The Kista Mentorspace; A Novel Method for Knowledge Sharing in Engineering Education

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***Abstract*—This Innovate Practice Work-In-Progress paper describes a novel, knowledge sharing environment that addresses several current problems in technical education. This environment is called the Kista Mentorspace, and is hosted by the Swedish Royal Institute of Technology, KTH. Although the problems it deals with are many, this paper focuses on the following areas.**

1. How to provision applied learning and practice to support technical theory.
2. How to do this in a way that shows convincing value from higher education institutions.
3. How to extend this value and contribution in a very broad sense.

The Mentorspace provisions applied learning and practice by combining students from different schools in order to share their knowledge with engineering students. Knowledge sharing leads to applied practice including tool use, but that aspect is secondary. The Mentorspace increases the value of engineering education by tying applied practice to local needs and opportunities for graduates within the community. To extend this value in a broad sense, the Mentorspace brings in business and community developers to add local economic and social factors to the engineering curriculum. Success of the space is measured through academic and personal accomplishment, and contribution to community and social development. Long term mentoring by all participants regardless of age or social position is a cornerstone of the Mentorspace.

***Index Terms*—education, knowledge sharing, learning environments, social issues**

I. Introduction

The problem area addressed in this paper is how to create an educational environment that bridges theory to applied engineering practice in a way that emphasizes modern interdisciplinary skills, and contributes broadly to academic, economic, and social needs. New solutions are needed because of the increasing breadth of what are considered to be information technology (IT) products. Although the problem area is broad, this paper focuses on three solution areas. The first is how to provision applied learning and practice that connects to technical theory normally given in engineering courses. The second is how to do this in a way that gives convincing value from Higher Education Institutions (HEIs), and the third area is how to extend this value and contribution in a very broad sense. What is described here is a novel and unique environment for solving this problem that fits well within a university or other HEI. It is called the Kista Mentorspace, and it is novel in the way that it recognizes the breadth of the problem area, and solves it though a knowledge sharing process that involves all key players in the community; academics, business, and local government.

A Mentorspace is an open environment where knowledge sharing between people is the primary function. What makes it unique is the context and the scope over which knowledge is exchanged. In a Mentorspace, people engaging in knowledge exchange do it in the context of their own personal and intellectual growth, and the scope of the exchange spans the connections of that person to others in an academic, economic, and community sense. The Kista Mentorspace was started in 2007 in the community of Kista, Sweden near Stockholm and is hosted by the Swedish Royal Institute of Technology, KTH. It was created initially to answer the question of how engineering students can acquire the ability to realize future Information Technology products. This is no small question as it became quickly apparent that a single HEI acting alone can not accomplish this goal in any broad sense. One indication of this is that IT products have become extremely diverse over time, and IT can now be found in products that only a few years ago had little or no IT in them. Social services, personal fitness, transit logistics, living and working spaces, fashion, media, literature, and art are all examples of areas where IT and digital methods have become central to their design and use. But these disciplines are usually not broadly covered at technical HEIs. Another indication of this comes from several technical businesses local to the Kista area who have expressed dissatisfaction with the university graduates they interview and an unwillingness to hire them. They cite the lack of any bridge between theory, science, and practice in technical knowledge, leaving students unable to contribute to the business needs of local firms. The students themselves often recognize this deficiency, but few resources are offered to them to go from theory to ability in a way that promotes both applied and entrepreneurial practice. Finally, the Kista community itself has recognized that IT in many forms are central to future urban development, spanning how communities are constructed, managed, provisioned, and used by the citizens. However, local government have few opportunities to tie social issues to the curriculum given at technical HEIs. The Kista Mentorspace has addressed these problems by creating

an environment that combines academics, business, and local government in a way that equips students to contribute to the social, economic, and knowledge base of the communities they live in.

II. Provisioning applied learning

One problem the Kista Mentorspace addressed early is how to bridge theory to scientific and applied practice in STEM courses, although this problem exists in non-STEM areas as well. There are many causes for this disconnect, but significant ones are concerned with cost, experience, and connection to the community. Cost is a factor because theory is relatively easy and inexpensive to provide to students compared to applied practice requiring materials, equipment, and access to facilities such as laboratories. In addition to the cost of providing such things, applied practice of engineering theory often cannot be done on-line, providing an incentive to eliminate such practice entirely. Educator experience is a factor because many university instructors have little non-academic work exposure in the areas they teach, making them poorly equipped to show the connections between the theory, realization of the theory, and the resulting consequences to society. Community involvement is a factor because without connecting business or government to the theory, relevance to the real world and the opportunities this represents are lost. Under such conditions many students see no relevance in the theory, local industry see students with few marketable skills or entrepreneurial vision, and local government see few options for solving community problems.

Solutions to this problem that have become popular in recent years are often associated with the makerspace movement [1] [2], and tend to focus on access to tools, technology, or fabrication skills. It is not clear that this approach is effective [3]. Makerspaces, although useful by providing students with access to tools that they would not normally have, often have no connection to any curriculum with established learning outcomes. Tool skills are useful, but do not by themselves show the relevance of technical theory to any applied realization, especially if the students' teachers do not have these skills. It is for these reasons that simply giving students access to a room filled with tools and equipment is not enough to solve the theory to applied science problem.

The Kista Mentorspace addresses this by recognizing that students themselves can create the bridge between theory, science, and practice when they see interdisciplinary and entrepreneurial spaces that technical theory can contribute to. Examples include art, music, fashion, classic design, healthcare, transport, and urban planning. In many technical theory courses, these disciplines are not represented. The Kista Mentorspace provides these missing pieces by being open to students from all schools in the Stockholm area, thus creating a very interdisciplinary environment where students studying different areas can share what they are learning and what they want to achieve. One example is a long relationship that the Mentorspace has had with the Stockholm based art university Konstfack. Students participate in each others' course activities and share their knowledge from their own areas of study. By bringing in students from other disciplines, all students can see the connections between the problems the other students are trying to solve and their own problem spaces. This is especially important for engineering students who otherwise may not realize that what they are studying has broad impact in areas that they have not been exposed to such as interactive art, architecture, and active clothing. By sharing their knowledge, working together, and asking "what if", a path is created to applied practice. The question "what if" leads to "could we" and on to design and construction of an idea and realization of the technical theory into tangible artifacts. It is at this point that access to the tools and machines that are in the Mentorspace can be important, but it is secondary to the interdisciplinary knowledge sharing, and in all cases these activities are directly part of the students' coursework.

KTH technology students in the Mentorspace have now worked with students from other HEIs, high schools, and primary schools. All students who use the Mentorspace are not limited to scheduled course times, and can come back to the Mentorspace anytime to continue interacting. The Mentorspace is never closed and costs nothing to use which is a significant incentive for students to become involved. Having a Mentorspace open to all students at all times promotes creativity, and the formation of teams with diverse skills to develop ideas further. For engineering students, this open environment centered on interdisciplinary knowledge sharing leads to an understanding of what the technical theory is for and is key to building the bridge to science and practice. This model also provides for socialization among the participants and encourages mentoring and the sharing of life experience, which taken together goes far beyond what on-line courses and students working in isolation can do.

III. Providing convincing value for the HEI

Courses offered on-line change the value structure of higher education because without any value additions for the students other than remote access, the reasons for attending a local HEI can be called into question. Why attend the local school when one can get a credential on-line from a school with a well known prestigious name? This is a very reasonable question to ask because enrollment in on-line programs are no longer limited by the number of physical seats that can be offered. To attract students to the local HEI, there has to be convincing value. Providing resources for applied learning, and bridging theory to practice as previously described does provide value in itself. This is extended further by providing to the students the resources they need to progress from applied knowledge to tangible accomplishment. This is important as many local IT companies have made it clear to the Mentorspace that they often base hiring decisions not so much on academic measures but instead on demonstrable technical accomplishment. Students able to show this have an advantage, especially when their applied practice and accomplishments are strongly tied to local needs and employment opportunities within the community. Physical classroom or on-line content of the local

HEI can be specifically constructed to enable this in ways that a more general approach from a distantly located school cannot do.

The Kista Mentorspace provides for this by including local businesses and city government in its operational model. Kista is home to a wide range of companies that include engineering, consulting, and other IT firms. Representatives from these local companies are invited to come to the Mentorspace as participants in courses and applied projects that involve working directly with students. This contributes to the students' experience in two focused ways. First, the company representatives work with the students to show the importance and opportunities of the technology they are learning to local business activities. This gives relevance to the course material and helps to answer the question "Why am I learning this?". Second, they provide a very important source of mentoring to the students that is directly tied to the curriculum of the local HEI. The mentoring is of significant value to the students, both from a practical and an intellectual view. The practical view comes from the experience of the industry mentors. They are able to compliment the course theory by adding technology development methods that result in outcomes that are practical, innovative, and commercially viable, and which they understand should be part of engineering education but are often difficult for an HEI to provide. The intellectual view comes from the further academic and career advice given by the industry mentors to the students. This has an impact on the elective courses they choose, and leads them to adopt appropriate soft skills, such as technical communications and team dynamics. It also helps them understand the complexities of the employment market, how to find the opportunities they want, and critically assess the job offers they receive. In the case of the Mentorspace, this all comes with a strong connection to the local economic ecosystem with very accessible mentors. In exchange, businesses benefit by having a direct voice in the design of courses, participation in student development, and early identification of talent.

Community developers in the form of local government officials also contribute to this value add. Like the business leaders, they can join in the courses taking place in the Mentorspace to help the students understand how community development depends on what they are learning. This is important for any community, but it is especially important in Kista which is a center for technology companies in the Stockholm area. Kista expects to expand this economic base, and like many cities, Kista has a vision of becoming a digitally advanced multi-use community that uses emerging technology to further enhance opportunity, equality, and quality of life. By bringing this vision into the Mentorspace and sharing knowledge about plans and needs in the local community, students can see outlets for their developing skills that constructively contribute to the communities they live in. The community leaders also provide mentoring which adds an element of government and politics to the technical knowledge that is exchanged. In all cases, the course material is directly tied to and exploits the involvement of industry and government in the Mentorspace, which as an aggregate drives the course outcomes. It is this relevant and real connection to the local ecosystem that gives value, and helps to answer the question of why one should attend the local HEI. A general on-line course from a distant HEI cannot address these points, show the relevance of course material to the community, or provide the mentoring to help them understand how to build their abilities and show accomplishment.

IV. Providing value in a broad sense

Although the Mentorspace includes schools, local business, and city government in its educational operations, the value that it provides must extend beyond the individual benefits offered to its participants. Peter Drucker and Joseph Maciariello articulate this [4] when they point out that interest that does not extend beyond individual benefits results in pluralist societies with differing values. Such societies have in the past destroyed themselves because no entity concerned itself with what they term the *common good*. The scope of this problem is further described in a 2018 report by the World Bank [5] where they point out that despite efforts to advance education, individual actors often work in ways that only serve to further their own interests at the expense of the common good. It is in this regard that the Kista Mentorspace provides broader value by providing what Drucker and Maciariello term *civic responsibility* which is giving to the community while involved in the pursuit of one's own interests.

The Mentorspace does this by bringing together the interests of the participants and combining them through the knowledge exchange activities in ways that span across individual benefits. One way is though the mentoring process, and another way is through the interdisciplinary nature of the knowledge exchange. Mentoring is an activity that takes place between all participants in the Mentorspace, and is a process of sharing experience with the intent of helping another person to decide on a strategy to accomplish something. Mentors are not only participants from local businesses, and include anyone who uses the Mentorspace regardless of age, background, or social position. Much of the mentoring that takes place is in the context of the knowledge being shared, leading towards decisions about academic or career paths. But often the mentoring extends well beyond the immediate academic concerns, and can address any aspect of life. For example it often serves to give another person the confidence to see things in different ways, to explore something new, or try something that others have said they can't do. Mentors learn that they are not telling others what to do, but instead are sharing their own experience, and from that they are sharing themselves and building trust among others. To do this they learn humanistic skills that lead to empathy, understanding, and transparency. Mentoring by the Mentorspace participants is also important because HEIs are often not prepared to give individual career advice, especially with regard to soft skills required by industry, and entrepreneurial guidance. Strategies to manage one's career, and build ability over time is something that many will find to be necessary life long. All age groups have shown the ability to

serve as mentors for others, and graduated students routinely return to the Mentorspace to continue to both give and receive mentoring, and share new skills. They know that they are welcome to do this for as long as the Mentorspace exists. To know that this can be part of engineering education is one of the most rewarding aspects of the Kista Mentorspace, and are skills that are well adapted to the common good.

Interdisciplinary knowledge exchange contributes to the common good in another way by bridging the individual interests to form a collection of shared opportunities for community growth. By sharing opportunities broadly across multiple disciplines, the participants can see what connects themselves with others and with technology, and how they can cooperate to achieve shared values and objectives. It allows those companies with corporate social responsibility programs to include the Mentorspace in a way that directly combines their business interests with the needs of local government and education. This model also provides a framework for continuing education in the community, emphasizing technology, digitalization of society, and skills leading to individual digital literacy, for example in Scandinavian education [6]. The need for this kind of framework has also been identified by the World Bank [5] as a way to provide life long learning resources, but with the advantage of direct community ties. Through this, all Mentorspace participants develop a sense for the common good, and share in the task of civic responsibility.

V. Results and Conclusions

Early results in the development of the Kista Mentorspace are primarily qualitative, but do show that the Mentorspace has had concrete positive impact. Since 2016, the number of KTH students voluntarily using the Mentorspace has averaged 11 new students per month, or well over 100 new students per academic year. This number is in addition to students who gain access in order to take scheduled classes or events. The number of companies that participate in Mentorspace events has over this time grown to seven. In addition to this number, the Mentorspace receives sponsorship from the KTH Innovative Center for Embedded Computing, which is an industry collective currently representing 32 members, all of whom can be involved with Mentorspace courses and events. Kista City local government is also involved by facilitating an urban development initiative called the Kista Urban ICT Arena (UICTA) [7] which aims to bring emerging technologies into the Kista city infrastructure. The Mentorspace has served as the space where students, industry, and the city have worked together on several UICTA initiatives that benefit the community.

Students have shown their acceptance for the Mentorspace though feedback regarding courses and their own learning experience. In communicating with the Mentorspace, several students have made it clear that they would have dropped out of KTH if it had not been for the Mentorspace, both for the mentoring that it provides, and the meaning the applied practice gives to the theory courses they have taken. Students have been especially enthusiastic in courses that allow them to share their knowledge and experience with younger students. A recent example took place in the 2019 fall term when a class of grade 8 students studying entrepreneurship at a neighboring school joined in with a class of KTH engineering masters degree students studying product realization methods. The grade 8 students were looking at business opportunities that serve global social and environmental needs, while the masters students were studying engineering methods that optimize product development from both technical and business points of view. Through knowledge sharing and mentoring, the grade 8 students discovered how to best develop their ideas through technology use and prototyping. The masters degree students discovered new considerations for realizing products that emphasize the environment and sustainability. Both groups of students found that the level of understanding of their respective subject areas was enhanced by teaching each other, and explaining the connections between their own and the other students' work. The diverse age and expertise differences between the two classes were an enhancing factor, and the broadening influence of both student groups was evident in each others outcomes. Many students have said that courses like these are the best they have ever taken in their academic lives. Companies have recognized the value the Mentorspace provides, and have turned to it for a source of talent for internships, thesis projects, and permanent employment for graduates. As these companies are local to Kista, the benefit to the community through business growth is apparent.

Future work in the Kista Mentorspace is currently directed toward methods that can be used to expand subject and participation diversity even further, deployment of new tools used in applied engineering education, and ways to quantitatively measure how effective these methods are in several areas. These areas include intellectual growth in the students who use the space, and the degree to which the Mentorspace contributes to economic and social development in Kista. This work will supplement the use of subjective surveys with technology deployment that can give detailed and objective data. Another future work area is focused on ways to include more of the community to add value in an even broader sense. One potential example is to work with public facing organizations such as libraries in order to involve students with their parents and community leaders in areas of ongoing social concern. In addition to working to develop applied digital literacy skills in the community, students involved can assess the role of ethics as a component in the design of IT intended for public use. These processes will continue to include knowledge and methods from academics, local business, and city planners.

As an evolving organization, the Kista Mentorspace has shown very positive contributions to the way that engineering education is offered and used to further the interests of all the participants. It is hoped that as this work progresses, the operational details and practice developed in the Kista Mentorspace can be shared and replicated, especially those that support engineering education, and at the same time allow all interests in the space to contribute to the common good of the community.

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