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Guest Editorial: Maker Spaces in Engineering Education

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Maker spaces are informal sites in which people with the same interests can collaboratively build creative projects by using emerging technologies. In recent years, libraries and museums in the U.S. have established a lot of maker spaces to promote making (or DIY) experiences. The trend of out-of-school maker movement also spreads to K–16 learning environments. Universities and high schools not only designed maker spaces at campus, but also regularly hosted a maker faire to facilitate student innovation. However, the growing interest in maker spaces is often linked to STEM (or STEAM) learning practices. The engineering design as a core principle at maker spaces is not emphasized. The key theme in this special issue is to explore pedagogical and learning issues with a focus on engineering projects in maker spaces.

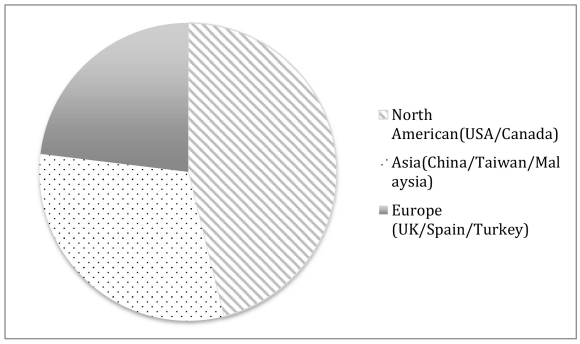

Fig. 1. Contributors' country origin.

Based on the peer review outcomes from submitted manuscripts, this special issue selects 13 outstanding papers, covering several important topics on maker spaces in engineering education. Figure 1 shows the author country origin. Table 1 summarizes the profiles of selected papers.

Figure 1 indicates that authors from North America and Asia are major contributors to this special issue. Furthermore, information in Table 1 shows that most of selected articles investigated various topics at college maker spaces while only two articles (Chung et al. and Tsai et al.) focused on pre-college students. Of those studies on college maker spaces, few (Lenhart et al. and Namasivayam et al.) examined teachers' perspectives on maker spaces. Regarding research method, the number of qualitative and quantitative studies is almost equal.

Because of a time limit on paper submission for this special issue, several research themes listed in the call-for-paper flyer (at the IJEE official website) were not fully investigated. To promote further research regarding maker spaces in engineering education, potential research topics are proposed

Table 1. The profiles of selected papers in the special issue

Author	Research Topic	Research Method	Research Subject
Hoople et al.	Makerspaces at formal and informal learning settings	Qualitative	College students
Dámari et al.	Graphic creativity on maker projects	Quantitative	College students
Lei et al.	The CDIO-based makerspace framework	Quantitative	College students
Budinoff et al.	Prototyping process on maker projects	Quantitative-centered	College students
Wettergreen et al.	Makerspaces in different countries	Qualitative	College students
Chung et al.	Maker projects in a vocational high school	Quantitative-centered	Pre-college students
Galaleldin et al.	A maker program in engineering design courses	Qualitative	College students
Lenhart et al.	Engineering faculty perceptions of university makerspaces	Qualitative	College faculty
Tsai et al.	Maker projects in a vocational high school	Quantitative	Pre-college students
Doğan et al.	Issues of makerspace environment	Qualitative	College Students
Namasivayam et al.	Impact of makerspaces on student learning	Qualitative	College Students and faculty
Kalogeropoulos et al.	Students' views on makerspaces	Qualitative	College Students
Neumeyer	Makerspaces for entrepreneurship education	Quantitative	College Students

Table 2. Potential Research Topics Regarding Maker Spaces in Engineering Education

Research Themes	Potential Research Topics
Curriculum design in maker spaces	1. The effects of different instructional methods on maker projects (e.g., Tsai et al.'s article in this special issue). 2. The instructional design of maker-centered learning (e.g., Clapp et al. [1] and Mckay and Glazewski[2]).
Engineering design methods in maker spaces	1. Development of engineering design principles for different levels of learners (e.g., Chou's [3] study for elementary school students). 2. A comparison on learning process among different engineering design methods.
Learning environment design in maker spaces	1. The use of different interior design at maker spaces (e.g., Doğan et al.'s article in this special issue). 2. An investigation on safety issues at maker spaces (e.g., Lenhart et al.'s article in this special issue).
Instructional strategies for facilitating engineering projects	1. The use of different instructional strategies (e.g., case-based learning or problem-based learning) on maker projects. 2. The design of innovative instructional strategies for maker-centered learning (e.g., Lei et al.'s article in this special issue).
Maker faire for promoting engineering professions	1. Students' learning experiences in a maker faire. 2. Parents' or teachers' involvement experiences in maker faire.
Teachers' engineering professional training in maker spaces	1. Course development for pre-service teachers at teacher education centers. 2. Workshop training for in-service teachers.
Assessment tools for measuring learners' engineering projects	1. The design of innovative assessment tools (e.g., MIT's new assessments [4] in maker education). 2. An investigation on students' learning transfer after learning achievement tests in maker education.
Computer applications in engineering projects	1. Emerging technologies for building prototypes (e.g., Budinoff et al.'s article in this special issue). 2. A comparison on project prototypes among different computer applications.
Design thinking in engineering projects	1. A comparison on design thinking between novice and expert makers. 2. Students' learning patterns in the design thinking progress.
Engineering practices in out-of-school maker spaces	1. Students' learning experiences at library or museum maker spaces. 2. A comparison on learning outcomes between formal and informal learning settings (e.g., Hoople et al.'s article in this special issue).
Comparison between college and pre-college maker spaces	1. Pre-college makers' learning experiences (e.g., Chung et al.'s article in this special issue). 2. A comparison on learning styles between college and pre-college makers.

in Table 2. I hope that information may be helpful to educators who attempt to explore maker spaces in the engineering disciplines.

Finally, on behalf of all the authors and reviewers contributing to this issue, I would like to thank Editor-in-Chief Ahmad Ibrahim for his support to our scholarly efforts. I hope you will find these outstanding articles interesting and useful.

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