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The impact of science shops on university curricula and research

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1 Abstract

The paper analyses the impact of university-based science shops on university curricula and research. Science shops are organisations offering community groups access to scientific knowledge and research. A number of science shops are part of a university, where students and researchers co-operate with citizen groups as part of the curricula or as research activity about the knowledge need put forward by the community group. Experience show that besides assisting citizen groups, science shops can contribute to the development of university curricula and research. The paper discusses the impact of science shops on university curricula and research based on a questionnaire sent out to science shops and through follow-up interviews with employees from nine different university-based science shops. The case studies have been supplemented with articles and reports.

One direct impact on the curricula is the competence students develop through science shop projects, when students as part of their curricula work together with citizen groups on a topic proposed by the citizen group. The better the possibilities in the curricula are for doing this kind of work the bigger is the potential impact from the science shop. At some universities the possibilities in the curricula are part of the way the curricula are organised, while at other universities the science shop or scientific staff supporting the science shop develops the possibilities.

Another type of impact on curricula is seen when this kind of competence is offered to students in other ways besides the direct work with science shop projects. The following mechanisms behind this kind of impact have been identified:
- *Science shop staff develop theoretical and methodological courses, where students learn the competence that can be developed through science shop projects*
- *Science shop staff supply case studies based on science shop projects to courses*
- *Science shop staff participate in the development of and the teaching at courses within topics emerging from problems raised by citizen groups*
- *Science shop staff participates in restructuring of curricula in order to bring in methodological competence from science shop projects.*

The impact on university research is understood as changes in research agenda or research methodology based on or inspired by the work with projects in a science shop. The following mechanisms behind this kind of impact have been identified:
- *A science shop acts as an incubator for a new research area*
- *Scientific staff and graduates develop a new research area or change focus within an existing research area together with science shop staff and sometimes also citizen groups as dialogue partners*
- *Science shop staff introduces participatory research methods to scientific staff*

- *A science shop is developed into a research centre for participatory research*

A number of enabling factors and conditions for impact on curricula and research have been identified:
- *Science shop influence on strategic university decisions through own participation or through building alliances,*
- *Access to resources in terms of science shop staff with scientific qualifications, grants for scientific staff, Ph.D. grants etc.*
- *Science shop staff working also as teachers and/or researchers*
- *University internal visibility of the achievements and the competence of the science shop*
- *Changes in the societal discourse about the competence needs of academic candidates towards more practice or user oriented competence*
- *Changes in the societal discourse about the relations between university and society towards more interactive relations.*

It is not possible to point to a blueprint strategy on how to obtain the most impact on curricula and research. Scientific staff as part of the science shop staff seems, however, to be the best basis for obtaining impact Furthermore impact seems to be a question about utilising those occasions, which show up and can be used for strengthening the role of the science shop, and the role of community orientation and participatory methods at the university.

2 Introduction

This paper[i] discusses the impact of university-based science shops on university curricula and research. Science shops are organisations offering community groups access to scientific knowledge and research. A number of science shops are part of a university, where students and researchers co-operate with community groups as part of the curricula or research activities about the knowledge need put forward by the community group. Experience from science shops shows that besides assisting citizen groups, science shops can also contribute to the development of university curricula and research. This impact has been investigated through a questionnaire sent out to science shops and through follow-up interviews with employees from nine different university-based science shops and one university researcher. Not all the case studies are done with institutions, which call themselves "science shops", but in the paper the term "science shop" will be used, when the cases are referred to in general. The interviews have in most cases been supplemented with written material about the science shops. The chosen science shops had indicated in the questionnaire that the science shop in one way or the other has had impact on university curricula and/or research. The analyses are theoretically based on literature on universities and education and research as institutions and earlier articles about the impact of science shops on education and research.

The analysis focuses on the kind of impact, which the science shops have reported. This impact has been related to the local history of the science shop. The analysis does not point to a certain science shop model as the best, but point at enabling factors and conditions, which have been identified in the case studies. More detailed information about the case studies can be found in (Hende & Jørgensen, 2001).

3 Theoretical and methodological background

The arguments for establishing and running science shops (and other types of community-based research organisations) are multiple, however overall they seem to relate to two groups of interest: 1) community and citizens and 2) researchers and students. In the following a brief presentation is given of what interests these two groups of actors may have in the working of science shops (SCIPAS, 1999).

Citizens' access to information and research resources and the linking of and mediating between academic spheres and societal spheres, and theoretical spheres with practical ones are key points to science shops and community-based research organisations whether they are related to a university or not. In addition to these perspectives, science shops at universities also deal with and involve students and researchers and the university as institution in general. By doing so, these science shops are not only influenced by the citizen groups they co-operate with, but also by the universities they are affiliated with and the researchers and students which engage in their activities. The science shops themselves can also have some influence and impact on the research agenda as well as the curricula at the universities. Together with the society related education and research, the renewal processes of education and research at the universities are

described as central by these science shops (SCIPAS, 1999). In some cases, the activities at science shops have led to the establishment and development of new research areas and new topics in courses and curricula, as well as new research and teaching methods (SCIPAS, 1999).

From the students' point of view a science shop can represent an opportunity to work with a real-life problem, together with real-life people who have real-life needs of finding practically applicable solutions to their problems. Another benefit may be that the methods of studying and solving problems in the science shop are different from what the university otherwise offers to teach the students. Seen from a societal point of view and a labour market point of view, science shops can provide students with valuable competence and qualifications that are not only vocationally but also socially relevant in later job situations. As such the science shops can provide a possibility of establishing more dynamic and direct beneficial relations between the academic world and practical life in that the two spheres can become more reflected in one another. Also the science shops can provide the opportunity of making teaching and research multidisciplinary (SCIPAS, 1999).

3.1 Scope of the study

The interest of the study, which this paper is based on, was to investigate how science shops (and other university-based community research organisations) contribute to the development of research and education at the universities. Hence the study primarily focuses on the role and motivations of science shops, researchers and other actors with respect to establishing processes, where the knowledge needs put forward by citizen groups become a part of and rooted in different institutions at the university such as research and research programmes, and curricula in courses and teaching.

To uncover these processes, the study has tried to grasp the relations between science shops, researchers, and teachers as well as these actors' relations to the institutional environment in which they act and operate.

3.2 Methods for collection of data

The study was built upon studies of existing literature about the workings of institutions dealing heavily with knowledge production. This literature makes up the theoretical part of the study. The empirical part of the study consists of a number of questions in a questionnaire developed in the SCIPAS project. These questions were focused on:

- whether the requests fit into existing curricula
- whether curricula have changed to fit science shop projects
- whether results from science shop projects have been included in courses
- how experience from projects are accumulated
- whether research methods at the university have changed due to the science shop
- whether research agenda has changed due to the science shop.

Based on the answers to the questionnaire, a number of science shops were selected for case studies. The study involves nine cases about the impact of science shops and community-based research organisations on university research and curricula. The selection of science shops of more interest to the study has been based on the principle of diversity in terms of

- Countries and geographic regions – east, west
- Professional fields – the humanities, social science, natural science
- Organisational framework/structures
- The science shop concept applied
- The role of students involved

Besides the studies of literature and written material about the universities and the science shops, the collection of information has also included qualitative interviews with science shop employees and with a researcher, whom has co-operated intensively with a Danish science shop. The Danish interview was carried out in person, whereas all the other interviews have been made by telephone. The interviewees have been given the opportunity to comment on the summary of the interview made with them.

3.3 Education and research as knowledge systems and institutions

We consider higher education and research as social systems or communities of practice where a fundamental characteristic is that its most important activity is to work up knowledge. This means that within these systems knowledge is discovered, extracted, preserved, communicated, and applied (Vught, 1997).

The aim of this section is to present the theoretical understanding of the role and working conditions of the teacher and researcher, which the study was based on.

According to Pinch and Bijker, there is a widespread agreement among researchers that scientific knowledge is thoroughly socially constituted. Such an understanding of scientific knowledge being constituted by social factors implies "that there is nothing epistemologically special about the nature of scientific knowledge: it is merely one in a whole series of knowledge cultures" (Pinch and Bjiker 1984, p. 401-2). This does not mean there is no need to explain why some knowledge cultures are and become more successful than others. It does, however, mean that it is reasonable to see the success of certain knowledge cultures as a sociological phenomenon and discuss different social elements that constitute it.

3.3.1 Education and research as knowledge systems

The production and communication of knowledge is one of many assignments that teachers and researchers deal with in their everyday work. It is interesting to discuss some of the functions that scientific knowledge has in the modern society as well as the institutions that are related to the development and application of this knowledge. It is possible to understand modern science as a knowledge system, which 1) is structured, which 2) has become institutionalised with research institutions and educational institutions, which 3) has a certain fairly limited content and certain functions in the society, and which 4) is determining for a particular form of rationality (Hefferlin, 1969, p. 14).

According to Jakobsen and Pedersen, knowledge systems consist of different components of knowledge. In modern knowledge systems one such obvious component is *the theories, methods, and results* dealt with in scientific literature. Apart from literature, other components may be religious or literary works or may be partial narratives that have not been written down and tradition (Hefferlin, 1969).

The knowledge in a knowledge system embraces more than theories, scientific results and narratives. In order to be able to deal with and understand different (scientific) arguments, it is necessary to be familiar with different assumptions, different types of assessments, and different types of coherence. For example, what is considered right and wrong, true and false has varied throughout history. This means that the meaning of an opinion or argument given has to be understood through an establishment of a link between the argument given and the context in which it has come into existence. That is, any knowledge system is based on a more general *frame of understanding*, without which the theories, assumptions, and arguments in question would be ambiguous or incomprehensible (Hefferlin, 1969).

Another characteristic of knowledge systems is that specific understandings of what can be regarded as acceptable justifications for knowledge exist within the system. In the theoretical work within different subjects or scientific disciplines, different understandings develop of what differentiates sensible reasons from insensible ones, preferences for specific ways of arguing, for specific types of models describing the reality, as well as preferences for the type of results that the work aims at. The sort of justifications regarded as acceptable are, together with the preferences of arguments, models, and forms of descriptions, all a part of what can be called the *type of rationality* of the knowledge system (Hefferlin, 1969, p. 14).

It is important to bear in mind that specific types of rationality are opening up for some formulations of problems and certain questions that can be asked and are closing for others. All systems of knowledge are based on assumptions of a metaphysical character, i.e. assumption of how the nature works or of a world order (Hefferlin, 1969).

Beyond the components, another common characteristic of knowledge systems is their different functions in the cultures in which they are developed, and that they are attached to social institutions. Firstly, knowledge systems have a *metaphysical function* in that they give reason to an understanding of the world. Secondly, they have an *instrumental function* since they tell us how important problems ought to be solved. Furthermore, the knowledge systems are also justified in that they support a certain order in the society, meaning that they have a *legitimating function* (Hefferlin, 1969).

Crises in knowledge systems arise when a new order in the society is developed which cannot be justified on the base of the old knowledge system. They arise when the knowledge system is no longer capable of answering those questions that are asked or – in other words – because the metaphysical, instrumental, and legitimating functions of the systems are considered as insufficient (Hefferlin, 1969).

According to Jakobsen and Pedersen (Jakobsen and Petersen (ed.), 1990)), a knowledge system has a high degree of resistance towards perceptions and understandings that may lead to crises. Firstly, it is difficult to develop, to take in and to convince other people about understandings that are in conflict with existing understandings within a knowledge system. The existing frame of understanding and type of rationality will have links to perceptions, which are difficult to go beyond. Furthermore, knowledge systems are capable of living with (limited) inconsistencies and conflicting understandings for long periods. Finally, the institutions that are attached to a knowledge system, will react against crises – and thereby also against any threats to their own existence and *raison d'être* (Hefferlin, 1969).

3.3.2 Education and research as institutions

According to Vught, the working up of knowledge within education and research systems is related to a number of basic principles. The first one of these concerns the *authority of the experts*, which among other things are occupied with decisions about the knowledge oriented academic activities such as research and teaching. Also, the decisions of what and how to research and what and how to teach are to a large extent overlooked by academic experts. Such a system emphasises the vocational autonomy of the experts (Vught, 1997).

Another basic principle within the institutions of further education is that the *fields of knowledge* are in focus. Understood in this way, the building units of the organisation of higher education consist of the fields of knowledge, and any organisation within the system will not be able to exist if not a certain institutionalisation of these units is made (Vught, 1997).

A third principle is that the *authority to make decisions* is spread out on many actors. Vught finds that decentralising the processes of decisions is an inevitable characteristic of an organisation dealing heavily with production and communication of knowledge (Vught, 1997).

The final principle is concerned with *the way in which authority is delegated within the institutions*. In the relations between the academic and the administrative groups of actors, the authority is traditionally exercised by the academic experts and to a lesser content by the administrative staff. Putting the relatively more limited ability to exercise influence of administrative groups together with the professional authority, systems of further education may appear as complex institutions containing a high degree of autonomy (Vught, 1997). On the other hand, more and more universities are managed by hired professionals (and not by managers elected by and among their colleagues) at university level and at department level. This means that decisions about what to teach and research might become more centralised decisions.

The university as institution has been subject to large changes throughout the years. For instance, the role of the university has changed over time and the role also differs from country to country. Compared to earlier, many universities and the academics employed are today responsible for many types of assignments such as teaching, research, development and innovation, evaluation etc. Earlier, the assignments would be limited to research and teaching, and earlier again only to the task of teaching. The amount of students to be taught has also differed throughout the years starting from educating a very small academic elite to today's education of large groups of professionals. The latter is synonymous with the so-called 'mass university'. A division between research and teaching has also emerged in many universities in spite of the fact that these two activities earlier were regarded as very closely connected to each other (Rasmussen, 1997).

According to the picture of the university academics drawn above, (s)he is a very busy (wo-)man who is engaged in many varied assignments of which many often have a close relation to actual societal questions. In spite of this, the more 'traditional' picture of the professor being an actor who is totally engaged in a very special subject that has no or only very little relevance to practice is still very prevalent. In order to be able to better understand the choices and priorities that academics make in their every day work, it is necessary to handle such traditional conceptions of academics and their work with care (Rasmussen, 1997).

The students at universities can be seen as choosing their way through the universities based on a mixture of considerations concerning scientific interests, career considerations, social and political values, their economic conditions and personal relations to other students and to teachers.

Vught finds universities have a low degree of formalisation, a low degree of centralisation, a low degree of stratification of rewards, a high degree of complexity, put large emphasis on quality in production, and stress the efficiency to a lower degree and the contentment in the employment to a high degree (Vught, 1997). This points in the direction of a conclusion saying that 'higher education may as a whole be considered as showing low resistance towards innovations'. However, Vught also points to another perception expressed by Hefferlin, which is shared by many. According to this other perception, systems of higher education work are conservative organisations by nature, which do not easily provide a basis for new thinking. According to Vught, Hefferlin finds that new innovations will only appear in systems of higher education insofar that these contain a high degree of instability. This means when special circumstances happen, such as for example reorganisations of faculties as a consequence of expansion or reduction of professional fields, low degree of permanent employment, rotation in the management of the institution etc. (Vught, 1997) and (Hefferlin, 1969).

Insofar as the characteristics of higher education show that the actors and structures in education and research systems have a low degree of resistance towards innovations, these same characteristics will be the reason why it is difficult for the same actors to hold on to any new formations. Also, dissemination of new formations relies on the vocationally motivated conviction that the introduction of certain news is worth the trouble. According to Bok, members of a teacher college on a faculty will only approve new formations if they evaluate and assess that the new system will somehow be of benefit to their own existing activities (Vught, 1997).

Seen from this point of view, even the most promising new formation may not survive unless some action is taken to make it gain larger dissemination. In relation to this, Vught suggests that an effective action most likely will appear when colleagues view the new formation as an effective solution of a common problem (Vught, 1997).

Becher and Kogan argue that systems of higher education and research always will be local and specific in their character: "…we do not deal with a hierarchical system, where change can be decided from above, but on the contrary with a system of negotiation, where the individuals, the basic units, and the institutions each believe that they are entitled to decide what is best for themselves. Consequently, any suggestion of renewals ultimately has to be approved by those who have to implement them." (Vught, 1997, p. 65).

3.3.3 Focus of the analyses

The analyses of the information from the questionnaire and the case studies concerning the impact of science shops on curricula and research are based on the understandings of universities presented in the previous paragraphs. Figure 1 shows the understanding in a graphical way.

The focus of the analyses is on the kind of changes and on the driving forces behind the changes:

- What kind of changes have taken place; including whether theories, methods and types of rationality of knowledge systems have changed
- Whether the impact has taken place as institutional changes or as local changes based on initiatives of single researchers and teachers
- What alliances have been created in order to carry through the changes and what arguments have be used to create the support for the changes
- Why students have participated in science shop projects (e.g. for social, for competence oriented etc. reasons) and whether institutional changes have supported or hindered this involvement
- Why researchers and teachers have taken part in science shop projects and in follow-up investigations to projects in science shops (e.g. for social, scientific etc. reasons) and whether they have experienced some kind of resistance from colleagues, management etc.
- Whether changes in research have been institutionalised as new fields of knowledge or the changes have taken.

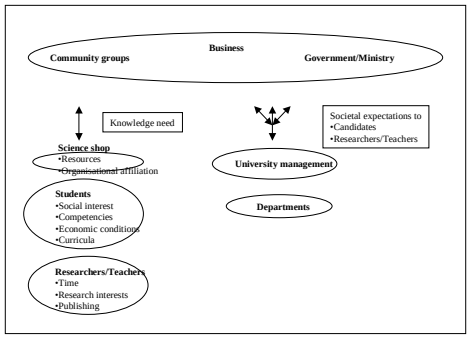

Figure 1: The understanding of the relations between society, university and science shop

4 Impact on curricula

4.1 Introduction

This paragraph presents the different types of impact on curricula science shops (and similar types of community-based research), which were found. Furthermore it also discusses the competencies that can be gained by doing science shop projects as part of higher education curricula.

One direct impact on the curricula is the competence students develop through science shop projects, where the students as part of their curricula work together with citizen groups on a topic proposed by the citizen group. Around 70% of the science shops answering the SCIPAS-questionnaire say that students work with science shop projects as part of their education. The better the possibilities in the curricula for doing this kind of work the bigger is the potential impact from the science shop. At some universities the possibilities in the curricula are already there, while at other universities the science shop or scientific staff supporting the science shop develops the possibilities. Around 40% of the science shops report that curricula have changed to fit science shop projects better, while 10% report that the possibilities have become worse.

Another type of impact on curricula is seen when competencies normally gained through science shop projects are offered to students in other ways besides the direct work with science shop projects, e.g. when science shops cases are used as cases in ordinary courses or when science shops develop and run methodological courses like user-oriented planning. It is, however, only around one third of the science shops that report that.

The impact have been assessed qualitatively, such as what kind of competencies the science shop can give the students, and quantitatively, such as how big a proportion of the students that actually work with science shops or follow courses developed on the basis of the science shop work.

4.2 The framework of science shop projects

The majority of the science shops (around 70%) answering the SCIPAS questionnaire answer that students do project work in the science shop as part of their curricula (course, diploma work, thesis etc.). That is, it is a widespread concept among science shops that students work with at least some of the requests coming to the science shop.

The case studies included in this study cover a range of learning and research situations. These are seen in relation to the participation of the citizen groups in the research process and in relation to the project set-up. The citizen participation seems to vary depending on

- The topic (whether citizen participation is necessary – for example in projects about citizen participation in local waste segregation)
- The personnel resources of the citizen group
- The concept of the science shop

The Chemistry Shop at University of Groningen in the Netherlands characterises the concept applied as 'research *for* community', while the Policy Research Action Group, PRAG, in USA (a network of 4 universities and 15 community organisations in the Chicago metropolitan area) is based on participatory action research and characterises their concept as 'research *with* community' (Nyden et al, 1997, p.7).

The students seem to be involved in science shop activities or activities similar to these mainly in two different ways:

- Through placement and internship in the citizen group
- Through project work carried out in co-operation with the citizen group

In general, the European science shops seem to use project work in co-operation with the citizen group as their concept for student involvement. Brunel University in the UK uses placements and internships as their concept. The same goes for PRAG, which also seems to use placements and internships as the concept for their participatory action research. University of Toronto in Canada uses both the placement and the project approach.

4.3 Competencies developed through science shop projects

When students as a part of their education make science shop projects in co-operation with citizen groups it can be seen as what is also called community-based learning, where students undertake research with local third sector organisations (Hall et al, 2000, p.2). According to Hall, proponents of community-based learning claim the following advantages:

- It makes connections between abstract concepts learned in the classroom and real applications in the world outside
- As a form of experiential learning it promotes learning through a cycle of action and reflection (cited from Hall et al, 2000)
- Through the engagement of students and interaction with others, it fosters a deep rather than a surface approach to learning (cited from Hall et al, 2000)
- It develops general skills that are useful in other contexts, particularly the world of work

These four aspects of community-based learning all show up in the case studies analysed as can be seen in the following examples. Beyond these, the cases have also shown another dimension of community-based learning, which deals with developing new perspectives or new ways of looking at the community groups worked with. Another competence dimension of community-based learning, which was found in a study of science shop impact on curricula and research, is students' development of practice and values recognising community groups as equal partners with expertise (as contrary to values looking upon community groups as weak groups needing help) (interview with Evelyn Schaafsma, 30 Nov 2000).

According to the co-ordinator in the Physics Science Shop at Utrecht University in the Netherlands, the science shop gives students competencies in doing fieldwork by giving them the possibility to work in real-life situations outside the laboratory. The competencies focused on here are that the students gain a better understanding of real-life work and become better to solve professional problems (interview with Patricia Huisman-Kleinherenbrink, 08 Dec 2000).

Interviews with students at the evaluation of science shop projects at the Technical University of Denmark highlight problem orientation, practice orientation and usefulness as attractive to the students. Furthermore, there may also be a wish among these students to influence and have an impact on their own educational curriculum as well as a will to take

a responsibility of formulating parts of this by themselves. This is based on the interviews where the students have given expression to the view that there are two major aspects that they find interesting in science shop projects; working with a project, where the problem is not well defined from the beginning and working with a problem where the results are going to be used by somebody.

The statements below have been found in interviews among Romanian students at the Technical University of Iasi. These show the students' experience of the competencies gained through participation in science shop projects as being useful for them in a later work context. Apart from the very technical skills the projects also provide them with other more general types of social skills, which are considered useful in order to be able to put the first ones in practical use. Furthermore the projects also provide the students with better abilities to apply more bottom-up oriented strategies involving relevant actors in the solution of professional problems. The students think science shop projects can complete their university education by providing the following possibilities to (interview with Carmen Teodosiu, 06 Nov 2000):

- Get a better understanding of environmental problems
- Work in groups and apply technical knowledge to practical situations
- Have contacts with citizens' groups
- Learn about project and task management
- Engage in international student co-operation
- Improve communication and language skills
- Develop pedagogical skills

In the Romanian context, the education of environmental engineers is viewed as having an important role in the development of democratic processes. In relation to the community, the role of the Environmental Science Shop at Iasi is among others to offer civil society information, consultancy in environmental protection, increase environmental awareness, and a scientific basis for public participation in environmental policymaking. Another role of the science shop here is to educate future engineers with competencies that are considered useful for a democracy. These are competencies such as the ability to work independently, make research plans, make surveys and evaluate activities, disseminate results, apply a practical approach to environmental problems etc.

4.4 Mechanisms with impact on the possibilities of doing science shop projects as part of the curricula

The direct impact of science shops on curricula depends on the amount of students that work on science shop projects and the amount of students depends among others on their possibilities to do this kind of project work as part of the curricula. Around 40% of the science shops answering the SCIPAS questionnaire report that the curricula have changed so the possibilities to fit in science shop projects have become better. Around 10% report the possibilities have become worse and around 25% report that the possibilities have not changed. The following mechanisms with influence on the possibilities for doing and establishing/integrating science shop projects as part of the curricula have been identified in the case studies:

- A science shop develops the possibilities for doing project work as part of established courses
- A science shop develops the possibilities for working together with citizen groups as part of the curricula
- Scientific staff finds the competence that science shop projects offer so relevant that they want to improve the possibilities for the students to do science shop projects
- Scientific staff finds that the science shop offer services that can minimise their own workload, when they want to fulfil institutional or local aims
- The degree of accordance between the topics in the requests from the citizen groups and the scientific focus of the faculty
- Changes in curricula improve or reduce indirectly and unintentionally the possibilities for working with science shop projects as part of the curricula
- Resources available for the actors involved in science shop projects.

Some of the concrete experience identified in the case studies is:

- At Eastern European universities a science shop might be the basis for the introduction of project-based learning. A science shop co-ordinator has developed the first possibilities for doing project work at a university as part of her teaching at courses.
- In some cases a science shop has developed into a centre for community research offering possibilities for the students to work together with community groups as part of the curricula.
- In one case a university teacher found the competence science shop projects offer so relevant that he initiated the development of a course module giving all students the possibility to do science shop projects as part of the curricula
- In some cases scientific staff have found a science shop offers services minimising their own workload by offering project proposals, which they can use in order to fulfil institutional objectives about close relations to the region or when students want to do project work.
- Low degree of accordance between the topics raised by the community groups and the scientific focus of a faculty might limits the possibilities finding supervisors and students for science shop projects. Dutch physics science shops report that community groups mostly ask questions about noise and about irradiation, which is not part of the research interest of the physics departments today.
- Changes in curricula can improve or reduce indirectly and unintended the possibilities for science shop projects as part of the curricula. E.g. introduction of more project-based learning can improve the possibilities for working with science shop projects. More project -based learning has been introduced in some curricula in order to make the students more capable as graduates to plan their own work and build competence within new fields. On the other hand has worse economic conditions for Dutch students made it more difficult for the science shops to find students for the projects, because some students choose a more main-stream curriculum without project work with community groups, which might be more time-consuming than ordinary lecture courses.

4.5 Ways of gaining impact on curricula

In the following paragraphs other types of impact on the curricula, apart from the direct impact when students work with science shop project as part of their education, will be described and analysed. Only around one third of the science shops (around 15) report that experience or methods from science shop research has been included in courses or modules. Only one science shop reports that the inclusion has not been successful. One third of the science shops report that there has been no inclusion of research and another third do not answer the question, which probably also should be seen as no inclusion has taken place. There may be several reasons why only one third of the science shops report that science shop research has been included in courses and modules. One reason might be that the science shop does not have the embedding of methods and topics as part of its aims and focus. Another reason might be that a science shop has tried to contribute to changes, but has not been successful.

The following types of impact have been identified:

- Scientific staff includes community topics in existing teaching activities. This seems often to be inspired by the experience from supervision of students. Driving forces identified are teachers' social and scientific interest and how they see the relevance for the competence of graduates.
- Science shop staff includes science shop case studies in own teaching activities. Some science shop co-ordinators are also teaching at a department, which gives them the possibility to use experience from science shop projects to introduce new topics in the courses.
- Science shop staff and scientific staff develop and teach at courses on topics emerging from projects with community groups. This kind of co-operation has been based on teachers' interest in topics or fields of knowledge developing from projects with community groups or interest in the scientific approach science shop staff can teach.
- Science shop staff develops and runs courses on methodology and theory in community-based research. This kind of courses is also based on the possibility of science shop co-ordinators to teach courses. The courses cover e.g. interaction between science, scientists and community, roles of scientists, research planning, communication and participatory methods.
- Science shop staff develops courses within topics and problems raised by community groups. In some cases a science shop develop new teaching fields not yet covered by the curricula. This has happened either because there was no department to teach the new topic or because an existing department was not interested. That is, the science shops act as an incubator for a new area.
- Science shop staff participates in the restructuring of curriculum through formal planning activities. In some cases

science shops have been invited to take part in the restructuring of curricula making them more project oriented or more practice oriented.

The following paragraphs discuss some of the mentioned ways of having influence on the curricula.

4.5.1 Scientific staff includes community topics in existing teaching activities.

Scientific staff includes in some cases on their own initiative community topics form science shop projects in their teaching and develops these from 'within' in the professional fields they are already working with. Driving forces for including community initiated topics in the curriculum has, in one of the following two cases, been a personal professional interest combined with a consideration of what knowledge and competencies the professor finds the students will need in their future work as professional engineers within the field of water treatment. In the other case, a driving force is related to a change in the focus within the education that affected how the relevance of the science shop's contributions is looked upon.

A study from the mid-1980s of the impact on research from ten years' work in the Amsterdam science shops also showed impact on the curricula. In several cases were materials developed in science shop projects done by researchers, incorporated in educational material (Zaal & Leydesdorff, 1987).

The following describes cases from the SCIPAS project. The co-ordinator of the Science Shop for Medicines at the University of Groningen in the Netherlands tells that other scientific staffs often consult her when they need to make new projects about patients' perspectives in their own teaching activities. They consult her because they know the science shop has worked with that perspective for many years. Knowing that the science shop has been dealing with this issue and that the co-ordinator has concrete examples of how this particular perspective on how to perform as pharmacist can be taught to students constitute good reasons for consulting her. In combination with this, a related reason is also the fact that pharmacy education in general is heading towards a more and more patient oriented approach. The science shop co-ordinator is also consulted very often in relation to a new field called 'pharmaceutical care', because she holds knowledge about what patients want and what patients need (interview with Evelyn Schaafsma, 30 Nov 2000).

At the Technical University of Denmark, what could be called 'development from within' has been practiced in an established area. Here scientific staff from a department embeds topics from science shop projects into their own teaching activities together with the science shop as a dialogue partner. The professor of the department has supervised several student projects in the science shop at the university. The professor at the department for environmental technology has made a gradual introduction of elements and issues of the projects into his courses. It is his interest for water treatment together with his interest of dealing with problems of how to treat (waste-)water in order to reach a wanted quality that has led him to other areas, such as collection and (re-)use of rainwater. He did not immediately introduce problems of rainwater or green wastewater in the ordinary courses, because he thinks the focus of what he teaches has to correspond to the focus of the students' later working situation. In this case, the scale of alternative technologies (such as green wastewater treatment and (re-)use of rainwater) did not correspond with the scale of the technology traditionally implemented, since the alternative technology were often small plants used on the household level, whereas the type of the plants that the students were going to deal with in future jobs would be large facilities. Such large-scale facilities are typically owned by the local authorities. Today however, teaching in green wastewater treatment plants has become a part of the curriculum in two regular courses due to a change in the societal strategy for wastewater treatment. Implementation of green wastewater treatment plants is no longer only taking place in individual households. Today groups of households are also making requests of these plants, and the plants needed are no longer just the large scale ones which engineers traditionally worked with. At the same time these groups of households possess economic resources that enable them to actually hire a consultant. So, as the type and requirements of potential users of the plants have changed, so has the relevance of taking these issues into the courses (Jørgensen, 1999).

4.5.2 Science shop staff contributes case studies to own or others teaching

In this case the science shop staff supplies existing courses with case study material based on science shop projects. The courses can be taught both by the science shop staff itself and/or by other teachers.

According to one Dutch science shop co-ordinator, examples of science shop keepers in the Netherlands who also teach in university courses are mostly found where the science shops are affiliated with and a part of a faculty – that is to say

in decentralised science shops. In opposition to this, staff will often mediate and organise projects for all the faculties at universities where the science shop is positioned centrally. Then the scientific staff can use the projects in their own teaching if they want to (interview with Dick Schlüter, 06 Dec 2000).

In the examples given by the case studies, the possibility to integrate case material from science shop projects in regular courses is heavily related to the fact that all of the science shop co-ordinators stay in positions where they can act in roles of both science shop co-ordinator and as teacher. Being in these two roles gives them (easy) insight and access both to materials and examples of science shop cases and a group of students that can work with these cases as a part of their regular curriculum. A precondition of this is that the teachers are free to choose how they want to organise their teaching. Within these universities, these co-ordinators' positions and acting in these two roles has hence become important in the practical process of integrating science shop activities more in curriculum.

At University of Groningen in the Netherlands, the science shop staff, both in the Chemistry Science Shop and in the Science Shop for Medicines, is also teaching at the Faculty. The Chemistry Science Shop has for a number of years given a course on 'chemistry and society', which it was asked to take over when the Faculty closed the department on science and society. Furthermore, one of the science shop staff members has also developed a course on 'industrial innovation for environment' based on his own research interest. The science shop staff uses cases from the science shop in both courses as part of their empirical base (interview with Henk Mulder, 06 Nov 2000).

4.5.3 Science shop staff co-operates with scientific staff about new courses within topics from science shop projects

In some cases the science shop staff co-operates with scientific staff about the development of and teaching at new courses deal with topics, which have emerged from problems initially raised by citizen groups. A number of the science shops have academic staff also employed as teachers and/or researchers. This gives these science shop staff members the possibility to develop and teach regular courses too. Some of these science shops have developed new courses and curricula within topics originally emerged from problems and strategies raised by citizen groups. The courses have been made either within the science shop or in co-operation with other departments.

The cases show three aspects that have acted as motivation factors for co-operation between science shop staff and scientific staff about teaching. Firstly, there have been good personal relationships between the two groups, secondly, they are interested in and work within the same topics, and thirdly, they both find that perspectives contributed by the science shops are beneficial for the students.

The Centre for Urban Research and Learning, CURL, at Loyola University in the USA, has in co-operation with the Graduate School at the university developed an interdisciplinary educational program – "Urban Life and Learning: Chicago". Students attending this can get a master's degree or a certificate. The two have also developed a certificate programme on "Philanthropy and Non-Profit Sector Graduate Certificate Program". This programme includes three courses on non-profit organisations, on philanthropy, policy and community change and an internship with local philanthropic organisations.

This Dutch example shows how a science shop staff member, who has done research in science shop projects herself, later on based on that insight and seeing the need, has been able to establish a new course bringing up science shop topics. The Chemistry Shop at University of Groningen in the Netherlands has developed a course in Environmental Chemistry based on the need for more people holding professional knowledge in this field that science shop projects had shown. The science shop co-ordinates the course and invites a number of external speakers. The basis for the establishment of the course has been that the science shop co-ordinator has a strong chemical background. The concept of this science shop is that the science shop staff carries out a number of the projects themselves. And in this case the co-ordinator has been able to use this in a way so that she can use some of the projects, which she has carried out herself in science shop, as part of the empirical case material applied in the course.

The three Danish examples on urban ecology, cleaner production and organic food production show three different science shop strategies for the embedding of topics from science shop projects in curriculum: 1) the science shop co-operates with departments in the development phase of new areas, 2) the science shop makes a more permanent involvement in co-operation with departments and 3) the science shop acts as an incubator for a new area, until it is possible to involve scientific staff from departments close to the area.

The Science Shop at the Technical University of Denmark has three main goals:

1. To help groups outside the university
2. To give the students possibilities for qualifying through co-operation with user groups on real-life topics, and
3. To contribute to the renewal of the education and research at the university

The aim of the renewing activities is to give the knowledge needs of the user groups of the science shops more permanent impact on curricula and research. One of the ways the Science Shop has contributed to the renewal is through new research programmes and new courses within areas, where a number of science shop projects have been carried through.

The Science Shop has initiated and been involved in a number of renewing activities within urban ecology, cleaner technology and organic food production during the years through the Interdisciplinary Centre. An important vehicle for these renewing activities within the curricula was the creation of two so-called optional 'frame courses' given the broad title 'holistic technological development'. By establishing frame courses, the science shop and the centre got the opportunity to develop and offer new courses dealing with different areas based on a number of requests that had been received in the Science Shop. These courses were therefore developed in order to be able to offer these types of new topics to as many students as possible.

4.5.4 Science shop staff develops and runs courses within theory and methodology

Some science shops develop their own courses or teach at existing courses, where students can learn theory and methodology needed for co-operation with citizen groups (like science communication, academia-user dialogue etc.). In this case, the courses deal with theory and methodology.

At Utrecht University in the Netherlands, the Biology Science Shop has developed and run a course in community-based research, where the students learn general qualifications needed in community-based research. The course lasts 14 weeks (2 hours every week) and the students end the course by writing a paper related to general topics about the interaction between science, scientists and community. Some of the topics covered by the course are: oral communication, researchers as external advisors, information sources, desk research, research planning, and science communication to lay people. The science shop uses finished project cases from the science shop as part of the empirical basis of the course. Traditionally, the Biology Science Shop staff has not been allowed to develop and run its own courses. But by making a so-called 'zero-appointment' (each science shop staff is on the staff list of each department but not paid by this) between the science shop and the departments, this has become possible. Besides getting the possibility to reach a larger group of students through the allowance to establish regular science shop courses, this zero-appointment arrangement has also been good for the contact between the science shop staff and the scientific staff members at the departments of the Faculty (interview with Caspar de Bok, 08 Dec 2000).

At the Technical University of Denmark the science shop developed in 1986 an optional course on 'co-operation with user groups'. The students learn about theories about co-operation between academic experts and so-called 'experience experts' (citizen groups, employees etc.) in the course. They also learn different methods like future-creating workshops, which can be used in co-operation with user groups. In the last part of the course, the students do a project where they evaluate a project with co-operation between academia and citizens (some of the cases might be science shop projects or research projects based on earlier requests form citizen groups to the science shop). Also in this case, a larger outreach of methodologies of the science shop has been possible via the establishment of the course. Hence the course does not only fulfil the aim about giving potential, present, and earlier students in the science shop the possibility for making theoretical and methodological reflections upon this kind of activity. It also works as a space where other students can get a chance to 'sniff' at the ideas underlying science shop projects without necessarily also having to try them in practice themselves.

4.5.5 Science shop staff participates in the restructuring of curriculum

Some science shop staff participates in formal curriculum planning activities in order to bring in more focus on competencies from science shop projects.

The examples below show how some science shops can gain more support at the universities, because they offer qualifications that fit with a recent practice-orientation of higher education. That is, the science shops become important due to a change in the discourse about the competencies students should develop through the curricula.

In the Netherlands, changes are being introduced in natural science-based curricula like biology, chemistry, pharmacy and physics. The curricula of the bachelor and the master programme have recently been under investigation and changed. According to one science shop co-ordinator, the changes have come – among other reasons – because the science shops have been able to show good results both with students doing practical research and with the motivation of the students. At the same time it has been discussed whether four years to get a degree in Master of Science was too short or if the curricula for these higher educations needed to be extended to five years instead. In effect, the Ministry of Education agreed to finance curricula that last five years instead of four years on the condition that the new curricula become more practice oriented and include societal issues. This means that the education in those five years, according to the Ministry of Education, shall not only be a science oriented education but that students also shall face societal problems as a part of the last year in their study (interview with Evelyn Schaafsma, 30 Nov 2000).

At Twente University, courses where the students have to carry out a piece of practical work in the region have already been established. This is rather new in the curriculum and one of more of the consequences of the change and the more openness towards practical research with the real customer. One problem with these courses is that the different faculties give them and they are only running in a part of the year since they follow the academic calendar. The science shop does, for their part, get customers the whole year round. Making such courses therefore requires the science shop to organise the integration of projects in the curriculum in a different way than it is used to do. This problem is faced by more of the science shop and internship programmes.

At the University Centre for Pharmacy, University of Groningen, the department where the science shop is affiliated has recently changed the curriculum, so the students now use one day a week to make integrated projects. It is the idea that the project work shall act as the *leitmotif* during the year of study. As a part of the process of setting up these integrated projects, the scientific staff at the department has discussed with the science shop co-ordinator what type of examples would be suitable for such kind of interdisciplinary projects. This involvement of the science shop co-ordinator in this process is due to her educational background as one of the few pharmacists at the department and the fact that she has been working there for some years so that the other scientific staff knows her expertise in the field.

Despite these close relations to the scientific staff and experience in teaching in practice oriented competencies, the science shop staff has not been invited to take part in the planning of the newly introduced fifth year of the curriculum at the Faculty level. This is because the Ministry of Education feels that the students should work with more society-oriented topics in this last year of the new curriculum. Hence the role of the science shop at this Faculty has not changed due to the change in curriculum even though the focus of the new curriculum makes the benefits of involving the science shop in the planning of regular teaching activities more obvious (interview with Evelyn Schaafsma, 30 Nov 2000).

At the Biology Faculty at Utrecht University the change in the view on the length of the curricula has led to the development of three different profiles, directed towards research, communication and education, and management and policymaking, respectively. The Biology Shop has been invited to participate in the planning of the profile on management and policy making, probably because the Faculty sees that the science shop offers the students some relevant qualifications in the course the science shop teaches on ‘science and community’ and on ‘community-based research’. The co-ordinator believes that one reason why the science shop has been asked by the board of their Faculty to become a partner in the discussion of the development of these profiles is that it has a certain expertise in this field (interview with Caspar de Bok, 08 Dec 2000).

5 Impact on research

This section presents the different types of impact on research science shops (and similar types of community-based research), which were found.

The impact on research is understood as more permanent changes in research agenda or research methodology based on or inspired by the work with the requests coming to the science shop and the projects carried out. Only a few science

shops answering the SCIPAS questionnaire report changes in research. 20% of the science shops report changes in research methods, while 60 % report no changes and 20% do not answer the question. In relation to changes in research agenda around 20-25% of the science shops answer each of the following options: 'a little', 'hardly at all' and 'not at all'. Another 20-25% gives no answer. Only one out of around 45 science shops report that the research agenda has changed a lot. There can of course be different interpretations of what a little influence is and what a lot of influence is. But putting these two categories together, it is only around 30% of the science shops that report that the research agenda has changed due to the science shop. One science shop mentions explicitly that the science shop always has worked rather separately from the rest of the university. Another science shop reports that the research agenda at the university has changed a lot towards more community orientation, but that the science shop has had only a small degree of influence on this change.

The following mechanisms leading to impact on research have been identified in the case studies:

- A science shop acts as an incubator for a new research area and the science shop staff carries out research;
- University funding for science shop based research;
- Researchers integrate science shop themes in their research;
- Science shop staff introduces participatory research methods to scientific staff;
- A science shop is developed into a research centre for participatory research.
-

5.1 Science shop as incubator for new research area

If a science shop has scientific staff employed as described in the previous paragraph it gives possibilities to develop new areas, although there might not be interest among the scientists at the departments. This paragraph gives two examples of science shops as incubators for new areas.

At the CURL, a grant from the U.S. Department of Education has allowed CURL to establish a participatory evaluation research collaborative in response to needs identified by CURL's community-based partners. Central among community interests has been routine involvement of community residents in research. In this initiative the participatory approach is needed to document successful models of community programmes that can be strengthened and shared with regional or national other groups. Another example is CURL's team-based model of participatory evaluation research that has been used for around 5 years. Faculty, graduate students, undergraduates, community fellows and community organisation staff are involved in shaping and completing all stages of research from conceptualisation of the issues to be studied to the writing of the final report. The model was developed as an alternative to the traditional evaluation research model, where the people, whose daily life or programmes are being evaluated, do not play an active role in the research process. They only give information by filling out questionnaires or giving interviews (Report on Accomplishment and New Initiatives, 1999, p.14).

The role as incubator for activities on organic food production carried out by the Interdisciplinary Centre at the Technical University of Denmark was introduced in paragraph 4.5 on the renewing activities at the universities. The focus now is to show that building of such a new area as an area for research and education might take 5-10 years. It is not a process that can be planned in detail from the beginning, because the development is an interaction between the societal discourse on the subject, the activities the changes in discourse allow the science shop to do, and the development in the established researchers' interest. The established researchers are those being challenged by the new research area or the modifications of their existing area. Table 1 illustrates this interaction.

Period	**Development in societal discourse related to organic food production**	**The activities undertaken by the science shop and the affiliated community research centre**	**The interests of the 'established' researchers at the university**
1985 - 1990	- Organic agriculture starts growing on the initiative of city people moving into the countryside. - Focus more on agriculture than on food processing.	- The science shop receives questions from organic agriculture organisation. Projects done as student projects. - Research centre decides to make organic food production to an area that should be embedded at the university. - Apply for funding for research project on organic food production and invites food researchers and community organisations.	- Food researchers and environmental researchers as supervisors on science shop projects done by students. - Food researchers do not want to participate in research project on organic food processing since they were not lacking resources, due to many resources from biotechnology research.
1990 - 1998	- Organic agriculture grows faster due to problems with pesticides in ground water. Conventional farmers start to convert to organic agriculture in bigger numbers. - Some regions see organic agriculture as a business strategy and others as an environmental strategy. - Retail chains start using organic food as competition parameter to attract consumers.	- Research capacity on food processing has to be found outside the university due to the lack of interest from the food researchers at the university. - Regional strategies for organic food production and organic food in public catering as new research topics in research centre. - Receives university money to plan course on organic food production. - The teaching at the course financed by overhead in the research centre from other projects. - Research group as supervisors on science shop projects on organic food production.	- Food researchers invite science shop researcher to give lectures at food technology course.
1998 -	- The number of processed organic food products increase.	- Has to cancel course on organic food production due to lack of resources. - Apply for funding from the national food research programme. Invites food researchers to co-operate. - Suggests consumer organisation to plan research project on consumer policy.	- Food researchers agree to co-operate with organic food research group on project on care in food processing. Interest due to growing societal importance of organic agriculture.

Table 1: The embedding of organic food production at Technical University of Denmark as interaction between the societal discourse, the activities in the science shop and the affiliated research centre and the interest of the food researchers.

5.2 Impact on research through funding and programmes

One way of impacting on the research agenda is access to funding for science shop based research. It was not been possible within the project to investigate systematically the impact on the research agenda based on this kind of funding. However, some data have been available about the impact on research from the science shops at University of Amsterdam in the 1980's. Besides this, some recent experience from some Dutch science shops is discussed.

Some of the first experience getting more permanent influence on the research agenda via science shops was done at University of Amsterdam in the 1980's. It was the experience of the science shops at the university that only through long-term research programmes was it possible to get influence. The science shops convinced the council of the university about this research strategy and an agreement about a research fund was made between the university and the biggest national confederation of trade unions. The fund was around 15 person-years of research. The conditions to get money from the fund was that community organisations should participate in the planning of the project, that it was not possible to get other kind of funding and that the project should be interdisciplinary. Several projects were done with this funding, for example a project about the pollution of a big river and about the use of medicine at shift-work. It was, however, the experience that these projects only had limited long-term influence on the research agenda at the participating departments. It was the feeling from the science shops that the departments saw this money as a possibility to get projects funded that the department did not prioritise that highly itself. The balancing of different political interests seemed also to be a potential problem. In one case was the publishing of the results delayed, because the researcher became a member of a governmental working group within the same topic (river pollution). This implied that the environmental organisation that had participated in the planning of the project had to delay their plans for activities based on the project (Jørgensen, 1995, p. 69). Based on the experience with this fund, the university developed another strategy for community influence on the research agenda. The idea was to make 'programme studies', where science shops, researchers and community organisations together could plan more long-term research programmes. A programme study would typically include:

- An overview of the requests to the science shops within the area and of the experience from the projects;
- An overview of research and education within the area;
- An assessment of the future development within the area;
- Development of a plan for future research, including plans for the financing and the organisation of the research.

At the University of Amsterdam, program studies were made in co-operation with the trade union movement and with the environmental movement. Together with trade unions a programme was designed on occupational health and safety, financed by the university and some ministries. The programme included:

- A research programme;
- Advising of community organisations in part of the researchers working time;
- Postgraduate education on occupational health and safety;
- Training of trade union members in occupational health and safety.

One result of the programme was the formation of an interdisciplinary research group at the university on occupational health and safety. The science shops were aware that it could be difficult for local community groups to set aside resources to participate in such programmes, which implied that it would mostly be national organisations that took part in the programmes. The science shops were therefore aware that these studies should not take too many of the science shop resources, because it might take too many resources away from the daily work with short-term advising. (Jørgensen, 1995, p. 70)

The experience from three science shops in Leiden, Delft and Rotterdam from a programme study on soil pollution, which should formulate some of the topics to a national research programme on soil pollution, is that the environmental organisations lack experience with discussions of more long-term research needs. They are more focused on here-and-now knowledge production. On the other hand, it was the experience from the programme study that the organisations developed expertise in discussing research needs through the participation in the programme. One of the science shops summarised their experience with programme studies as:

- It is important early in the programme study to start co-operating with the departments where the science shops hope to start research;
- The topic should not be too broadly defined;
- The work is complicated if too many departments are involved;
- The interest of the departments of participating is greater if the programme study has links to earlier research;
- It is a challenge to balance the wishes of the community organisations and the involved researchers;
- It is often possible to get programme studies financed by the university and/or the relevant ministries with 3-6 month of research. This is often not enough, which means that the programme study often takes time from the day-to-day work in the science shop (Jørgensen, 1995, p. 71).

This last experience about the difficulties balancing the day-to-day activities and the more long-term research and educational activities is also the experience from the science shop at the Technical University of Denmark.

Also today, some Dutch science shops have the possibility to get research financing based on topics raised through the science shop. One of the schemes that seem to have existed for quite a long time is at Tilburg University. In May 1984 it was decided that the university would make funds available for the Science Shop of Tilburg University, which would enable the Science Shop to finance long-term research projects. These projects should make scientific research at Tilburg University more committed to the needs of society. In the first years after 1984 the Science Shop allotted most money to projects which had a duration of one or two years. Since the end of the Eighties, most of the money has been spent on the co-investment in Ph.D. projects. Also some money goes to 6-month preliminary investigations that should lead to proposals for Ph.D. projects. Nowadays all our Ph.D. projects are co-financed on a matched funding basis. Other partners in these projects are mainly the departments of Tilburg University, but other institutes, municipalities and other parties outside of the university also take part.

The university makes available 135,000 Euro for these projects on a yearly basis. Some of the projects also make use of external funds. At this moment 8 Ph.D. projects and 1 preliminary investigation are running. Themes that are covered include: multiculturalism, the role of environmental groups in environmental law, intercultural management and the sustainable use of water.

Proposals for these projects are, on the one hand, made by the Science Shop to departments, or on the other hand by members of departments of our university to the Science Shop. These proposals should be approved of by the board of the Science Shop and by the board of the department involved in the project. All proposals should be both relevant to society and should be of a high scientific level. All projects show that it is indeed possible to make these conditions meet.

Each Ph.D. project that is co-funded by the Science Shop has its own steering committee, which consists of members from societal organisations, such as environmental groups, civil servants of municipalities or departments, representatives of minority groups, etc. In this way Ph.D. researchers get their input from society on the one hand and the members of these committees get the latest results from scientific research on the other hand. These interactions turn out to be extremely useful and are highly valued by both parties. There is also some interaction between some of these Ph.D. projects and the research questions from groups and organisations in society that are mediated by the Science Shop and that are researched by Master students of our university. This kind of cross-fertilisation is beneficial to both our Ph.D. projects and to the research questions from groups and organisations in society (Tim van der Avoird, 28 March 2001).

Another recent examples is from the University of Groningen the science shops have received about three Ph.D.-grants during the last 10 years or so. The university has a central fund for some Ph.D. grants. When the science shop gets a grant they are invited to describe a project, which then is affiliated with one of the departments at the university.

5.3 Developing new research topic within an existing department

Researchers at the scientific departments can also be actors – without funding – embedding science shop topics in research. An investigation from the mid 1980's of the spin-off from 10 years of science shop projects in the Amsterdam science shops analysed the impact from science shop projects on the research agenda and showed that this impact was bigger than from 'traditional' research activities (Zaal and Leydesdorff, 1987). The investigation analysed the impact from 162 science shop projects that had been done by researchers. 22 cases had led to 33 scientific publications or congress papers and 21 cases had resulted in follow-up investigations independent of the original questions. The reasons for the researchers to go into the science shop projects in the first place was in most cases either for social (71 cases out of 162) or scientific reasons (30 cases out of 162). For those not pursuing follow-up activities the reasons found were:

- the problem does not match with the focus of the researcher;
- the problem was too narrow;
- the problem was too familiar (and therefore did not give new scientific challenges);
- lack of time for doing follow-up activities;
- the problem is more of an applied research question (that is, not a more basic research question).

Among researchers taking up projects for scientific reasons, the motivation was in some cases the possibility to get access to data that normally would not be accessible, like studying personal dossiers or doing participant observation. In a few cases (10 out of 162) the researchers had reformulated the question as part of taking up the science shop project. These cases showed the highest relative number of publications and follow-up investigations.

The development of research on so-called green water management (local waste-water treatment and on (re-)use of rain water) at the Technical University of Denmark is a recent example showing how a researcher (and teacher) within an established field of research and teaching at a university develops a new field of research and teaching in co-operation with a science shop, but is carried by a combination of scientific and social interest of the researcher. (The development of teaching within this area was described in paragraph 4.5).

In relation to the field of rainwater, the involved professor has participated in building up a coherent network by combining different relevant groups or social units that operated within the field. He believes that building up a very large contact network is important in the beginning of establishing a new research field.

The means of building a network has been the arrangement of a number of seminars held by the science shop and two departments (on environmental technology and on urban planning) in co-operation. As a part of an attempt of establishing a new research field, the seminars were intended as the creation of a forum, where desultory/sporadic experiences held by different social groups could be brought together already knowing something about the alternative technology. The professor's contribution to the seminars includes, among other things, pointing out what he finds to be critical areas and formulate topics that need further research. This was done in student projects supervised by the professor or some of his colleagues. Later on the students presented their results from projects relevant for the issue of a certain seminar. By being critical and formulating questions that are based on academic thinking instead of practical problem solving, the professor not only contributes to a reformulation of what problems are related to rainwater technology and how these problems should be solved, he also participates and contributes to a process where this field becomes a part of research undertaken by the institute. Today the network consists of users, authorities, companies, and researchers who are somehow related to these technologies.

The building of a network and the activities related to this is an example of how a field can develop from within an institute at a university based on science shop projects. As such the interests in rainwater technology are going from firstly being held by actors outside the university (the citizen groups) to another actor inside the university (the science shop) to a third actor, which also acts within the university community (two departments). The issue is being 'carried' by different social actors into different communities of practice. In this way, the network both works towards the world and internally at the university.

Dealing with alternative technology, the professor's own field of research has been widespread and holistic not only in the research themes, but also in the approach applied in the research. Whereas he used to deal with treatment of wastewater, he now works only with waste from households in general. Including more mass streams in his research, he applies a more overall view on household waste (interview with Mogens Henze, 25 Oct 2000). The co-operation with the group on urban ecology at another department has also strengthened their co-operation.

One incentive for researching in alternative technologies is that the professor finds the 'mainstream' research too uninteresting to deal with alone. Besides this, it is also possible for him to apply his knowledge and experiences from one of the fields to the other. Seen in this light, his engagement in science shop projects is also closely related to the fact that his interest for environmental issues has been congruent with themes of the projects offered by the science shop.

Being able to make enough publications on the base of his mainstream research and models developed here, the professor is not obliged to publicise articles within this new research area. He has, however, experienced several problems with academic profiling within the alternative fields. There is no tradition of scientific documentation and publicising within the fields of rainwater and green wastewater treatment and periodicals are lacking within the alternative field. Among traditional periodicals the attitude is that the (alternative) research is not well enough documented and that there is great insecurity about the reliability of the results, and finally that an increasing number of articles for publishing makes the competition harder. This means that not only have the conditions of publishing changed in general and it has become harder to get a chance, the researchers who research in alternative fields also face a number of additional barriers in their efforts to publicise (interview with Mogens Henze, 25 Oct 2000). Table 2 shows the interaction between the societal discourse, the science shop activities and the role of the university teachers and researchers:

Period	Development in societal discourse related to green water management	The activities undertaken by the science shop and the affiliated community research centre	The interests of the 'established' researchers at the university
1985 – 1990	- Focus on low-tech wastewater treatment. - Focus on reuse of rainwater.	- The science shop receives questions. Projects done as student projects.	- Teacher finds science shop projects time saving and interesting. - Topics are not included in existing courses.
1990 -	- Strengthened interest for local wastewater management. - Debate on the reuse of rainwater. - Stakeholders participate in seminars. - EPA starts projects on reuse of rainwater and local wastewater management.	- Science shop decides to try to embed activities on 'green water management'. - Proposes two departments to organise seminars together with science shop.	- Teacher proposes new project themes – from a more critical angle. - Departments get research projects. - Teacher starts integrating topics in existing courses due to the growing relevance for engineers. - Researchers have problems publishing in scientific journals. - Also used to publish in non-scientific journals.

Table 2: The embedding of' green water management' at Technical University of Denmark as interaction between the societal discourse, the activities in the science shop and the affiliated research centre and the interest of the researcher.

In North America the criteria for getting a tenure position seem to be a barrier for some researchers' interest in community research. A community researcher has now been encouraged to apply for a tenure position. This might pave the way so more researchers become interested in community research and do not skip the area because they fear they put their scientific career at a halt.

5.4 Introduction of participatory research methods at the university

At the University Centre for Pharmacy, the co-ordinator in the Science Shop for Medicines some years ago introduced focus group interviews as a way of involving patients in research projects to her colleagues at the department, where the science shop is affiliated. The co-ordinator did this due to own experience with this method. It is her experience today that the scientific staff is now so confident with the method that they propose themselves to use the method when the department considers new research projects. (interview with Evelyn Schaafsma, 30 Nov 2000). The enabling factor for this impact is the close relation between the science shop and the department (as described in section 3 about impact on curricula), due to the fact that the present head of the department is former science shop co-ordinator and the present science shop co-ordinator also teaches at the department.

5.5 From science shop to centre for participatory research

Two case studies show impact on the research through the creation of a centre for education and research within which the co-operation with citizen groups – but also the development of initiatives within curricula and research – takes place. The two cases are the Center for Urban Research and Learning (CURL) (and the affiliated PRAG network) at Loyola University and the former interdisciplinary centre at Technical University of Denmark. The advantage seems to be the possibility of using resources for as well as research and teaching, as networking initiatives within the university and with citizen groups and other important stakeholders.

These two aspects were also mentioned in paragraph 4.5 in the discussion of the renewing activities at the Technical University of Denmark. The centre was formed as a so-called 'common unit' among five departments at the university.

The experience from the centre is also that the challenge precise is the balancing of these two types of activities: 'own' activities and networking activities. An example of a research network activity combined with concrete research was a three years research programme on urban ecology and cleaner technology at the university from 1991-94. The Interdisciplinary Centre was encouraged to organise and co-ordinate this programme, because university politicians found the community relations and the research capacity of the centre as two important prerequisites to the research programme within urban ecology and cleaner technology at the university. Altogether, 16 departments and research units took part in the programme, which was applied for as a so-called high-priority area at the university. The group got money from the university for half a year of visiting professorship, three Ph.D. grants, two senior researcher grants and seed money for preparation of research projects.

Networking activities can also be seen from the activities that PRAG as network and CURL as centre are doing besides the work with support for collaborative research through interns, research assistants and community apprentices and fellows:

- PRAG working groups in order to support more focused research and action activity in subject and geographic areas that have emerged in the projects already supported. Each working group has two co-chairs, who represent either the research or action sides of policy issues;
- Community access to routine research tools. Through some of its participating universities, PRAG has been providing computer accounts and library privileges to community partners in collaborative research;
- Policy breakfasts with local government officials. Through a formal agreement with the mayor's office, PRAG is sponsoring policy breakfasts that brief city commissioners, city staff, and city council members on completed research projects (Nyden et al, 1997, pp.25-26).

CURL has built on its collaborative policy and educational work by seeking to establish a local-to-local, community-based policy research network that provides an alternative to the dominant top-down policy development process. The intention is to create links between university-community collaborative projects in multiple cities as the foundation for developing national policy alternatives that are anchored in the day-to-day realities of urban communities (Report on Accomplishment and New Initiatives, 1999, p.14).

6 Conclusion

The study has shown that science shops, besides 'helping' citizen groups by carrying out a project based on their knowledge need, also can 'give' the host university a lot. Students can get other types of qualifications. The science shop projects can inspire to new ways of project based and problem oriented studying and to new course topics. Researchers might get inspiration to new research topics and might involve citizen in their research. It seems, however that many science shops do not have a strategy for how to get impact on curricula and research at the host universities. The focus is mostly at the co-operation with the citizen group on the single project.

The analyses have discussed the direct impact on the curricula when students do science shop projects as part of their education, which is possible in around 70% of the science shops answering the SCIPAS questionnaire. The indirect and more long-term impact on curricula and research seems more difficult to obtain. Only around 30% of the science shops report that science shop research has been included in course and modules. Less than 30% of the science shops report to have had impact on the research methods and the research agenda at the university.

A number of enabling factors and conditions for obtaining long-term impact on curricula and research have been identified through the case studies:

- Science shops can influence strategic university decisions, either through participation in the decisions or through alliances with scientific staff or university management with influence on strategic decisions.
- Personal resources for networking and own initiatives at the university and towards citizen groups. This can be in terms of science shop staff with scientific qualifications, grants for scientific staff, Ph.D. grants etc.
- Science shop staff also working as teachers and/or researchers gives the opportunity to develop own courses and research activities.
- Visibility of the achievements and the competence of the science shop make the university administration and the scientific staff aware of the potential in involving the science shop.
- Scientific staff gets involved in science shop activities due to social and or scientific interests.

- Tenure criteria not acknowledging community research can be a barrier to scientists' involvement in community research.
- Changes in the societal discourse about the competence needs of academic candidates towards more practice or user oriented competence discourse and about the relations between university and society towards more interactive relations are a potential for the science shop. These changes can give science shops possibilities of getting involved in the dissemination of the competencies that can be obtained through science shop projects to more students and disseminating participatory research methods to the scientific staff.

It is not possible to point to a blueprint strategy on how to obtain the most impact on curricula and research. It is more a question about utilising those occasions that show up and which can be used for strengthening the role of the science shop and the role of practice orientation and participatory methods and thereby making the science shop valuable and indispensable to the university. When a science shop gets involved in activities aimed at developing education and research it is a challenge to balance between the day-to-day activities and the long-term impact. It can also become a challenge to maintain the identity and the role of the science shop, when the interactive approach is expanded to include more than citizen groups, like small and medium sized enterprises. That is, the impact should be seen as a local or situated interaction between the science shop, the university as institution, the teachers and researchers and the development in the societal discourses.

T theoretical approach applied in the study, where the impact at the universities are analysed as processes of social change and the changes are related to the local history and the development in societal discourses, has proven to be valuable. There is, however, a need to make more analyses. One type of analyses needed is statistical analyses relating the impact on curricula and research to the approach of the science shop, to the resources available etc. Another type of analyses needed is more interviews with researchers that have taken part in changes of curricula and/or research related to topics emerging from science shop projects in order to understand their motivation of taking part in this kind of activities and in order to get more information about how the interaction between science shop, researcher citizen group and societal discourses actual impact the research agenda and by that impact a central part of the knowledge production.

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