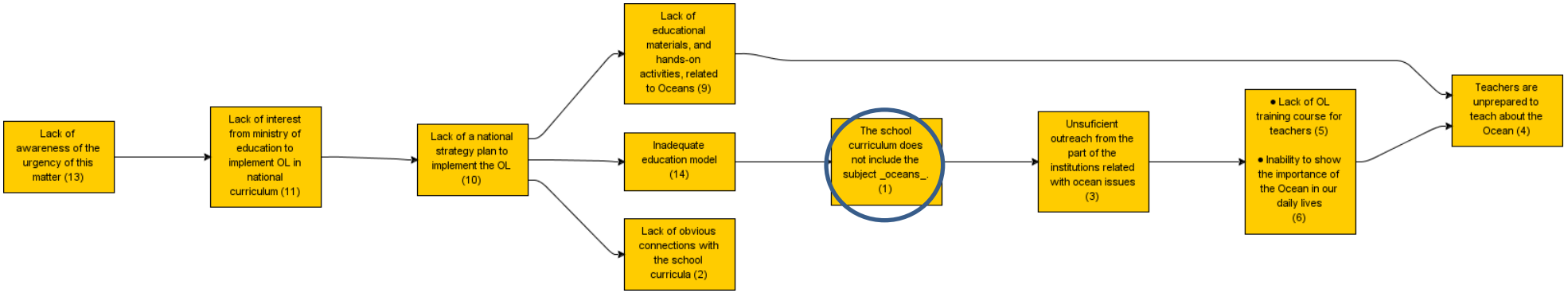

Fig. 41. Portugal structural map (Curriculum barrier encircled).

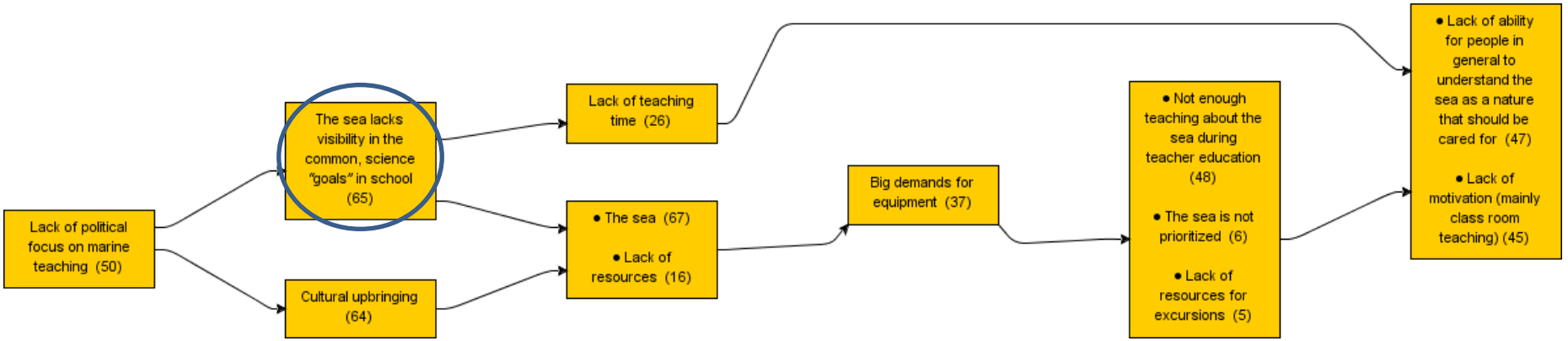

Fig. 42. Denmark structural map (Curriculum barrier encircled).

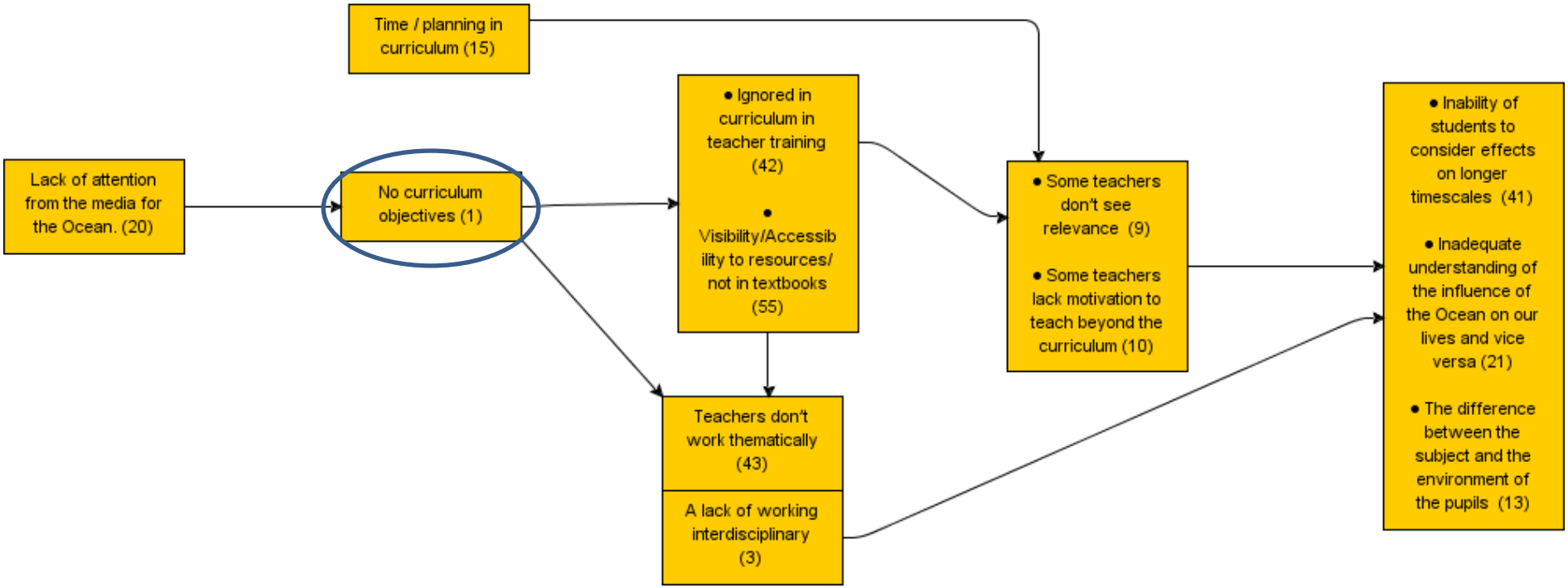

Fig. 43. Belgium structural map (Curriculum barrier encircled).

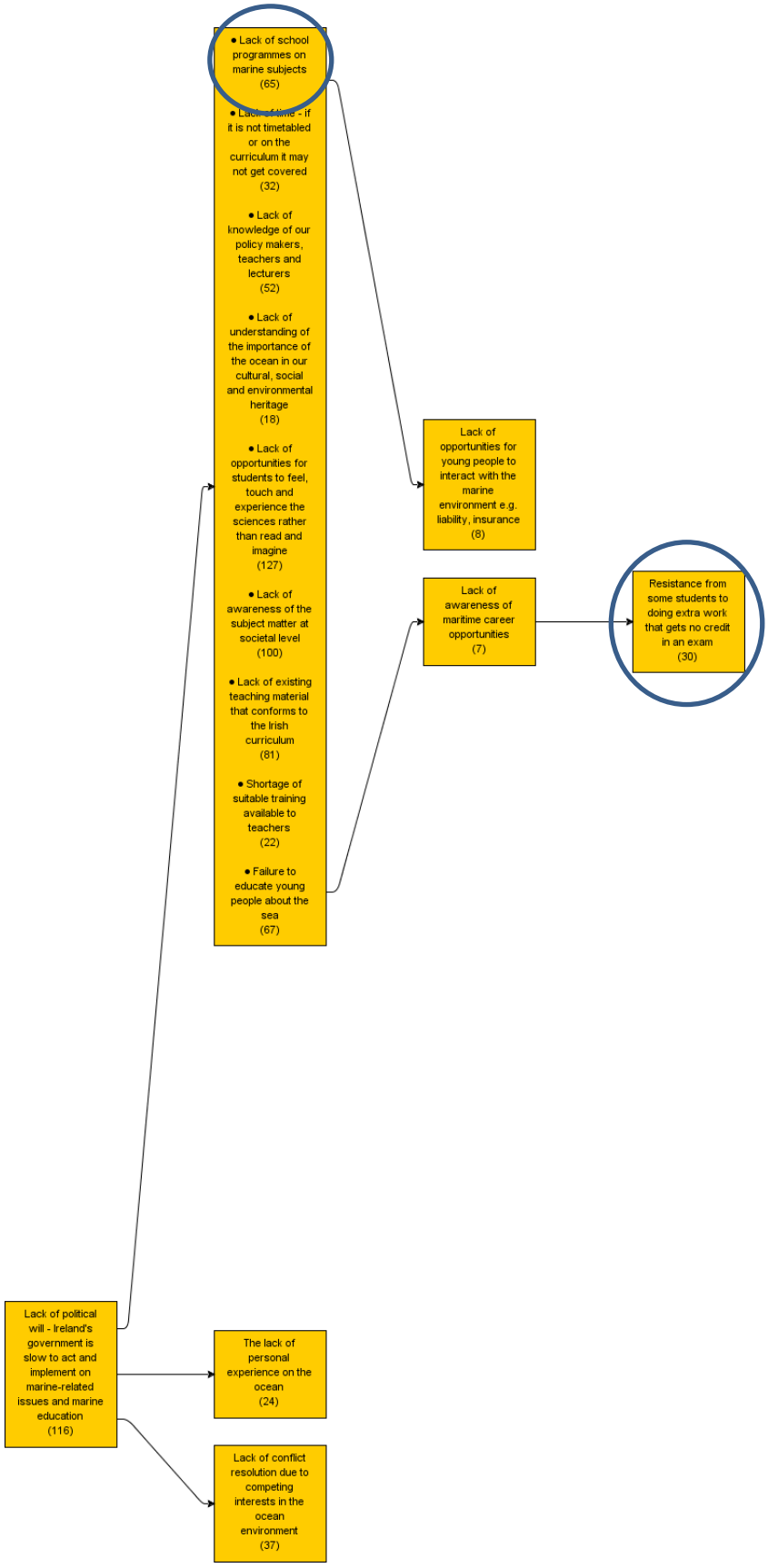

Fig. 44. Ireland structural map (Curriculum barrier encircled).

3.4.7. Time

A total of 30 Sea Change stakeholder barriers were placed within the Time category. These barriers relate to there not being enough time on the curriculum to include ocean subjects. The barriers within this category received 32 votes, making it the seventh most important category to the stakeholders (Appendix 3). Of these 30 barriers, five were chosen by the stakeholders in various consultations to be included in the structuring phase (Table 17).

Table 17. Structured barriers within the Time category

Lack of time – if it is not timetabled or on the curriculum it may not get covered
Time / planning in curriculum
A shortage of curricular time against competing monitored priorities is the single biggest obstacle in this sector. The only real solution for this would be at DFES level and a change to the named element of the national curriculum in particular the Environment Section
Lack of teaching time
Lack of data on what students already know

Time is located in stage 4 of the multistage influence map, which suggests that the majority of the structured Time barriers will also be found in the Centre or to the right of the individual structural maps. In the **UK** structural map, "A shortage of curricular time against competing monitored priorities is the single biggest obstacle in this sector. The only real solution for this would be at DFES level and a change to the named element of the national curriculum in particular the Environment Section" is located in stage 2 of the map (Fig. 45). As can be seen in the **Greek** structural map (Fig. 46) below "Lack of data on what students already know" is located at the end of the map (to the right). In the **Danish** structural map (Fig. 47) barrier "Lack of teaching time" is positioned in the Centre, which confirms the suggestion. While the **Belgian** structural map (Fig. 48), the barrier "Time / planning in curriculum" is positioned to the left. Finally, the **Irish** structural map (Fig. 49) and its barrier "Lack of time – if it is not timetabled or on the curriculum it may not get covered" was positioned in the Centre. This suggests the barrier is both a driver and receiver of influence.

None of the top voted for options are feasible and impactful for the Time category.

Fig. 45. UK structural map (Time barrier encircled).

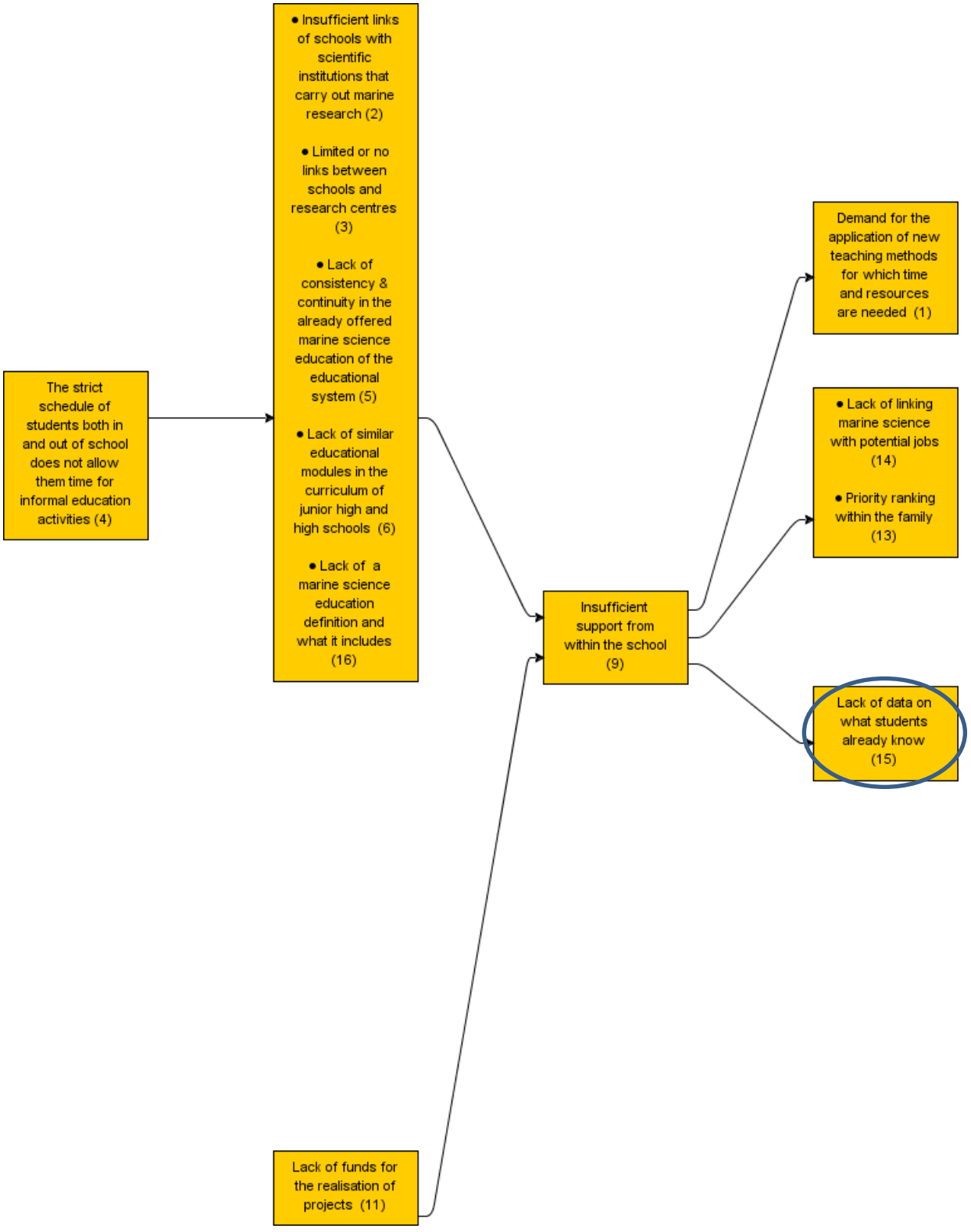

Fig. 46. Greece structural map (Time barrier encircled).

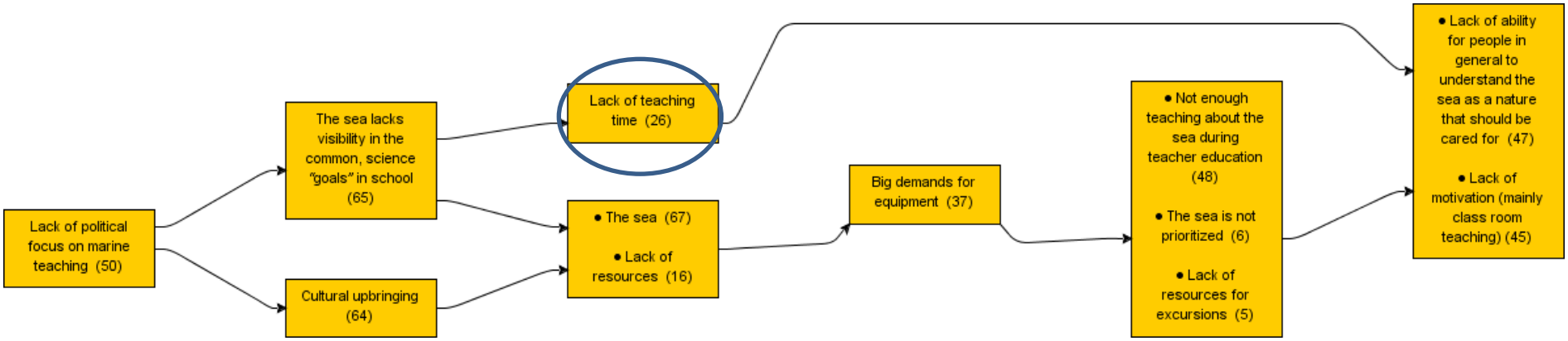

Fig. 47. Denmark structural map (Time barrier encircled).

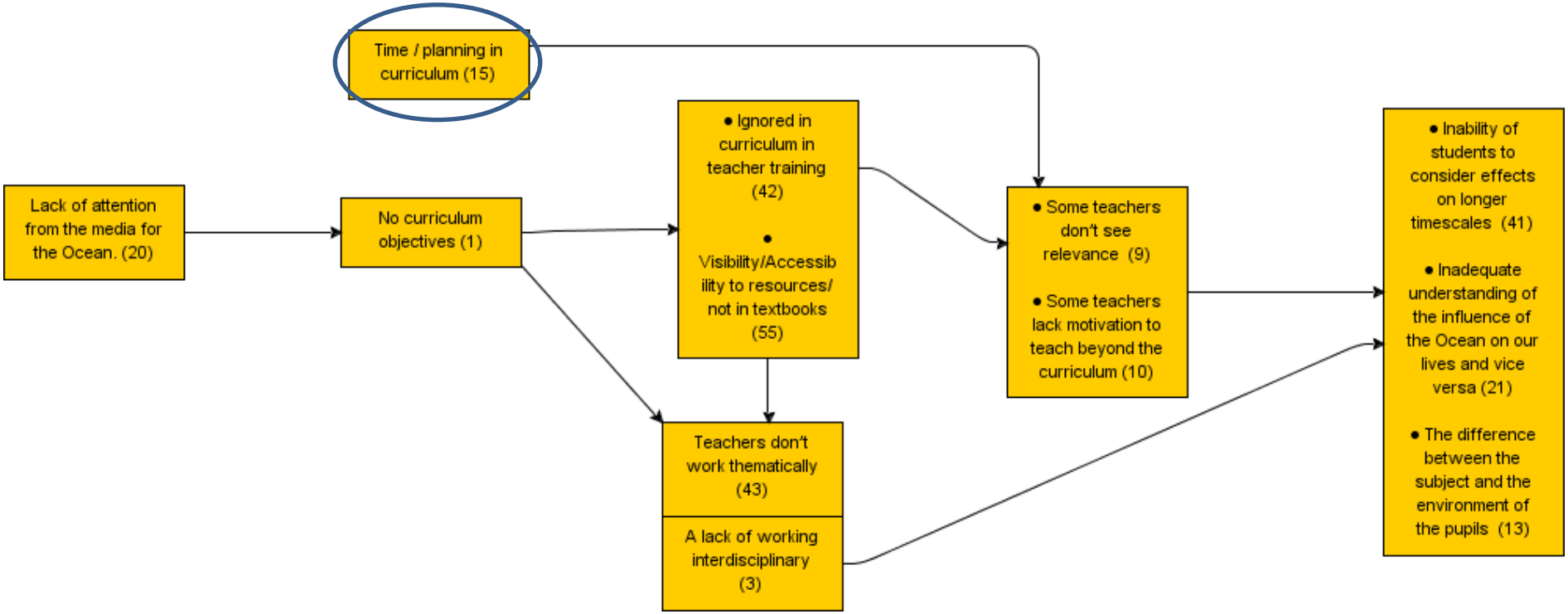

Fig. 48. Belgium structural map (Time barrier encircled).

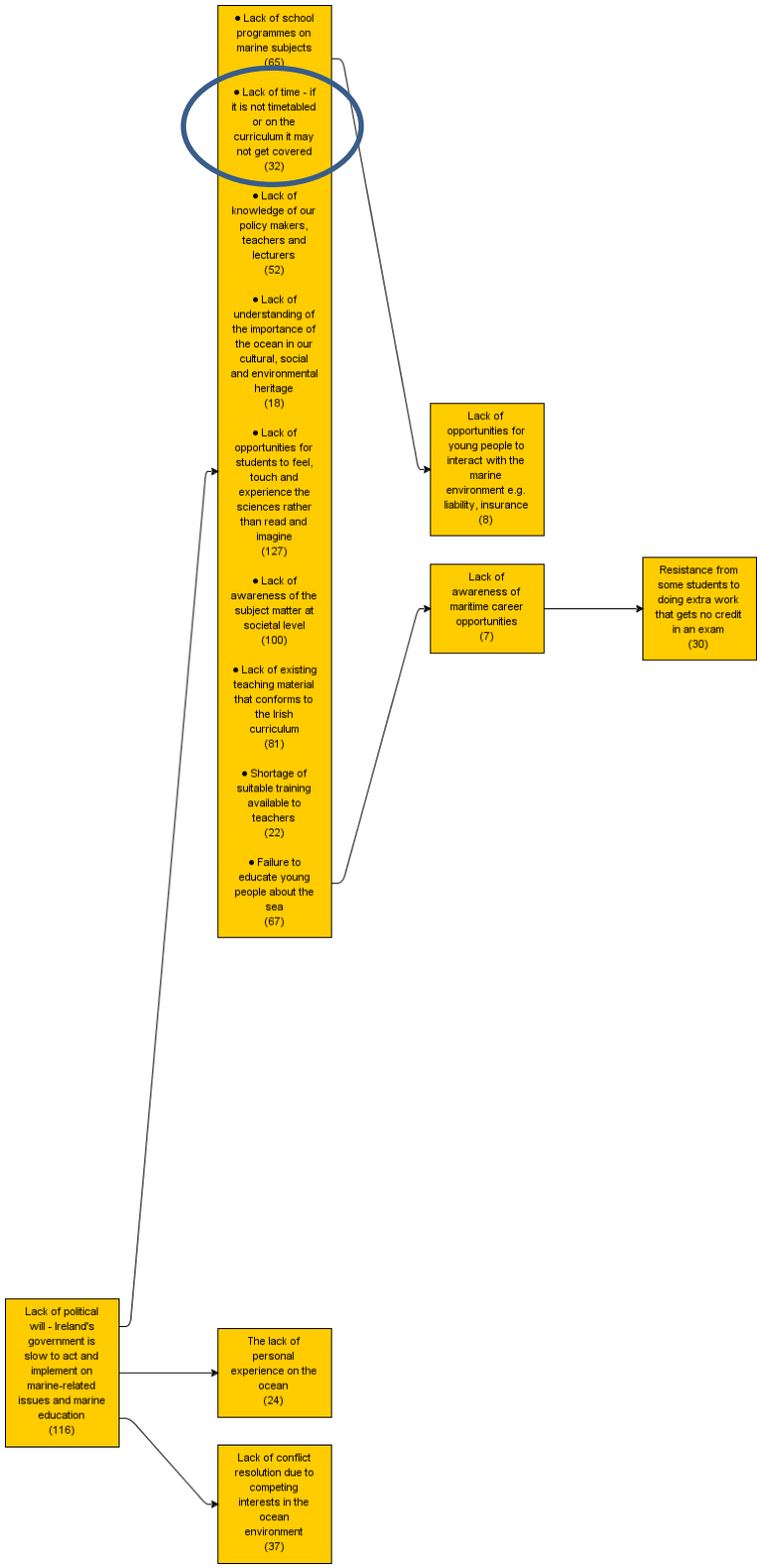

Fig. 49. Ireland structural map (Time barrier encircled).

3.4.8. Teaching material

A total of 36 Sea Change stakeholder barriers were placed within the Teaching material category. This category contained two subcategories: Needs to be improved; There isn't enough. These barriers relate to there not being enough teaching material on the ocean in schools and that existing teaching material needs to be improved. The barriers within this category received 6 votes (Appendix 3). Of these 36 barriers, three were chosen by the stakeholders in various consultations to be included in the structuring phase (Table 18).

Table 18. Structured barriers within the Teaching material category

Little visibility/accessibility to resources - not in textbooks
Lack of existing teaching material that conforms to the Irish curriculum
Lack of teacher resources and learning opportunities that are offered

Teaching material is located in stage 4 of the multistage influence map, which suggests that the majority of the structured Teaching material barriers will also be found in the Centre or to the right of the individual structural maps. In the **Spanish** structural map (Fig. 50), "Lack of teacher resources and learning opportunities that are offered" is located in stage 2 (to the left) of the map. As can be seen in the **Belgian** structural map (Fig. 51) "Little visibility/accessibility to resources - not in textbooks" is located in the Centre of the map, confirming the suggestion. In the **Irish** structural map (Fig. 52) "Lack of existing teaching material that conforms to the Irish curriculum" is positioned in stage 2 (out of 4). This suggests the barrier is both a driver and receiver of influence.

The most feasible and impactful Teaching material options can be seen below:

- Initial teacher graduation should include specific Ocean Literacy subjects and lifelong updating in (re)search skills, ability to adapt and create new tools, contents and activities (18 votes)
- Organize a platform to share educational materials with a forum to discuss ideas about the educational materials (11 votes)
- Change or incorporate aquatic education into relevant curricula e.g. history, geography, biology, chemistry etc. (10 votes)
- Evaluation of the already existing educational material with the aim of enriching it and/or creating new teaching methods in the framework of interactive educational teaching (10 votes)

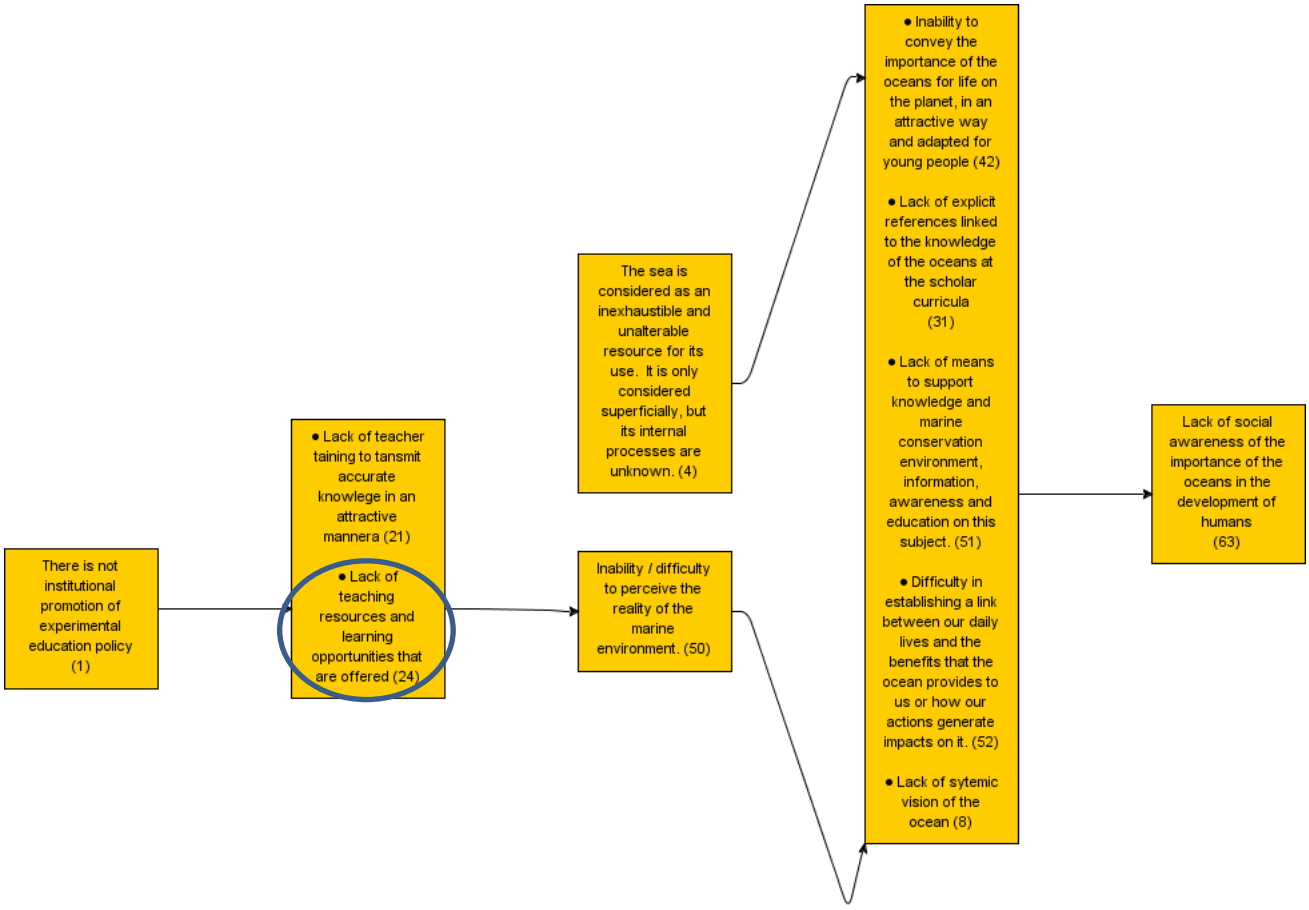

Fig. 50. Spain structural map (Teaching material barrier encircled).

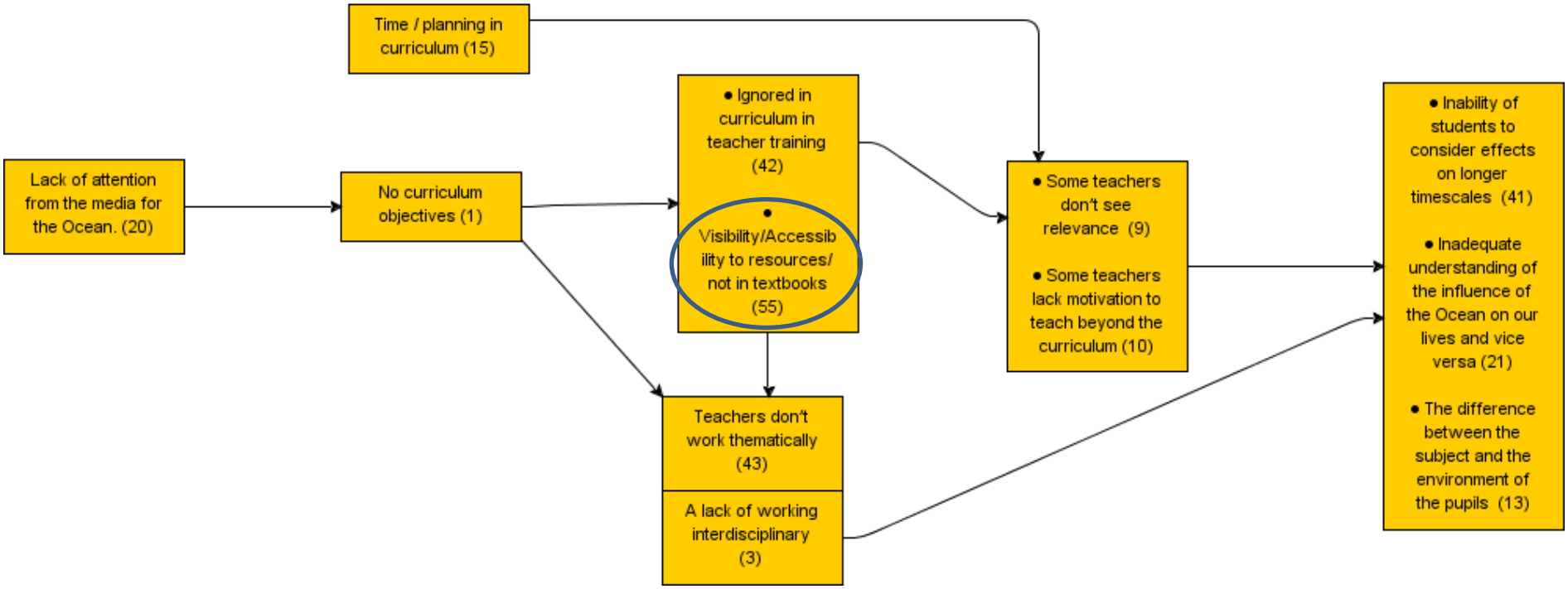

Fig. 51. Belgium structural map (Teaching material barrier encircled).

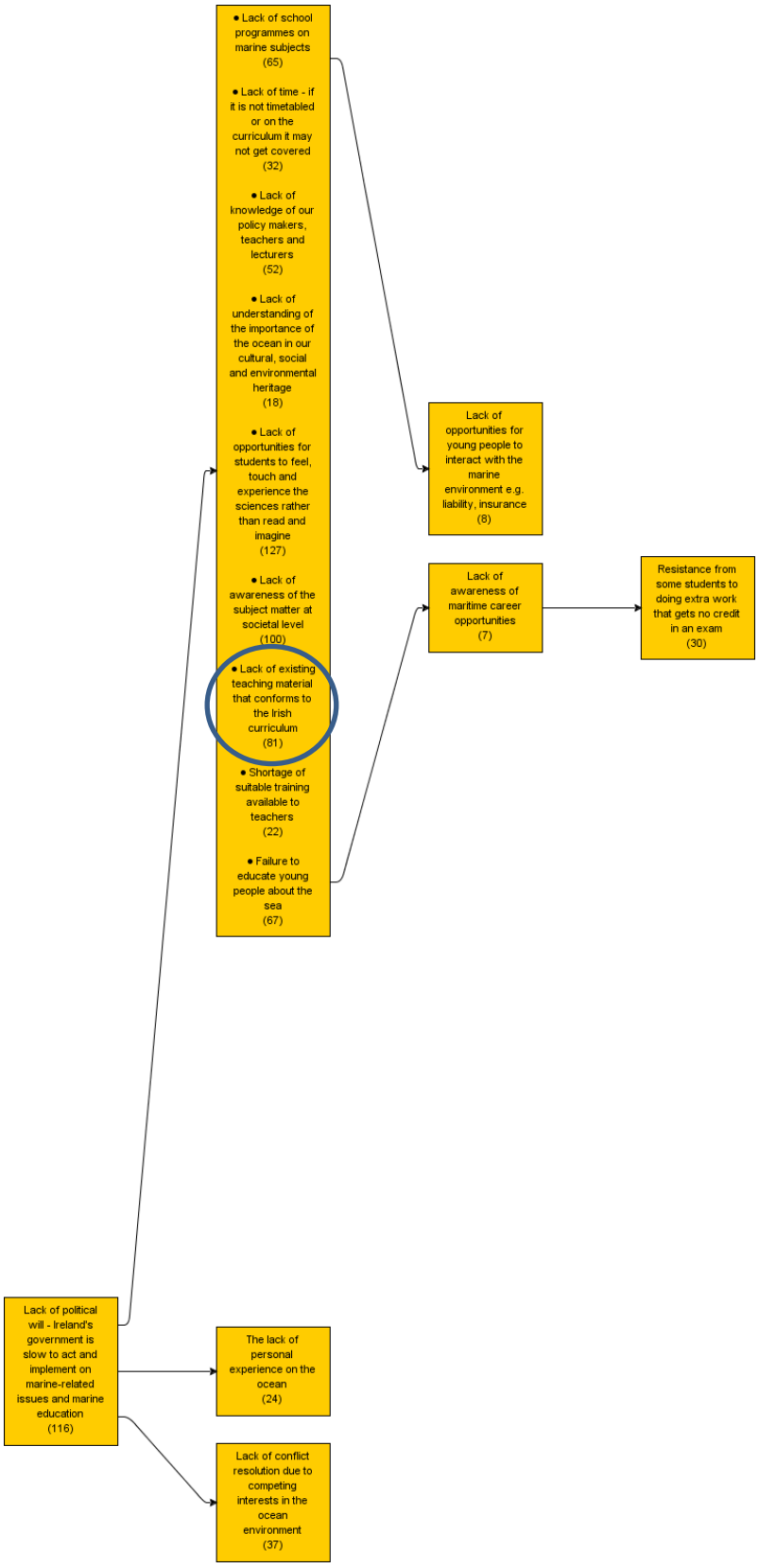

Fig. 52. Ireland structural map (Teaching material barrier encircled).

3.5. The Ocean itself

The Ocean itself appears in stage 4 of the influence map (Fig. 1). The barriers within this Ocean itself received an average influence score of 3.33 (Appendix 3), together with Formal education sector with an average influence score of 3.43, a difference of 0.10. Due to the similar average influence scores, both of these categories were placed in stage 4 of the influence map. The Ocean itself consists of two categories; Access and Complexity. Each of these two categories will be discussed in turn.

3.5.1. Access

A total of 30 Sea Change stakeholder barriers were placed within the Access category. This category contains two subcategories: Physical Location; Socioeconomic. The barriers within this category received a total vote score of 10, making it the fourteenth most important category to the stakeholders (Appendix 3). These barriers refer to access and how access to the ocean is affected by a person's physical location or due to socio-economic reasons. Of the 30 Access barriers that were generated, one was chosen by the stakeholders to be included in the structuring phase (Table 19).

Table 19. Structured barriers within the Access category

The sea (itself is a barrier)

Access is located in stage 4 of the multistage influence map suggesting that the majority of the structured Access barriers will also be found in the Centre or to the right of the individual structural maps. In the **Danish** structural map (Fig. 53), “The sea (itself is a barrier)” is located in the Centre of the map, confirming the suggestion.

None of the top voted for options are feasible and impactful for the Access category.

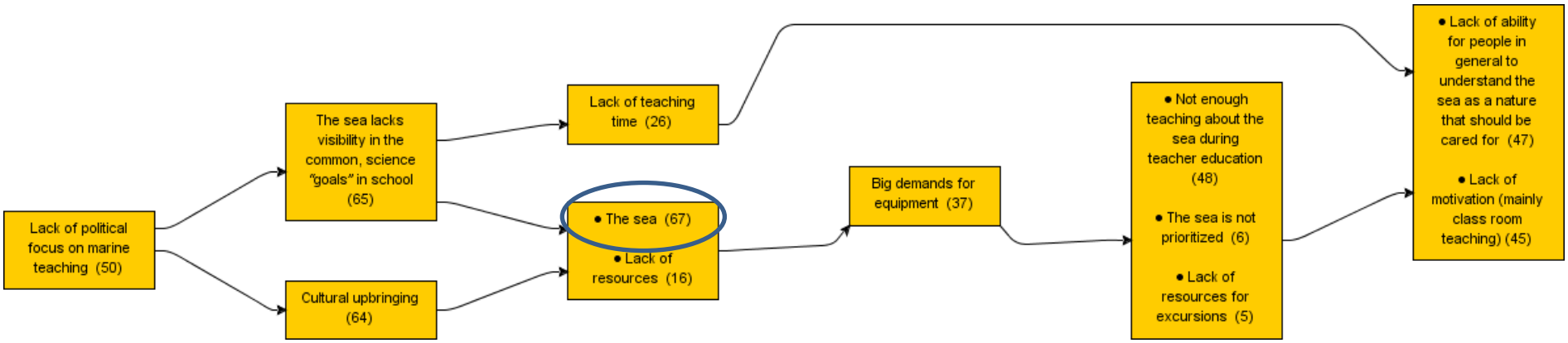

Fig. 53. Denmark structural map (Access barrier encircled).

3.5.2. Complexity

A total of 20 barriers were generated which were placed in the Complexity category. This category has two subcategories: invisibility; holistic. These barriers refer to the ocean being considered complex and that it is difficult to get an overview of it. The Complexity barriers received 14 votes from the stakeholders, making it the eleventh most important barrier (Appendix 3). Of the 20 Complexity barriers that were generated by the stakeholders, two were chosen by the stakeholders to be included in the structuring phase (Table 20).

Table 20. Structured barriers within the Complexity category

Lack of systemic vision of the ocean
Inability/difficulty to perceive the reality of the marine environment

Complexity is placed in stage 4 of the multistage influence map, which suggests that the majority of the structured Complexity barriers will also be found in the Centre or to the right of the individual structural maps. In the **Spanish** structural map (Fig. 54), "Lack of systemic vision of the ocean" and "Inability/difficulty to perceive the reality of the marine environment" are situated in the Centre and towards the right of the structural map, which confirms the suggestion.

The most feasible and impactful option for Complexity is:

- Educate in complexity fostering a change on the methodology (19 votes)

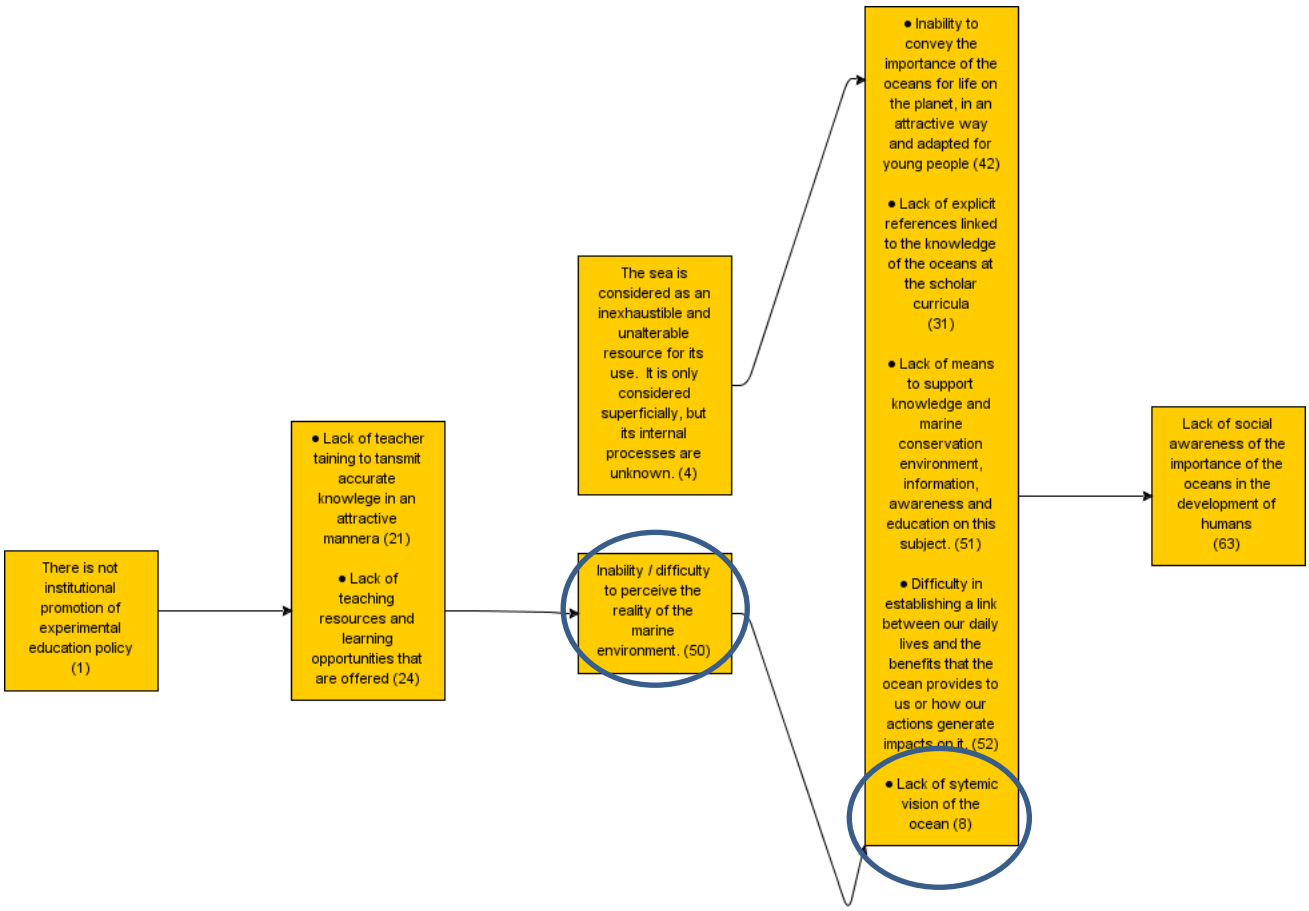

Fig. 54. Spain structural map (Complexity barriers encircled).

3.6. Collaboration

Collaboration is found in stage 5 of the influence map (Fig. 1), with an average influence score of 2.2 (Appendix 3). Collaboration is made up of three categories: External programmes, Informal education and Partnerships. Each of these categories will be discussed in detail.

3.6.1. External programmes

The barriers within External programmes refer to the number of external programmes on offer; which can be too many or too few, both imposing different obstacles. A total of 17 barriers were generated in relation to External programmes, the barriers within this category received a total voted score of 0 votes making it one of the least important category to the stakeholders (Appendix 3). Of the 17 barriers that were generated by the stakeholders in relation to External programmes, two were chosen by the stakeholders to be included in the structuring phase (Table 21).

Table 21. Structured barriers within the External programmes category

Insufficient outreach from the part of the institutions related with ocean issues
Competition and lack of clarity / coordination between providers

As External programmes is found in stage 5 of the influence map, we would expect to find the structured External programmes barriers to the right of the individual structural map. In the **UK** structural map (Fig. 55), the barrier “Competition and lack of clarity/coordination between providers” is situated in the final stage (to the right), which confirms the expectation. In the **Portuguese** structural map (Fig. 56), “Insufficient outreach from the part of the institutions related with ocean issues” is situated towards the right.

None of the top voted for options are feasible and impactful for the External programmes category.

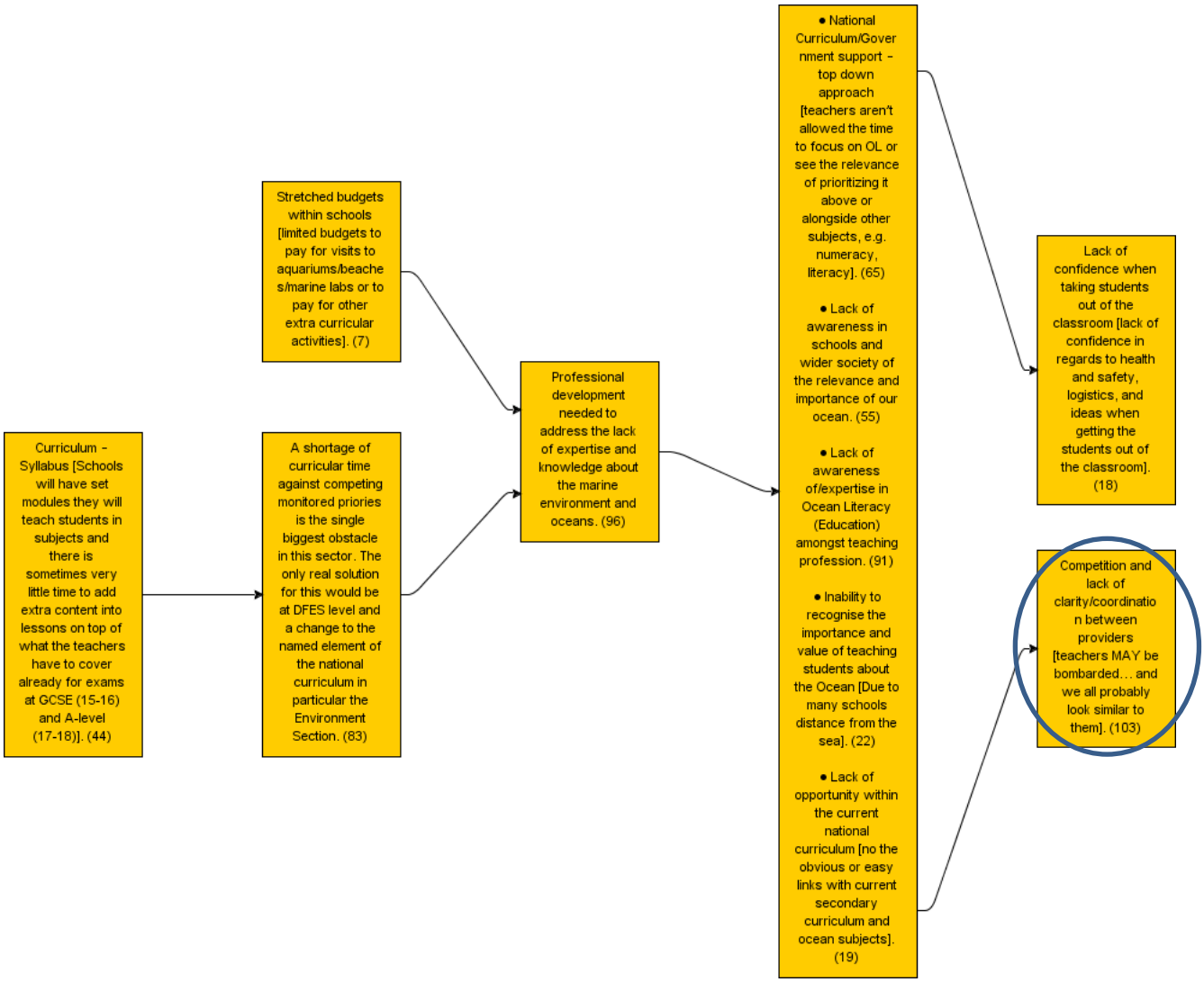

Fig. 55. UK structural map (External programmes barrier encircled).

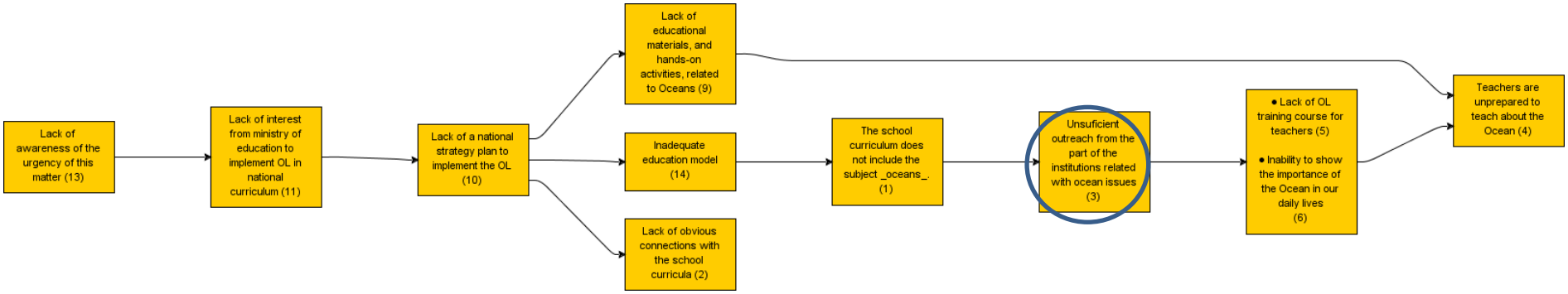

Fig. 56. Portugal structural map (External programmes barrier encircled)

3.6.2. Informal education

13 barriers were generated in the Informal education category. These barriers refer to a lack of marine activities and marine teaching centres. The barriers within this category received 0 votes (Appendix 3). Of the 13 barriers that were generated, one was selected to be included in the structuring (Table 22).

Table 22. Structured barriers within the Informal education category

Insufficient support from within the school

As Informal education is located in stage 5 of the influence map, it is likely to find the structured Informal education barriers to the right of the individual structural map. In the **Greek** structural map (Fig. 57), "Insufficient support from within the school" is situated towards the right, which confirms the expectation.

None of the top voted for options are feasible and impactful for the Informal education category.

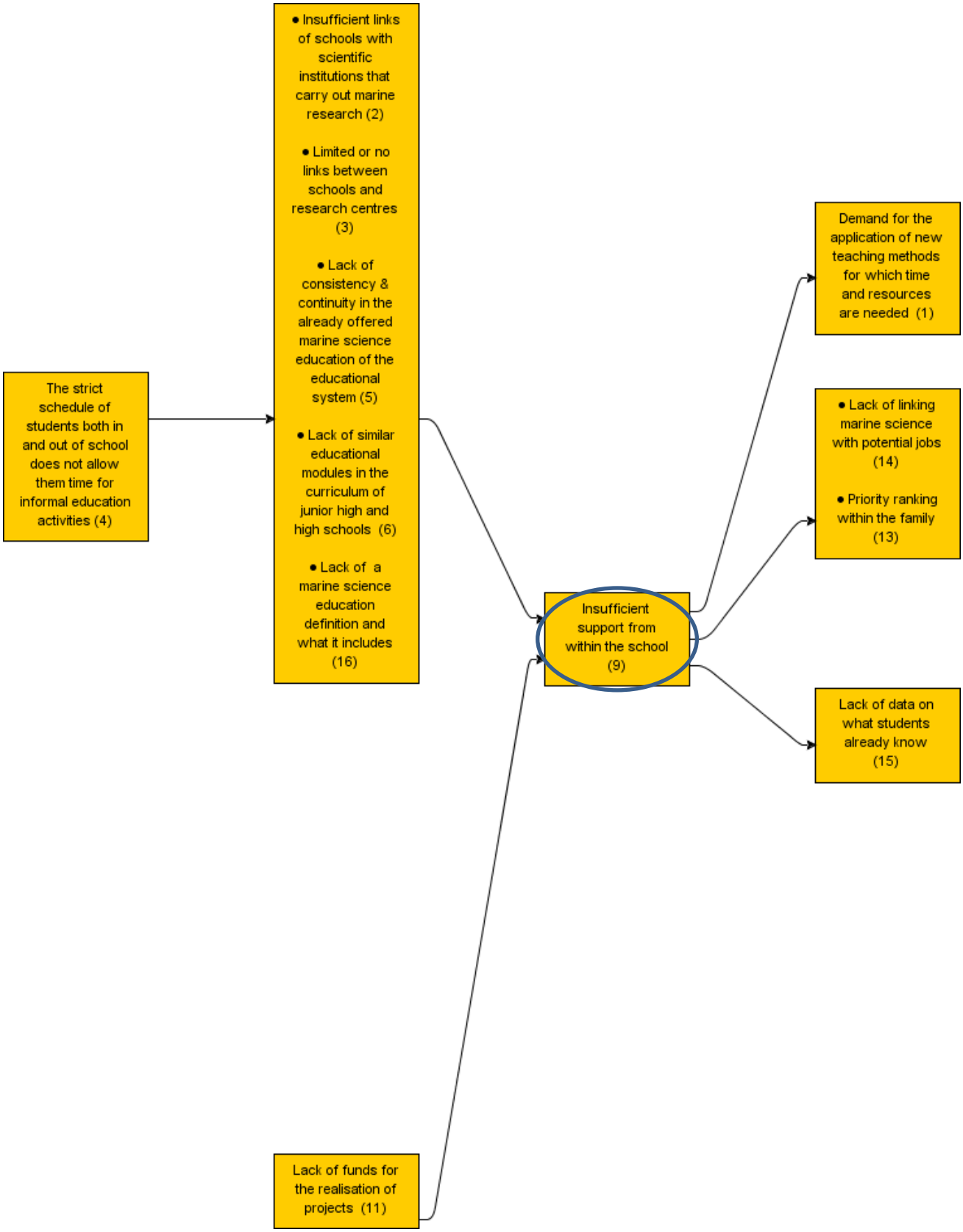

Fig. 57. Greece structural map (Informal education barrier encircled).

3.6.3. Partnerships

14 barriers were generated in the Partnerships category. These barriers relate to the disconnection between schools and scientific institutions. The barriers within this category also received 0 votes (Appendix 3). Of the 14 barriers that were generated, two were selected to be included in the structuring (Table 23).

Table 23. Structured barriers within the Partnerships category

Lack of funds for the realisation of projects
Lack of natural contact with researchers or non-profit organizations involved in maritime issues

As Partnerships is placed in stage 5 of the influence map, one would expect to find the structured Partnerships barriers to the right of the individual structural map. In the **Swedish** structural map (Fig. 58), "Lack of natural contact with researchers or non-profit organizations involved in maritime issues", is located towards the left. In the **Greek** structural map (Fig. 59), "Lack of funds for the realisation of projects" is also situated towards the left. This indicates that the barrier is more of a driver of influence.

The most feasible and impactful options to overcome the barriers within the Partnerships category are:

- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- Develop collaboration with other schools, universities and non-profit organisations (14 votes)
- Establish partnerships to jointly lobby govt. to change National Curriculum (13 votes)
- The institutions must have mandatory time and budget assigned to outreach projects about the ocean (12 votes)
- Design and development of a thematic educational program with the cooperation of HCMR, Universities, Environmental Education Centres and the Environmental Education Department of the Ministry of Education (10 votes)

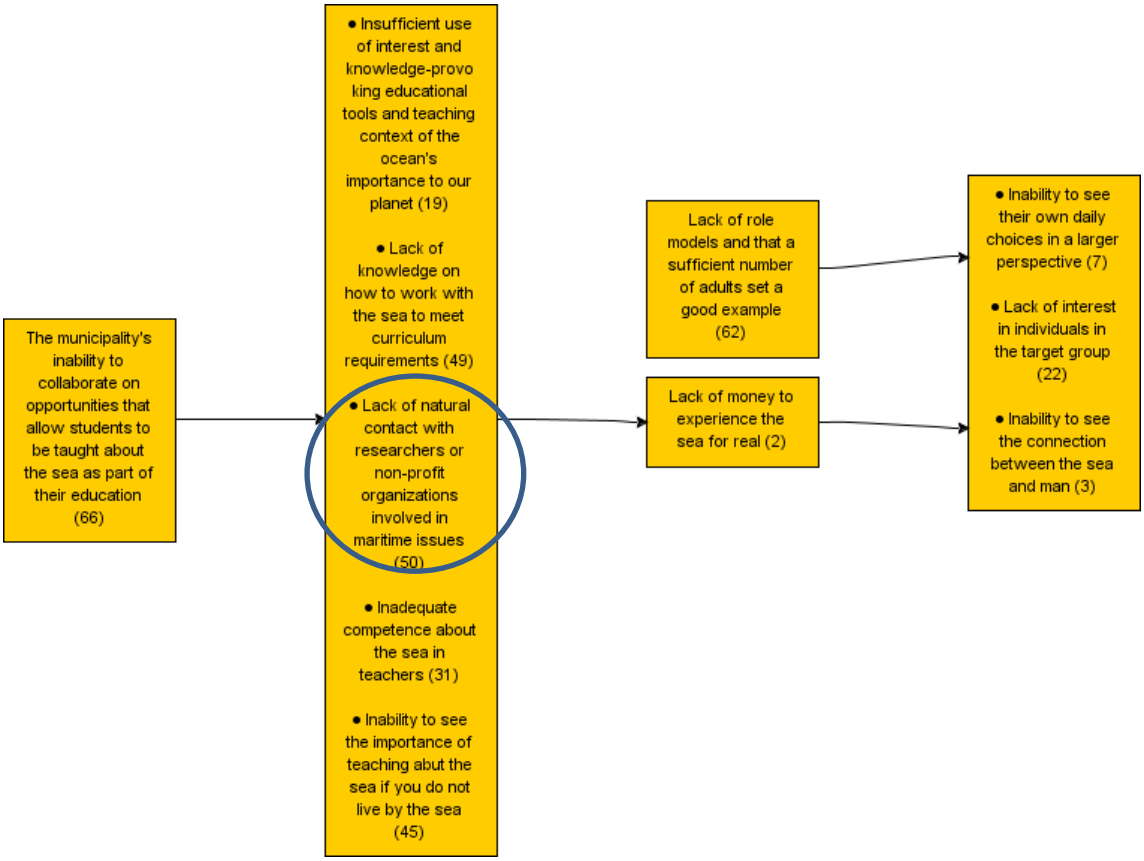

Fig. 58. Sweden structural map (Partnerships barrier encircled).

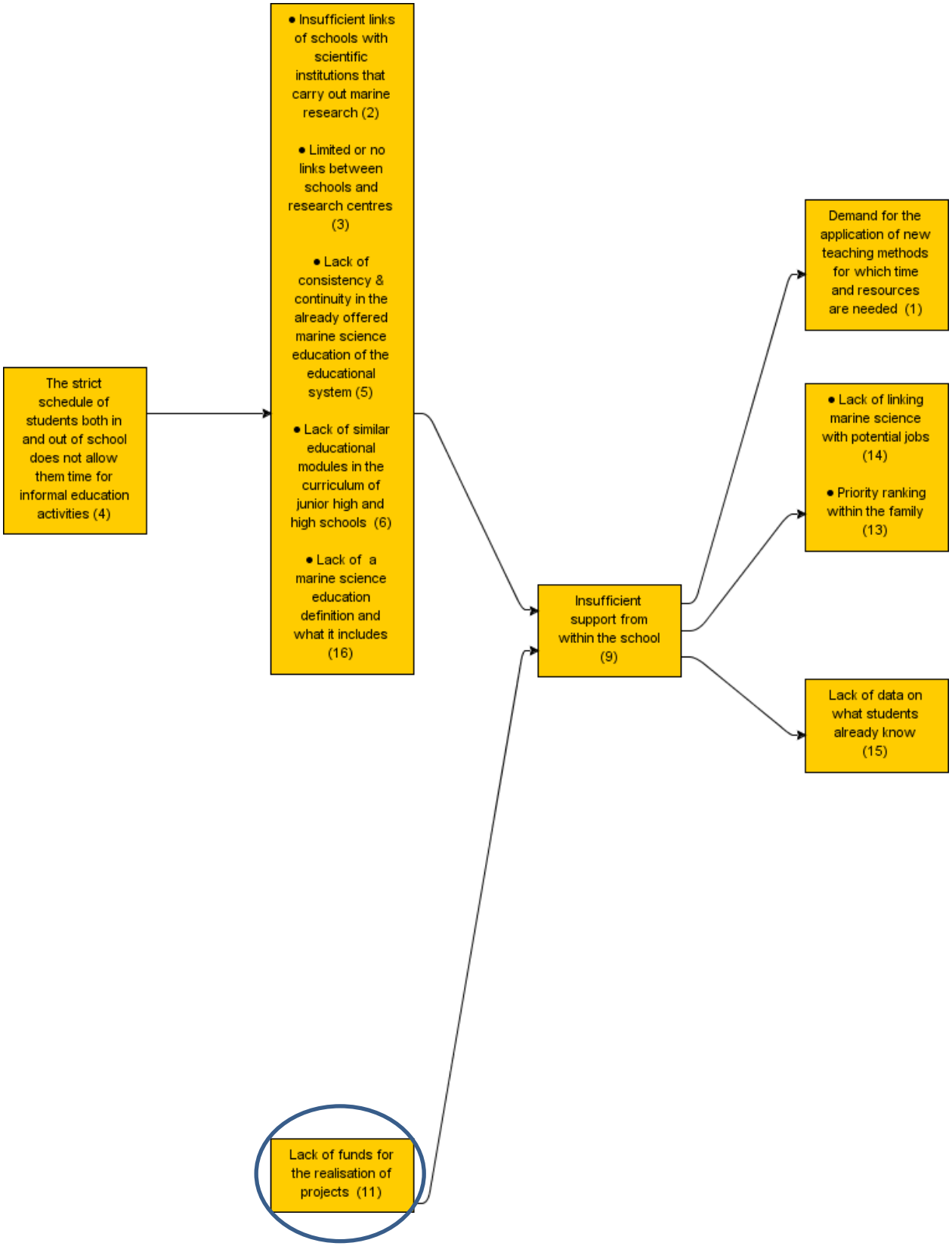

Fig. 59. Greece structural map (Partnerships barrier encircled).

3.7. Connections between humans and the ocean

Connections between humans and the ocean is in stage 6 of the influence map, together with Blue economy (Fig. 1). The barriers within this category received an average influence score of -2.5 (Appendix 3). A negative average influence score means that the category exerts no influence; therefore all of the barriers within the previous five stages influence these barriers. Connections between humans and the ocean is made up of three categories; Personal Experience; Culture; Everyday Life. Each of these three categories is discussed below.

3.7.1. Personal experience

A total of 13 stakeholder barriers were generated in relation to Personal experience. These barriers relate to lack of personal experiences of the ocean. The 13 barriers within the category received 15 votes, making it the ninth most important barrier by the stakeholders (Appendix 3). Of the 13 barriers that were generated in this category, two were chosen to be included in the structuring phase (Table 24).

Table 24. Structured barriers within the Personal experience category

The lack of personal experience on the ocean
Lack of ability for people in general to understand the sea as a nature that should be cared for

As Personal experience is positioned in the final stage of the influence map, it is expected to find the structured barriers in a similar position. In the **Danish** structural map (Fig. 60), "Lack of ability for people in general to understand the sea as a nature that should be cared for" is located in the final stage of the map. As can be seen in the **Irish** structural map (Fig. 61) "The lack of personal experience on the ocean" is located in the final stages and is more a receiver of influence.

The most feasible and impactful options to overcome the barriers in the Personal experience category are:

- Build a personal relationship with the sea through interactive learning where does the fish finger come from (16 votes)
- Use real examples to work with - the education should be connected to real projects (16 votes)
- Making World Ocean Day a community event / linking in with a national one day school event (15 votes)
- External teaching can make the class more alive (10 votes)

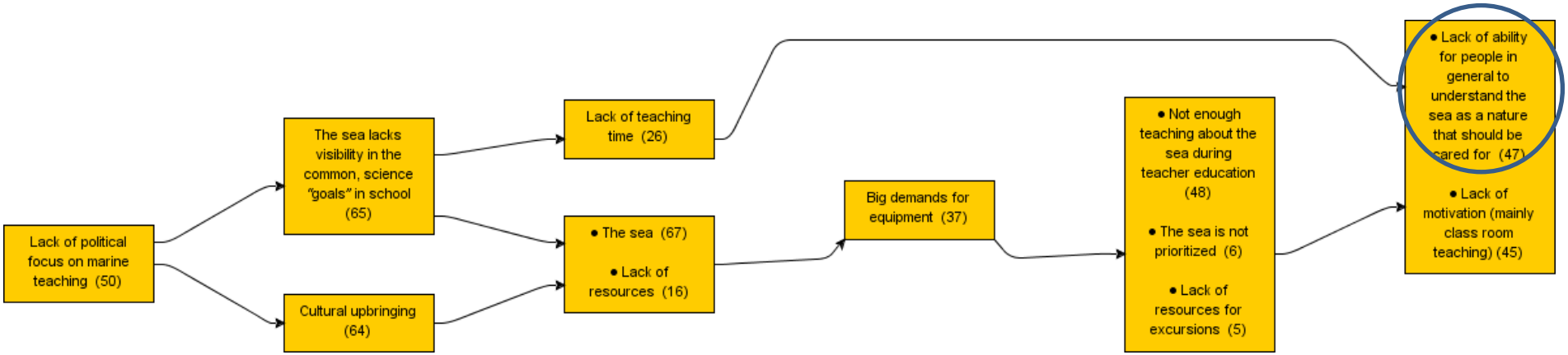

Fig. 60. Denmark structural map (Personal experience barrier encircled).

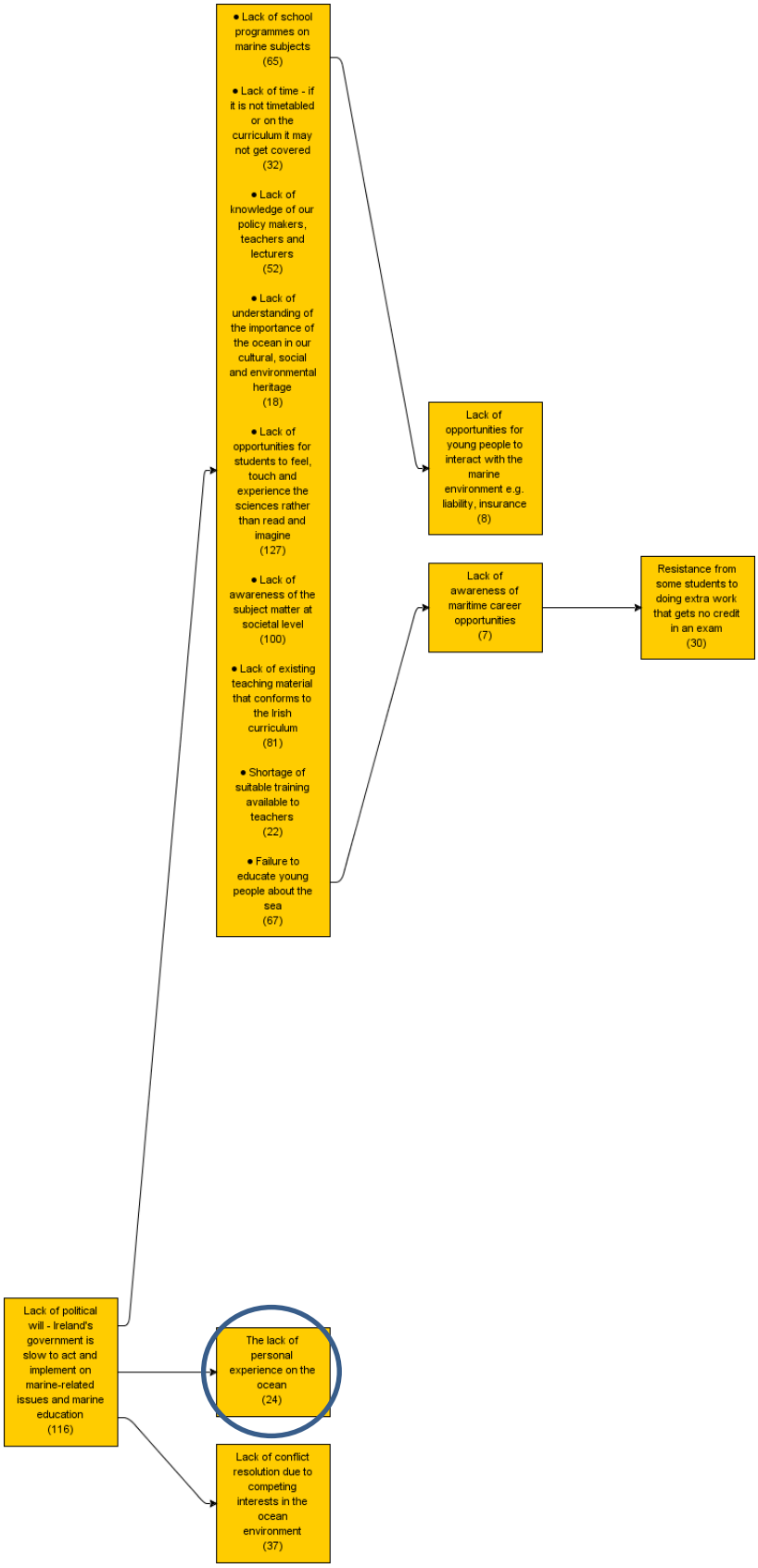

Fig. 61. Ireland structural map (Personal experience barrier encircled).

3.7.2.Culture

30 barriers were generated by the stakeholders in relation to Culture. These barriers refer to people not being able to understand the cultural and societal importance of the ocean. The barriers within this category received 48 votes, making it the fifth most import barrier by the stakeholders (Appendix 3). Of the 30 barriers that were generated in relation to Culture, nine were selected by the stakeholders to be included in the structuring (Table 25).

Table 25. Structured barriers within the Culture category

Failure to educate young people about the sea
Inability to see the connection between the sea and man
Lack of social awareness of the importance of the oceans in the development of humans
The sea is not prioritized
Lack of understanding of the importance of the ocean in our cultural, social and environmental heritage
Cultural upbringing
The difference between the subject and the environment of the pupils
Lack of awareness of the subject matter at societal level
Lack of awareness in schools and wider society of the relevance and importance of our ocean

The Culture category is found in the final stage of the influence map, thus it is expected to find structured barriers in a similar position. In the **UK** structural map (Fig. 62), “Lack of awareness in schools and wider society of the relevance and importance of our ocean” is located towards the right of the map. As can be seen in the **Spanish** structural map (Fig. 63) “Lack of social awareness of the importance of the oceans in the development of humans” is located in the final stage of the map. In the **Danish** structural map (Fig. 64), the barrier “Cultural upbringing” is located to the left, while barrier “The Sea is not prioritized” is located towards the right. In the **Belgian** structural map (Fig. 65), the barrier “The difference between the subject and the environment of the pupils” is positioned in the final stage of the map. This was also seen in the **Swedish** structural map (Fig. 66) with the barrier “Inability to see the connection between the sea and man”. The opposite was seen in the **Irish** structural map (Fig. 67) with the barriers “Lack of understanding of the importance of the ocean in our cultural, social and environmental heritage”, “ Lack of awareness of the subject matter at societal level” and “Failure to educate young people about the sea” all located in stage 2. This indicates that the barrier is both a driver and receiver of influence.

None of the top voted for options are feasible and impactful for the Culture category.

Fig. 62. UK structural map (Culture barrier encircled).

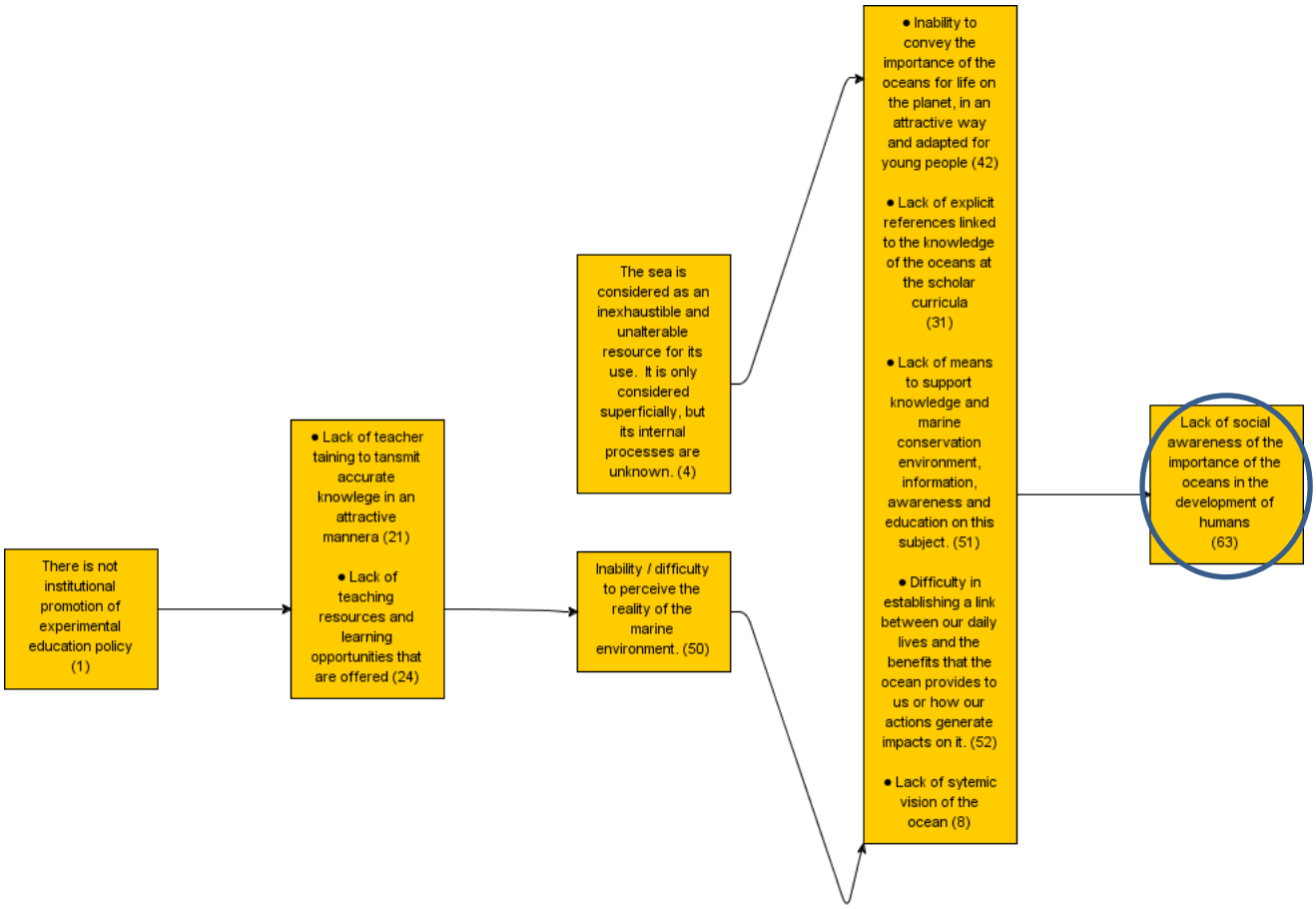

Fig. 63. Spain structural map (Culture barrier encircled).

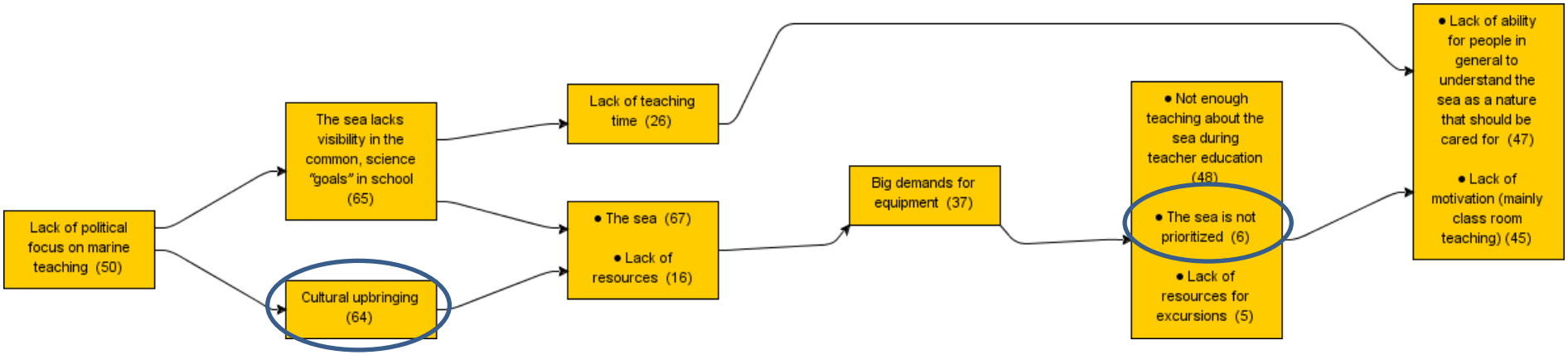

Fig. 64. Denmark structural map (Culture barrier encircled).

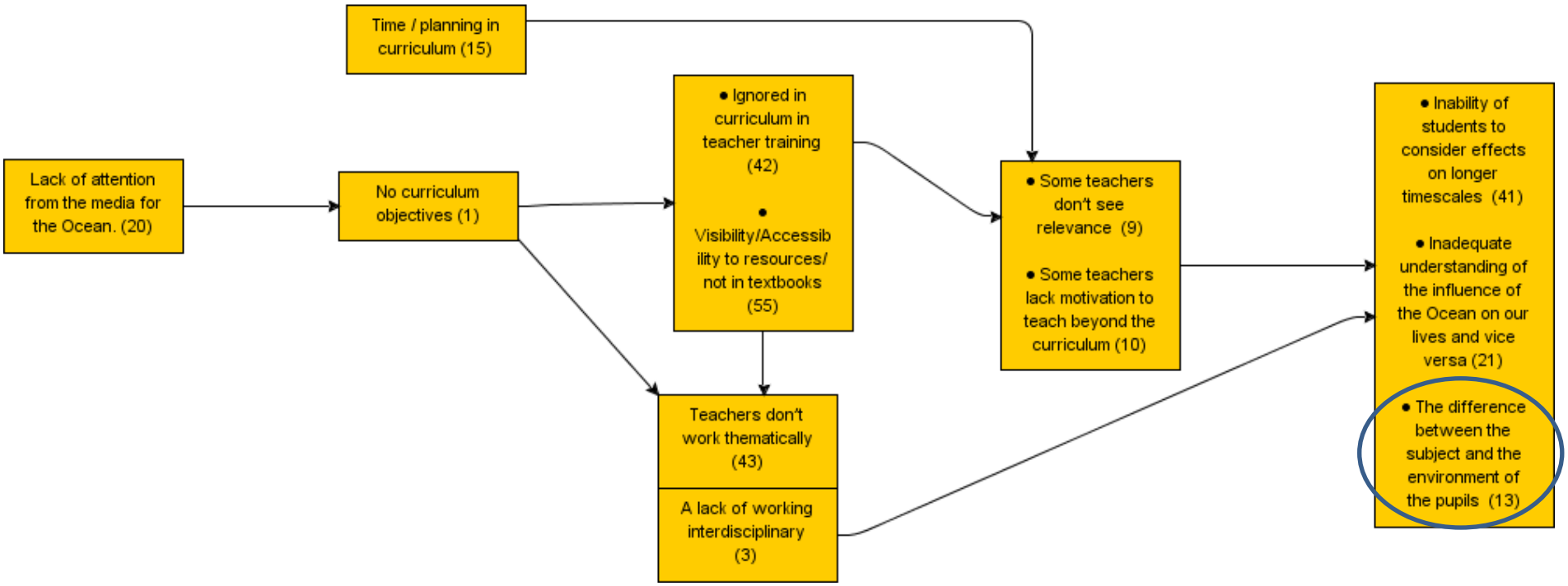

Fig. 65. Belgium structural map (Culture barrier encircled).

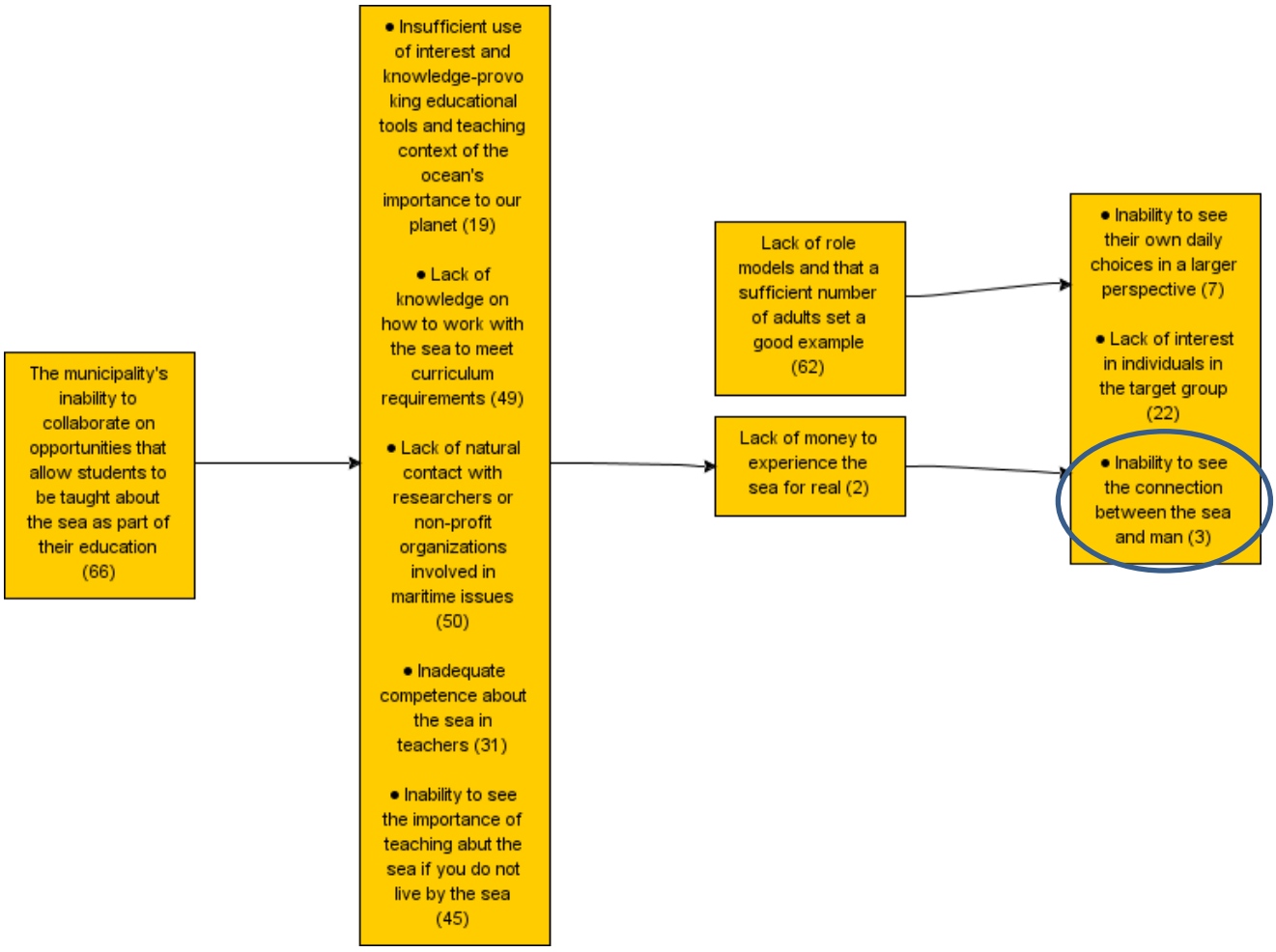

Fig. 66. Sweden structural map (Culture barrier encircled).

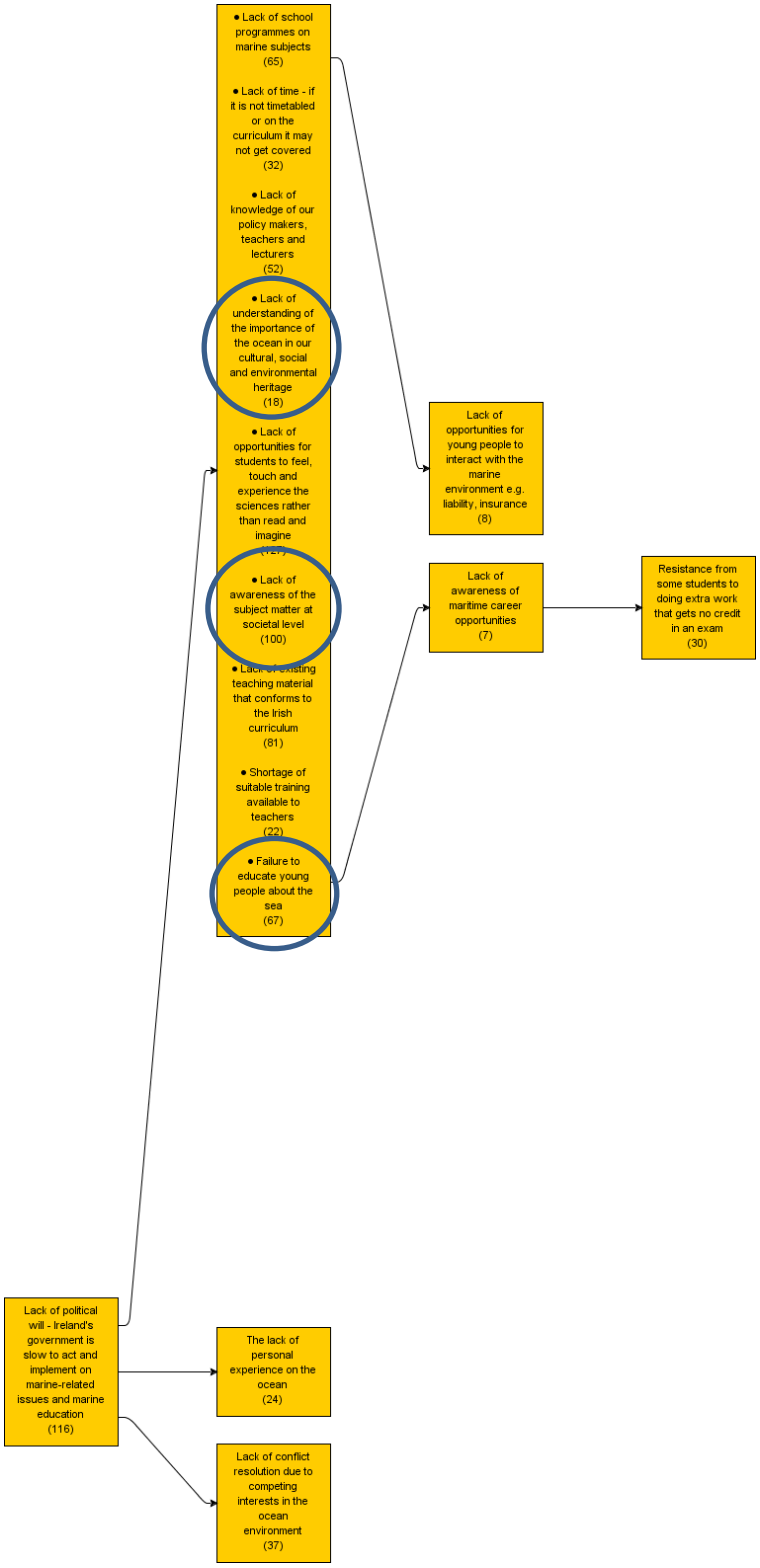

Fig. 67. Ireland structural map (Culture barriers encircled).

3.7.3. Everyday life

A total of 14 barriers were generated in relation to Everyday life. These barriers refer to people not being able to understand the importance of the ocean in our daily lives. The barriers within the Everyday life category received 36 votes, making it the sixth most important barrier by the stakeholders (Appendix 3). Of the 14 barriers that were generated in this category, five were selected by the stakeholders to be structured (Table 26).

Table 26. Structured barriers within the Everyday life category

Inability to show the importance of the ocean in our daily lives
Inability to see their own daily choices in a larger perspective
Difficulty in establishing a link between our daily lives and the benefits that the ocean provides us or how our actions generate impacts on it
Inability (of students) to consider longer timescales
Inadequate understanding of the influence of the ocean on our lives and vice versa

As the category Everyday life is situated in the final stage of the influence map, it is expected to find the structured barriers in a similar position. In the **Spanish** structural map (Fig. 68), "Difficulty in establishing a link between our daily lives and the benefits that the ocean provides us or how our actions generate impacts on it" is located towards the right of the map. As can be seen in the **Portuguese** structural map (Fig. 69) "Inability to show the importance of the ocean in our daily lives" is located towards the right of the map. In the **Belgian** structural map (Fig. 70), the barrier "Inability (of students) to consider longer timescales", "Inadequate understanding of the influence of the ocean on our lives and vice versa" is positioned in the final stage. This is also seen in the **Swedish** structural map (Fig. 71) where the barrier "Inability to see their own daily choices in a larger perspective" is also located in the final stage. The Everyday life barrier is mainly a receiver of influence.

None of the top voted for options are feasible and impactful for the Everyday life category.

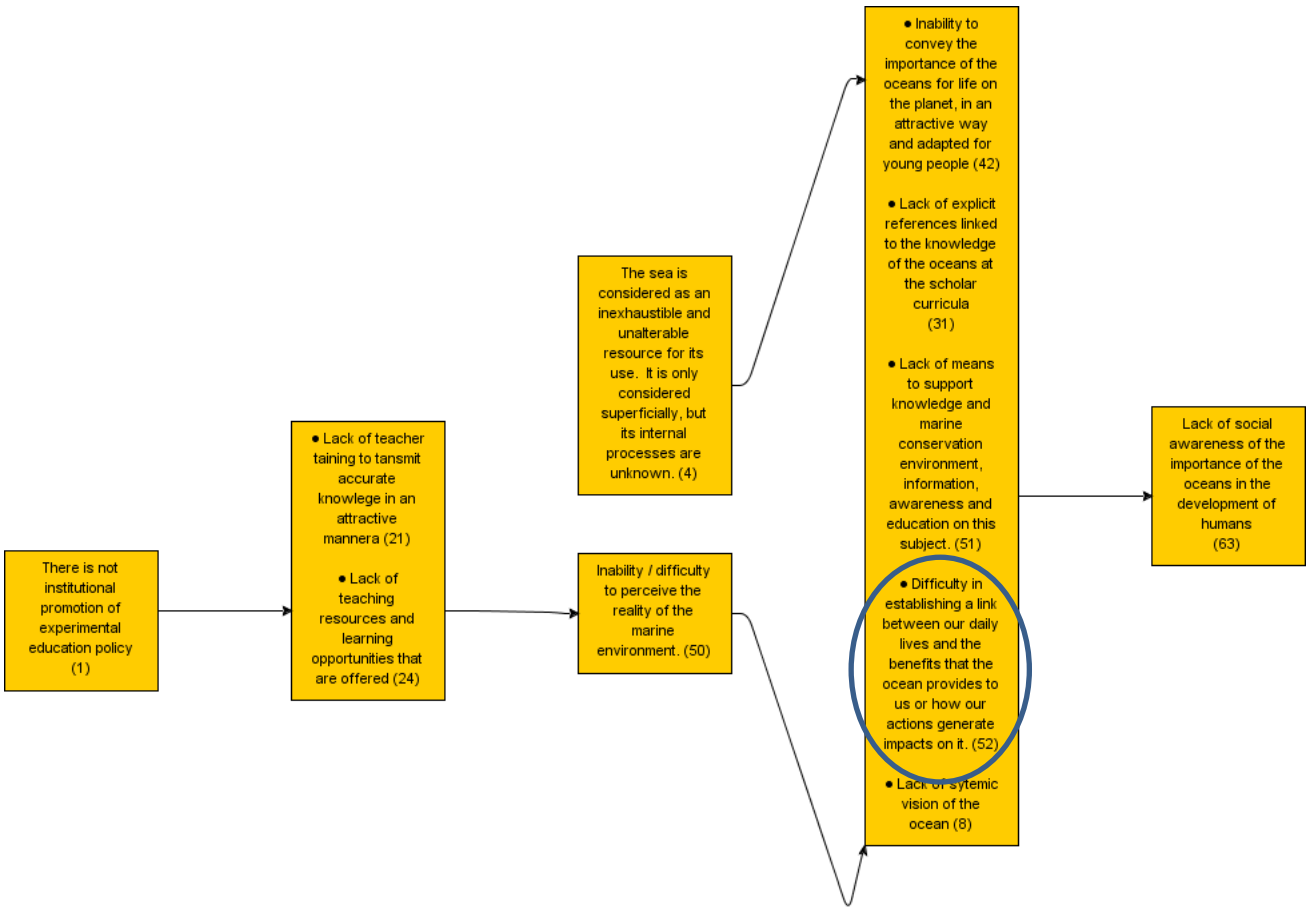

Fig. 68. Spain structural map (Everyday life barrier encircled).

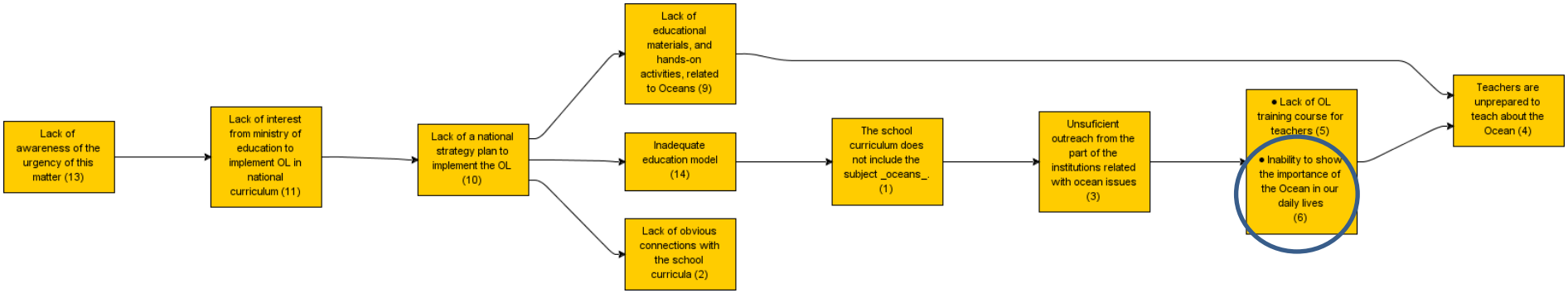

Fig. 69. Portugal structural map (Everyday life barrier encircled).

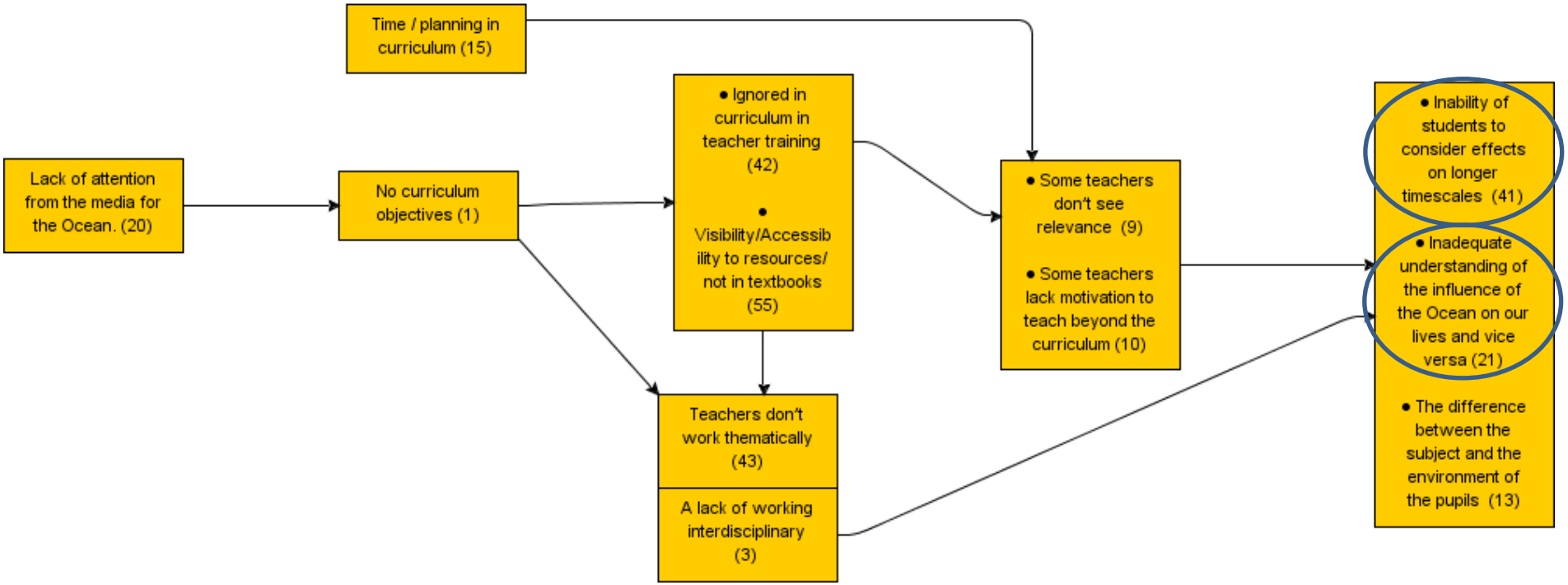

Fig. 70. Belgium structural map (Everyday life barriers encircled).

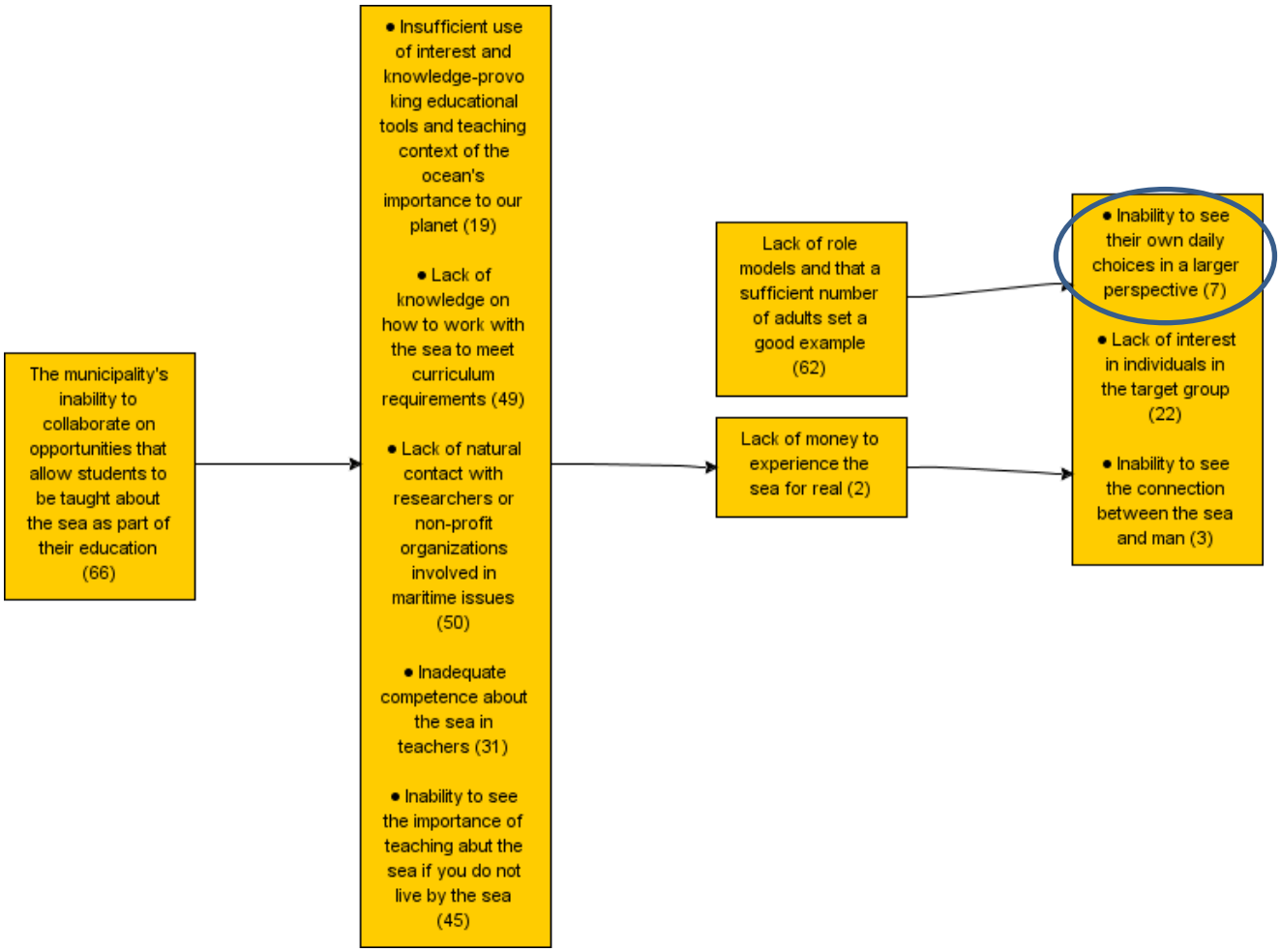

Fig. 71. Sweden structural map (Everyday life barrier encircled).

3.8. Blue economy

Blue economy is positioned in the final stage of the influence map, which is stage 6, together with Connections between humans and the ocean, and is the final high-order category (Fig. 1). The barriers within this higher-order category received an average influence score of -3.0 (Appendix 3). A negative average influence score means that the category exerts no influence; therefore all of the barriers within the previous five stages influence these barriers. There are two categories within the Blue economy higher-order barrier themes; Mareer (Marine career) and Industry. Each of these categories will now be discussed.

3.8.1. Mareer (Marine career)

The Mareer category has two sub-categories; Career prospects and Educators. These barriers relate to lack of awareness of marine career prospects and lack of marine educators. A total of 19 barriers were generated in the Mareer category. The barriers within this category received 0 votes (Appendix 3). Of the 19 barriers that were generated in relation to Mareer, two were selected to be structured by the stakeholders (Table 27).

Table 27. Structured barriers within the Mareer category

Lack of awareness of maritime career opportunities
Inadequate competence about the sea in teachers

Mareer is found in stage 6 of the influence map and it is expected to find the structured barriers in the final stage of the structural maps. One Mareer barrier was selected by the **Swedish** stakeholders to be included in the structuring. “Inadequate competence about the sea in teachers” and is situated in the second stage (towards the left) of the map (Fig. 72). The Mareer barrier chosen by the **Irish** stakeholders to be included in the structuring “Lack of awareness of maritime career opportunities” is situated towards the right of the structural map (Fig. 73). This suggests that the Mareer barrier is both a driver and receiver of influence.

The options that are the most feasible and impactful in response to the Mareer barriers are:

- Certificate for T.Y. students from National Governing Body (NGB) in Ocean Literacy. This should lead on to more work experience in the maritime industries (11 votes)
- Design vocational workshops to inform and educate youth on sea-related jobs (8 votes)

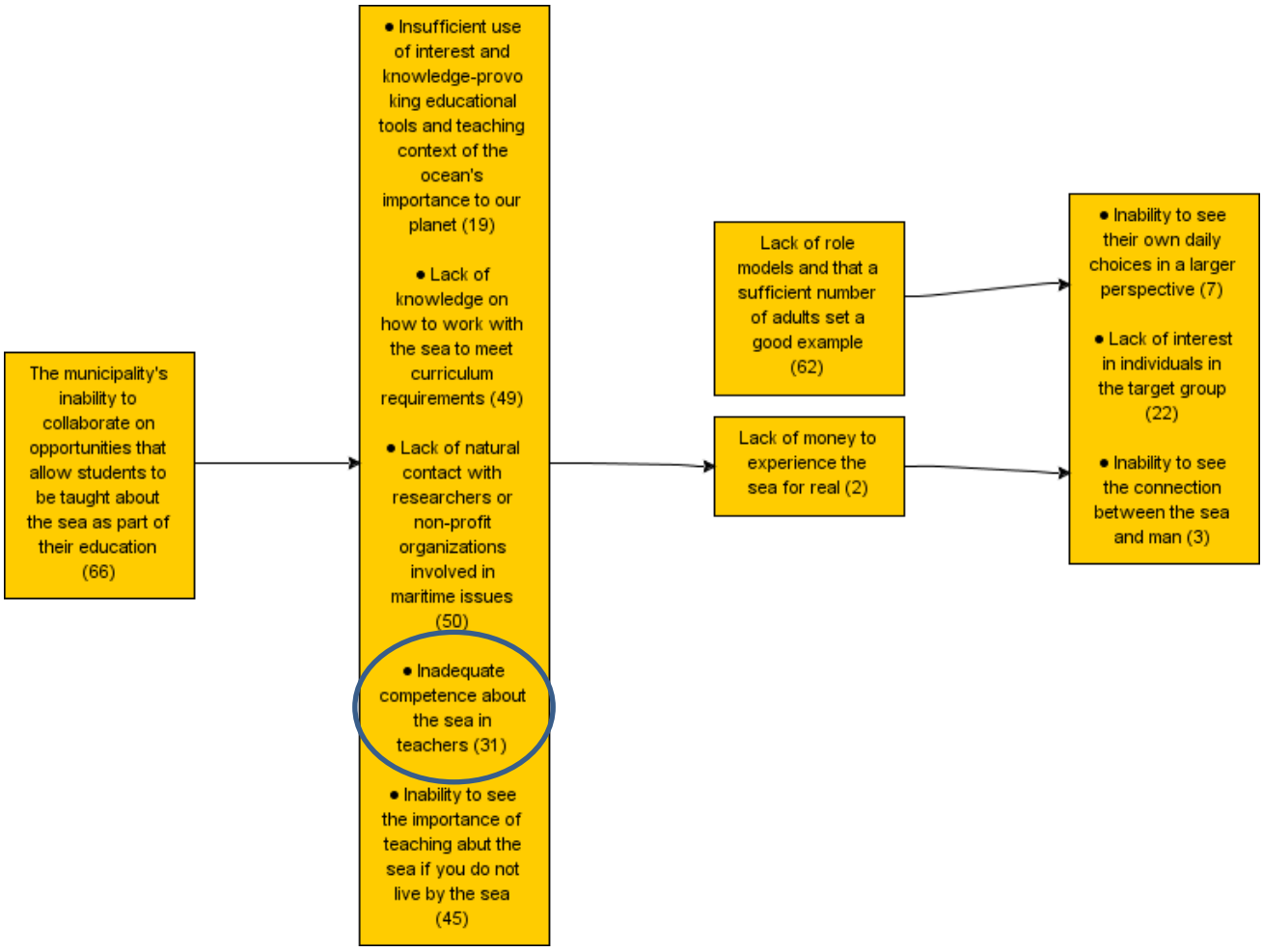

Fig. 72. Sweden structural map (Mareer barrier encircled).

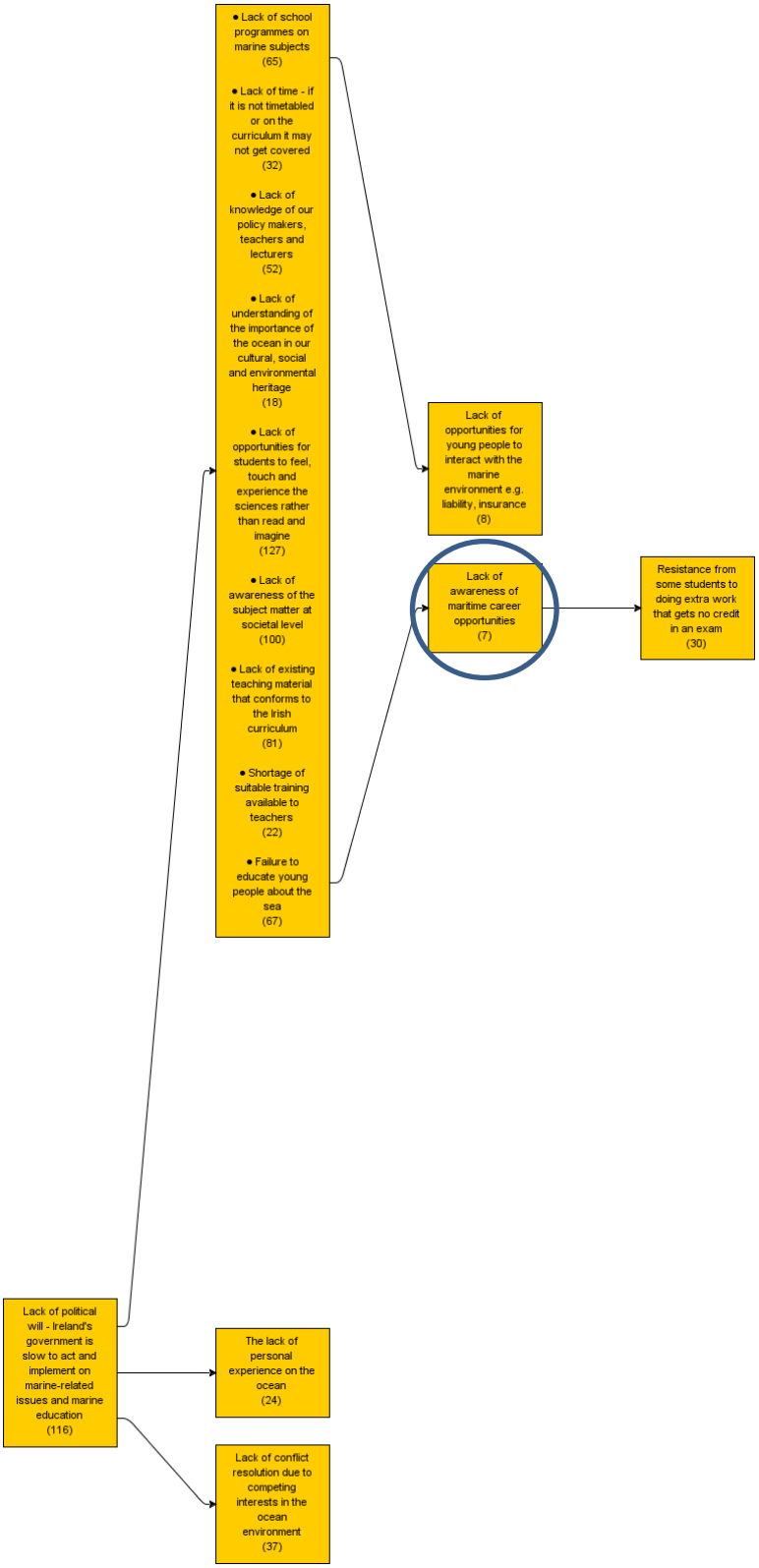

Fig. 73. Ireland structural map (Mareer barrier encircled).

3.8.2. Industry

The barriers within the Industry category state that competing interests in the ocean environment require an understanding of mediation for conflict resolution. A total of 15 barriers were generated in relation to Industry. The Industry barriers received 11 votes, making it the twelfth most important category (Appendix 3). While this category was seen as relatively important to the stakeholders, it has no influence. Of the 15 barriers that were structured, 1 was selected by the stakeholders to be structured (Table 28).

Table 28. Structured barriers within the Industry category

Lack of conflict resolution due to competing interests in the ocean environment

The category Industry is located in stage 6 of the influence map. This means structured barriers is expected to be found in the final stage of the individual structural maps. One Industry barrier was selected by the **Irish** stakeholders to be included in the structuring. “Lack of conflict resolution due to competing interests in the ocean environment” is situated in the final stage of the map (Fig. 74).

None of the top voted for options are feasible and impactful for the Industry category.

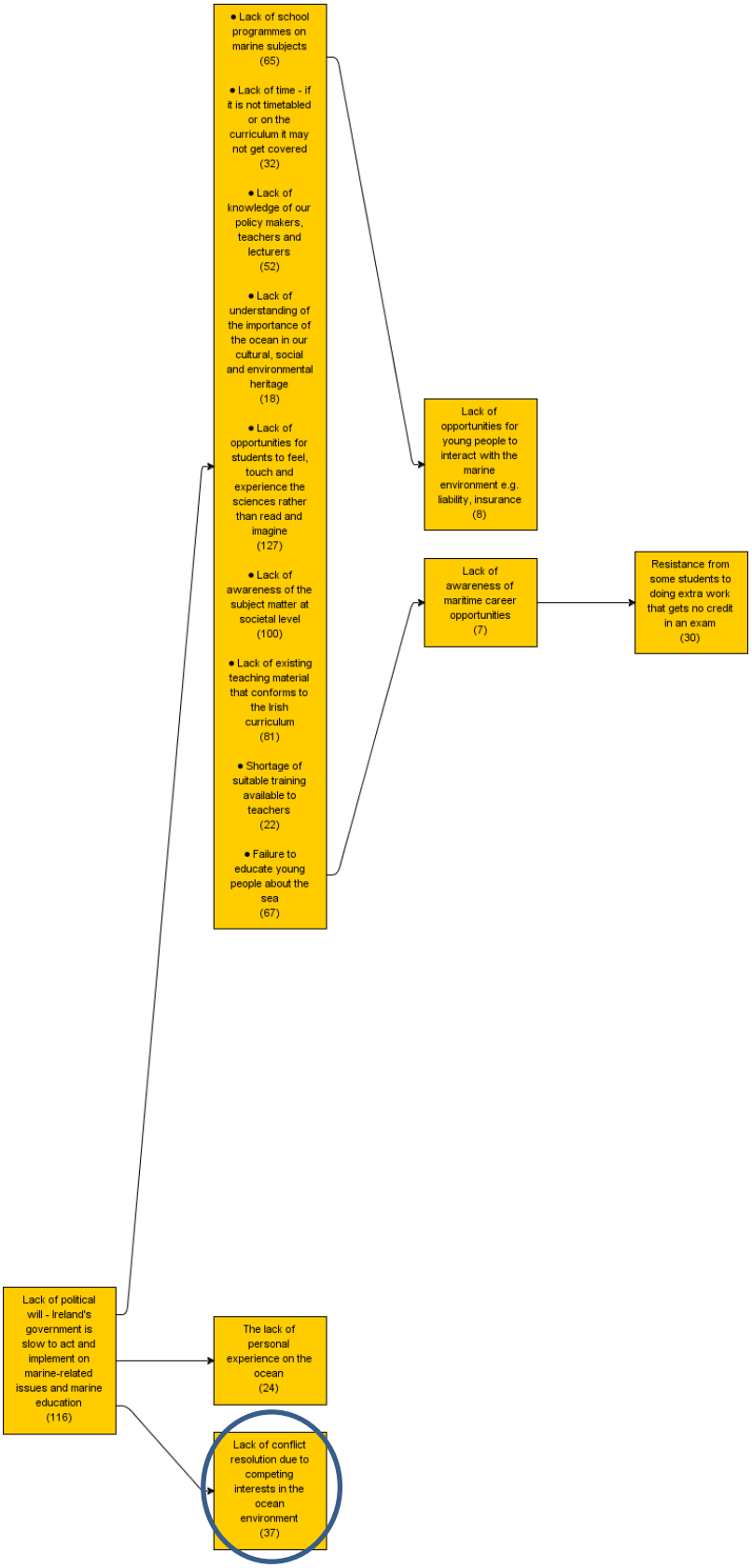

Fig. 74. Ireland structural map (Industry barrier encircled).

4. Importance versus Influence

During the meta-analysis, the importance and the influence of the meta barrier categories were calculated (Fig. 75; Domegan *et al*., 2014). The level of importance was achieved through counting the number of votes stakeholders assigned to the barriers in each of the 26 meta barrier categories (Appendix 3), while the level of importance reflected the structuring phase. The categories within **Group A** all exhibit negative influence scores and have no influence of the other categories. In addition, these categories were deemed relatively unimportant according to the education stakeholders, receiving between 0 and 15 votes. Mareer rated low in both level of importance (0 votes) and level of influence (-3). Both Industry and Personal experience rated low on importance (11 and 15 votes, respectively) and influence (-3 and -2.5, respectively). Culture and Everyday life are located in **Group B**. These categories have similar negative influence scores to Group A, but are seen as more important (26 and 48 votes, respectively) than the Group A categories.

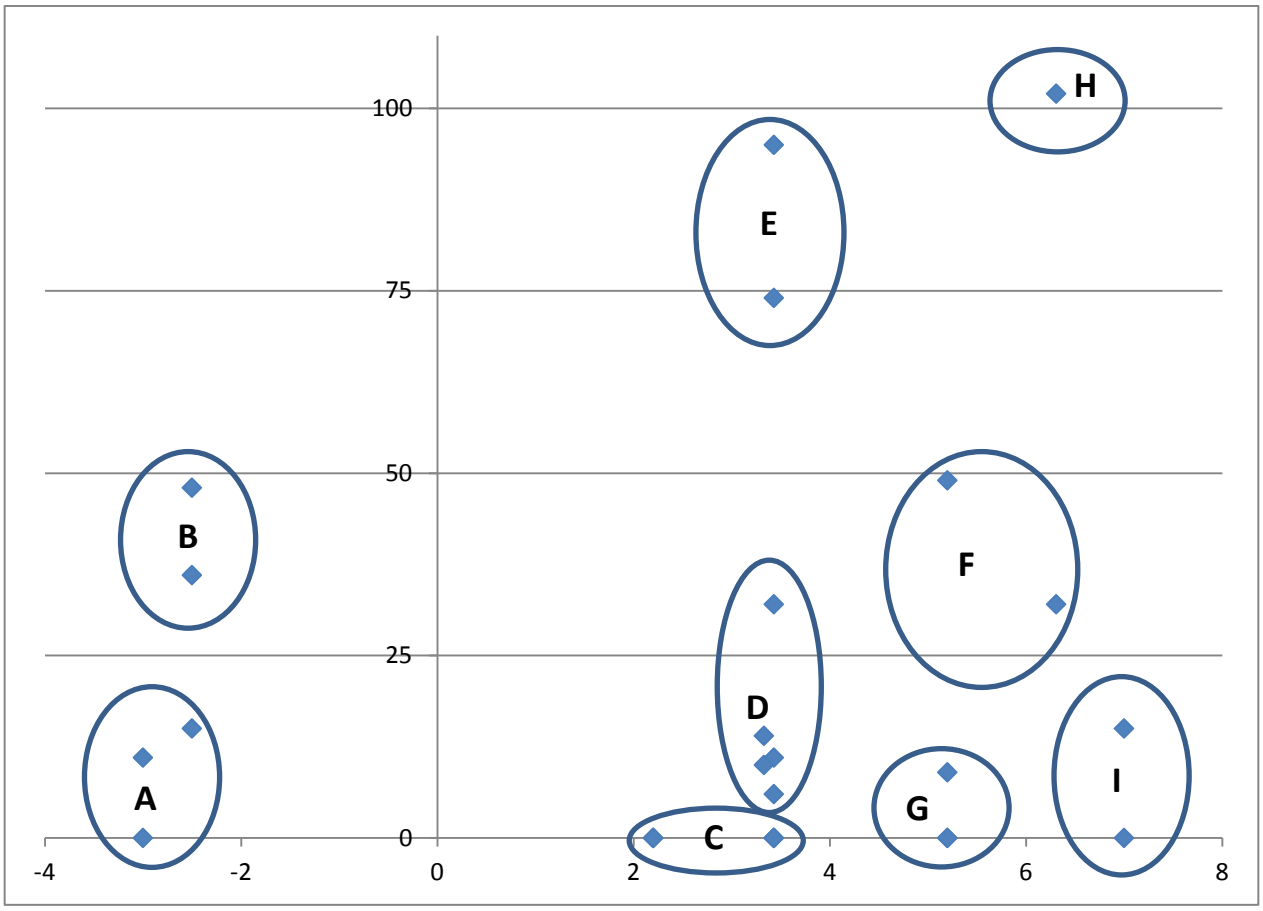

Fig. 75. Importance versus Influence grid: the level of importance reflects the number of votes which the stakeholders assigned to the barriers, while the level of influence reflects the structuring phase.

External programmes, Informal education, Partnerships, Fieldtrip, Interdisciplinary and Equipment are all grouped together in **Group C**. These categories have an average influence score between 2.2 and 3.43. The Group C categories are not seen as very important (0 votes) to the education stakeholders. **Group D** contains five categories: Teaching material, Access, School culture, Complexity and Time. These categories have similar average influence scores to Group C (3.33 and 3.43), but have a higher level of importance (receiving between 6 and 32 votes). In **Group E** categories Curriculum and Teaching are very important (74

and 95 votes, respectively) and relatively influential (both scoring 3.43). Overall, teaching is seen as more influential than Curriculum. The categories within **Group F** are Funding and Communication and both have high average influence scores (6.31 and 5.2, respectively), and relatively high levels of importance (32 and 49 votes, respectively). **Group G** contains three categories: Distractions, Hands-on and Interest. These categories have little importance as they received between 0 and 9 votes. But these categories have a relative amount of influence, with an average influence score of 5.2. Governance is the only category in **Group H**. This category has high importance as it received 102 votes and also has a high average influence score of 6.31, making it the **most important category** overall. Group I contained the categories, Ocean Literacy and Ocean Knowledge deemed as **least important** to the education stakeholders. The categories received 0 votes and 15 votes, respectively, but have an average influence score of 7.0 (the highest score).

5. Sea Change findings

One of the major outcomes of the meta-analysis was the creation of the European influence map of stakeholder eight higher-order barrier themes. In the map, the themes are displayed as highest (stage 1) to lowest influence (stage 6) to teaching 12-19 year olds about the ocean (Fig. 1). The map should be read from left to right – with barrier themes to the left having more overall aggravating influence, in comparison to the barrier themes to the right (Domegan *et al*., 2014). This means the Awareness and perceived knowledge barrier theme (stage 1) exercises the highest level of overall influence to teaching 12-19 year olds about the ocean. Table 1 below further describes the eight higher-order barrier themes and their respective stakeholder descriptions in relation to each stage of the EU influence map of barrier themes. While Connections between humans and the ocean and Blue economy (stage 6), exercises the lowest level of influence for teaching 12-19 year olds about the ocean. In terms of successful mobilisation action, the themes to the left of the map (Fig. 1) are more likely to have a stronger impact on "the overall system of barriers" (Domegan *et al*., 2014), while at the same time relieving pressure on the barriers belonging to the themes on the right. Thus, mobilisation actions taken to have an impact on barriers in the Awareness and perceived knowledge theme, that is, to focus on "The concept of Ocean Literacy (OL): either lack of understanding the concept or some of the elements of OL" could have considerable impact on more 12-19 year olds being taught about the ocean and may have a positive effect on barriers located in themes towards the right of the map, such as Policies and strategies. It is important to be aware that this influence map is not to be considered an action plan, since other factors may come into play when deciding on actions to be taken (Domegan *et al*., 2014). It is not necessary to address Awareness and perceived knowledge first, if there is an immediate opportunity, for example, to address the Policies and strategies theme (stage 2). The map suggests, however, that chance of successful policies might be greater if Awareness and perceived knowledge actions was implemented at the same time. No matter where the initial action is taken, the map can advise us on the possible impact of mobilisation actions, as well as barriers that will have an effect on their success. This map, which "portrays a complex, dynamic, and mutually interrelated set of barriers, reflecting pluralistic values, knowledge, experiences, and expertise, is an invaluable planning tool" (Domegan *et al*., 2014). The most influential higher-order barrier theme to teaching 12-19 year olds about the ocean was found to be Awareness and perceived knowledge, since it was located in stage 1 of the influence map but the meta barrier categories within in the higher-order category theme (Ocean Literacy and Ocean knowledge, Table 2) did not score highly in stakeholder importance. This was in contrast to the overall most important meta barrier category – Governance, which is both a driver and receiver of influence and part of the Policies and strategies higher-order theme (stage 2 of the influence map).

In addition, the education stakeholders generated 316 options to overcome the barriers to teaching 12-19

year olds about the ocean. The "most feasible and highest impact options" (Domegan *et al*., 2014) were arranged into one or more meta barrier categories. It is advised, however, that the generated options are not used as custom-made mobilisation action plans. Although, used in combination with the Sea Change multistage EU influence map of stakeholder barrier themes, these options can be very significant and effective whilst designing a mobilisation strategy (Domegan *et al*., 2014). As an example, the five most impactful and feasible options in the Awareness and perceived knowledge higher-order barrier theme included the following ideas: "spreading the marine topic over the curriculum," "Ocean Literacy subjects to be included in teacher training," "build a personal relationship with the ocean through interactive learning; connecting education with real projects," and "link World Ocean Day with a 1-day school event." A European mobilisation challenge might not include all of the Awareness and perceived knowledge options, in all of the European countries. But any mobilisation that includes these options may engage the stakeholders better. For example, if "connecting education with real projects" was selected as a mobilisation challenge then the objective could be to identify ocean outreach projects and citizen science initiatives at universities or research centres and disseminate them to teachers. Such a strategy would address "Limited or no links between schools and research centres," which is a barrier within the Governance category (stage 2 of the Influence map, Fig. 1). When the Sea Change mobilisation challenge "happens at a region or a country level, it can be adapted to reflect the local context and people" (Domegan *et al*., 2014).

How Sea Change is already addressing some of the barriers

Sea Change's consultations have identified barriers and solutions to teaching 12-19 year olds about the ocean in formal education across eight European countries. The urgency of the matter is due to a widespread lack of Ocean Literacy among the public (Belden Russonello & Stewart and American Viewpoint, 1999; Ocean Project, 2009 and 2011; Steel *et al*., 2005). This lack of Ocean Literacy described by several researchers is further confirmed by this report with one of the identified barriers being "Lack of awareness in schools and wider society of the relevance and importance of our ocean." This is an important barrier to consider, as without awareness it is difficult to engage in ocean responsible behaviour (Cava *et al*., 2005; Dupont & Fauville, 2016) or to see the ocean as a potential future career (Guest *et al*., 2015). Barriers need to be identified in order to be able to take efficient and expedient action to address them. Therefore, the barrier statements and the options (solutions to the barriers envisioned by participants) in this report could be useful to the ocean education community in their future collective action plans.

The EU influence map (Fig. 1), coupled with stakeholder barriers and options, provide robust support for actions already taken within Sea Change. Sea Change is already addressing some of the barriers by implementing some of the options that were identified in the consultation workshops. For example, "Lack of educational material/hands-on activities related to the ocean," through designing an interactive e-learning book on Harmful Algal Blooms, which is aligned with relevant science education methodologies. In addition, five marine modules are also under development to be distributed through the Foundation for Environmental Education (FEE) and Sea Change networks. These five modules will each focus on a topic:

1. The ocean is planet Earth's life support system
2. Seafood and human health
3. Marine pollution and human health
4. The ocean - a treasure trove for human medicine
5. The sea and our physical and mental wellbeing.

Furthermore, a Massive Open Online Course (MOOC) titled "From ABC to ABSeas: Ocean Literacy for All", aimed at helping teachers and students to incorporate Ocean Literacy into educational programmes, addresses the above barrier ("Lack of educational material/hands-on activities related to the ocean") but also addresses another one, namely "Lack of suitable training available to teachers." One of the options that were identified in the consultation workshops ("Organize a platform to share educational materials with a forum to discuss ideas about the educational materials") is addressed through the Sea Change public launch of the Ocean EDGE platform. Ocean EDGE is an online inventory of both formal and informal educational resources and activities that are either available as downloadable products or serve as an inspiration. The European Marine Science Educators Association (EMSEA), through its conference and its network, also promotes sharing educational materials between members of the Ocean Literacy community.

Sea Change recommendations

Sea Change suggests a number of potential actions that could be taken into consideration by education stakeholders:

Teachers

The barrier "Lack of interest in individuals in the target group" can be addressed by using the solution "Use real examples to work with - the education should be connected to real projects." Ocean science educators can support teachers to introduce an element of fieldwork into their curriculum and also give students time to reflect on their experiences. This will create a more profound understanding and an opportunity to realise its relevance to the world outside the school (Ballantyne *et al*., 2010). This would also address another barrier "Lack of opportunities for students to feel, touch, experience the sciences rather than read and imagine." Teachers can find relevant projects in the Ocean EDGE database. A number of the hands-on projects in Ocean EDGE have been contributed by universities and research centres. The fact that research institutions develop and test marine education material addresses another barrier revealed during the consultation ("Limited or no links between schools and research centres").

There is potential for teachers working as teams to share time and resources ("Lack of time" and "A lack of working interdisciplinary" were two identified barriers). If several teachers are involved, each using their allocated teaching time, it could mean that students can focus on learning about the ocean for a longer period of time. Also, since the school curriculum in many EU countries does not include the subject ocean, it is hoped that teachers find ocean projects among Sea Change resources that will fulfil their regular curricular needs.

Teacher training organisations/University teachers

During their training, teachers could become more familiar with both the content and the pedagogy required to teach about the ocean in their future classrooms. This would address two identified barriers, namely "Ocean Literacy ignored in curriculum of teacher training" and "Shortage of suitable training available to teachers." Professional development available for teachers on marine topics would help teachers to expand their own capacity and to foster their network of colleagues teaching marine science. This would also be an efficient way for scientists and teachers to connect and collaborate (identifying on-going science projects that can be adapted to be used in a school setting). This kind of partnership would address the "Limited or no links between schools and research centers" barrier.

Partnerships

Building partnerships between scientists and educators is not a new effort. Beginning in 2002, the US National Science Foundation-funded Centers for Ocean Sciences Education Excellence (COSEE) support scientist/educator partnerships that promote improving Ocean Literacy among the public. Still more efforts are needed, as evidenced in the identified barrier "Limited or no links between schools and research centers." A key element in building partnerships is visibility, and it is suggested that parties join communities or networks (e.g. EMSEA, COSEE, national science conferences, etc..) to get exposure and get to know like-minded colleagues across Europe and the world for further collaboration and partnerships.

Policy makers

As identified during the consultations, there is a "Lack of a national strategy plan to implement Ocean Literacy" in Europe. There is worldwide concern about the protection and the health of the ocean, which can be tackled better with an ocean literate society. Indeed, Ocean Literacy is important for Europe's quest for a more marine-based economy and society based on sustainable management of marine resources. This should also address the barrier "Lack of interest from ministry of education to implement OL in national curriculum," as the issue of Ocean Literacy concerns us all and the future of this planet.

Moving forward

The current report presents a milestone in Ocean Literacy as for the first time an in-depth study of the barriers encountered by education stakeholders to teach marine science is released. This document will be made available to European policymakers (and beyond) to move toward a more ocean literate form of education. We recommend that this report be used to inform and guide future policy decisions concerning education and the role of the ocean in the curriculum experienced by any young European citizen.

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Appendices

Appendix 1. Higher-order barrier theme scores

Category Title	Pos	Total Items	Avg Pos	Ant	Suc	Act	Net SA	Avg Sa	Inf	Avg Inf
Awareness and perceived knowledge	10	3	3.33	17	28	45	11	3.67	21	7
Policies and strategies	47	13	3.62	54	89	143	35	2.69	82	6.31
Engagement	35	10	3.5	49	66	115	17	1.7	52	5.2
Formal education sector	121	42	2.88	251	274	525	23	0.55	144	3.43
The Ocean itself	9	3	3	17	18	35	1	0.33	10	3.33
Collaboration	13	5	2.6	28	26	54	-2	-0.4	11	2.2
Connections between humans and the ocean	30	16	1.88	147	77	224	-70	-4.38	-40	-2.5
Blue economy	6	3	2	27	12	39	-15	-5	-9	-3

Appendix 2. Higher-order barrier themes

Higher-order theme:	Awareness and perceived knowledge
Barrier categories:	Ocean Literacy, Ocean knowledge
Explanation:	The barriers relate to the concept of Ocean Literacy (OL): either lack of understanding of the concept or some of the elements of OL.
References:	3, 12, 25

Higher-order theme:	Policies and strategies
Barrier categories:	Funding, Governance
Explanation:	Explanation: Policies and strategies affect the school, how schools are run and the school budgets.
References:	2, 14, 15, 17

Higher-order theme:	Engagement
Barrier categories:	Distraction, Communication, Interest, Hands-on
Explanation:	The barriers relate to the importance of engaging students and speaking their language to increase interest and awareness of the ocean.
References:	7, 9, 13, 20, 24, 26, 33

Higher-order theme:	Formal education sector
Barrier categories:	Interdisciplinary, Fieldtrip, Time, Equipment, Teaching, Curriculum, School culture, Teaching material
Explanation:	The barrier categories relate to the concept of Ocean Literacy (OL): either lack of understanding of the concept or some of the elements of OL.
References:	4, 5, 16, 18, 21, 29, 31, 34

Higher-order theme:	The Ocean itself
Barrier categories:	Access, Ocean complexity
Explanation:	The very nature of the ocean makes it difficult to experience or understand.
References:	6, 27, 36

Higher-order theme: Collaboration

Barrier categories: Informal education, Partnerships, External programmes

Explanation: Collaboration between different marine education actors.

References: 11, 23, 28

Higher-order theme: Connections between humans and the ocean

Barrier categories: Personal experience, Everyday life, Culture

Explanation: It is about how the ocean matters to both individuals and society.

References: 10, 19, 22

Higher-order theme: Blue economy

Barrier categories: Industry, Mareer (marine career)

Explanation: The barriers all relate to Blue Society, which is the long term strategy to support sustainable growth in the marine and maritime sectors as a whole.

References: 1, 8, 30, 32, 35

Appendix 3. Importance versus influence scores

Importance (Barrier Votes)	**Influence (Influence Model Scores)**
Governance (102 votes)	Ocean Literacy (Avg Inf =7)
Teaching (95 votes)	Ocean knowledge (Avg Inf =7)
Curriculum (74 votes)	Governance (Avg Inf = 6.31)
Communication (49 votes)	Funding (Avg Inf = 6.31)
Culture (48 votes)	Interest (Avg Inf = 5.2)
Everyday life (36 votes)	Distractions (Avg Inf = 5.2)
Time (32 votes)	Communications (Avg Inf = 5.2)
Funding (32 votes)	Hands-on (Avg Inf = 5.2)
Personal experience (15 votes)	Teaching (Avg Inf = 3.43)
Ocean knowledge (15 votes)	Fieldtrip (Avg Inf = 3.43)
Complexity (14 votes)	Interdisciplinary (Avg Inf = 3.43)
Industry (11 votes)	Equipment (Avg Inf = 3.43)
School culture (11 votes)	Teaching material (Avg Inf = 3.43)
Access (10 votes)	School culture (Avg Inf = 3.43)
Distractions (9 votes)	Curriculum (Avg Inf = 3.43)
Teaching material (6 votes)	Time (Avg Inf = 3.43)
Hands-on (0 votes)	Access (Avg Inf = 3.33)
Ocean Literacy (0 votes)	Complexity (Avg Inf = 3.33)
Interest (0 votes)	External programmes (Avg Inf = 2.2)
Fieldtrip (0 votes)	Informal education (Avg Inf = 2.2)
Interdisciplinary (0 votes)	Partnerships (Avg Inf = 2.2)
Equipment (0 votes)	Personal experience (Avg Inf = -2.5)
External programmes (0 votes)	Culture (Avg Inf = -2.5)
Informal education (0 votes)	Everyday life (Avg Inf = -2.5)
Partnerships (0 votes)	Industry (Avg Inf = -3)
Mareer (0 votes)	Mareer (Avg Inf = -3)