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The Role of Teamwork on Students' Engineering Professional Identity Development in the AAU PBL Model: From the Perspectives ofInternational Engineering Students

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Abstract

Engineering identity has been seen as a significant indicator for engineering students' persistence and competence development. In order to develop students' engineering professional identity, PBL has become an effective learning method because it provides a pathway for engineering students to experience solving real-world problems as real engineers. Among various PBL implementations, the PBL Model in Aalborg University has been practiced over decades. Previous studies have evidenced benefits of PBL on local students regarding problem-solving skills, teamwork skills and leadership. However, it has also been reported that PBL can be challenging for international students who come from educational backgrounds that focus on lectures and individual learning and who had no prior PBL knowledge and experiences. It's important to clarify how international students perceive and how AAU PBL model contributes their engineering identity development. Thus, this study explores major components of engineering identity developed by international students during their study in the AAU PBL model, compared with their pervious learning experiences. Methodologically, a qualitative method with six first-year international engineering students in their Master study participated in the semi-structured individual interviews. Compared to lecture-based traditional learning, students reported that they improved their confidence, interest in engineering, transferable skills and understanding of teamwork and engineers' responsibilities through AAU PBL experiences.

Keywords: PBL; International Learning experience; Engineering Identity; Teamwork

Type of contribution: PBL research

1 Introduction

Engineering talents of the 21st century are not only expected to have academic knowledge and technical skills, but also need practical experiences and diverse competences, such as problem-solving skills, teamwork skills, and self-learning skills (UNESCO, 2017). With these demands of future engineers, project/problem-based learning (PBL) has become an effective learning method to develop students' competences of solving complex problems, collaboration, team management and leadership (De Ríos-Carmenado et al., 2015). By exposing students to complex, real-world, and multidisciplinary problems, PBL provides students a pathway to work as real engineers to gain practical experience and builds a bridge for the gap between university and industry. Students with PBL experiences are reported to have better preparation for future engineering job and develop higher levels of engineering identity (Du, 2006; Yadav et al., 2011). With the benefits of PBL on training engineering talents, PBL methods have been widely used in engineering education (Chen, Kolmos & Du, 2020). Among various PBL implementations, the PBL model in the Aalborg University (AAU PBL model) has been developed and practiced over three decades. In the AAU PBL model, each semester is organized with 50% course work (15 ECTS) and 50% project work (15 ECTS) in

teams, where students work together on real-world and complicated problems and finish their semester reports. Many researches provide evidence on benefits of the AAU PBL model on local students regarding students' development of problem-solving skills, teamwork skills, self-directed learning and leadership (Kolmos & Holgaard, 2019; Guerra & Kolmos, 2011). Graduates from AAU were reported with higher levels of engineering identity and received higher levels of employer satisfaction (Clausen & Andersson, 2019; Kolmos & Holgaard, 2015).

However, transferring from traditional learning methods to PBL methods is a challenging job, especially for students without PBL or teamwork experiences (Huang, 2011). In AAU, many international students, who may come from educational background that focus on lectures, are facing the challenge of adapting PBL methods and collaborative learning. Prior studies explored international students' learning experiences as foreigners with culture differences in the Danish context and pointed out identity change through learning processes is an important learning outcome in PBL (Du & Hansen, 2005). For further understanding of the influence of PBL on international students' engineering identity formation, it's important to explore what PBL means to those international students and how AAU PBL model contributes to their development as future engineers. Thus, this study focuses on processes of international students' engineering identity development via AAU PBL model, and aims to answer the following research question: From international students' perspectives, compared with their pervious learning experiences, what major components of their engineering identity have been developed under the AAU PBL model?

2 Theoretical Framework

To explore engineering identity with a clear structure, this study adopts Godwin's (2016) model of engineering identity as theoretical framework, with three dimensions of performance, recognition and interests. Performance refers to students' belief and ability to achieve learning goals and understand engineering content. Recognition means that students could get recognition from peer, parents or teachers as being good engineering students. The last component, interest means students' desire and curiosity to explore professional fields, which motivate students to learn knowledge and skills. Godwin pointed out that engineering identity was developed through interactions with others in the community of practice, but this model mainly from individual perspectives or focus on individual learning processes. Thus, in order to catch the missing link between engineering identity development and interactions in communities, this research use this framework to investigate engineering identity development in a PBL context. Although Godwin's (2016) model of engineering identity focuses on individual learning processes, it still can provide us a structured perspective to explore students' engineering identity development in teamwork processes. With guidance of Godwin's (2016) model, this study reports how AAU PBL model contributes to international students' engineering identity formation and development, which could enrich our understanding on engineering identity from the perspective of team learning processes and inspire the optimization of PBL design to improve learning experiences and learning outcomes of students without previous PBL or collaborative learning experience.

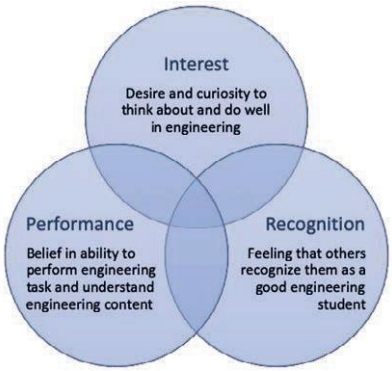

Figure 1: Godwin's model of engineering identity (2015; 2016)

3 Methodology

This study adopted a qualitative method. Empirical data were collected through individual semi-structured interviews. With the perspective of teamwork and the guidance of Godwin's model of engineering identity, an interview protocol with dimensions of performance, recognition and interest was designed. Then the interview protocol was tested and revised through three rounds, including descriptive questions like "Could you describe briefly how you collaborate with your team members to finish the projects?" and questions in three dimensions, such as "What do you learn from this PBL and teamwork experience?", "In which ways you consider yourself as a future engineer?", "In which ways your current study has helped you develop such as sense of feeling as an engineer?", "What differences do you find between PBL experience you're your prior study?" and so on. In the process of collecting data, purposeful sampling was employed in recruiting international engineering students with PBL experiences in AAU as interviewees. Six international engineering students who finished their bachelor's study in their home countries and now are in the first semester of master's study in AAU were recruited (Table 1).

In this study, interviews were conducted in English and transcribed carefully, and every interview lasted 30-40 minutes. For the sake of privacy protection, pseudonyms are used in the transcripts for all interviewees. In order to build a structured codebook, the three dimensions in Godwin's model were identified as the initial categories in the first step. Then open-coding and thematic analysis methods are used to identify both theory-driven and bottom-up codes, which enables us to come up with new characteristics of identity development in PBL processes. The initial codebook was built upon analyzing three transcripts with rich information, constituting a relatively stable frame for coding (MacQueen et al., 1998). To enhance the validity of data analysis, daily journaling, self-monitoring and auditing procedures were conducted to refine the codes in data analysis processes (Cresswell, 2009). A revised codebook was formed through this process and then used for data analysis.

Table 1: The basic information of participants.

Name	Gender	Nationality	Subjects
Ivy	Female	Croatia	Energy engineering
Daisy	Female	Croatia	Mechanic engineering
Gina	Female	Hungary	Energy engineering
Carl	Male	China	Electronic engineering
Ken	Male	Croatia	Energy engineering
David	Male	Portugal	Energy engineering

4 Findings

With the guidance of the engineering identity model, we analyze and scrutinize evidence of how AAU PBL model contributed to international students' engineering identity and what differences they reported between their previous learning experiences and PBL experience in AAU. Part of our preliminary findings in the dimensions of performance, recognition and interests are presented as follows.

4.1 Performance

Link theories to practice

Based on qualitative data, all six international students reported that one of the most important change in their study was the chance to link theories to practice in PBL. In their previous study, theoretical knowledge was mainly learned through lectures and lab work. What they were required to do mostly focused on

memorizing and understanding those theories, where they had a few chances to apply the knowledge into practice. When they conducted PBL in AAU, they were exposed to the real-world problems and learned to work in teams as engineers. It's challenging for these PBL beginners because they needed to identify core problems and directions of possible solutions by themselves, which gave them an opportunity to apply the theoretical knowledge they learned in their home universities in their projects. As Ken said, the most important reason he chose AAU to pursue a master degree and what helped him most is PBL, which enabled him to consider things not only from the perspective of theories but also from angles of real life, including the needs of clients, the cost, the influence of environment and so on. In his opinion, those PBL experiences in AAU could help him know more about the ways of engineers' work.

> "I think the **biggest reason why I came here is the PBL**. It is really something else, the problem-based learning, because actually you deal with the tangible projects, and **you actually see what components you need to think about in real life**. Because **in theory, we assumed a lot, and we didn't care about many things before**….**PBL broadens my horizons** in engineering, because when I was only in theoretical learning, I only saw the one solution, but now when I'm in the practical one, I can **see that the solutions are many**. It's only the matter of choice, which you take if you want to, for example, take the at least expensive thing, or just to put it work, or you want some middle solution between the cost, effectiveness, efficiency, or if it is an eco-friendly product. But when you do the theoretical solving of the problems, it's always one and it's a number on that. But actually, a lot of things are should be important." Ken

In Daisy's case, she pointed out that PBL provides a real-life situation, where they needed to decide everything by themselves instead of told what to do. This real-life connection is also a way to conduct professional practice, which is also an important role element for professional identity building (Patrick et al., 2017). With those practical experiences, she thought that she would adapt her job more quickly after graduation from AAU more quickly than graduating from her home university.

> "We can combine the project with the theory learned from Croatia, and now this like a real-life situation with working in a group on a project, and you don't know where to start. You just have a piece of paper with some text, and you have to build something from that. I think **that's a great practice for future, for the company**, for everything. And I think **if I finish like the college in Croatia, I would come to my workplace and I would be like: ok, so can you show me what to do now? But now with this experience, I could come here and immediately I guess where the inputs** of this, this, this, and **start to** work on something or research for starters." Daisy

David shared his project experience in his home university in Portugal and compared the differences with AAU PBL model. Although he had projects to finish in his bachelor's study, the problems were well-structured problems and repeated every year, which made it possible to "copy" others' answers. When he and his group members conducted projects in AAU, to solve those real-life, open-ended and ill-structured problems, they became the center of learning and needed to identify the direction of their projects because in real life of engineers, no one will give them the answers or solutions directly. He further understood the importance of self-directed learning and necessity of being responsible forhimself.

> "**In Portugal, the projects that we are used to do is just like the repeating what students did the last year.** So, you would ask for an older guy: can you just send me your project just to see what have you done? **And we would do the same thing that he had done, but with a different calculation of different values. But the reasoning would be the same, and it was not our reasoning**. It was the older, older, older guy's reasoning. So, **learning and thinking independently is one of the things that PBL brings me to here, at the AAU, because you have no answer to copy and you need to be responsible for yourself**, totally different from my prior project experience. I know the ranking of engineering subjects, and AAU is the first in Europe, the fourth in the world in engineering. I think that PBL is the most reason to be here." David

Improve generic skills

Compared to traditional learning methods, students got more chance to develop their generic skills in PBL. All six students reported their teamwork skills and communications skills have been improved. Four students pointed out the development of their problem-solving skills, two students emphasize the importance of emotion management skills, and two students reported the improvement of their time management skills. One student also mentioned the development of his interdisciplinary skills. With this simulation of working as engineers, they realized the importance of those transferable skills in PBL and could practice those abilities in teamwork processes. For example, in Carl's case, PBL inspired his thoughts about the meaning of teamwork and how to work as a real team. During the PBL processes, to reach effective teamwork, Carl saw the importance of communication and idea sharing, which he did not practice too much in his home university. He learned a lot from his team members with more practical experiences and began to look at things from other angles. Moreover, he pointed out the responsibilities of engineers were not limited in engineering, but also included knowledge from other subjects, and engineers could utilize all those knowledge and skills in their projects.

> "In China, we had heated competition and almost everyone studies alone. Even though we had projects, we just divided the tasks and didn't care about others' parts. But now, **I need to learn how to work in a real team, not just dividing the tasks**. How to integrate into a new team? How to do things in professional and effective ways? How to deliver your idea to others? Engineers need not only to do engineering stuff, but also to care about all aspects of the products, including business promotion, aesthetic values and so on….I also realize that I need to share what I do with others, and others also share their experience and ideas with me. We have a team member who is 26 years old and has working experiences. He teaches us a lot because he has broader horizon than us and know more about practical things, including using professional software, different angles to look at things and solve problems, a better way to express your opinions…" Carl

In addition, Carl also assessed himself with better time management skills in PBL than before. When conducting projects alone, he tended to procrastinate and put things to be done to the last minutes. However, a team as a whole would exert pressures on individual members, influence their thoughts, identity and actions, and also affect team cohesiveness and productivity (Lewin, 1939). In PBL context, in order to avoid troubling other team members and keep pace with their schedule, Carl realized the importance of finishing tasks on time and tried to improve his skill on time management.

> "**When I work alone to finish a project, I was always procrastinating**. My bad habit was that I would not work unless the deadline is coming. But it become better in teamwork. You are required to finish your tasks and communicate with your team members, otherwise you could hinder the whole team and influence others' work negatively, which brings me the pressure to do things on time**. You're not just responsible for yourself, but also for all members in your group**. So, now I **understand the importance of team management** and **enjoy the feeling of finishing things in advance**. I can say I'm better at managing my time." Carl

4.2 Recognition

Get confidence from others' recognition

Among all students, two students reported that PBL boost their confidence because of the recognition from their peers and supervisors. With many interactions with team members and supervisors in project processes, students could be encouraged by positive feedback from others. In Gina's case, she found a problem which did not be identified by others, and her supervisor praised her as a smart engineering student, which made her feel more confident and encouraged her to show more active performance in teamwork processes. Similarly, Carl also pointed out PBL as an important pathway to build confidence and

inspire enthusiasm of engineering because finishing a real-world project brought him the sense of achievement.

> "I found a problem and discussed with our supervisor, and he didn't answer me at that time. But in our next group meeting, he said: ok, so last week we had a very smart students to find out something, so I just want to show you the solution for that. I **felt really very good at that moment**, I mean that's the best engineers university and all of the people are so smart, and it just felt so good that I was the only one who found out that thing. It doesn't happen so frequently, so I felt very good, and it **encourages me to be more active in our group**." Gina

> "**PBL is a good way to build confidence and gain recognitions** because you're really creating something. When you finish the project, no matter how hard the process is, you will have a great **sense of achievement**. And we also got very **positive feedback from our supervisor**, so I **felt encouraged and can't wait to the next project**." Carl

Realize the benefits of PBL for future engineering job

All participants involved in this study did not experience PBL in their previous learning experience, and they were in their first projects when the interviews were conducted. Based on qualitative data, all six students reported that they could see the values and benefits of PBL, which help them better prepare for future engineering jobs. As what Ivy said, AAU PBL model provided students with an imitation of real engineers' work, where they learned practical experience and skills and enhanced their feeling of future engineers. Ken also pointed out that through working on real-world projects, he experienced how engineers work by himself, which was the unique advantages of AAU PBL model in building students' career path. These PBL experiences equipped him with a good engineering background for future job.

> "I think the **group work and project could help me for future engineering jobs**. That is really important and it's very helpful. I'm happy that I **get more relevant experience**, working in a group than I would get if I was working and learning alone. I believe that in the future, at a future job, I won't be working completely alone. At times that I'm pretty sure that it's more going to be working in a group, smaller group or a bigger group, or team working on a project, just like we are now. So, I think that's **a good imitation** of that. **Working with others in AAU is more like working as a real engineer**. It did give us the feeling of that because we're working on a project where solving a problem by ourselves, and in the end, we're going to do something that has a specific function and it's going to be able to do things. So that's a good feeling." Ivy

> "So, I think **AAU will provide me a good background for the future** with that, especially the project-based learning. I mean the reason why I'm here because nowhere else I saw that you can **actually work from something real** that can be produced in a company. I can say graduates with years of PBL experiences like these could **better prepare for their future jobs**." Ken

4.3 Interests

Find the interest in problem-solving

In the interviews, two students reported they developed the interest in problem-solving via the PBL experience. As what Daisy said, it was an enjoyable process for her to figure out the rationale behind the problem and then apply her own understanding into practice to solve problems. Problems exist in every aspects of daily life, so the PBL experience provided her more training on solving problem.

> "For me, **problem solving makes engineering interesting for me**. The feeling I get when I solve a bigger, more difficult problem is really good. The feeling is like that I'm studying something, and then I click how it works. And I can apply it anywhere because I have understood how it works. I love that feeling, and that's a process of problem solving because everything is problem, and we're just doing problem solving with the project and everything." Daisy

Enhance one's interest in engineering

Three students mentioned the enhance of their interest in engineering. Different from theoretical work, doing projects and developing new products had more connections with daily life. The processes of applying engineering knowledge in real life is new experience for those international engineering students, which inspired their interest in engineering. In Ivy's case, compared with traditional learning methods in her home university, she got more opportunities to work in a real-world engineering environment and to use various engineering equipment to make products for their projects.

> "It's very interesting because we **have the opportunity to work with real equipment** which is really cool so far. In my previous education, I haven't had the opportunity for that. And there are really a lot of opportunities here to take part into some extracurricular activities with your team members. I don't know maybe someone wants they can make their own start-up and stuff like that. So, I think that's **very helpful, making engineering more interesting**." Ivy

However, although evidence on the development of international students' interest in engineering were reported, students also reflected the challenge of heavy workload in PBL context, which might reduce the satisfaction level of their learning experience. One participant, Gina, had no PBL experiences in her bachelor study, and this was her first time to conduct an ill-structured project in a team. On one hand, she mentioned that PBL enhanced her interest in engineering and brought her better learning outcomes. On the other hand, as a "PBL beginner", it was challenging for her to adapt the PBL paradigm and the learning approach of teamwork. She needed to put in much effort and time to keep pace with the team, which made her feel doubtful about the balance of input and output. In the interview, she called for less workload in PBL and teamwork processes.

> "I think PBL enhances my interest in engineering because I think the **program here or the way they teach us** is so good. We learn much more then. I don't know others, but I learned much more than in my bachelors. And I think that I **have an idea what's going on in the semester** because in my bachelors, sometimes I didn't know what was going on. And then just before the exams, I just studied one week just preparing for the exam. So, now is much better, more interesting to learn new things. But one thing **which is not so interesting is the heavy workload**. Sometimes, it's so tiring, so much times that it takes, making our life hard. So, that makes me a bit, I don't want to say depressed, but sometimes I'm thinking about if it's worthy. Maybe less workload would be better." Gina

5 Discussion and Conclusion

Framed in the engineering identity model, this study explored how AAU PBL model contributed to the formation of engineering identity of international engineering students, who had no teamwork or PBL experiences before. Based on semi-structured interviews, students reported their engineering identity development via PBL experiences in AAU in the dimensions of performance, recognition and interests.

Performance: Compared with those international students' learning experiences in their home universities, one of the biggest benefits of AAU PBL model is the opportunity to link theories to practice, which could shorten the gap between universities and industries, in accordance with findings on local students. (Kolmos & Holgaard, 2019). Through working as real engineers in teams, students pointed out that they further understood the significance of transferable skills and reported the improvement of their teamwork skills, communication skills, problem-solving skills, emotion and time management skills.

Recognition: In this dimension, several students' self-confidence was found to be enhanced by recognitions from peers and supervisors. Recognitions from members in the professional communities can motivate individuals to develop the sense of belongings (Strayhorn, 2018). In engineering education, positive feedback and comments from engineering staff could inspire students' belief in their abilities to be competent to engineering work (Leydens et al., 2017). In addition, by experiencing AAU PBL model by themselves, those international students realized the benefits of PBL for future engineering jobs and got

more self-confidence of preparation for their engineering career, which promotes their engineering identity and might enhance their persistence in engineering (Meyers et al., 2012).

Interests: PBL was pointed out as an effective method to enhance students' interests in engineering. For these international students without PBL experience, their first projects inspired their interest in problem-solving. In PBL, the opportunities to work with real engineering equipment aroused students' curiosity and made the learning processes more vivid. Learning by doing in PBL could support students' deep learning in professional knowledge, practical skills and engineering competences (Cobo-Benita et al., 2010), and participants in this study also reported better learning outcomes in AAU PBL model than in traditional learning.

Although AAU PBL model was identified by international students as an effective way to develop their engineering identity, challenges were also mentioned during the interviews. Previous studies have pointed out that culture differences brought difficulties for overseas students' learning experience in PBL (Du & Hansen, 2005). Especially, non-western students coming to western universities might face marginalization socially and academically (Selvarajah, 2006; Gram et al., 2013). In addition, transferring from traditional learning context and adapting those active learning methods challenges international students, specifically for students who come from environments where teachers are the center of learning and authorities of knowledge (Du et al., 2020). In this study, as entry-level PBL learners, several students also reported that it was a challenging job for them to adapt the PBL paradigm and overcome difficulties such as heavy workload, team pressure and self-doubt. More attentions are needed to focus on the challenges faced by PBL beginners. The PBL curriculum for international students could be optimized with more components of PBL skills trainings and pedagogical workshops.

In terms of limitations of this study, there were only six participants in the interviews, which might influence the richness of the collected data. However, this study serves as a polit study and provides primary findings of the contributions of AAU PBL model on international students' engineering identity. Future work will expand the sample size to make comparison between students' prior learning experience and PBL experience in AAU, and to explore the challenges they meet as "PBL beginners" in their teamwork processes. More attentions could be paid on the long-term influence of PBL on students' engineering identity development. With more finished projects, international students might have more learning experiences and reflections on the differences between traditional learning methods and the AAU PBL model.

6 References

Clausen, H. B., & Andersson, V. 2019. Problem-based Learning, Education and Employability: A Case Study with Master Students from Aalborg University, Denmark. *Journal of Teaching in Travel & Tourism*, **19**(2), 126-139.

Cobo-Benita, J. R., Ordieres-Meré, J., Ortiz-Marcos, I., & Pacios-Álvarez, A. 2010. Learning by Doing in Project Management: Acquiring Skills through a Collaborative Model. *In: IEEE Education 2010 Conference, April, 701-708*.

Chen, J., Kolmos, A., & Du, X. 2020. Forms of Implementation and Challenges of PBL in Engineering Education: A Review of Literature. *European Journal of Engineering Education*, 1-26.

Cresswell, J. 2009. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches: 3rd ed*. Thousands Oaks, CA: Sage.

De Ríos-Carmenado. I., Lopez, F. R., & Garcia, C. P. 2015. Promoting Professional Project Management Skills in Engineering Higher Education: Project-based Learning (PBL) Strategy. *International Journal of Engineering Education*, **31**(1), 184-198.

Du, X., & Hansen, S. 2005. Confronting Cultural Differences: Learning Engineering as Foreigners in a Danish Context: A Case Study of Chinese Students. *Journal for Science and Technology Studies*, **17**(3-4), 61-84

Du, X. 2006. Gendered Practices of Constructing an Engineering Identity in A Problem-Based Learning Environment. *European Journal of Engineering Education*, ***31***(1), 35–42.

Du, X., Chaaban, Y., Sabah, S., Al-Thani, A. M., & Wang, L. 2020. Active Learning Engagement in Teacher Preparation Programmes: A Comparative Study from Qatar, Lebanon and China. *Asia Pacific Journal of Education*, 1-16.

Godwin, A. 2016. The Development of a Measure of Engineering Identity. *In: ASEE Annual Conference and Exposition Conference Proceedings, Jun 26-29, New Orieans, LA.*

Godwin, A., & Potvin, G. 2015. Fostering Female Belongingness in Engineering through the Lens of Critical Engineering Agency. *International Journal of Engineering Education, **31***(4), 938–952.

Gram, M., Jæger, K., Liu, J., Qing, L., & Wu, X. 2013. Chinese Students Making Sense of Problem-Based Learning and Western Teaching: Pitfalls and Coping Strategies. *Teaching in Higher Education*, **18**(7), 761-772.

Guerra, A., & Kolmos, A. 2011. Assessing Learning Outcomes and Engineering PBL Project Reports. *In: SEFI Annual Conference 2011, Sep 28-30, Lisbon.*

Hung, W. 2011. Theory to Reality: A Few Issues in Implementing Problem-Based Learning. *Educational Technology Research and Development*, **59**(4), 529–552.

Kolmos, A., & Holgaard, J. E. 2019. Employability in Engineering Education: Are Engineering Students Ready for Work?. *The Engineering-Business Nexus, 499-520, Cham: Springer.*

Kolmos, A., & Holgaard, J. E. 2015. Design of Virtual PBL Cases for Sustainability and Employability. *Global Research Community: Collaboration and Developments*, 312-323.

Lewin, K. 1947. Group Decision and Social Change. *Readings in social psychology,* **3**(1), 197-211. Leydens,

J., Kepa, A. T. K., Morgan, B., & Lucena, J. 2017. Mechanisms by Which Indigenous Students Achieved a Sense of Belonging and Identity in Engineering Education. *In: 2017 ASEE Annual Conference & Exposition, Jun 26-29, Columbus, Ohio.*

MacQueen, K. M., McLellan, E., Kay, K., & Milstein, B. 1998. Codebook development for team-based qualitative analysis. *Cultural Anthropology Methods*, **10**(4), 31–36.

Meyers, K. L., Ohland, M. W., Pawley, A. L., Silliman, S. E., & Smith, K. A. 2012. Factors Relating to Engineering Identity. *Global Journal of Engineering Education*, **14**(1), 119-131.

Patrick, A. D., Choe, N. H., Martins, L. L., Borrego, M. J., Kendall, M. R., & Seepersad, C. C. 2017. A Measure of Affect toward Key Elements of Engineering Professional Practice. *In: 2017 ASEE Annual Conference & Exposition, Jun 26-29, Columbus, Ohio.*

Selvarajah, Christopher. 2006. Cross-Cultural Study of Asian and European Student Perception: The Need to Understand the Changing Educational Environment in New Zealand. *Cross Cultural Management: An International Journal*, **13**(2): 142-155.

Strayhorn, T. L. 2018. *College Students' Sense of Belonging: A Key to Educational Success for All Students*. Routledge.

UNESCO. 2017. *Education for Sustainable Development Goals Learning Objectives*. Retrieved from Education Sector, UNESCO: https://unesdoc.unesco.org/ark:/48223/pf0000247444