

**Student Voices through Journals in a Japanese University STEM Project-Based Learning Class for EFL Learners**

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**Abstract**

From April 2014 to January 2017, language faculty from a national university, in conjunction with engineering faculty, designed and implemented three Project-Based Learning (PBL) English language courses in which 24 second-year architecture and mechanical engineering students, over one semester, collaborated in teams of four to design, build, and present two or three projects using English as the primary working language. The presenters followed students from each yearly iteration of the course through a series of yearly questionnaires, freewritings, and focused interviews using theoretical coding research methods in a grounded theory framework to track student development and understand not only the effects of this type of course on students academically and non-academically, but also to listen to student voices to create a better experience for successive iterations of the course. In this paper, the authors will briefly introduce the course design and give detailed analysis of theoretical coding data on the students' longitudinal experience gained from qualitative research methods, with particular focus on data collected through the professional journals students kept for the class. Finally, the authors will discuss themes developed from this writing data analysis and explain possible meaning the class had for students who participated in the course, as well as significance of these emerged themes on future iterations for PBL pedagogy.

*Keywords:* Project-Based Learning (PBL), STEM, EFL, tertiary education, collaborative learning, longitudinal, grounded theory

**Introduction**

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) places project-based learning (PBL) as a vital element in reforming Japan's education system by 2030. The objective is to make Japan a place able to thrive in the 21st century (Suzuki, 2015). With this reform effort, MEXT highlights skills gained through pedagogies like project-based learning, such as critical thinking, communication, and forethought, as requirements for success in a 21st century globalized world (Suzuki, 2015). By setting the year of achievement at 2030, MEXT implies it is taking a long-term view in reforming education and in preparing Japanese society for the future. This longitudinal view of reform is the core of the current research endeavor that will be described in this paper. Furthermore, this paper will present the voices of the very students MEXT sees as the future leaders, thinkers, and caretakers of Japan.

First, the objectives of the research study will be stated. Then the actual course being explored will be described. After that, the theoretical framework will be given to describe the big picture vision of the project, and to show what literature the authors drew from in order to support and fill their knowledge base. Moving forward, the methodology will be laid out in detail. Data was collected through journal entries completed over a three-month period during the course in the spring of 2014. This data was analyzed using grounded theory style coding methods in order to present a precise account of the students' voices. Taking this approach

allowed for showing the direct connection to the presented interpretations. The final discussion will focus on how the student voices of this first iteration provided guidance and direction for the two subsequent iterations of this particular PBL class.

### Objectives

The authors designed a longitudinal research study that looked at the effects an English language medium of instruction project-based learning class had on multiple groups of engineering and architecture students at a national university in Japan. By the end of the full research project, three separate iterations of the project-based learning course will have been taught. Student participants will total 72. Moreover, the authors will have collected a wealth of qualitative data from various sources including open-ended questionnaires, professional journals, and student and faculty interviews. For the purposes of this paper, the authors will briefly describe each project during iteration one and present in-the-moment reflections from select students as way to understand what these students were thinking and understanding as the class proceeded. The data source was professional journals the students were required to keep as part of the course.

### The Course

The course will be laid out starting with the initial inspiration for the course. This will be followed by a brief explanation of the planning process. After that, the course objectives, followed by the descriptions of each project will be given.

**Inspiration.** The current state of Japan seems to be defined by a search for identity, or a reaffirmation of a perceived dominance painted by astronomic success throughout the 1980s. Whatever the perception, the actions on the ground by governing bodies and socio-economic and socio-politico organizations informs observers that Japan is trying to invigorate the populous as a way to deal with the very real implications of being a major economy in a world defined by globalization. This macro-understanding of the world has real implications for institutions of higher education responsible for educating and training the human resources of the future: the designers, builders, and leaders of tomorrow.

Therein lies the simple inspiration for creating an English language class utilizing a project-based learning pedagogical approach. The driving force was to create communicatively competent professionals who will be able to contribute to Japan as a nation, and a member of the world of nations (Ravesteijn, De Graff, & Kroesan, 2006). Also, this class was created based on prevailing actions by government ministries like MEXT to create funding programs specifically designed to allow institutions of higher education to create and implement programs that will advance the critical thinking skills, communication skills, emotional intelligence, global competence, and many other characteristics of the student body, while preparing them with practical English language skills to do the work of a professional in the 21<sup>st</sup> century (Suzuki, 2015). Society is not built upon one static force. Be it pure economics, or health and welfare, or art, or education, etc., multiple forces push and pull society creating the dynamism needed for a successful standard of living. University students are being called upon by businesses and society to engage more with the world in order to bring the benefits of globalization to Japan. Without the ability and skill to think critically, communicate effectively, or empathize appropriately, Japan could be on the negative end of what globalization has to offer. The goal of the class was to make sure the students experience a course that prepares them to be able to harness the forces within globalization and focus the best of those forces into Japan.

**Planning.** The development of this project-based learning course can be summed-up with two words, *collaboration* and *meetings*. From October 2013, the authors and the director of

the department where they teach met with a group of four engineering teachers with the goal of designing projects suitable for second year first semester mechanical engineering and architecture students. Even before these meetings in October of 2013, the director met with various administrators to ensure adequate class time and financial resources could be allocated for a course of this nature. Also, department heads in the engineering faculty met with the authors and their director to determine which engineering teachers wished to be a part of this class, which was unique for the university.

By October 2013, the course facilitators of the class were known. What was needed was a tangible curriculum, and students. All the details were worked out over weekly meetings between the director and the English and engineering faculty, and syllabus was developed by April 2014. Also, 24 students were chosen to be in the class. Twelve mechanical engineering majors and twelve architecture majors were selected based on the highest TOEIC scores within each major. A lot of discussion was had regarding how to choose the students, and because all engineering students were taking the TOEIC regularly, this gave the planning group some relatively objective way of choosing the most English-proficient students in terms of ability to read and understand technical English. This was not a perfect solution, but one the planning group thought was the most practical given time and resource constraints. When the students were selected, a meeting with the selected students was scheduled. During this meeting, the students were informed about the parameters of the class in Japanese so they could more easily comprehend what was being asked of them. The choice to participate in this class was 100% voluntary. If a student did not want to participate in this course, they had the ability to withdraw and instead be placed in a regular non-PBL English class. There was no penalty of any kind for choosing not to participate. In the end, all the students who participated in this class volunteered to do so. (This remained the student selection policy for all following iterations of this class.)

**Course Objectives.** In designing the objectives that would guide the course, looking back to the theoretical framework was important. Based on the literature the following objectives were derived:

1. To improve engineering English skills;
2. To improve professional presentation skills;
3. To improve collaboration skills; and
4. To improve critical thinking skills

These objectives were created with the rationale that students may not have ever heard of project-based learning, or know the epistemological and ontological roots of the approach, so the instructors tried to articulate them in terms and ideas the students could have understood. This emphasis was also important in order to make faculty and administration aware of these critical components for the class. The authors did not know the level of understanding various populations at the university brought to the development of this class. However, these ideas, are fairly understandable in English and Japanese. This became apparent during the initial planning phases.

**The Projects.** The following subsections will lay out the details of each project as designed by the engineering faculty, who were a vital part of this class, and the English language instructors. These are brief descriptions containing the core elements of each project. Throughout all projects, engineering faculty who work in professional circumstances provided technical support to the groups by means of lectures and class-to-class feedback concerning the process of building the projects. At any given time, there were at least three faculty members in any one class – two English language instructors and one engineering instructor. All projects for the first iteration were completed within one academic semester – April 2014 to August 2014. Students were required to keep professional journals using a log (journal) sheet where they would record vocabulary, concepts, and other information

pertinent to their learning (Beckett & Slater, 2005). This was complimented with a page for freewriting designed to allow the students to reflect, explore, and communicate directly with the teachers.

**Construct a bridge.** In teams of four, each team was given materials to make a bridge that could carry the weight of ten kilograms. All teams were issued the same materials – plywood planks and beams sufficient to make a miniature bridge. Grading criteria included weight – the less the finished structure weighed the higher the points to be awarded; aesthetics – a judging and ranking system was employed to determine the best looking bridge by where the students chose the top three most aesthetically-pleasing bridges; and displacement of the bridge when holding up to ten kilograms – the engineering professor collaborating for this project used a laser displacement mechanism to determine the structural integrity of the bridges by where the bridge that held the steadiest and bent the least received the most points.

**Make a luminaire.** Again, in teams of four, students were tasked with designing and building a lighting fixture – a luminaire. With this project, each of the teams had to buy original materials they had planned to use in constructing their luminaires. All student expenses were reimbursed through department budget allocated for the class. As for grading, students were graded on the aesthetics of the luminaires. To decide the most aesthetically pleasing lighting fixture, a judging and ranking system was again employed.

**Design eyewear.** The third project was a little different than the bridge and luminaire projects. Students were presented with a challenge to design eyewear for particular country markets – Italy, Germany, Dubai (United Arab Emirates), India, Denmark, and the United States. The president of a local prominent eyewear production company presented this challenge with the goal to only design the glasses. For this project, there would be no physical product made. Students designed the glasses based on market research, then proposed the idea to the president of the company in a public presentation. The president of the company selected the best three designs. As this was the final project, it was planned to culminate in a community-wide public presentation, which was open to and attended by the university and surrounding community, and covered by local and national press.

Throughout all three projects student teams had goals they had to reach, but how they traversed the path to achievement of those goals depended a lot on team dynamics, instructor support, and ability to understand the materials provided to them. Each project resulted in student teams giving a presentation to their classmates and instructors, in English. The final presentation was larger and more consequential than the final grade. Following the success of the graded public presentation, the student groups had the opportunity to bring their presentation from university grounds to an actual local community eyewear event where they were able to present their designs to real people working in the eyewear field.

### Theoretical Framework

At every stage of this study critical thinking is a foundational theoretical underpinning. In the course itself, critical thinking is a key pillar of what the authors tried to teach the students to understand and utilize to their best abilities. This section will provide information on the critical thinking literature used to construct the theoretical framework that surrounds this study.

Critical thinking as Mergendoller (n.d.) defines is “ordinary thinking done well, that is reflectively, with attention to criteria, and with the goal of making a defensible, reasoned judgment” (para. 4). Researchers from the University of Louisville (2016) say, “The ability to think critically calls for a higher-order of thinking than simply the ability to recall information” (para. 1). Lau and Chan (2016) define critical thinking as “the ability to think clearly and rationally about what to do or what to believe” (para. 1). In another form, Paulo Freire’s (1996/1970) concept of *conscientizacao* takes ideas of critical thinking to a more

activist realm. One has to be engaged in his or her environment in a critical manner by being literate enough to know what messages are being communicated on their behalf. This engagement will allow for greater social, political and economic empowerment thus placing power in the hands of the individual. Once people know how to engage through being literate they can think critically and conscientiously (Freire, 1996/1970). These understandings of critical thinking support and frame the project-based learning approach employed by the university instructors in their objective to foster a learning environment where critical thinking was a major organic compound for the students to develop their linguistic as well as scientific abilities.

As described, critical thinking was central to the formation of the class being presented in this paper. The class itself is a STEM-based project-based learning course, so the identification of critical thinking as a key building block of the class is natural. Capraro, Capraro, and Morgan (2013), who wrote specifically about STEM-based project-based learning, asserted that central to project-based learning was critical thinking. Mergendoller and Larmer (2015) identified eight essential elements of project-based learning that include:

1. Challenging problem or question
2. Sustained inquiry
3. Authenticity
4. Student voice and choice
5. Reflection
6. Critique and revision
7. Public product
8. Key knowledge, understanding, and success skills

When cross-referenced with the theoretical definitions and concepts presented earlier, unity between critical thinking and project-based learning is complimentary. The following excerpt from Capraro, Capraro, and Morgan (2013) highlight the stated complimentary aspects of project-based learning and critical thinking,

Project-Based Learning is...composed of several problems students will need to solve. It is our belief that PBL provides the contextualized, authentic experiences necessary for students to scaffold learning and build meaningfully powerful science, technology, engineering, and mathematics concepts supported by language arts, social studies, and art. STEM PBL is both challenging and motivating. It requires students to think critically and analytically and enhances higher-order thinking skills. STEM PBL requires collaboration, peer communication, problem-solving, and self-directed learning while incorporating rigor for all students. STEM PBL builds on engineering design as the cornerstone and as the foundation on which students bring their compartmentalized knowledge of science, technology, and mathematics to bear on solving meaningful real-world problems (p. 2).

Finally, this grounding in critical thinking aligns with the overall ambitions of MEXT to provide students with the environment – resources and opportunities – to move to a higher order of thinking that will provide Japan with the necessary human capital to achieve great successes in the 21<sup>st</sup> century (Suzuki, 2015).

### Methodology

The methodology guiding this study is based on principles of qualitative research where multiple data sources are collected so as to build a thick and rich narrative account as it pertains to whatever specific phenomena is under investigation. While students kept multiple records as requirements of this course – freewritings, journal sheets, self-assessment questionnaires, the focus of this particular study utilized the freewritings as the main data source. (The researchers also conducted semi-structured interviews with select students. To

prepare for those interviews, students constructed mind maps as means to illustrate and organize their memories of the class. This information will not be presented in this paper as they were out of the scope of this research plan.)

Freewritings were collected from the professional journals of each student. Three separate freewritings were isolated during particular points in the class timeline. The first set of freewritings is from week six of the course; the second set is from week ten; the third set is from week fourteen. Each freewrite signals a change in project. Freewrite one is the transition point between the bridge and luminaire projects. Freewrite two is the transition point between the luminaire and eyewear project. Freewrite three was the final freewrite exercise for the entire class. These three points were chosen because they signaled a significant change in the class – a new project, new team members, the immediate reflection of a past project and presentation.

The freewritings of five student participants were chosen based on completeness and appropriateness of the freewrite. Even though the researchers tried to compile complete data sets some freewrites were missing. Only two participants maintained complete and valid entries for week ten.

The length of each entry varies, from roughly a quarter of an A4 size sheet of paper to a full page. The time period is roughly mid-May 2014 for Week 6 entries, mid-June 2014 for Week 10 entries, and the end of July 2014 for Week 14 entries.

The freewrites were analyzed using a grounded theory style approach. Initial themes were developed for each student participant. These initial themes were then cross-referenced and streamlined thus producing more workable and insightful trends and patterns. The trends and patterns were analyzed against the backdrop of the theoretical framework grounded in critical thinking, as well as the previous literature from MEXT encouraging educational institutions to incorporate pedagogical approaches such as project-based learning in order to train and build the work force of the 21<sup>st</sup> century. Analysis and findings based on these themes and trends comprise the following section.

### Theoretical Coding

The authors primary research interest has to do with the longitudinal effects of a project-based course on university students in Japan, and so have been utilizing a grounded theory method of theoretical coding on the data described above to not only analyze the data, but also allow them to “choose or construct new data collection methods and revise earlier ones” as necessary (Boyatzis, 1998; Prince & Feldar, 2006; Thornberg & Charmaz, 2014). Particularly, the authors, in analyzing the freewriting entries, utilized the constant comparative analysis research method developed in the grounded theory approach in order to develop and support any core categories within the data (Holton & Walsh, 2017). For this paper, the authors conducted a line-by-line version of initial coding on all the data in order to develop core categories (Thornberg & Chamaz, 2014). Though there is a risk of researcher bias with determining codes, the authors attempted to create codes independently and compare them against each other to counter any researcher assumptions that might be “forc[ed],” as described by Holton and Walsh (2017).

### Analysis & Findings

#### Week 6 Themes

For Week 6, where the authors were able to collect writing data from all five participants, the following themes came to light.

**Unease.** Four of the five students expressed *unease* within their freewriting for this period immediately following the initial bridge project and the following luminaire project.

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- (1) Participant A: I think this project is more difficult than the last one. It's mainly because luminaire is so abstract a topic. Also, goals of the illumination project are not so clear.
- (2) Participant B: When I know this project, I think it is difficult because we have to design a lamp, choose material, buy it ourselves, and make a lamp. We have to do more tasks than the bridge project.
- (3) Participant D: I'm not good at speaking English. And I'm not accustomed to giving a presentation. So I don't have confidence in this advanced class at first.
- (4) Participant E: My group has only my opinion. I want to listen to another person's opinions, feelings, and ideas... I felt left out and [group members].

**Expectant.** Despite having the *unease* theme illustrated above, four of the five students also felt *expectant* about the upcoming luminaire project.

- (5) Participant A: ...I try hard to think about what is nice illumination and make the proud one.
- (6) Participant B: My group members are reliable, so we can image the abstract design by this week. I have never made a candle myself yet, but I try to do my best cooperating with my group members.
- (7) Participant C: I'm looking forward to doing this project... Main reason why I'm looking forward to do is I can work with new members and in this member, I'll speak English and can debate. I like to speak and debate with any people! So I'm looking forward to work... I want to become friends with my team member.
- (8) Participant D: Making presentations and building real bridges was very difficult, but I could learn that and I decided to make more effort.

**Cooperation.** Participants B and C also made overt reference to *cooperation* in their writings. These are present in Examples (6) and (7).

**Self-Assessment.** In Examples (3) and (8), Participant D makes reference to *self-assessment*. In the Week 6 entries this is the only reference, but it will be relevant in following samples.

### Week 10 Themes

For Week 10 Themes, the authors were able to collect writing data from only two of the five participants.

**Distribution of Work.** Only one participant referenced *distribution of work* for Week 10, but in Week 14 it will become a more salient theme.

- (9) Participant A: We tried to finish making the presentation material. But we did not finish, so we divided into 4 sections. "Concept" and "Conclusion" were finished in class, therefore each of us can be making easily, I think.

**Self-Assessment.** Mentioned above, another reference was made towards *self-assessment* by Participant A and Participant B.

- (10) Participant A: This time I tried to stop talking freely. Last time I ignored speaking time, so this time I plan the draft for presentation.
- (11) Participant B: I want to do a better presentation in the next project.

**Admiration.** Both Participant A and Participant B mentioned in their writings things they admired during this period.

- (12) Participant A: After finishing presentation, I was impressed with the illumination which other groups made. Because many illuminations are well-crafted.
- (13) Participant B: After I finished our group presentation, I feel tired and appreciate my group member... Other group members' presentations were also good and their candles look beautiful.

**Satisfaction.** Finally, for Week 10, both Participant A and B felt a sense of *satisfaction*.

- (14) Participant A: Finally I was satisfied with our illumination when the class-room light turns off. It is beautiful in dark place.
- (15) My group members presentation is very good.

#### Week 14 Themes

For Week 14, the authors were able to collect writing data from all five participants.

**Frustration.** For the final, and arguably the most difficult project, all participants expressed *frustration* in this final set of entries.

- (16) Participant A: I lost my way to write “free writing”. Because I am not a professional of economics, I have no ability to handle math formula about population of India.
- (17) Participant B: We can’t find the information “Do Danish people like LEGO?”
- (18) Participant C: Group work is so difficult. When three people satisfied, a person may not satisfied or another idea... Selfish person let group confused... Selfish action is don’t think other people and only think oneself’s profits or opinion, can’t listen other people’s idea, and can’t look around. Around selfish feel bad, but selfish can’t understand it. It is big problem.
- (19) Participant D: This is last project, but I think this is the most difficult project. Because I didn’t know about Dubai, and I thought that designing eyewear is difficult.
- (20) Participant E: In this week, “Market Research Proposal” is disappointed. I think this reason is our group is separated design and MRP. So our group couldn’t share information.

**Distribution of Work.** In this week of entries as well, two participants commented on *distribution of work*. One is given in Example (20).

- (21) Participant B: We separate two group, one group finish writing sunglass’s design and market research, the other group make the presentation writing.

**Satisfaction.** Two participants expressed satisfaction in their final entries.

- (22) Participant B: ... we recommend our sunglass because our sunglass looks cool and Danish famous glass’s brand “LINDBERG” glasses are also cool. So, Danish people like something cool and we are satisfied with our design.
- (23) Participant D: Although drawing was difficult, but thinking about marketing plan was fun. I made an effort to make presentation.

#### Discussion

Though a small sample, based on the coding analysis, it is clear that participants had a wide range of experiences that seem both positive and negative. In the Week 6 data, Participants A, B, D, and E felt *unease* with the difficulty of the next task – the luminaire project – but in the *expectant* theme, Participants A, B, and C were encouraged by either the teamwork aspect of the project development or their initial planning for the luminaire. Participant D seemed bolstered by successful completion of the bridge project. Participants B and C, in their writing, also mention *cooperation* as a key factor. And Participant D references *self-assessment* of their English ability, which though this course was an ostensibly English course, reference to actual English ability is mentioned in this fashion only a few times in the participants’ writings. The only other references towards *self-assessment* occurred in Week 10, with both Participant A and B having mentioned either time management of their presentation speaking time or working towards a better presentation



respectively; neither comments directly about their English ability in terms of this PBL course.

Furthermore, in Week 10, Participant A and B both expressed *admiration* for other groups' project outcomes. Also, they both expressed *satisfaction* in their own efforts in the luminaire project, with Participant A mentioning the luminaire itself and Participant B mentioning the presentation. Also in Week 10, Participant A writes about distribution of work, which also is mentioned by Participant B in Week 14.

In week 14, all participants expressed *frustration*, though for different reasons. Participants A, B, and D seem to have had issues with data collecting and analysis for the project. Participant C and E seem to have been more concerned about the breakdown in collaboration between group members. Finally, *satisfaction* is mentioned again by Participants B and D, with the former referring to the product they created and the latter referring to marketing plan and presentation.

### Conclusion

It should be stressed that much of what the participants write about are the actual work details of developing the physical projects, and not the act of developing the project and presentation using English, even though this was an English class. Even when there was some sort of *self-assessment* of or reflection on language, only Participant D made overt reference to English. Otherwise, it seems almost a wide range of emotions – both positive and negative – that the participants felt towards the project development itself, such as *unease*, *expectant*, *frustration*, *satisfaction*, and *cooperation*. These are all comments that the participants might make about actual conditions if they were working at an actual job, not just in an English class. In this sense, the course developed by the authors may to an extent mimic these conditions, and therefore give students experiences that contribute to their lifelong learning for any future career. To gain more concrete insight into this particular area future interviews with student participants will need to be conducted. These interviews will need to focus on exploring this particular idea of transference of practiced skills in the classroom to applied skills in the workplace.

The freewritings by the students of this course allowed the authors to hear the student voices of the class. With these writings, along with other data including interviews and questionnaires, the authors gained important feedback to initiate positive adjustments for future iterations of this course. And with these student voices, we can understand some of the varying experiences a student of a project-based learning course may have, not just for the authors' own courses but also for any course taught with a similar pedagogy or content. The student voices presented here can serve to inform and guide any other educator who wishes to create an active learning, and more specifically, project-based learning course.

### References

- Beckett, G. & Slater, T. (2005). The project framework: a tool for language, content, and skills integration. *ELT Journal*, 59 (2), pp. 108-116.
- Boyatzis, R. (1998). *Transforming qualitative information*. Thousand Oaks: SAGE Publications.
- Capraro, R. M., Capraro, M. M., & Morgan, J. R. (2013). *STEM project-based learning: An integrated science, technology, engineering, and mathematics approach* (2nd Ed.). Rotterdam, The Netherlands: Sense Publishers.
- Freire, P. (1996). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). London, EN: Penguin Books. (Originally published by The Continuum Publishing Company in 1970)
- Holton, J. & Walsh, I. (2017). *Classic grounded theory: Applications with qualitative and quantitative Data*. Sage Publishing: Thousand Oaks.

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- Lau, J. & Chan, J. (2016). [C01] What is critical thinking? Retrieved from <<http://philosophy.hku.hk/think/critical/ct.php>>
- Mergendoller, J. (n.d.) Teaching critical thinking skill through project-based learning. Retrieved from <http://www.p21.org/news-events/p21blog/1097-teaching-critical-thinking-skills-through-project-based-learning>
- Mergendoller, J. R. & Larmer, J. (2015). Why we changed our model of the “8 essential elements of PBL.” Retrieved from [http://bie.org/blog/why\\_we\\_changed\\_our\\_model\\_of\\_the\\_8\\_essential\\_elements\\_of\\_pbl](http://bie.org/blog/why_we_changed_our_model_of_the_8_essential_elements_of_pbl)
- Prince, M.J. and Felder, R.M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education*, 95(2), 123-138.
- Ravesteijn, W., De Graff, E., & Kroesen, O. (2006). Engineering the future: The social necessity of communicative engineers. *European Journal of Engineering Education*, 31(1), 63-71.
- Suzuki, K. H. (2015). OECD/Japan seminar – Japan’s educational reform for 2030. Retrieved from [http://www.mext.go.jp/component/a\\_menu/other/detail/\\_\\_icsFiles/afieldfile/2016/01/05/1365660\\_3.pdf](http://www.mext.go.jp/component/a_menu/other/detail/__icsFiles/afieldfile/2016/01/05/1365660_3.pdf)
- Thornberg, R., & Charmaz, K. (2014). Grounded theory and theoretical coding. In U. Flick (Ed.), *The SAGE Handbook of Qualitative Data Analysis* (pp. 153-170). London: SAGE Publications.
- University of Louisville. (2016). What is critical thinking? Retrieved from <http://louisville.edu/ideastoaction/about/criticalthinking/what>