# ADAPTING THE CDIO FRAMEWORK TO BIOMEDICINE EDUCATION

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## ABSTRACT

This paper presents "work in progress" with adapting the CDIO framework to a BSc program in biomedicine. The aim is to create a new curriculum aimed at training students to be able to identify, assess and implement biomedical ideas, and to understand how these concepts can be developed into products in the biomedical field. The work was initiated after an alumni questionnaire identified significant changes in employment opportunities for biomedicine students. From academic positions, more alumni were employed outside academia, specifically in the industry and non-traditional workplaces. Moreover, although good employability, the program has had fewer applicants in the last couple of years, and students have had difficulty to identify with the profession as medical biologists. To create a new curriculum where students not only learn deep disciplinary knowledge, but also learn how to apply these in real working situations, a network with stakeholders from the industry and SME was created. Information about the future need in the field of biomedicine was collected and a need for students with capabilities matching those stated for CDIO, i.e. "a medical biologist who can conceive, design, implement and operate complex biomedical research questions and methodologies". The CDIO framework will be implemented with initial focus on Standards 1, 2, 3 and 8.

## KEYWORDS

CDIO framework, Entrepreneurship, Project Based Learning, Biomedicine, Communication, Bio entrepreneurship, CDIO Standards: 1, 2, 3, and 8.

## INTRODUCTION

For 20 years ago, Linköping University created a BSc in Biomedicine that provided graduates to PhD programs. The main focus was to provide graduates with academic skills. Over the last 20 years several great changes have occurred in the life science industry. Big pharma has reduced the number of employees and increased the involvement of contract research laboratories (CRO). At the same time, the numbers of small and middle size enterprises (SME) have increased, also including CROs. These changes have created a new employment situation for graduated biomedicine students. Furthermore, the employment situation is also changed in academia due to less funding capacity for basic research. Less PhD students have been registered the last 5-10 years. The change in employment situation was confirmed by a recent alumni questionnaire that visualized that most of the biomedicine students, after finalizing a future MSc or PhD program, are employed in the life science sector outside academia. From the student's perspective, it has been unclear to identify a future career, since the program primarily has been focused on academic positions for graduating students. Thus, due to unclear career path for the future graduates, the program had hard to recruit new

students although a high employability. The number of applicants was decreased dramatically. Based on above finding we initiated a work to rewrite the curriculum.

Despite the changes in the job-market, a great need for people with deep disciplinary knowledge in biomedicine still exists. However, students today also need other skills such as: Excellent oral and written communication skills, knowledge of project management, an innovative way of thinking, skills within advanced technologies and bioinformatics. It is more common today to work in interdisciplinary team, with a need to translate and communicate knowledge between engineers and medical doctors (multihelix.se). These skills are best homed in real situations where students will meet potential customers of employers. Additionally, close contact with the society outside academia would make it easier for student to identity their future possible professions.

The Faculty of Medicine and Health Science at Linköping University is well known for successful programs within professional medical education such as medical doctor, nursing, physical therapist in the health care sector, and so on. The medical school have been ranked as one of the best in the country regarding learning outcome related to patient care, team working and interpretation of skills from medical school Grundutbildningsenkät (2014) and Lövtrup (2015). However, the faculty is also running both a BSc and MSc program within biomedicine that were created to prepare for a future academic career. Traditionally, the faculty uses student centered learning with a problem-based pedagogical profile Dahlgren (2009). The professional programs have good success stories in using multidisciplinary teams in teaching and learning situations. However, while it has been easy to prepare students within the professional programs for future working situation, it has been harder to find similar situations for the BSc students.

It was decided to use previous experience on how professional medical education is taught at the faculty together with an adaptation of the CDIO framework which is used at the Faculty of Science and Engineering to create a new curriculum within the framework of the current biomedical education at Linköping University. The main goal is to prepare students for future work situations within the life science sector outside academia by adapting and using the CDIO framework, but also to identify the future professional status of the biomedical student in a better, more clear way.

## CDIO BACKGROUND

The CDIO framework is a powerful and widespread tool for design and management of engineering education, and a thorough introduction to the framework is given in Crawley et al (2014) and the web site the CDIO Initiative (2018). The main purpose of this paper is to present initial ideas and activities for adapting the framework to the field of biomedicine. Another example of application of the CDIO framework in a wider context are given in Martins et al (2017). In the engineering context the framework consists of four key components:

- A definition of the role of an engineer.
- Clearly defined and documented goals for the desired knowledge and skills of an engineer (The CDIO Syllabus).
- Clearly defined and documented goals for the properties of the engineering education program (The CDIO Standards).
- An engineering approach to the development and management of education programs.

However, provided it is possible to describe the intended role of the graduates from an education program in some other field it should be possible to apply the CDIO framework also there. As mentioned earlier this paper describes initial ideas and activities for adapting the framework to a bachelor's program in biomedicine. According to the CDIO framework, see Crawley et al (2014), the goal of engineering education is that every graduating engineer should be able to:

*Conceive-Design-Implement-Operate complex value-added engineering products, processes, and systems in a modern, team-based environment.*

An initial challenge in the work is hence to formulate a corresponding statement for graduates from the biomedicine program, and this work will be carried out in collaboration with various stakeholders of the education program. Provided a formulation of the role of the graduates has been stated the next steps will be to investigate to what extent the fundamental documents the CDIO Syllabus and the CDIO Standards need to be adapted to the new context. The CDIO Syllabus (2018), which can be found via the CDIO web site, is the basis for formulation the learning outcomes of both individual courses and the entire program. The CDIO Syllabus consist of four main sections

I - Technical knowledge and reasoning.
II - Personal and professional skills and attributes
III - Interpersonal skills: Teamwork and communication.
IV - Conceiving, designing, implementing and operating systems in the enterprise and societal context.

with corresponding sub-sections and sub-sub-sections. When applying the CDIO framework to the new field the main efforts will be on adapting Sections I and IV, dealing with the disciplinary knowledge and the professional role. The CDIO Standards (2018), which can be found and explained in detail via the CDIO web site, is a set of twelve components that are necessary to design and run an engineering program that enables the students to reach the desired knowledge and skills. The twelve standards are:

1. The context
2. Learning outcomes
3. Integrated curriculum.
4. Introduction to engineering.
5. Design-implement experiences.
6. Engineering workspaces.
7. Integrated learning experiences
8. Active learning.
9. Enhancement of faculty competence.
10. Enhancement of faculty teaching competence.
11. Learning assessment.
12. Program evaluation.

With appropriate adaption all items in The CDIO Standards are relevant for the bachelor's program in biomedicine. Hence a self-evaluation against the Standards would be of interest, but due to limited time this will be left for future work. Instead the focus in this paper will be on Standards 1, 2, 3 and 8.

As mentioned above, formulating a statement corresponding to “Conceive-Design-Implement-Operate …” for the graduates of the biomedicine program is a main challenge, and it needs thorough discussions with the various stakeholders of the education, i.e. the life science industry, faculty members, students, etc. However, since this formulation forms the basis of Standard 1, i.e. *The context* of the education, it is very important for the next steps of the redesign of the education program. Also, with an adapted version of Standard 1 in place one of the following steps is to start the process of having e.g. faculty members, students, etc adopting the view.

Standard 2 deals with the *Learning outcomes* of the entire education program and how they should be integrated in the various courses. As mentioned, one of the main drivers for the redesign of the program is the shift in terms of future job market of the graduates from academia to the life science industry. This will of course have influence on the learning outcomes of the program, and, as will be described below, one aspect is a bigger emphasis on entrepreneurial skills.

Next, Standard 3 stresses the importance of an *Integrated curriculum* with mutually supporting courses. Concerning this it should be stressed that there is already a well working curriculum of the previous program, and this can serve as a good starting point. In addition, the process of designing an integrated curriculum benefits from an appropriate organization around the program with close collaboration between the involved faculty members. This has for example led to a redesigned organization around the program, as shown I Figure 2.

Finally, Standard 8 talks about *Active learning,* and since there is a long tradition of Problem based learning within the Faculty of Medicine and Health Science this is a natural part of the education. Of course, since the redesigned program will be more focused on the life science industry this will imply new forms of student centered learning, in e.g. projects in collaboration with industry. Examples of this type of activity are given below.

## PROGRAM OVERVIEW

The biomedicine program was initiated around 20 years ago by a pure academic need. The program had a high number of applicants and was rewarded with a good success rate with regards to students completing the program as well as the graduating students’ employment situation following completed studies. However, to address the current drastic changes in the need from the life science sector as well as the students, the program has a new curriculum beginning fall 2018. It will be the first international BSc program at Linköping University. The new curriculum has been named “BSc program in Experimental and Industrial Biomedicine”. As previously stated, the primary goal is to prepare students for employment outside academia as well as continued studies at advanced and research level. Through project-driven courses based on typical situations/problems from academia, healthcare and industry, students will be provided with a multidisciplinary base, latest approaches in project management, and an understanding of bio entrepreneurship. The program will train the students to be able to identify, assess and implement biomedical ideas, and to understand how these concepts can be developed into products in the wider biomedical field.

The program aims to integrate in-depth knowledge of medical biology with the latest experimental methods in biomedical research. Throughout the program, the students will receive practical experience in project management, laboratory techniques, as well as in data analysis, report writing and presentation techniques. Students will also meet industrial collaborators where they will be trained to translate biomedical knowledge into biomedical

applications, to prepare for further work in academia, healthcare or business. Students will have the opportunity to spend a semester at an academic or industrial actor in Sweden or abroad.

***Teaching and learning strategies, and methods of coursework***

At the Faculty of Medicine and Health Sciences student-centered and problem-based learning make up the foundation for both teaching and learning. The student personally takes responsibility for his/her studies and researches current content of the courses and study program. The methods of the course work challenge the students to independently formulate questions for learning, to seek knowledge and in dialogue with others and to judge and evaluate achieved knowledge. Students work together in groups on reality-based situations and problems to develop their own learning, contribute to co-students´ learning and to practice cooperation. The teacher´s role is primarily to support the students in this way of learning and give the students material on which they can base and expand their learning and knowledge. The course methods and integration modules stimulate and support the student´s development of professional and inter-professional competencies as well as prepare the student for cooperation in the coming profession.

The BSc program in Experimental and Industrial Biomedicine cooperates with the Faculty of Science and Engineering throughout the entire program as well as with other actors in academia, healthcare and business through project-integrated courses. Students learn to identify a need or an idea where they can apply their basic biomedical knowledge. During the program, students work in teams to develop medical ideas into products or services. The students will be well prepared to meet the needs of customers, to implement biomedical knowledge, and to manage projects with an entrepreneurial approach. The students learn to meet the requirements within project management and communication within their future professions in academia, healthcare and industry (Figure 1).

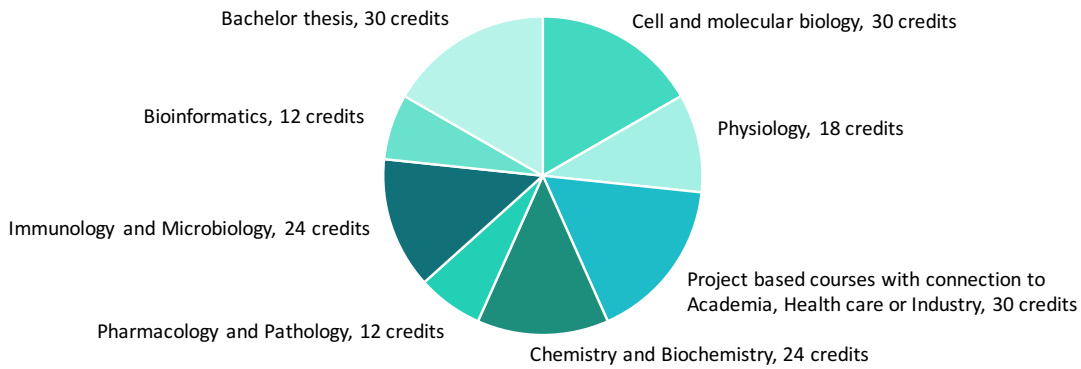


*Figure 1. The new curriculum for the BSc program in Experimental and Industrial Biomedicine includes activities to bridge the gap between the educational world and real world with future employers in academia, health care and industry.*

## THE DRIVE TO ADAPT CDIO IN BIOMEDICINE

With the above in mind, we initiated an adaptation of the CDIO framework to provide students with skills where they can adapt, integrate and use disciplinary knowledge. This also included a more clearly defined educational profile for the program to provide a better professional identity.

To understand current and future needs medical biologists in life science industry, an academic and industrial collaboration was established with the main goal to achieve a mutual understanding on how a program syllabus could be reformulated in order to prepare students for future work outside academia, while not losing the focus on the biomedical knowledge taught within the old curriculum. The group included the program director for current BSc program, big pharma (Astra Zeneca), stakeholders for SME (SwedenBio and the research-based pharmaceutical industry in Sweden (LIF)). Deep interviews were performed with people in different positions within big pharma. A close dialogue was held with a national working group in biomedicine and the program directors for the BSc program in Sweden. The goal of the national working group was to strengthen biomedicine as a profession in Sweden.

To validate our findings from the deep interviews and the dialogue with the national group, we invited stakeholders from the life science industry in Sweden together with all program directors for biomedicine programs in Sweden to a conference. The goal was to discuss the specific need of a close collaboration between the academia and the industry in Sweden. We decided that this group would function as a national reference group for biomedicine educations, where current and future needs can be discussed in yearly meetings. The creation of this reference-group will make it easier to understand ongoing changes in the life science industry and take these into account when developing new courses or course-material i.e. field-trips, guest lectures, laboratory work.

***Organizational Changes***

The best motivation factor to create a new curriculum was to remind the faculty that we already had a good program, but to maintain the excellent teaching and learning environment, and maintain student interest, a redesign was needed. This also included to the creation of a stronger professional identity for current and future students. The program has provided students with high employability but did not meet the current or future need in the biomedical field, due to the changes in both the academic and industrial profession over the last five to ten years. A strong motivation factor was to increase the applicant number of the successful program, and to meet future need with an up-to-date syllabus and modern learning techniques.

The Dean of the Faculty of Medicine and Health Sciences together with program directors for both BSc and MSc programs, initiated the work with the new curriculum. A team of teachers together with program directors was created that had close contact with the faculty and the local program committee. A close collaboration was created between the BSc and MSc program to oversee a progression in learning. The program committee includes today student, academic teacher, teacher responsible for internationalization and the student counselor, which had insight and were able to follow and affect the process. However, for the new curriculum, the program committee was expanded with stakeholders for academic research, industry and healthcare.

Initially, many groups were created that worked with the new curriculum in parallel to the current curriculum. This created a disorganization and difficult communication. To develop a more transparent process we went from the ad hoc solution to a more structured organization. Under the program committee, a management group were created including the program-directors and the co-directors for the BSc and MSc program. The BSc program and MSc program had own management teams and committees. The management team had direct contact with thematic groups with primarily responsible to oversee current and future program goal and learning outcome. Four groups were created; Group 1: chemistry, pharmacology and drug discovery, Group 2: physiology, pathology, immunology and microbiology, Group 3: cell

biology, genetics and bioinformatics, and Group 4: project-courses that run each semester. Modified goals for curriculum and course development were discussed with the program committee.

The process to adapt the CDIO syllabus for the biomedical field is ongoing in close collaboration with a CDIO-expert at the Faculty of Science and Engineering. The faculty for the BSc and MSc biomedicine programs had a workshop about how CDIO is used in the Faculty of Science and Engineering. In additional meetings with the core personnel for the programs, adaptation of the CDIO syllabus was discussed. The program plan was rewritten to include skills that have been overseen before (Figure 2).

To quickly evaluate the possible implementation of the CDIO-approach within the new curriculum, the management team worked together with the thematic groups. Modified goals for curriculum and course development were discussed with the reference group.

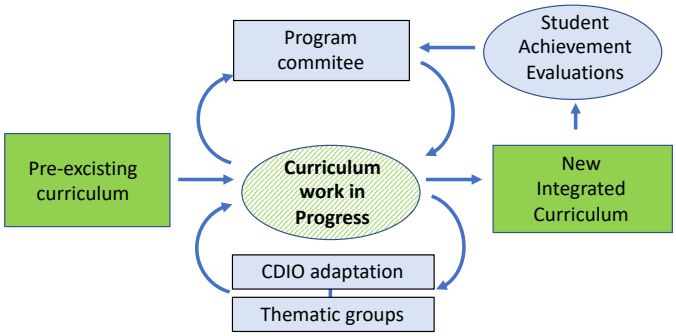


*Figure 2. The work to redesign the pre-excising curriculum to a new integrated curriculum is in progress that involves program committee, new thematic groups and continuously evaluations from current and future students.*

A syllabus survey will be created using a mixture of already excising question together with specific questions to students/alumni and stakeholders. The primary goal is to evaluate that the new curriculum is relevant and fulfils the goal. The questionnaire-responses will be used to guide future modifications and improvements of the curriculum, and to ensure the students' post-graduation success and employment.

The questionnaire is being developed and it will include questions relating to profession identity, theoretical and technical competence.

A. Questions specific to the students will include:
"How do you rate the program with regards to theoretical and practical knowledge?"
"How did your degree facilitate employment following graduation?"
"What is your current work-situation? In which area are you employed and what is your work-title?"
"Overall, what is your final impression of Program?"
"What, if anything, should be amended or altered in how the program is taught?"
"What did you find the most/least useful (of the components in the program) in your career post-graduation?

B. Questions specific to the stakeholders will include:

“What is the full set of interdisciplinary, interpersonal knowledge, skills, and attitudes that biomedical students should possess as they leave the university, and at what level of proficiency?”
“What knowledge, skills and attitudes of our biomedicine students are expected from alumni, faculty, industry leaders, hospital and society?”

## IMPLEMENTATION OF PROJECT BASED COURSE DESIGN

The program will have project-integrated courses with continuous development in project management within the biomedical field. During the earlier parts of the program, a greater focus will be on basic theoretical and practical knowledge and skills, while later parts of the program will have increased focus on interpretation of skills in different fields. This will enable students to explain human physiological and biomedical processes and, at a deeper level, understand how biomedical knowledge can be applied to issues in healthcare, industry and academia from both a commercial and a social perspective.

Disciplinary subjects will be taught in courses that run parallel with projects where biomedical professional skills are practiced. Scientific methodology, oral and written communication together with statistical methodology are taught within the course-work of the projects, and that knowledge is then integrated back into the disciplinary courses (Figure 3). The parallel approach allows for a wider application of knowledge, an approach that has been shown to increase learning and knowledge use in students (www.cdio.org).


*Figure 3. The program uses parallel integration of disciplinary courses and projects where the students learn to operate learned skills in real situations from the biomedicine field.*
A problem-based learning approach will be used for projects, where the disciplinary knowledge is interwoven around problems from real life situations. Each semester the students are introduced to an important need in the field of biomedicine that has been identified by the faculty and the reference group. The goal is for the student-group to use the CDIO-approach to in the end provide a solution to the presented need/situation.

The projects will start with a meeting with a “potential customer” that explains the need for a specific product or service. This will be integrated with specific lectures about the specific field of interest. Students need to understand the need and formulate an NABC (Need Approach Benefit and Competition) of the idea. The students will be working to identify their own professional skills for each project. Beside disciplinary knowledge, oral and written communication will be trained in the form of project report and a project conference that will take place at the end of each semester. Students will also have to design experiment examining the proposed need and implement and translate the obtained results to meet the specific need. By learning different types of projects management, students will practice working in a group and running a project together. The whole process will be evaluated by student-colleagues, a teacher examiner and the potential customer (Table 1).

*Table 1. The process for project courses include specific parts to ensure that the students can drive a specific need into a product or service.*

| 1. Significant Content | 2. Driving Question | 3. Student | 4. Skills | 5. Project Report | 6. Project Conference |
|---|---|---|---|---|---|
| Content identified by reference groups<br>-Biomedical Product Development<br>-Bioentrepreneurship<br>-Bioinformatics<br>-Drug Discovery<br>-Degree Project<br>-Clinical Trial | Students understand the need presented by the potential Customer by NABC<br>Need<br>Approach<br>Benefit<br>Competition | Student Active Learning:<br>Group Dynamics<br>Group Processes<br>Leadership | Parallel integration of skills<br>Disciplinary skills from parallel courses<br>Oral and Written Communication<br>Project Management<br>Scientific Methodology<br>Experimentation | Feedback from potential customer and teacher<br>Rethink<br>Rewrite | Delivery of report<br>Assessment<br>Student Ownership<br>Evaluation |

***A pilot test - Bio entrepreneurship***

The project course Bio entrepreneurship was created in 2016 as a pilot test in the current curriculum. Today, the project-work takes place during semester 5, when students have a good deal of previous knowledge from theory, as well as laboratory activities. The course started with lectures and a workshop about entrepreneurship and an introduction on the methodology of identifying an idea. During the course students also met entrepreneurs who were ventured into this field and found success. They met several business coaches from the innovation office and the start-up incubator LEAD at the university. This prepared the students for a new way of thinking. Instead of scientific methodology they learned an entrepreneurial approach. Students had to identify an unmet biomedical need and write an NABC (Need, Approach, Benefit, Competition: © SRI International)(Carlsson et al 2006). To do so, the students described who the potential customer was, and the need for the product or service. This was done in parallel with other courses, and students worked in small groups under supervision.

Students received further lectures on business management, oral and written communication, regulatory work, and Intellectual property right (IPR). Here, they learned how to present their own product or service following a business model canvas. Through value creating feed-back forum, students took a role as potential customer, investor or society, and gave specific feed-back to each-other to improve the product or service. The course ended with a “dragon-nest”, where students needed to pitch the idea for 60 seconds and describe the ideas deeper for 7 minutes. Students were examined by oral and written communication, through the dragon nest, NABC and the business model canvas.

In an oral evaluation student highlighted the importance of the course for the profession:

“This is an important essence of the program, and I highly welcome and encourage that it evolves from being just a single course in one semester to becoming as much a focus of the program as academic research. For too long, many students applying to the program have felt a certain insecurity as to what sort of career can be pursued after graduation. I believe this clarifies what sort of future an education in medical biosciences can offer you”.

**ACTIVITIES FOR IMPROVING THE PROFESSION IDENTITY**

In this part of the work the goal is to improve the professional identity and to bridge the gap between the educational world and real world with future employers in academia, health care and industry. We have previously been successful in establishing a close relationship between our student-body and academic research groups. Practical laboratory work during the bachelor thesis is often done together with research groups both in academia and industry. Several teachers are also active physicians and provide contact with the healthcare-sector. However, in the pre-excising curriculum we have not been working as actively on the professional identity of our students. Within the curriculum, outside of the thesis-work, there have not been people invited from the industry. Within the new curriculum, a broader aspect including healthcare, industry, academia and other putative employers, will be expanded to increase the future possibilities of our students.

In the new curriculum, project courses will focus on the professional identity each semester. Since the projects during the program will have different directions there will be different types of future careen opportunity that will be discussed. In the bachelor thesis, the students will get a chance to work a whole semester.

In addition, during each semester, one day with focus on professional identity for both the BSc and MSc program. The focus will be to discuss:

*What knowledge and skills and attitudes are expected from each graduating biomedical student?*

The spring event will focus on invited alumni that hold lectures. The topic/area will be changed on a yearly basis to cover all different areas within the life science sector where alumni work. The goal for the students is to understand what skills and attitudes the alumni appreciated from the program, how they have been useful, and how they can be employed by the current student-body in their future work-places.

The fall event will provide field trips to potential employers within the life science sector. Students will get a chance to understand how facilities work outside academia and get the latest update about the employer situation. Students will get a better understanding for how the work situation differ in the life science sector depending on the academic level. Students will also get a better understanding for different employers within SME, big pharma and healthcare.

## CONCLUSION AND FUTURE CHALLENGES

We can conclude that it is a strong advantage to have a close collaboration with technical faculty that has a long experience of working with the CDIO framework. We have started to implement standards 1, 2, 3 and 8. We are aware of that the implementation of the framework needs lots of time from teachers that is difficult to find. Our goal is to start with the curriculum and work with the adaptation over several years. We will have a great focus on good evaluations to provide data that our students learn to implement and operate disciplinary theory. We will also evaluate that students meet real working situations and potential employers to identify biomedicine as profession.

## REFERENCES


- C.R. Carlsson, W.W. Wilmot (2006*). Innovation: The Five Disciplines for Creating What Customers Want.* 1st ed, New York, Crown Business, 2006.

- E. Crawley, J. Malmqvist, S. Östlund, D. Brodeur, and K. Edström (2014). *Rethinking Engineering Education. The CDIO Approach.* Springer. 2nd edition, 2014.
- L.O. Dahlgren (2009). *Interprofessional learning and problem-based learning– a marriage made in heaven?* Journal of Interprofessional Care, 23:448-54, 2009.
- Grundutbildningsenkät *(2014), Om läkarutbildningens kvalitet.* Report in Swedish. Sveriges läkarförbund, 2015.
- *Kompetensförsörjning inom life science: en nuläges och framtidsanalys. Behov, tendenser och trender (2016),* Report in Swedish. *http://www.multihelix.se, 2016*
- M Lövtrup. *(2015) Läkartidningen. 2015; 112: DIE6*
- Martins, E. P. Ferreira, and J. C. Quadrado.(2017) *CDIO in the Design of a Non-Engineering Program.* 13th International CDIO Conference, Calgary Canada, 2017.
- *The CDIO Initiative*. (2018) http://www.cdio.org/, 2018.
- *The CDIO Syllabus*. (2018) http://www.cdio.org/, 2018.
- *The CDIO Standards*. (2018) http://www.cdio.org/, 2018.


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