Et tu, robots? The first step toward an interdisciplinary approach

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As the technological sphere of our life is changing at an accelerating speed, the future could be far more surprising than most of us think. This paper reports on a classroom project integrating the topics of science and future society, robots, and Artificial Intelligences. Lessons were effective in enhancing student motivation, English skills, and critical creative thinking and raising awareness in ethical issues regarding technological development as a part of global issues. Through talking with science professors, some common ground was found which could be developed together in the future to bridge English classes and science classes.

人類の生活における科学技術の側面は加速的に進歩しており、未来は、我々が考えるより遙かに驚くべきものであるかもしれない。この論文は科学と未来社会、特にロボットやAI(人工知能)のテーマを大学での授業に取り入れた試みについての報告である。レッスンは学生のモーティベーション・英語のスキル・クリテイカル・クリエイティヴな思考を伸ばし、グローバルな問題としての技術革新における倫理的側面への認識を高めることに効果があった。又、理系の教授達との対話から理系科目と英語の橋渡しを目的として将来的にカリキュラム共同開発の可能性が期待できるいくつかの共通基盤を見出すことができた。

> It is change, continuing change, inevitable change. That is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is but the world as it will be. This in turn means that our statesmen, our businessmen, our everyman must take on a science fictional way of thinking.
>
> Isaac Asimov

According to a recent *Japan Times* article with the headline: Osamu Tezuka: Fighting for peace with the Mighty Atom (Hornyak, 2007), Tezuka, with his pacifism and humanism, tried to make us look at the earth and mankind objectively for the sustainable future, through introducing an intelligent machine into human society. Thinking about peace and the future of mankind through talking about robots and Artificial Intelligences (AIs), while taking a little step toward an interdisciplinary approach, is the theme of this project.

The interdisciplinary approach is based on a constructivist view of learning (Kaufman, 1997), which suggests that new knowledge is created upon existing knowledge. Scholars such as Piaget, Dewey, Bruner, and others who hold a holistic view of learning support the idea. Interdisciplinary curriculum is defined as a curriculum which "cuts across subject-matter lines to focus upon comprehensive life problems" (Good, 1973) and prepares students for lifelong learning and abilities required by life in global society (Lake, 2001). From the neuropsychological point of view, human brains search for meaning and patterns so those synapses that are used and reinforced are strengthened. Therefore, what is learned in one area of the curriculum is connected and used to reinforce and expand the knowledge acquired in other curriculum areas (Bonds & Cox, 1993). Moreover, an interdisciplinary approach is effective in developing confidence (Wooten, 2000) and ultimately, an interdisciplinary approach means attempting to influence and develop the university itself (Evans, 1995).

Futures education, which develops the rich futures concepts while developing critical creative thinking skills, takes an interdisciplinary approach (Bateman, 2006). As the technological sphere of our world is changing at an accelerated rate, an element of uncertainty increases as we ponder the future. Teaching and learning about the future should play an essential role for constructing a better future (Tough, 1998), though there is little sign that the true importance of futures studies is recognized in school systems (Gidley & Hampson, 2005).

According to Moravec of the Carnegie Mellon University Robotics Institute (1999), human beings have two channels of heredity, a biological one and one for cultural information, which is handed down to us from mind to mind. Moravec argues that AIs, which will grow and learn from us, will be the "children of our minds," and that we, parents, gradually can retire as the children of our minds grow beyond our imagination. Computer power is growing faster than exponential speed (Figure 1) so Moravec claims that human-like robots will be possible in about five decades (Moravec, 2000). Scientist Naam (2005) suggests that what used to be science fiction is likely to be accomplished in the near future. A futurologist and an inventor, Kurzweil (2006), suggests that AIs are applied and embedded deeply in the infrastructure so AIs in our life are just like all the animals in the rainforest, invisible but surely existent, in the ecological system. Even a mock trial court case on whether it is right or wrong to unplug a self-conscious intelligent computer was held at a conference among real attorneys in San Francisco a few years ago (Rothblatt, 2003).

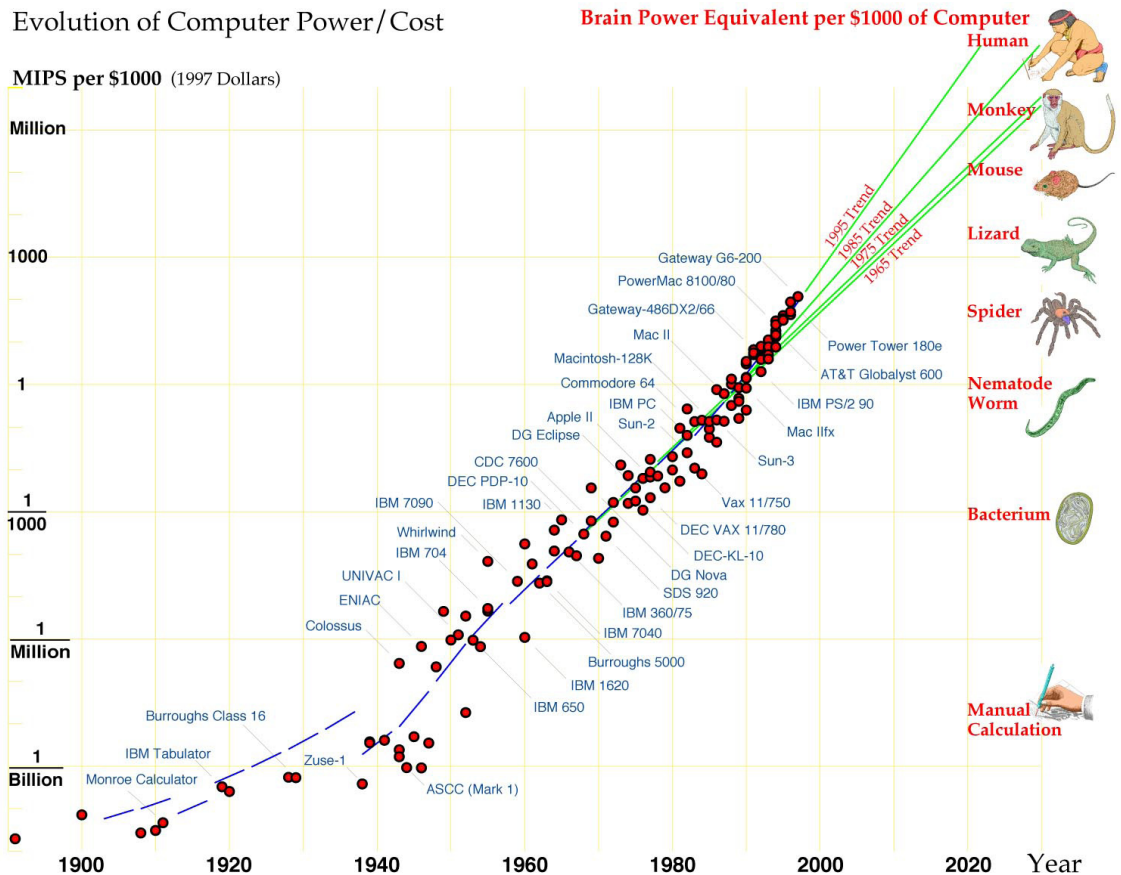

Figure 1: Evolution of Computer Power/Cost (Moravec, 1998)

It seems that scientists and legal experts with futuristic views are foreseeing the future and are preparing for the coming innovative changes. It is necessary for us to anticipate and prepare for the future before the future unfolds itself (Hicks, 2002). This project looks toward the future, reflecting the concept of futures education suggested by Hicks and other scholars, so students will be able to explore different scenarios that might possibly come out of current trends and to explore what is implied in these trends.

Setting and participants

The institutional setting of this project was the University of Electro Communications in Tokyo with a student body of about 4,000 students. Originally started as a training center for radiotelegraphy, the university puts emphasis on hands-on experience in learning. It was selected for the 21st Century Center of Excellence Program sponsored by Ministry of Education and is very oriented towards science and engineering. Students show a keen interest in science, cutting-edge technology, and IT related areas. In fact, many students, mainly graduate students, present their research and innovative technology at international conferences and according to the university homepage, some of them receive international awards each year, including in the field of robotics. Participants of this study are science major sophomores, 72 students in total (two classes), with the proficiency level of low intermediate to high intermediate. The course was called Academic English for 2nd Year Students.

Goals of the project

The goals of the project were to enhance English skills and motivation, while sharpening critical creative thinking and raising ethical awareness of technological development as a part of global issues. I tried to take the first step toward an interdisciplinary approach in this project to explore the ways to bridge science classes, which are the students' main concern, and English classes. In doing so I tried to foster the students' self-images as future scientists, growing toward self-actualization with self-determination, being interdependent with global community using English skills, and being interdependent with science community using knowledge and skills in science (see Figure 2). During the course of the project, I interviewed three science professors for the purpose of getting to know science professors, getting to know what they think of English education, and trying to find some common ground to bridge science classes and English classes.

Procedure and timeline

The project lasted 8 weeks. These were the middle 8 weeks of a 16-week semester. The class met once per week for 90 minutes.

Weeks 1 to 3

ABC News: Robot Science. The news report introduces several robots developed by Japanese engineers as helping hands to humans: robotic baby seal, humanoid with sophisticated attitude, and security robot, among others. Students studied this news report thoroughly. Then students,

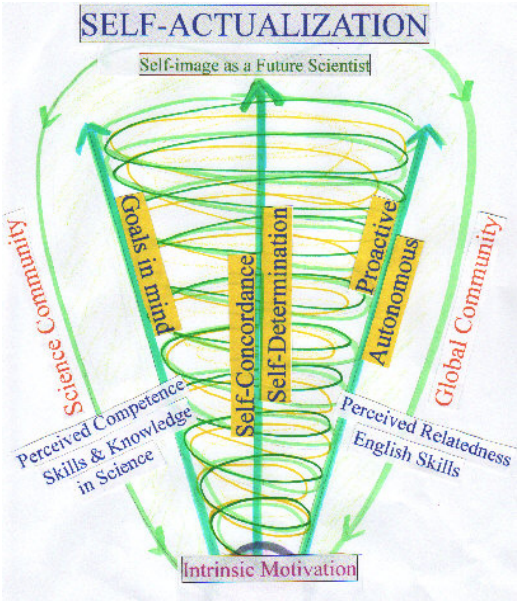

Figure 2. Upward spiral curriculum image for the science majors

in groups of four to five, designed their dream robot using a worksheet (see Appendix A), then created a poster or PowerPoint presentation.

Week 4

Students presented their dream robots in groups. One of the goals of this first part was to foster students' self-image as future scientists.

Week 5

ABC News: George. This news segment introduces an Artificial Intelligence as a human companion in cyber space and his inventor, Rollo Carpenter. George in cyber space learns through interaction with people and his personality is created from the influence of people with whom he has interacted with (Artificial Intelligence, 2006). Students discussed the program (see Appendix B).

Week 6

Film: *I, Robot* (Davis, 2004). In class, students watched part of the film after I briefly explained the plot. We closely read a few parts of the script of the film I had prepared and students in pairs practiced the conversation, for example, the dialogue between a self-conscious AI and .the main character. Then students summarized the story and commented on it.

Synopsis: The film is loosely based on Isaac Asimov's novel, *I, Robot* (Asimov, 1950). The year is 2035; the place Chicago. Humans and robots are living together. Dr. Lanning, the creator of the robots, has died. Sonny, a self-conscious AI with free will, is interrogated by the police. Toward the end of the film, all the robots revolt against the humans, controlled by the central intelligence, VIKI. Sonny, with his free will, saves the humans.

Week 7

The Financial Times: UK report says robots will have rights (Davoudi, 2006). The article says that a UK government-commissioned report raised the idea that we may one day

give sentient robots the kind of rights "traditionally reserved for humans." After reading the article with comprehension questions, students discussed the question: If scientists develop self-conscious robots that are fully integrated in the society and essential to day-to-day life, what kind of rights should we give to these robots? How about duties? What are possible problems and solutions? (See Appendix C.)

Week 8

After having discussions and mind-mapping their ideas, students wrote argumentative essays following the format for an argumentative essay which was provided. Theme: If scientists develop self-conscious robots that are fully integrated in society, do you think robots should have the full civil rights of humans or should we ensure human control over robots through the legal system?

Outcomes

Creative thinking

Creative imagination is essential in designing and envisioning preferable futures. When students in groups designed their robot, their creativity flourished and many interesting robots were proposed: for example, a babysitting robot with automatic food and beverage service; a cooking robot with 20 elastic arms; a rescue robot which rolls to the destination, transforms itself into a snake-shape to go into the narrow spaces and searches for people; a luggage carrying robot with special ID tags; and an almighty robot with global positioning system (GPS). In the open questionnaire many students commented that they enjoyed designing and creating their dream robot with their peers, giving shapes to their imagination. For example, Student A commented:

> I enjoyed preparing for the presentation and I enjoyed lots of interesting ideas for imaginary robots. Creating something new cooperatively and collaboratively is great. I attended the class more positively than usual.

There was much excitement throughout the course of preparation sessions and students tried to communicate in English using the phrases such as, *How about ~ing?, I agree but…, How interesting!,* and so on. During the presentation session, students proudly presented their robots with happy smiles. Both presenters and audience enjoyed and appreciated the innovative, original, eccentric, or quite realistic ideas for their creation. Students naturally and enthusiastically participated in the question/answer sessions after each presentation.

Comments on interdisciplinary aspects

Many students commented from an interdisciplinary point of view that they liked the topic and enjoyed studying English because they are majoring in science. For example, Student B commented:

> It was beneficial for me because the topic was what I'm interested in and specialize in. The words and expressions I learnt in this class will probably be useful when I read other papers and reports in my field in English.

Along with others, this student tried to bridge English classes and science classes, expressing his hope to apply what he learned in English classes in science classes.

Motivation and English skills

In the open questionnaire, many students wrote that their motivation to study was enhanced because the topic was interesting and thought provoking. Student C wrote:

> AI is a very interesting theme to work on. I was very much interested in and was motivated to study. The topic of robot was a good theme because it stimulated a lot of thinking. I worked hard on essay too, spending hours and hours.

Students liked the topic because it made them think a lot. Several students expressed their belief they felt like reading more and writing more because the topic captured their interest. Almost all the students completed well-organized persuasive essays, which was a successful outcome. I believe that when students show power and effort beyond the teacher's expectations, this is a sign that we have successfully stimulated energy within the students to strive for achievement for achievements' sake. In other words, students developed intrinsic motivation.

Many students commented that they felt that they made progress in English proficiency through thinking and creating using English. Also several students commented that presenting in English was beneficial for them because they would need the presentation skills in the real world.

Critical thinking

Critical thinking is essential in looking at the issues from multiple perspectives to probe for alternative ways of thinking. Students had ample opportunities to look at both positive and negative aspects of technological development and their critical thinking was activated and sharpened. In their argumentative essays, students took either a humanistic approach or skeptical approach and both sought for peaceful coexistence. As expected, students' arguments about robots' rights turned out to be very much like their arguments over human rights' issues. In their argumentative essays, about 30 percent of students took an idealistic, humanistic approach to the issue and argued for full civil rights for robots. For example, students wrote in their essays:

> I think robot with self-consciousness is one living thing. In other words, I think robots who have self-consciousness create one race so we should not discriminate any race. (Student D)

> Unless they have rights, robots will always be named as criminals, whenever there is a conflict between humans and robots. (Student E)

> If robots would have self-consciousness, free-will, feeling heart and emotion, robots would be much the same as humans. They should have the right to defend themselves against pain. (Student F)

Through thinking about robots, they thought of human rights, since their argument works the same for human society in a sense that unless people have full civil rights, they are discriminated against.

Skeptics chose to write on "human control over robots through the legal system" and their arguments toward peaceful coexistence were persuasive as well. For example, students wrote:

> Robots could be highly intelligent and their intelligence could be a threat to humans… Over time, humans could become lazy and excellent robots might rule humans. Superior beings have survived and ruled other creatures through the process of evolution. (Student G)

> I think robots are developed to do what humans want them to do. However, if robots start insisting their rights, they would refuse to do some dangerous tasks. (Student H)

> Robots will think that they are superior and that humans should not exist in the world, though humans are the creator and the robots are products. (Student I)

Students took a rather realistic skeptical approach and argued that intelligent robots could be a threat and a destructive power to human society. Many students pointed out that inventors and scientists should be aware of the danger of developing AIs with highly sophisticated intelligence. Thus, students' ethical awareness as a part of critical thinking was sharpened.

Ethical awareness

In fact, some students approached me and said that they would rather write that scientists should not develop self-conscious robots. I acknowledged their wish and that thesis became the third choice. For example, Student J argued as follows:

> What is self-consciousness? No two persons can live in the exact same situation and every single person has one's unique self-consciousness. Even identical twins have different self-consciousness. I don't think human-made robots could have ultimate self-consciousness. If one robot would have such imperfect self-consciousness, find that other robots have the same thinking pattern, he would be realized that he is an imperfect existence. He may destruct another robot to protect his own identity. Or he may hate humans who made him…

Here, this student argues that scientists should not develop self-conscious robots through going deep into the question of self-consciousness. And the question is closely related to the philosophical question of what it means to be a human: is it flesh and bones or is it self-consciousness? His argument reminds us of the agony of the monster in *Frankenstein*; as early as 1818, Mary Shelley warned us of the dangers of creating human-like creatures. Students raised their ethical awareness through thinking about the possible negative aspects of future technological development. With forward-looking attitudes, students called for decision making today for a healthier, more sustainable future.

Future-oriented view

Students mostly expressed their joy in taking a futuristic view and said that it was important for them to imagine the future through thinking about robots and AIs. Student K wrote:

> I think I was able to pursue this course with futuristic views. Recent development in robots and technological innovation are amazing and I came to think that someday we might coexist with robots. It was a good opportunity to start thinking about future society.

Generally, students enjoyed thinking about the future and found it meaningful to imagine the probable or preferable futures from the current situation. After the robot project, students in groups did research on the topic of their interest from a global perspective and did a PowerPoint presentations. Almost all the groups discussed the issues with future-oriented views. For example, using data on carbon dioxide levels, global warming, population, and AIDS patients, they predicted the future through insightful data analysis, which, I assume, was an additional fruition of this robot project.

Common ground

Through talking with science professors, I found some common ground which could be developed together in the future for synergistic learning and teaching.

Collaborative creative work: close to real-life situations

The collaborative robot poster project could be referred to as virtual real-life situation, where engineers from various fields collaboratively create new robots. In one interview, Prof. T (Robot Engineering) said that the robot was the aggregation of various technologies such as sensors for vision, walking, balance and coordination, so specialists from many fields got together to develop robotics. My students are all science majors but from different fields, so the robot poster project turned out to be an opportunity where students exchanged ideas and cooperated as a team to create something new and original, which was close to a real-life situation at a smaller scale.

Presenting new ideas to the world in English

The goal of language education is to enhance communicative skills so people can understand each other. Expressing one's unique ideas to the world is an important part of this. In the interview Prof. T said that about half of his graduate students presented at international conferences every year and that he wanted all of his students to have the chance to present in the future. I found that science teachers and English teachers share a common goal of helping students to be effective communicators so they can present their innovative ideas and achievements to the world using English.

Raising ethical awareness

One of the goals of using a science topic as a part of global issues in language classes is to raise awareness in ethical aspects of scientific development. In this sense, science

teachers and language teachers share another common goal. According to Prof. T, it is very important for young students to ponder how technology will develop in the future so he warns students not to create something that is contrary to social ethics. I found yet another commonality here between the goal of science teachers and our goals as language teachers.

Essence of global education

Darwin suggested the idea of the survival of the fittest. Conceptually, this project tried to cover a time span from the dawn of human evolution to the time when the survival of human beings comes into question, and whether we are going to hand down our civilization to robots and AIs in the future. In the interview Professor W (Quantum Mechanics) said:

> We started from simple protein and life has been continuing for billions of years. Human beings have used intelligence as a small niche for survival. Life as an individual ends after several decades but life as a species continues on and on. Sustainability depends on how far beyond, from an individual, to family, to friends, to community, to country, to species, you could regard to be part of yourself. If it stops at the country level, the wars occur.

This is exactly the essence of global education. The question of how far we can extend our scope of vision and regard other people and other species as a part of us would be the key to solving any conflict. Feeling that we are part of a larger whole helps to build a peaceful community for the sustainable future. Through the interview I discovered the great vision this science professor has for peace; another common ground.

Conclusion/reflection

Lessons on the theme of robots and AIs were effective in enhancing motivation, English skills, and critical creative thinking, and raising awareness of ethical issues regarding technological development as a part of global issues. Through thinking about the future, students enhanced their future-oriented attitudes. During both the course of the robot project and the research and presentation sessions which came after the project, students showed their forward-looking perspectives by predicting the future from current trends. They envisioned preferable futures and presented their ideas about possible decision making and actions now for a more sustainable future. Talking to science professors was stimulating and I found some common ground which could be developed together to bridge science classes and English classes in the future and strengthen the message to students.

I suggest lessons on robots and AIs, which foster forward-looking attitudes, could be meaningful and applicable in almost any teaching situation, since we are surrounded by computers and AIs whether we are conscious of it or not. Moreover, young people are not only accepting the cutting edge technology. They are also the ones who are going to create the future. I believe that the very tiny step toward an interdisciplinary approach I attempted to carry out is also applicable in almost any teaching situation as well, since English is interdisciplinary in nature and we could integrate any topic into our classes.

Regarding the conference theme, "Challenging assumptions, Looking in, Looking out," the assumption would be that taking an interdisciplinary approach is time-consuming and difficult, but the small first step I took was easy and quite fruitful. Looking into the classroom to think of students' needs and looking out to reach out to science professors to search for common ground was truly a valuable and enlightening experience for me. I would like to continue trying to bridge science classes and English classes in hopes that students will be able to self-actualize themselves in their fields in the global community. Additionally, looking into ourselves and our self-consciousness and looking out into the future of mankind was an inspiring learning experience for both students and for me, as a teacher and as an individual.

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Appendix A

Critical/Creative Thinking:

Share your ideas and opinions with your classmates

In your groups design your own robot!

Discussion:

1. What kind of robot would you like to have? Why?
2. What would your robot look like? (size, color, shape, etc.)
3. What special abilities would it have?
4. Does your robot understand human speech?
5. Does your robot help people? How?
6. What are some of the possible problems?

Memo

Appendix B.

ACB News – George –

Watch the Program. After you watch, try the tasks.

A.

Jot down any key words or phrases that you heard.

Jot down some questions or comments you have.

B. Talk with your partner and answer the questions.

1. Where does George live?
2. Who is the inventor?
3. How does George learn?

4. How do humans learn?
5. If you ask too many questions, what does George do?
6. How is George's personality created?
7. Why does George say that the sky is red?
8. Does George regard himself as a nerd?
9. How did George answer the question: Who will eventually rule this world? Humans or robots and computers?

C. Discuss with your group members:

10. Who do you think will eventually rule this world? Humans or robots and computers?

Appendix C

The Rights of Robots

Discuss with your partner and then in groups!

If scientists develop self-conscious robots that could be fully integrated in society and be essential in day-to-day life, what kinds of rights should we give to these robots? How about duties? What are possible problems and solutions?

Rights	Duties	Problems	Solutions

Three Laws of Robotics:

> ***The First Law:*** *A robot may not injure a human being or, through inaction, allow a human being to come to harm.*
>
> ***The Second Law:*** *A robot must obey orders given to it by human beings, except where such orders would conflict with the First Law.*
>
> ***The Third Law:*** *A robot must protect its own existence as long as such protection does not conflict with the First or Second Law. – Isaac Asimov (1942) –*