

COMMUNICATION IN ENGINEERING EDUCATION – A NEW WAY OF LOOKING AT INTEGRATED LEARNING ACTIVITIES AND FORMS OF COMMUNICATION

Ida Klasén

Royal Institute of Technology
School of Education and Communication in Engineering Science

ABSTRACT

A new analysis and development model has been designed to make the discussion about *'integrated communication in engineering education'* more multifaceted. The model includes the two main principles of communication in education – *communicate to learn* and *learning to communicate*, and new dimensions of how learning in communication is integrated in subject courses. Active and passive integration are two opposite ways of handling integration of communication skills training in subject courses. By including this approach in the discussion about integrated learning activates and combining them with the two main principles, a model of communication aspects in education can be drawn out. The objective of the model is to more clearly and more multifacetedly point out different types of situations and learning activities where the students are given the opportunity to, in one way or another, develop their skills and abilities in work life communication. The model has been the subject of a pilot study at the Royal Institute of Technology in Sweden. In the study teachers from the bachelor level were interviewed about their thoughts on integration of communication in engineering education. In the analysis the model was a base in identifying in what sense communication was integrated and in what area the integration was weak. The results of the evaluation of integrated communication in subject courses will also be discussed in the light of the teachers' willingness to make changes in their courses. The conclusion from this study is that the teachers need to rethink in what way they are integrating communication in subject courses. On course level the model of integrated communication can be used to inspire to a broader use of different types of teaching and learning activities do develop communication skills without making a major change in the way the course is carried out.

KEYWORDS

Integrated communication, passive integration, active integration, engineering education, learning activities, informal communication, formal communication

THE NEED OF A BROADER PERSPECTIVE

Talking about integration of communication in subject courses means in a broader perspective that teaching and learning in communication takes place together with teaching and learning of technical knowledge embedded in the same courses and in the same learning activities. That results in the fact that teachers in subject courses also have to take responsibility for the students' opportunities to develop communication skills. One aspect of what is needed to be discussed is if teachers in subject courses have the knowledge on how

to train their students in written and oral communication. A common attitude from teachers that has been discussed in literature is negativity against this integrated approach because the teachers are afraid of losing time for subject content [1]. These kind of arguments can easily be overcome with the insight that *what we teach our students is not the most important thing, the main focus should not be on what is taught but on what the students are able to remember from the class and what they have learned* [2]. To be an engineer, subject and technical knowledge is not enough. It is important for an engineer to possess skills and abilities that are more than calculation and modeling, exactly that is the meaning with the CDIO concept. In a learning perspective this interaction between the subject and skills does not make the education bad or less rich of technical substance, in fact new knowledge taught in a meaningful context is more memorable over time than if it had not had that context [3]. In a study from 2010 it came clear that integration of skills and abilities in subject courses exists on paper (e.g. syllabus document, course plans) but not in reality [4]. In fact, in the learning activities and in the assignments subject contents and skills were separated and not handled equally. It was pointed out that there exists an attitude of giving technical knowledge higher priority than skills and abilities [4 s. 6]. The result of this procedure does not help the students to be good engineers with the capability to behave as engineers. In another study this weakness in newly graduated engineers skills and ability to act as real engineers has been demonstrated [5]. The result from the 2010 study indicates that the teachers need to rethink their attitude to integrated skills and it has to be better defined what we mean by 'integrated communication' in subject courses [4]. We need to rethink how we integrate communication in engineering education to better provide opportunities for our students to develop engineering skills.

As for all types of engineering skills, communication is dependent of the content and the context and communication occurs in an interaction between people [6]. Communication for an engineer include the ability to talk to people in different contexts, both in front of people and smaller groups, to be able to write different types of document to different types of receivers and to be able to communicate in different languages [7], [8]. It is common when talking about communication in education to divide the area into two main elements, 'communication to learn' and 'learning to communicate' which represents ways to handle communication integrated in education. The 'Learning to communicate' approach emphasizes that communication is dependent on the discipline and is needed to be taught that way [9]. 'Communicate to learn' is more of a pedagogical approach where the communication represents a part of the learning activity that helps the students to work with new knowledge and put it into a context i.e. make new content their own knowledge. These two approaches concern in which relation to the subject that communication should be taught. They do not explain how communication could be a part of subject courses and how it could be integrated with the learning of subject content. Integration can be done in many ways. The question to ask is if the students learn different things depending what approach the instructor choose to have. To discuss this problem we have to be able to handle different types of integrated communication in a systematic way. To support that discussion a new definition or parameters have to be introduced to describe in what way communication and subject content are integrated with each other.

Passive and active integration

Communication skills are subject and discipline dependent, which means (in an engineering context) that to learn to be an engineer the student has to learn to communicate as an engineer in an engineering context. In other words students have to learn to act and communicate as engineers, not only learn to communicate in general. Today communication is often a part of subject courses. A study from 2010 showed that it was common with communication parts in engineering courses at KTH [4] but it was less common with integrated communication. The study described a reality of courses combining subject content with training in communication, but where both course learning outcomes and assessment separated the two parts from each other. When integration of skills and abilities

are discussed, the outcomes from the study in 2010 are important to have in mind. It has to be clear if we focus on 'real integration' where training in communication is impossible to separate from the learning of subject skills, or if the communication part of the course is easy to separate. To be able to handle these two different approaches a new concept is introduced, 'passive integration' and 'active integration', defined in figure 1.

<p>Passive integration: Communication is included in subject courses but is assessed separately from subject knowledge and not included in the curricula.</p> <p>Active integration: Communication skills are integrated with subject skills in the course curricula. Communication skills are practiced, taught and assessed together</p>
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Figure 1 - Passive and active integration

Integration of communication in subject courses is something complex and not simple and can be handled in different ways. Different perspectives should not be thought of as opposites of each other and none of the different perspectives are in by itself better than another. A combination of 'passive and active integration' and the common 'learning to communicate/communicate to learn' is needed to be able to enclose all approaches described in the national higher education ordinance and the CDIO syllabus.

MODEL OF COMMUNICATION ASPECTS IN EDUCATION

When handling the complexness of integrating communication in engineering courses a combination of different perspectives and approaches are needed to give the student the ability to fully develop higher skills in engineering communication. In a broader perspective the ability to communicate as an engineer is not only to be good at formal writing and oral presentation, but also to be able to act and talk like an engineer in engineering contexts. As a part of the literature study in my master degree project a *model of communication aspects in engineering education* was developed to more easily handle the complex world of integrated communication in engineering courses. The model combines the two main principles 'learning to communicate' and 'communicate to learn' with passive and active integration. In the model the four blocks represents different forms of communication e.g. direct and indirect communication, formal and informal communication in engineering education. The model is shown in figure 2.

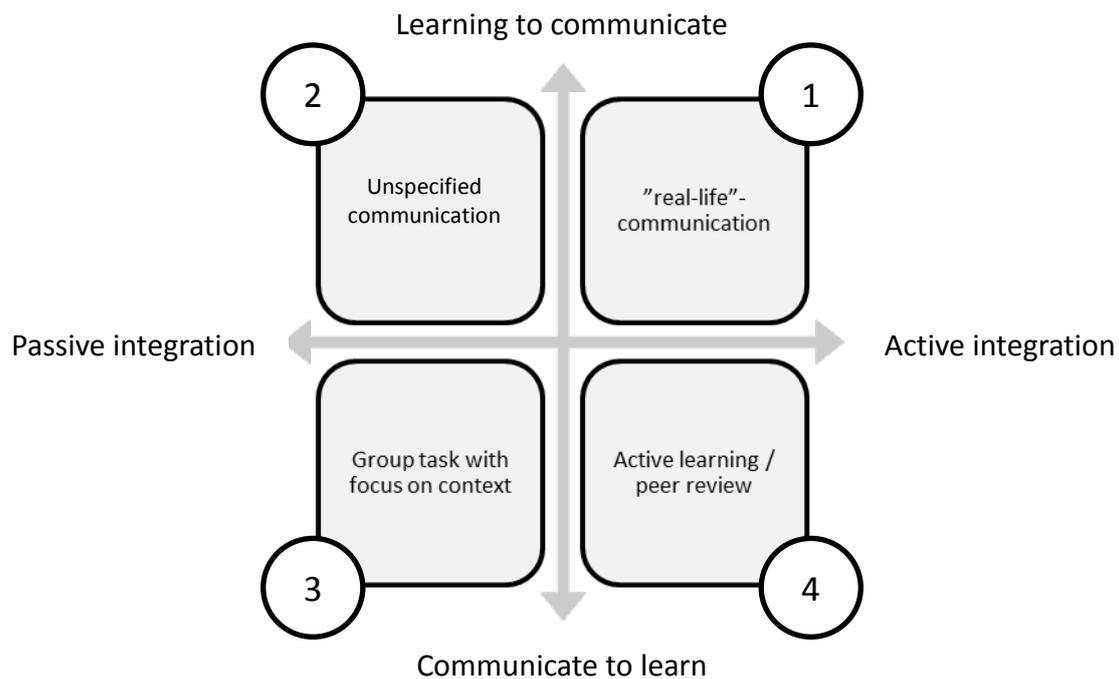


Figure 2– The model of communication aspects in engineering education

The model clarifies that communication in engineering education is multifaceted and consists of many different learning activities and different assignments and assessment tasks. To educate engineers that fulfill the CDIO-syllabus and the national ordinance of higher education in accordance with both communication skills and other skills and abilities, students need to be able to manage different types of communication skills. In the model these different part of communication are represent by the four different blocks.

In the model the vertical axis polarizes the two main approaches of using communication in subject courses – ‘learning to communicate’ and ‘communicate to learn’. These two concepts are derived from the two more known concepts ‘writing to learn’ and ‘learning to write’ [10][11]. These two describe possible aims of the communication part in the course. We have to choose if the aim is to use communication as a learning tool and as a carrier of knowledge by ‘communication to learn’, or if the aim is to provide the students with abilities in communication on a high level (as engineers) by ‘learning to communicate’. On the horizontal axis the two new perspectives are polarized. Passive integration of communication means that communication is a part of the course indirectly and the focus is not specifically on the communication parts but more communication is important to be able to handle the task/course. In the opposite direction the active integration takes place. By integrating communication in an active approach the teaching and learning is integrated in a thoughtful way where the whole learning activities integrate communication with learning in subject. This approach demands teachers to already think of integration in the planning of activates.

The four blocks and syllabus

The four blocks describes different perspectives in how communication can be an integrated part of the course. The given examples in the blocks in figure 2 are created to illustrate the core meaning of the approaches, but does not include the only potential activity or assignment. By continuously during the whole education integrating communication as described by the approaches in all blocks the student will have a fair chance to develop their engineering communication skills. In that sense none of the blocks alone is enough. An engineer is supposed to handle different forms of communication, and therefore the students are in need to practice the different forms. By analysing the form of integrated communication in the light of the Swedish national syllabus and the CDIO syllabus it is easy to see that all four approaches are important.

Block 1 ***Learning to communicate with an active integration approach***

By integrating communication in an active way the teacher need to already 'think' integration in the planning phase of the course or lecture. This approach means that the students develop their skills when using subject content in an environment or situation that is natural for an engineer in his or her occupation. This 'real-life' communication approach is multifaceted and contains for example the ability to write a technical report in a specific format, to write a conference abstract or to be able to sell the result to a board of directors. When assessing the students both the subject part and format of the product are important because the format and the content are so integrated in each other it is impossible (or difficult) to separate them when assessment is done.

Block 2 ***Learning to communicate with a passive integration approach***

In opposite to the 'learning to communicate with an active integration'-approach, the passive counterpart of learning to communicate do not in the specified way describe the circumstances around a specific assignment. An assignment that illustrates this approach may be a written technical report without any further instruction about format or receivers. Common with the active approach, the assessment is important but in this case it is more easy to separate the two parts from each other when the content not in a direct way are depends on the format of communication.

Block 3 ***Communicate to learn with a passive integration approach***

The simplest way of integrating communication in subject courses may be the 'communicate to learn' with a passive approach. The idea is that the students are learning to communicate by working with subject content. This is an indirect approach seen from the teachers' perspective. That means that the teachers do not 'do' anything to support the students in the communication situation. The students develop their communications skills by their own communication to learn more and/or better. A teacher can support this process by giving students pure subject assignment to do in pair or by giving the student the optional possibility to inspect other students work. The nature of this approach makes it very hard to assess the communication skills and performance.

Block 4 ***Communicate to learn with an active integration approach***

By using exercises with a communication focus as learning activities students can be given the opportunity to develop their informal communication skills at the same time as they consolidate and work with subject content. The active approach of integrated 'communication to learn' can take place in both large and small scale. The objective is to help the student to use all forms of

communication in an active way in the learning process. For example, if the students give each other feedback on some kind of task in an oral or written way, they do not only practice the communications skill that forms the feedback, they also need to use the knowledge of how to read and how to listen.

The number of types of activities that fits in the four blocks is huge. The scope of this paper do not include a full description of learning activities that satisfy the approaches of each of the four blocks. The model does not have the purpose to give the answer on how to integrate every approach but to give a broader perspective on in what way communication can be a part of subject knowledge. The model also does not include the versatility of communication in the sense that the skill includes ability to both in oral and in text be a receiver and a transmitter. To communicate is an ability to speak, listen, write, and read and to combine these four aspects in different ways. It is important to remember to include all aspects when designing learning outcomes in communication skills. As mentioned, the model in itself does not handle the four aspects, but for every approach each of the communication aspects can and should be included.

INTEGRATION OF COMMUNICATION IN REALITY ACCORDING TO THE OBJECTIVES IN THE MODEL

At the Royal Institute of Technology (KTH) the model has been used in a pilot study as a part of a master degree project to explore which of the four categories of communication in the model that is most common and how teachers are thinking about the concept of 'integrated communication' [12]. Teachers in different subjects and in different engineering programs were interviewed about their thoughts about communication as a part of education. The study depended on interviews with nine teachers from different parts at KTH with that in common that they all taught students in compulsory courses at the bachelor level (first cycle). The participants in the study were asked questions about their way of teaching, the presence of communication in their courses and what kind of support they needed to increase the prevalence of integrated communication in their courses. The main intended outcome of the study was to answer the two questions A and B in figure 3. The informants were asked open questions on a more detailed level. The informants were asked questions about their courses, how they were thinking when planning a lecture or a whole course and they were also asked to define what meaning communication had for them. The analysis and the aggregation of all the informants' different answers were used to answer the two main questions.

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| <p>Question A To what extent do teachers use integrated communication in their courses as a part of the learning activities and in assessment?</p> <p>Question B In what way do teachers need support to integrate communication in their courses, both in learning activities and in assessment?</p> |
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Figure 3 –main intended inquiries of the study

As a help in the analysis of the result the model of integrated communication was used to identify types of teaching and learning in communication. The analysis was made by interpreting the transcriptions from the interviews. To the greatest extent possible the informants' answers about how they think and act around integrated communication was matched with the blocks in the model of communication aspects in engineering education.

The existence of integrated communication (answer to question A)

Regarding communication, the teachers described a reality where the students, in their subject courses, had the possibility to develop their communication skills [12]. It came clear that the teachers had a limited view of communication skills and the opportunities to in their courses help students improve their skills. In a larger perspective the teachers had a limited thinking about communication in education: communication was commonly defined as presentation skills. By looking at the informants' answers in the study, block 2 in the model (learning to communicate with a passive integration approach) was the most common type of integrating communication in engineering education. The choice of assignments and the way the informants talked about how they wanted their students to study also indicated that the students had a large opportunity to, during the study time, learn subject by communicating in a passive approach (block 3 in the model). A large amount of courses had indeed assignments that invited the students to collaborate, but the informant did not define this as practicing communication. In the interview study it also came clear that teachers have a different attitude to "pure engineering skills" than to personal and professional skills and attributes [12]. The study testifies that teachers often have a view on subject knowledge as something more important than skills and abilities. One teacher describes *'For every lab they write a report, I ask them not to write so much, just focus on calculation and so on. Because that is what is important'* [12]. Almost every one of the informants had a good understanding of how questions during lectures could provide a better learning environment. This active learning approach that the teachers were talking about fits very well into block 4 of the model.

Way of making change (answer to question B)

The study conveys a positive attitude towards developing the courses to a more integrated approach. One specific force for making changes was identified by the informants in the study – the students' satisfaction. The informants described that the most important reason to make changes in the course was the students' feedback in the course evaluations and the feeling of student satisfaction. One informant described it like *'One clue that indicates that changes should be done is if the students are not interested in what I do on lectures and if a whole class on exam fail at the same task'* [12].

CONCLUSIONS

The study from 2010 shows that many attempts to give the students the opportunity to develop their communication ability were done, but maybe it could be done in a better way according to e.g. assignments. The interview study tells us that the teachers have some knowledge of how to introduce communication in lectures. The informants had not reflected on communication in a broader perspective in that sense that is drawn out in the model. In fact, many of the informants had not reflected on communication skills as something essential in engineering education at all. The same problem has been identified in another study in 2010 [4]. The teachers are willing and able to support their students to develop subject skills and knowledge. To help students to develop communication skills the teachers are more restrictive. It is not surprising; the teachers are experts on their subject, not teaching students to communicate. But like the focus in the CDIO Initiative, it is important to integrate opportunities for the student to develop personal and professional skills and attributes integrated with development of subject knowledge. On the other hand the interview study describes a reality where the teachers were well informed in what a good teaching and learning environments depend on, but it was difficult for them to make changes due to a lack of tools. According to that, to reorganize some assignments and by in a more systematic way including communication in already existing tasks it may be possible to in an 'easy' way give the students better opportunities to develop their communication skills.

It is important that teachers start to reflect on the different types of communication skills, the use of them and usefulness. By identifying the answers to the main question it is possible to see in what area work is needed to be done to provide a better understanding and usability of communication in an engineering context.

The *model of communication aspects in education* can be used to clarify what integrated communication in education means and can be a helpful tool in the process to develop and design new courses and learning activities with the target to provide the students communication skills and help them to start to communicate as engineers in real engineering contexts. A strength in the model is that the four perspectives in the model can be applied to both oral and text based communication and it includes formal as well as informal forms of communication. The model shows what is needed to be done and in what area of the integrated communication field that teaching and learning in communication is weak.

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Biographical information

Ida Klasén has a Master of Science in Engineering and of Education from the Royal Institute of Technology and Stockholm University. She is working as an educational developer at the school of Education and Communication in Engineering Science at the Royal Institute of Technology.

Corresponding

Ida Klasén

KTH School of Education and Communication in Engineering Science

Osquars Backe 31

SE-100 44 Stockholm, Sweden

+46-8-790 92 50

iklasen@kth.se