

## Mapping future graduate attributes in a medical engineering curriculum

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### Abstract

Curriculum mapping is a process to ensure that a curriculum is relevant to students after they graduate. This study was conducted to map a medical engineering curriculum to future graduate attributes. Using STEEP analysis to predict future trends, new competencies for graduates were obtained. They are multi-disciplinary knowledge, teamwork and collaboration, research, creativity, and a business mindset. Six future graduate attributes were chosen to match these competencies. They are systems thinking, innovative thinking, curiosity, empathy, teamwork and collaboration, and experimentation. The current study also developed a student persona which represents students entering an engineering program. From the persona, the student's deep need is to take ownership in managing his/her learning. Using this mapping in a medical engineering curriculum, the students graduated from the program will have the required future attributes to pursue positions of interest.

**Keywords:** Characteristic, Program, Planning, STEEP, Persona

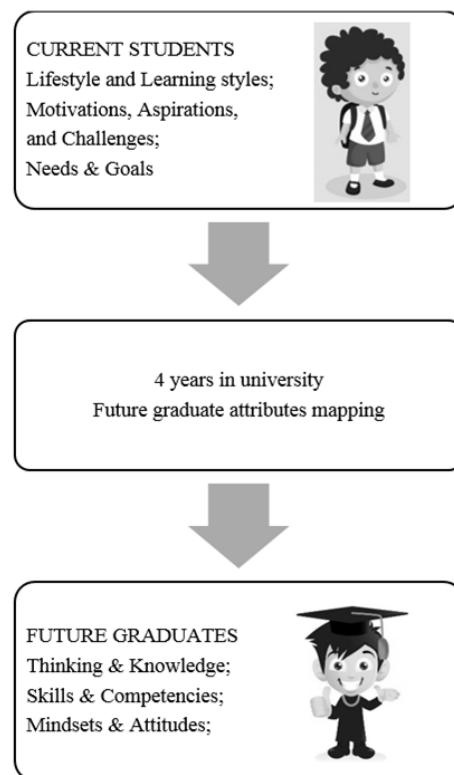
### 1. Introduction

Bachelor degree education is a process to transform students into graduates who are ready to work. For four years of education, their program needs to set up teaching and learning processes to enhance their students. Students gain knowledge and experience making them ready to thrive socially, environmentally, technologically and at work during these four years. Mapping is a process that is used to develop curricula and education to enable students to become future-ready graduates [1].

The mapping process is depicted in Figure 1. The steps are to first study the incoming students entering the program. The incoming students may be high school graduates, vocational school graduates, or first year students. Then, future trends are projected using STEEP analysis. Last, the outputs of the first and second processes are used to understand current students and future trends to maximize student outcomes after their eventual graduation.

### 2. Current student persona

The current student persona is the hypothetical student who represents the characteristics of most students. The persona has information about the incoming students to a medical engineering program. It includes information such as his/her demographic profile, social background and lifestyle, learning behaviors, motivation and goals, and deep needs statement. The current student persona

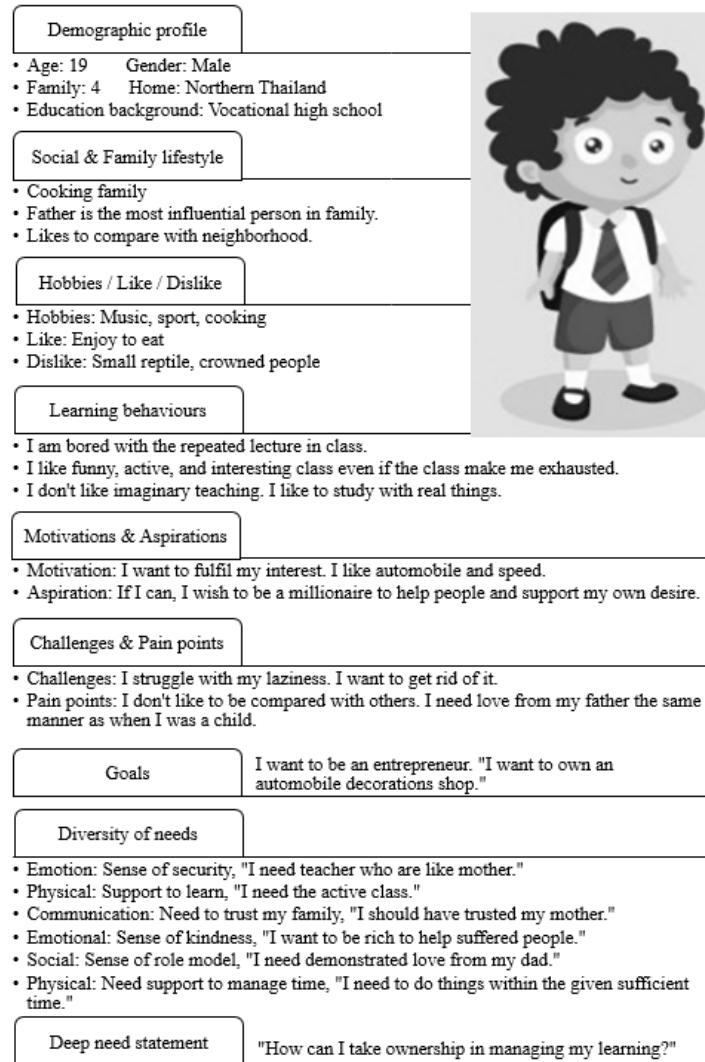


**Figure 1** Future graduate attribute mapping

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**Figure 2** Current student persona

was found after we researched and analyzed the deep needs of current students. Information about the student persona was collected by interviewing current students.

Figure 2 is the current student persona. This person is about 19 years old and mostly likely a male who graduated from vocational high school. His family probably consists of four people who live in northern Thailand. His father is the most influent person in family and also to him. His family likes to compare him with others in the neighborhood. His hobbies are music and sports. He likes active and interesting classes that study practical things. He does not want classes with a lot of lecture. He likes speed and automobiles, and his goal is to own an automobile detailing shop. He has a sense of humankind since he wishes to help people. He struggles with his laziness and does not like to be compared with others. He needs love from his father. He has diversity of needs, but his deep need is that he wants to take ownership in managing his learning.

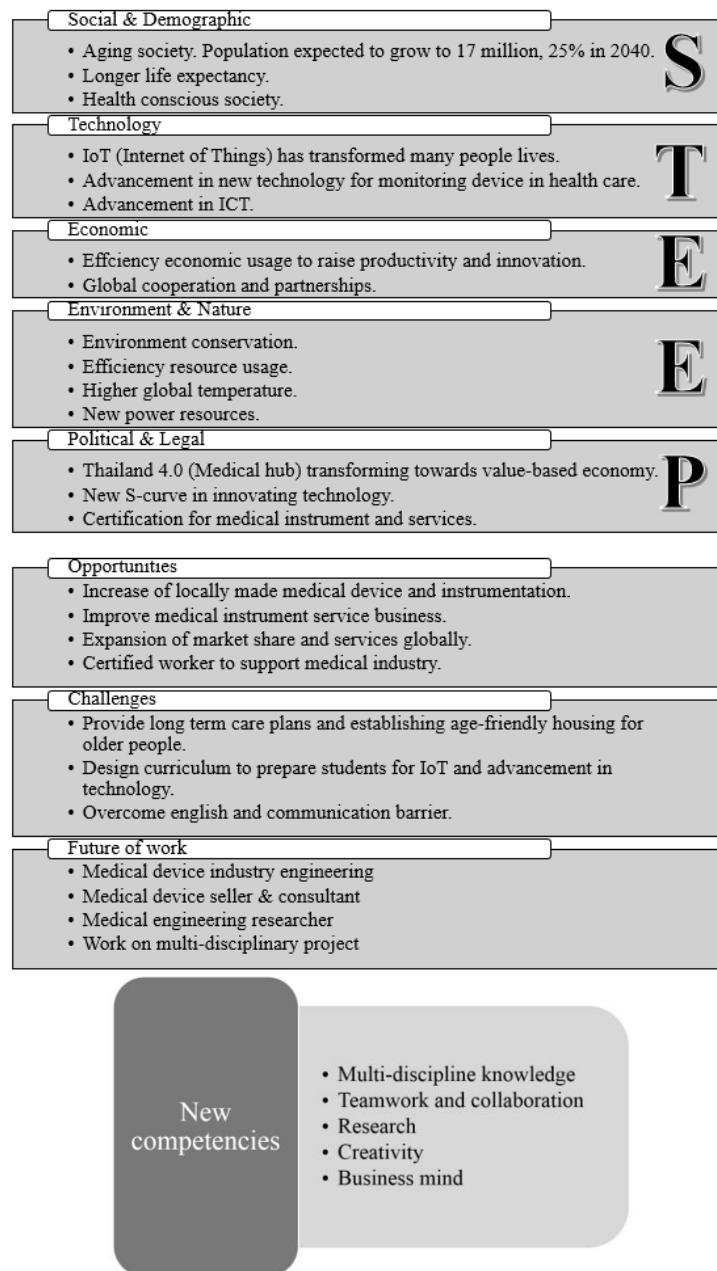
### 3. STEEP trend analysis

STEEP trend analysis is a process to foresee future trends. The five main topics on which focus is placed are social and demographic issues, technology, the economy, the environment and nature, and political and legal matters. The

information considering future trends that impact a particular industry and education need to be developed. Additionally, information about current trends needs to be considered as well. This will help us to understand the gap in our curriculum that needs to be bridged so that it fulfills future needs.

Future trend analysis includes SWOT, or STEEP trend analysis. SWOT analysis is focused on strengths, weaknesses, opportunities and threats. SWOT analysis may lack or miss information about technology since this is the most important information in an engineering program.

Figure 3 shows STEEP trend analysis for a medical engineering curriculum. Nowadays, medical engineering is very important and popular. It is a multi-disciplinary program that combines medical and engineering studies. It uses engineering principles to support medical techniques. Our university plans to start a medical engineering program bachelor's degree program within three years. The social trends include our aging society. Technology trends include more use of the internet. Value-based economics is used to increase productivity and innovation. Cooperation and partnership will be on a global level. Global temperatures will increase. People will need to conserve the environment and find the new energy resources [2-3].



**Figure 3** STEEP Trends analysis

As the country pushes forward to Industry 4.0 [4], certification for medical instruments and services will be required [5].

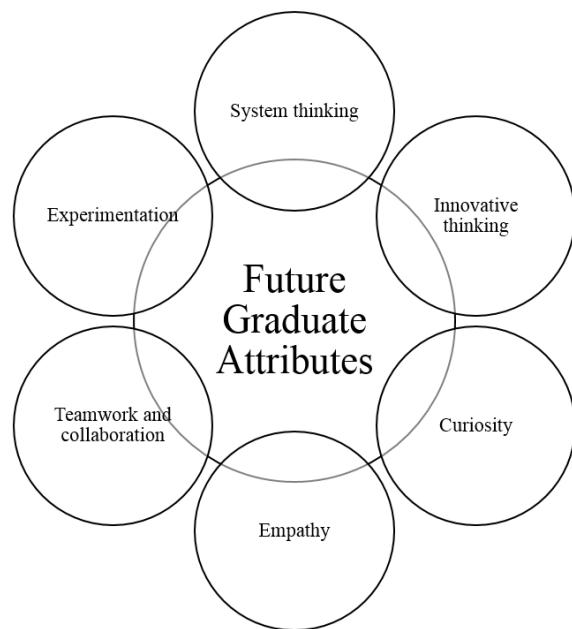
From the STEEP trend analysis above, there are opportunities to increase and improve local production, and expand into global markets. There are opportunities to train certified medical technicians to support this industry (Figure 3). The IoT (Internet of Things), our aging society and new technology need to be considered to take advantage of opportunities for a curriculum in medical engineering. Barriers to effective English language communications need to be overcome. Medical engineering graduates may work as medical device sales representatives, consultants, engineers, researchers, or work in other multi-disciplinary positions.

After consideration of the above information, it can clearly be seen that new competencies are needed to meet the opportunities and challenges of future of work. These new competencies are multi-disciplinary knowledge, teamwork

and collaboration, research, creativity, and a business mindset (Figure 3). The STEEP trends will impact healthcare, the internet and information technology, and power resources. Multi-disciplinary knowledge will be required. Teamwork and collaboration are needed to for global cooperation and partnerships. Innovation is part of many STEEP trends. The competencies of research and creativity to develop innovating technology are needed, and a business mindset will be required for economic success.

#### 4. Future graduate attributes

From the STEEP trend analysis, new competencies emerge that will be needed to work in the future. They are multi-disciplinary knowledge, teamwork and collaboration, research, creativity, and a business mindset. Six future graduate attributes were chosen to prepare graduates to reach



**Figure 4** Future graduate attributes

these competencies (Figure 4). These six attributes are systems thinking, innovative thinking, curiosity, empathy, teamwork and collaboration, and experimentation [6].

System thinking is a way of thinking that takes a holistic view of events or phenomena. It helps graduates to identify patterns, linkages, and relationships in complex processes.

Innovative thinking helps graduates generate new ideas or new ways of approaching things to create possibilities and opportunities.

Curiosity enables graduates to inquire, investigate and seek knowledge. It is a strong desire to know and to learn about the world around oneself.

Empathy is the ability to identify and understand another's situation and feelings. It is the basis of caring relationships and allows graduates to connect and understand people who may be different.

Teamwork and collaboration are the ability to work effectively and respectfully among diverse teams. It includes assumed shared responsibility for collaborative work, and valuing the individual contributions made by each team member.

Experimentation is the ability to conduct tests, trials, or test procedures to learn about principles, ideas, hypotheses, and product, among others.

Empathy, teamwork and collaboration help graduates to develop the ability to work with others. System thinking, curiosity, and experimentation strengthen the technical competencies of graduates with multi-discipline knowledge, their ability to do research, and to become life-long learners. Innovative thinking stimulates the creativity of graduates.

Future graduates should have four to six of these attributes. Initially, student competencies will not be completely developed. Students cannot rapidly develop deep skills in every competency. If a program provides its students with three or fewer of these attributes, it will not be competitive with other university programs.

## 5. Conclusions

Curriculum mapping is an important education process. A program needs to ensure that students who graduate from this curriculum have the attributes necessary to function in future workplaces. The six graduate attributes found in the current study are systems thinking, innovative thinking, curiosity, empathy, teamwork and collaboration, and experimentation (Figure 4). These attributes give graduates the competencies of multi-discipline knowledge, teamwork and collaboration, research, creativity, and a business mindset (Figure 3). From the current student persona, students require active classes, and they need to take ownership of their learning (Figure 2). With these six attributes, found using STEEP analysis and future graduate mapping, a program can transform new incoming students into future ready graduates who will be ready to effectively work after four years.

## 6. Acknowledgements

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