Perception among Students towards Learning Environment and Innovation: A Study among Engineering Students in Saudi Arabia

Zain Aljandali and Abu Samah Zuruzi*

Department of Electrical Engineering, College of Engineering, Alfaisal University, Kingdom of Saudi Arabia

Abstract

Human capability development is a key component of the Vision 2030 program of the Saudi Arabian government. Among others, it supports innovation and entrepreneurship culture to ensure global competitiveness of its citizens. Higher education institutions such as universities serve a special role in nurturing innovation. This paper investigates learning environments in Alfaisal University in Riyadh, how they stimulate innovative competence, students' perception of their competence and their perception of learning environment on campus to foster innovation. Data collection was carried out through a voluntary and anonymous online survey over a period of 16 days. A total of 60 students responded comprising of 31 females and 29 males. Results of a survey among students of various engineering programs in the university is presented. The survey instrument uses a 7-point scale response format to assess (i) classroom learning environment (ii) innovation competence and (iii) relevance of innovation competence. Students have the highest degree of self-confidence for their innovative competence with the creativity scale getting the highest average rating with mean and standard deviation of 6.64 and 1.69, respectively. In contrast, students gave the lowest average rating with mean and standard deviation of 4.65. and 1.46, respectively, for scale focussing on innovative competence when assessing relevance of innovation competence. However, the high standard deviation shows a large spread of perception among students' perception. The results suggest engineering curricula need to explicitly teach and assess innovation competence and students' learning goal must include innovation competence. It is also found that perception of students in this study were consistently higher than those in Netherlands assessed using a similar instrument.

Keywords: innovative perception; educational evaluation; engineering education; higher education; perception of learning; self-concept

1. Introduction

Engineering has been described as the act of creating artifacts, processes, or systems that advance technology and address human needs using principles of the sciences, mathematics, computing, and operations (Anderson, 2019). Inherent in this description of engineering is innovation competence which is the capacity to generate original, appropriate and implementable solutions to problems (Ovbiagbonhia et al., 2019). Indeed, the capacity to innovate is a core competence expected of an engineer (Beghetto & Kaufman, 2013). It can then be expected that innovation competence must be a critical learning goal for students in any discipline of engineering in higher education institutions. Graduates of engineering programs accredited by the Accreditation Board for Engineering and Technology Inc (ABET) should be able to lead in innovation among, other endeavours (ABET, 2021). Despite its importance in higher education, there was limited research into innovation competence up to early 2000s and it is only until fairly recently that reseach in this area has gained momentum (Hero et al., 2017).

Learning environments are the milieus in which students gain knowledge or skills and applies them. Research finds that student achievements are higher when the learning environment is conductive to learning (OECD, 2010). The learning environment include tangibles such as physical infrastructure to intangible ones such as content (and how it is delivered) and teaching behaviour that affects learning. To ensure innovation competence among its students, curricular of higher education institutions evolves with contemporary needs of industry and society.

Tertiary education system in the Kingdom of Saudi Arabia (KSA) is similar to those in North America. In general, higher education institutions in KSA offer bachelors, masters and doctoral degrees. Currently, there are 29 state universities and 14 private universities in KSA (Ministry of Education, 2021). Our review of the literature shows there are are few published works examining status of innovation in KSA. One paper focussed on innovation in firms (Al Othman & Sohaib, 2016) and another on universities (Khayati & Selim, 2019) in KSA. There was no prior work studying students' perception of learning environments and innovation. Indeed, there is a gap in the literature examining the learning environment in higher education institutions in KSA.

The aim of this study is to investigate the perception of engineering students in Alfaisal University, a private university, towards learning environment and innovation. The study used an instrument adapted from one developed to study perception of students at universities of applied sciences in the Netherlands (Ovbiagbonhia et al., 2019). Results of this current study will shed new light on the perception of engineering students and will be a useful input for

continuous improvement of the curricular. It will also serve as a useful comparison for other studies on students' perception.

2. Methods

This study gathers data through an online survey instrument. Students across the college of engineering ranging from freshmen to seniors at Alfaisal University were invited to participate in the survey. The survey was opened over 17 days in the middle of the semester when there were no exams so that students are able to provide accurate inputs. Furthermore, identifying information such as student name or number was not collected to ensure anonymity to all participants and no ethical concerns were raised during this study. The survey was on-line and students can access it from any location at any time at their convenience. This is to ensure feedback received were accurate.

2.1. Instrument

Instrument for data collection was a questionaire that was modified from one developed to study perception of students in the Netherlands (Ovbiagbonhia, et al., 2019). The original instrument was used to study perception of students in Built Environment programs across eight universities of applied sciences. The original instrument used elements of the Constructivist Learning Environment Survey (CLES) questionnaire (Taylor et al., 1997) that had been used and validated over numerous studies across many countries (Aldridge et al., 2000) (Kim at al., 1999).

In the current study, the instrument was designed to elucidate answers to the following research questions as shown in Table 1:

Table 1. Research questions addressed in current study

Number	Research questions	Domain
1	How do students perceive their own innovation competence?	Innovation competence
2	What are students' perceptions of the existing learning environment with respect to innovation competence?	Learning environment
3	How do students perceive the focus on innovation competence at the curriculum level and the relevance of teaching that aims to develop innovation competence in programme of study?	Relevance of teaching to development of innovation competence

Source: Adapted from Ovbiagbonhia, et al. 2019

To address the research questions, items in the questionnaire relate students' perceptions of the learning environment to innovation competence development, students' self-perceived level of innovation competence as well as to students' perceptions of the focus and relevance of innovation competence. All items used a 7-point response format of (1)Strongly Disagree,

(2)Disagree, (3)Somewhat Disagree, (4)Neither Agree nor Disagree, (5)Somewhat Agree, (6)Agree and (7)Strongly Agree. One item however used a 7-point response format of (1)Very Irrelevant, (2)Irrelevant, (3)Somewhat irrelevant, (4)Neither relevant nor irrelevant, (5)Somewhat relevant, (6)Relevant, (7)Very Relevant. More information about the domains is shown in the following tables.

To answer research question 1 on students' self-perceived innovation competence, four scales from three prior works were used. A total of 16 items were used in the present study. Table 2 provides a list of scales, their descriptions and sample items used to assess innovation competence.

Table 2. Scale, description and sample item used to assess perception of innovation competence

Scale	Description	Sample item
Creativity (Hurt et al., 1977)	Do things in new ways, think and behave in original way, receptive to new ideas	I find it stimulating to be original in my thinking and behaviour
Creative self-efficacy (Tierney & Farmer, 1977)	Having self-belief, self-confidence and self-assurance in creative ability	I have confidence in my ability to solve problems creatively
Risk propensity (Chell and Althayde, 1977)	Having tolerance and ability to take calculated risk	Fearing that I might fail my exams is a powerful motivator at school/college.
Ambiguous problems (Hurt et al., 1977)	Having ability to solve ambiguous problems	I am challenged by ambiguities and unsolved problems

To answer research question 2 on learning environment, three scales from a prior work was used (Taylor et al., 1997). A total of 11 items were selected in the present study. Table 3 provides a list of scales, their descriptions and sample items used to assess learning environment.

Table 3. Scale, description and sample item used to assess perception of learning environment

Scale	Description	Sample item
Personal relevance	Connection between students' learning to his/her experience or solving tasks across domains	In my studies within my major, students learn to reflect on innovative solutions beyond my major field of studies.
Uncertainty	Experience science as evolving, culturally and socially determined	In my studies within my major, students learn that innovation is influenced by people's values and opinions.
Student negotiation	Having a say, together with the teacher over the design and management of leaning activities and assessment	In my studies within my major, students explain their understandings of innovative process to one another.

To answer research question 3 on relevance of innovation competence, two scales from two separate prior work was used. A total of 5 items were selected in the present study. Table 4 provides a list of scales, their descriptions and sample items used to assess relevance of innovation competence.

Table 4. Scale, description and sample item to assess relevance of teaching to development of innovation competence

Scale	Description	Item
Focus on innovative competence (Beghetto & Kaufman, 2013)	Connection between students' learning to his/her experience or solving tasks across domains	In my school, innovation competence is an end goal.
Relevance of teaching for innovation competence (Adams, 2013)	Experience science as evolving, culturally and socially determined	Do you think that it is relevant to be taught how to become innovative in your study?

Inputs received were examined for completeness and consistency. Data were transferred and analysed using MS-Excel. Mean and standard of each scale were computed as outcome variables are treated as continuous variables.

3. Results

3.1. Respondent profile

A total of 60 students provided complete responses. Most respondents (68%) are enrolled in the industrial engineering program and are sophomores (77%). Furthermore, a majority (52%) of respondents are females. Also, most of the respondents are self-funding their studies. The aggregated profile of student respondents is shown in Figure 1 which express responses in percentage; absolute numbers are shown in brackets.

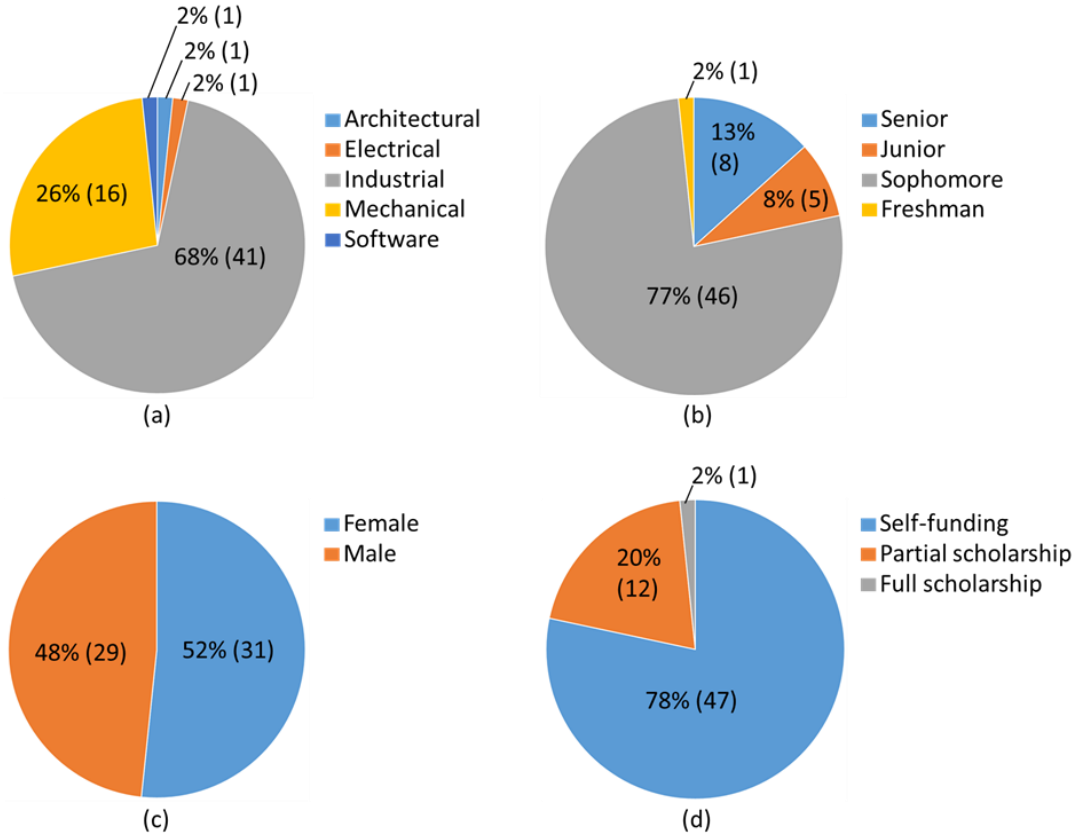

Figure 1. Profile of respondents in terms of (a) program enrolled; (b) year of study; (c) gender and (d) means of financing studies.

3.2. Students' perception of their own innovation competence (Research Question 1)

In general, students' perception of their own innovation competence are high; as shown in Table 5. Students' have the highest perception of their own creativity with a mean and standard deviation of 6.64 and 1.69, respectively. This is followed by other constructs namely creative self-assurance, risk propensity and solving ambiguous problems. It is also noted the standard deviation is large reflecting significant differences in perceptions between students for these constructs.

Table 5. Results of assessment for perception of innovation competence

Statistics	Creativity	Creative self-assurance	Risk propensity	Ambiguous problems
Mean	6.64	5.31	5.22	4.73
Standard Deviation	1.69	1.27	1.66	1.31

3.3. Students' perception of the learning environment (Research Question 2)

Results for Research Question 2 which deals with students' perception of their own learning environment are high as well; as shown in Table 6. Students' have the highest perception of uncertainty with a mean and standard deviation of 5.11 and 1.24, respectively although student negotiation follows closely with corresponding values of 5.09 and 1.42, respectively. Students' perception of personal relevance is the lowest. The standard deviation is also large indicating significant differences in perceptions between students.

Table 6. Results of assessment for perception of learning environment

Statistics	Personal relevance	Uncertainty	Student negotiation
Mean	4.88	5.11	5.09
Standard Deviation	1.48	1.27	1.42

3.4. Students' perception of relevance of teaching to development of innovation competence (Research Question 3)

Students' perception of relevance of teaching to development of innovation competence is high; see Table 7. Students' have the highest perception of relevance of teaching for innovation competence with a mean and standard deviation of 5.15 and 1.69, respectively. Students' perception of focus on innovative competence is lower with corresponding values of 4.65 and 1.46, respectively. Standard deviation for research question 3 is also large indicating significant differences in perceptions between students, similar to those of other research questions.

Table 7. Results of assessment for relevance of teaching to development of innovation competence

Statistics	Focus on innovative competence	Relevance of teaching for innovation competence
Mean	4.65	5.15
Standard Deviation	1.46	1.69

4. Discussion

This study reveals students on average have high perception of their innovation competence. Similarly, students have high perception of their learning environment and relevance of teaching on further developing their innovation competence. On a 7-point scale, it can be interpreted that a score between 1 to 3.4 indicate a low perceived level, a score between 3.5 to 4.4 indicate a medium perceived level and a score above 4.5 indicate a high perceived level (Ovbiagbonhia et al., 2019).

Focus on innovative competence scale measuring relevance of teaching to development of innovation competence scored the lowest with mean and standard deviation of 4.65 and 1.46,

respectively. Students, while having high perceived level of the teaching on the focus on innovative competence, rank this scale the lowest. Hence, one area of improvement is to relate more clearly the focus of learning activities on innovative competence. This can be achieved perhaps through explicit statement in the teaching documents such as description of courses or learning outcomes at the content level. It must be noted however that perception of students' to relevance of teaching for innovation competence scale is high.

In contrast, the scale with the largest average score is students' perception of their creativity which scored a mean and standard deviation of 6.64 and 1.69, respectively. This result indicates students have the highest perception of their own capability for creativity. This observation perhaps could, in part, be explained by the socio-economic background of students in this study. Kingdom of Saudi Arabia provides free education to its citizens enrolled in its public universities; indeed, students are provided an allowance. However, tuition fees in private universities, which Alfaisal University is one, are significant; annual tuition fees range from about USD15,000 to USD25,000 depending on the program of study. It is plausible that students in the present study, almost 80% of whom are self-funded which suggest they come from a comfortable socio-economic background, have high perception of their self-abilities. This observation is aligned with a recent study showing significant dependencies between elements of the socioeconomic factor and self-concept (Gasa et al., 2018).

While this study aims to investigate perceptions of students in KSA, it is informative to compare results of the present study to another study carried out in Netherlands which used a similar instrument. Students' perceptions measured in this study, reflected in the larger means, were all higher than those measured in the earlier Netherlands study among Building Environment students at eight Universities of Applied Sciences (Ovbiagbonhia et al., 2019). The instrument used in the present study was adapted from that used in the Netherland study. While it is impossible to provide a definitive explanation to the observation above, one can infer an educated guess about self-concept between different countries. Using data based on mathematics and science self-concept it was found that students in Netherlands tend to have lower self-concepts compared to counterparts from middle-eastern countries; KSA was not involved in that study (Wilkins, 2004). It is speculated that high perceptions among students in the present study could be due to cultural factors although others such as socio-economic reason could also have an effect.

5. Conclusions

Perception of students to innovation competence, learning environment and relevance of teaching to development of innovation competence was investigated among engineering students in Alfaisal University, Kingdom of Saudi Arabia. It was found that students have

high confidence in their abilities to innovate and of their learning environments and teaching received towards development of their innovation competence. This study also revealed that perceptions of students in the present study are higher than those measured using a similar instrument among built environment students in eight universities of applied sciences in the Netherlands.

Acknowledgment

The authors gratefully acknowledge Dr Ovbiagbonhia, Hanze Universities of Applied Sciences, Gronigen, The Netherlands for sharing the survey instrument which was adapted for use in the present study.

References

ABET. (October 2021). Accreditation Adds Value. [Online]. Available: https://www.abet.org/accreditation/what-is-accreditation/why-abet-accreditation-matters/

Adams, J. W. (2013). A Case Study: Using Lesson Study to Understand Factors That Affect Teaching Creative and Critical Thinking in Elementary Classrooms [PhD thesis, Drexel University]. Drexel University Online Repository. Available: https://idea.library.drexel.edu

Aldridge, J. M., Fraser, B. J., Taylor, P. C., and Chen, C. -C. (2000). "Constructivist learning environments in a cross-national study in Taiwan and Australia," *International Journal of Science Education,* vol. 22, pp. 37-55.

Anderson, J. L. (2019). "President's Perspective: What Is engineering?" *The Bridge,* vol.49, pp. 4-5.

Beghetto, R. A., and Kaufman, J. C. (2013). "Fundamentals of creativity," *Educational Leadership,* vol. 70, pp. 10-15.

Chell, E. and Athayde, R., (2009). *The Identification and Measurement of Innovative Characteristics of Young People*, 1st ed. London, U.K.: National Endowment for Science, Technology and the Arts.

Gasa, V., Pitsoane, E., Molepo, L., and Lethole, P. (2018). "The effect of families' socioeconomic status on the self-concept development of learners," *Early Child Development and Care,* vol. 189, pp. 2334-2346.

Hero, L.-M., Lindfors, E., and Taatila, V. (2017). "Individual innovation competence: A systematic review and future research agenda," *International Journal of Higher Education,* vol. 6, pp. 103-121.

Hurt, H. T., Joseph, K., and Cook, C. D. (1977). "Scales for the measurement of innovativeness," *Human Communication Research,* vol. 4, pp. 58-65.

Khayati, A., and Selim, M. (2019). "The status of innovation in Saudi universities," *Cogent Education,* vol. 6, pp. 1653635.

Kim, H. -B., Fisher, D. L., and Fraser, B. J. (1999). "Assessment and investigation of constructivist science learning environments in Korea," *Research in Science & Technological Education,* vol. 17, pp. 239-249.

Ministry of Education (October 2021). Ministry of Education, Kingdom of Saudi Arabia. Available: https://www.moe.gov.sa/en/Pages/default.aspx

OECD. (2010). The Learning Environment. PISA 2009 Results: What Makes a School Successful? [Online]. pp. 87-102. Paris: OECD Publishing. Available: https://www.oecd.org/pisa/pisaproducts/48852721.pdf

Ovbiagbonhia, A. R., Kolloffel, B., and den Brock, P. (2019). "Educating for innovation: students' perceptions of the learning environment and of their own innovation competence," *Learning Environments Research,* vol. 22, pp. 387-407.

Taylor, P. C., Fraser, B. J., and Fisher, D. L. (1997). "Monitoring constructivist classroom learning environments," *International Journal of Educational Research,* vol. 27, pp. 293-302.

Tierney, P., Farmer, and S. M. (1997). " Creative self-efficacy: Its potential antecedents and relationship to creative performance," *The Academy of Management Journal,* vol. 45, pp. 1137-1148.

Wilkins, J. L. (2004). "Mathematics and science self-concept: An international investigation," *The Journal of Experimental Education,* vol. 72, pp. 331-346.