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Determinants of Student's Success in ABU Robocon: A Case of Lac Hong University

[1]Thanh-Lam Nguyen, [1]Lam Thanh Hien, [2]Ngo Quang Huan and [3]Pham Xuan Giang
[1]Lac Hong University, Dong Nai, Vietnam (VN)
[2]University of Economics Ho Chi Minh City, Ho Chi Minh, Vietnam (VN)
[3]Industrial University Ho Chi Minh City, Ho Chi Minh, Vietnam (VN)

Abstract: Participating in robotics competitions, including ABU Asia-Pacific Robot Contest (ABU Robocon), has been a preferred learning environment to identify and foster student's creative potentials and skills for high quality 21st century workforce. Lac Hong University (LHU) and its students have made special achievements in ABU Robocon. Therefore, this study aims at identifying the determinants of their success as a typical example, so that, we can have proper actions or strategies to motivate students in actively participating in technological challenges/competitions for their future success. Top key determinants identified in this study include: student's passion in robotics and in innovations; interest of school leaders, faculties and staffs in the field school supports for student's makerspace; collaboration among team members and experiences from previous teams, their practice/trials; preparedness for future careers and vision of the development in robotics and mechatronics domains.

Key words: Determinants, student's success, Lac Hong University, ABU Robocon, Vision, domains

INTRODUCTION

Creating proper learning conditions and environment to identify and foster the creative potential of students is very important for every teacher and education institution (Eckhoff, 2011) because creativity has well been identified as one of the key skills required from 21st century workforce and it should be considered as a critical goal for relevant stakeholders in education systems (Chan and Yuen, 2014; Robinson, 2011; Wagner, 2014). Richardson and Mishra (2017) proposed a tool named "SCALE- Support for Creativity in a Learning Environment" to provide specific examples for the support of creativity. Students need to be creative to deal with complex problems happened in their careers and daily lives (Wagner, 2014). However, Beghetto (2010), Dababneh *et al*. (2010) and Plucker *et al*. (2004) pointed that the traditional teacher-led activities and uniform tasks constrained student's creativity. Hence, more and more efforts have been paid in changing traditional teaching approaches to a more active ones with student-centered environments, for examples, problem-based/project-based learning, cocreation and cooperation, role play, model making or learning atmospheres in which innovative ideas are appreciated and mistakes are an important part of their knowledge construction, etc., (Jindal-Snape *et al*., 2013; Chan and Yuen, 2014). Such environments significantly support student's creativity and provide them with better senses of own success, stronger intellectual ability, higher confidence, intensified resilience, boosted motivation and engagement and enhanced critical thinking and problem-solving skills (Beghetto and Kaufman, 2014; Jindal-Snape *et al*., 2013; Peppler and Solomou, 2011).

Among the above listed approaches, Problem-Based Learning (PBL) has well attracted special attention of numerous scholars (Gupta *et al*., 2017; Rovers *et al*., 2018) as they significantly shape students for their future professional life (Raghav *et al*., 2008). PBL is based on problems to be facilitated in small groups for their self-regulation and discussion towards targeted learning objectives (Barrows, 1996), thus, it has positive impacts on student's learning process in higher education curricula across the world (Davidson *et al*., 2014; Moust *et al*., 2005; Yew and Goh, 2016). PBL helps students to remember learning content longer (Strobel and Van Barneveld, 2009) have deeper learning and conceptual understanding (Berkson, 1993; Gijbels *et al*., 2005) and skill development (Dochy *et al*., 2003; Kasim, 1999; Vernon and Blake, 1993).

In the engineering technology domain, participating in robotics competitions is a preferred learning strategy in PBL approach (Behnke, 2006) because students will have more opportunities or challenges in the optimality and/or reliability of their robots in terms of design, build and operation to satisfy all specified requirements within

Corresponding Author: Thanh-Lam Nguyen, Lac Hong University, Dong Nai, Vietnam (VN)

limited resources such as time, budget, space and manpower. In addition, it will also help students to effectively develop their interaction skills and knowledge from various industries involved in the robotics and automation sector. Practically, there are several robotics competitions annually held across the world to stimulate the enthusiasm of students in pursuing technological challenges in their field of study. Among them, ABU Asia-Pacific Robot Contest (ABU Robocon) held annually aims at cultivating passion and ability among young engineers for making and building things and developing their interpersonal exchange.

From our viewpoints, student success in a competition is important in encouraging others to follow. And it is significant to clearly know the factors affecting the success, so that, we can propose proper actions or strategies to motivate students in actively participating in technological challenges/competitions. Therefore, as a typical example, this study aims at identifying the determinants of the great success by the students in Lac Hong University (LHU) in ABU Robocon because LHU holds national champion title for 8 years, 2 Grand Prix (2014, 2017) and three 1st runner-ups (2010, 2012, 2013) of ABU Robocon (Anonymous, 2015, 2018).

MATERIALS AND METHODS

Briefs about ABU Robocon and Lac Hong University

ABU Robocon: Officially known as the ABU Asia-Pacific Robot Contest, ABU Robocon has been sponsored by the Asia-Pacific region's federation of broadcasting organizations, the Asia-Pacific Broadcasting Union (ABU), since, 2002. The event is organized once a year in every August with the participation of teams from countries in the region. Annual competition theme is proposed by host country, thus, the wide variety of cultures from the different areas results in the appealing challenges to all participants. ABU Robocon always appreciates the creative solutions among students from different countries to the same problem proposed each year, hence, creative and imaginative thinking in designing optimal mechanisms and techniques is critical to the success of a team in the fierce contest.

Lac Hong University: Founded in 1997, LHU is the first private university located in Dong Nai Province of the Southern key economic zone of Vietnam. With the ferocious competition on the labor marketplace, Board of Rectors of LHU firmly believe that providing high quality human resources satisfying the practical needs from industries is the key for the survival and sustainable development of LHU. Therefore, besides making necessary investment in recruiting high quality faculties, upgrading the quality of facilities/equipment, providing convenient learning environment, etc., they have several educational activities to motivate student's learning. One of which is encouraging students to participate in ABU Robocon due to its positive impacts and benefits to the students. The utmost efforts of the student help LHU have a high position in the international contest.

Impacts of robotics competition: There are several benefits of robotics competitions in building student knowledge and interest as pointed by Akagi *et al.* (2015). According to the review by Eguchi (2016), robotics competitions provide participating students with several positive impacts in terms of: confidence in using technology, understanding of the role of science and technology in solving real-world problems, interests in pursuing degree/career in technical, math or science related field, understanding of the value of working in teams, Increased self-confidence, learning on physics, programming, mechanical engineering, electronics and science, skills of communication, team work and personal development. These positive impacts can be seen constantly across geographical or cultural differences.

Such activities have a wide impact on not only students but also high school pupils to stimulate their interests in robotics which can effectively help them to be innovative in finding optimal solutions to solve problems, thus, they can gain useful benefits for their project-based programmes (Barak and Zadok, 2009). Moreover, through the building of their robots, students in a team learn how to collaborate with each other in their discussions, solution proposals, knowledge sharing, etc., meaning that they can effectively foster their "team skills" (Varney *et al.*, 2012; Sugimoto, 2011). Hence, participating in robotics competitions is a good chance for students to have a collaborative and practical learning experience (Chang *et al.*, 2010; Hong *et al.*, 2011).

Student success: According to Kinzie and Kuh (2016), the term "student success" can be understood from different aspects, thus, there are several different definitions and indicators to be considered in the literature, for example, student success can infer individual or group achievement levels, shortened "time to degree", degree completion and post-college employment and earnings, content knowledge gains, engagement in educational processes that foster a high-quality undergraduate experience and even student's personal success, etc. In this study, student success in ABU Robocon refers to the performance and achievement of students in the game as

Table 1: Items used in official questionnaire

Observed variables	Code
Personal perspectives	**P**
Personal passion in innovation	P01
Knowledge in robotics	P02
Personal passion in robotics	P03
Vision of the future development in robotics and mechatronics	P04
Preparedness for future career	P05
Initiative in implementing creative ideas	P06
Competence in analyzing problems	P07
Competence in identifying problems	P08
Competence in proposing feasible solutions	P09
Competence in critical thinking	P10
Competence in expressing ideas	P11
Competence in automation programming	P12
Competence in creating optimal mechanisms	P13
Other personal perspectives	P14
Organizational perspectives	**OR**
Interest of LHU leaders	OR1
Interest of faculties and staffs in the field	OR2
School support of material/facilities for student's makerspace	OR3
School support in having flexible study schedule for those participating in the competition	OR4
School support in providing initial financial aid for making prototype	OR5
Adequate encouragement during the student's practice and trials to perfect their robots	OR6
Other organizational perspectives	OR7
Other perspectives	**OT**
Collaboration among team members	OT1
Advances in science and technology	OT2
Available equipment in automation and control	OT3
Cumulative experiences learnt from previous teams	OT4
Experiences learnt from practice and trials with other teams	OT5
Competition among teams in the school	OT6
Competition with other teams from other schools	OT7
Expectation and encouragement from their family	OT8
Expectation and encouragement from their friends	OT9

well as their career opportunities and income resulted from their achievement. As a matter of fact, LHU students from Robocon teams are usually employed by prestigious companies with a highly-paid salary even before they graduate from their study programs.

Kuh *et al*. (2006) pointed that student success includes several perspectives, including: sociological, organizational, cultural, psychological and economic. According to the discovery of Sorensen (2016), the success of a PhD candidate is affected by some factors, including: interest, incentive, idea, initiative, integrity and interpersonal relationships whereas the success of a postdoctoral one is usually determined by identity, independence and image, implementation, innovative and important topics, in-depth knowledge, interactive and integrated with research community and internationally oriented.

Research method: Based on literature reviews, we classify the determinants of the student's success into three categories, including: personal factors, organizational factors and others. We developed relevant measures for each scale in a self-completed questionnaire designed on 5-Likert scale about the level of impacts of each specified item on the success of LHU students in ABU Robocon over the past few years. We first conducted qualitative research and pilot test before producing our final version. Table 1 briefly shows the items and their respective coded names used in our official questionnaire.

Then, we created online version, so that, we can have more participants in our official survey. Our target participants include: LHU Leaders including Rector, Vice Rectors, Deans and Deputy Deans (denoted by LEAD); Faculties who are in or relate to Information Technology (IT) discipline and Mechatronics discipline (denoted by FIM); Faculties who are in other Disciplines (denoted by FOD); Team Members (denoted by MEM); Students studying IT discipline or Mechatronics discipline (denoted by SIM); Students studying other Disciplines (denoted by SOD); Student's Parents (denoted by STP); and Others from the listed positions (denoted by OTH). Relevant positions from other universities are also included in our official survey which was conducted in July 2018. In this study, we only used descriptive statistics to analyze the collected data.

RESULTS AND DISCUSSION

There were 502 completed questionnaires collected in hard copies and online; among them, there were 54 invalid observations due to several missing values. Consequently, 448 valid observations are used in this data analysis.

Participant positions: Figure 1 briefly shows the percentage of each type of positions investigated. Among the 448 valid observations, team members account for about 26% and students studying IT discipline or mechatronics account for more than 35%. That FIM, SIM and MEM account for more than 70% of the total valid observations is critical in this study because they can provide reliable evaluations for the examined perspectives.

Descriptive statistics: Table 2 clearly shows that the evaluation of each investigated item is affected by the role and viewpoints of the participant. Based on the Variation Coefficients "VC", it can be concluded that there is significant difference in the evaluation of P01, P03, P04,

Table 2: Descriptive statistics of surveyed items according to positions

Items	Positions LEAD	FIM	FOD	MEM	SIM	SOD	STP	OTH	Mean	SD*	VC**(%)
P01	4.17	4.17	4.13	4.65	4.27	4.85	4.11	4.16	4.40	0.76	17.27
P02	3.44	3.44	3.58	3.43	3.50	3.60	3.44	3.60	3.50	0.36	10.29
P03	4.17	4.10	4.19	4.92	4.56	4.19	4.22	4.16	4.50	0.92	20.44
P04	4.11	4.29	4.13	4.81	4.19	4.11	3.78	3.80	4.31	0.52	12.06
P05	4.72	4.66	4.61	4.72	4.08	3.85	3.78	3.92	4.32	0.40	9.260
P06	4.06	3.93	3.94	3.97	4.04	4.04	4.22	4.08	4.01	0.36	8.980
P07	3.89	3.88	3.90	3.88	3.89	3.94	3.89	3.92	3.89	0.40	10.28
P08	3.72	3.83	3.87	3.78	3.72	3.77	3.78	3.80	3.77	0.40	10.61
P09	3.89	3.73	3.97	3.79	3.76	3.77	4.11	3.76	3.79	0.39	10.29
P10	3.56	3.73	3.74	3.66	3.68	3.77	3.89	3.52	3.68	0.37	10.05
P11	4.06	3.93	4.03	3.95	3.99	3.96	4.00	3.92	3.97	0.32	8.060
P12	3.94	3.90	4.03	3.97	4.01	3.96	3.89	4.00	3.98	0.38	9.550
P13	3.83	3.83	3.84	3.79	3.81	3.79	4.11	3.84	3.82	0.38	9.950
P14	3.50	3.07	3.26	3.35	3.36	3.34	3.22	3.20	3.32	0.48	14.46
OR1	3.67	4.12	4.13	4.45	4.52	4.32	4.33	4.52	4.38	0.43	9.820
OR2	4.28	4.44	4.45	4.39	4.38	4.36	4.56	4.32	4.39	0.39	8.880
OR3	4.39	4.71	4.32	4.26	4.32	4.15	4.11	5.00	4.36	0.97	22.25
OR4	4.06	3.95	4.10	4.08	4.13	4.13	4.22	4.12	4.09	0.38	9.290
OR5	4.39	4.24	4.32	4.25	4.23	4.32	4.22	5.00	4.30	1.05	24.42
OR6	4.22	4.39	4.32	4.29	4.28	4.28	4.33	4.28	4.30	0.38	8.840
OR7	3.39	3.66	3.74	3.66	3.67	3.36	3.89	3.68	3.63	0.53	14.60
OT1	4.39	4.32	4.35	4.36	4.29	4.45	4.44	4.40	4.35	0.38	8.740
OT2	4.28	4.22	4.26	4.32	4.34	4.36	4.22	4.32	4.30	0.39	9.050
OT3	4.33	4.44	4.35	4.34	4.05	4.26	4.67	4.36	4.24	0.42	9.910
OT4	4.22	4.29	4.32	4.58	4.22	4.28	4.22	4.36	4.34	0.41	9.450
OT5	4.17	4.24	4.23	4.56	4.25	4.23	4.33	4.40	4.33	0.38	8.780
OT6	4.17	4.12	4.16	4.14	4.20	4.15	4.11	4.08	4.16	0.37	8.890
OT7	4.17	4.37	4.19	4.16	4.19	4.19	4.33	4.28	4.20	0.39	9.290
OT8	4.06	4.22	4.16	4.04	3.97	4.04	4.89	3.96	4.05	0.49	12.10
OT9	3.94	4.05	4.06	4.03	4.10	4.09	4.22	4.16	4.07	0.39	9.580

*Standard deviation; **Variation Coefficient (VC = SD/Mean)

Table 3: Results of one-way ANOVA analysis

Investigated items	Sum of squares	df	Mean square	F-values	Sig.
Personal passion in innovation					
Between groups	26.881	7	3.840	19.586	0.000
Within groups	85.875	438	0.196		
Total	112.756	445			
Personal passion in robotics					
Between groups	40.873	7	5.839	30.953	0.000
Within groups	82.625	438	0.189		
Total	123.498	445			
Vision of the future development in robotics					
Between groups	44.114	7	6.302	35.415	0.000
Within groups	77.940	438	0.178		
Total	122.054	445			
Preparedness for future career					
Between groups	54.419	7	7.774	30.110	0.000
Within groups	113.088	438	0.258		
Total	167.507	445			
Interest of LHU leaders					
Between groups	18.272	7	2.610	10.519	0.000
Within groups	108.689	438	0.248		
Total	126.962	445			
School support of material/facilities for student's makerspace					
Between groups	19.332	7	2.762	14.186	0.000
Within groups	85.269	438	0.195		
Total	104.601	445			
School support in providing initial financial aid for making prototype					
Between groups	13.616	7	1.945	7.850	0.000
Within groups	108.521	438	0.248		
Total	122.137	445			
Available equipment in automation and control					
Between groups	10.985	7	1.569	6.171	0.000
Within groups	111.376	438	0.254		
Total	122.361	445			
Cumulative experiences learnt from previous teams					
Between groups	9.507	7	1.358	5.682	0.000
Within groups	104.690	438	0.239		

Table 3: Continue

Investigated items	Sum of squares	df	Mean square	F-values	Sig.
Total	114.197	445			
Experiences learnt from practice and trials with other teams					
Between groups	8.801	7	1.257	5.959	0.000
Within groups	92.421	438	0.211		
Total	101.222	445			
Expectation and encouragement from their family					
Between groups	9.155	7	1.308	5.995	0.000
Within groups	95.553	438	0.218		
Total	104.709	445			

Table 4: Different evaluation between positions in each detected item

Variables	FOD	MEM	SIM	SOD	STP	OTH
LEAD		P01, P03, P04,				
		OR1, OT5	P03, P05, OR1	P01, P05	P05	P05, OR1,
FIM	OR3	P01, P03, P04, OR1,	P03, P05,	OR3		OR3, OR5
		OR3, OT4, OT5	OR1, OR3	P01, P05,	P05, OR3	P04, P05, OR1,
FOD		P01, P03, P04,	P03, P05,			OR3, OR5
		OR1, OT5	OR1, OT3	P01, P05	P05	P05, OR1, OR3, OR5
MEM			P01, P03, P04,	P03, P04, P05,	P01, P03,	P01, P03, P04,
			P05, OT3,	OT4, OT5	P04, P05	P05, OR3, OR5
			OT4, OT5			P03, P04,
SIM				P01, P03, P05		OR3, OR5
SOD					P01	P01, OR3, OR5
STP						OR3, OR5

Table 5: Top 10 determinants of student's success in ABU Robocon

Determinants	Rank
P03-Personal passion in robotics	1
P01-Personal passion in innovation	2
OR2-Interest of faculties and staffs in the field	3
OR1-Interest of LHU Leaders	4
OR3-School support of material/facilities for student's makerspace	5
OT1-Collaboration among team members	6
OT4-Cumulative experiences learnt from previous teams	7
OT5-Experiences learnt from practice and trials with other teams	8
P05-Preparedness for future career	9
P04-Vision of the future development in robotics and mechatronics	10

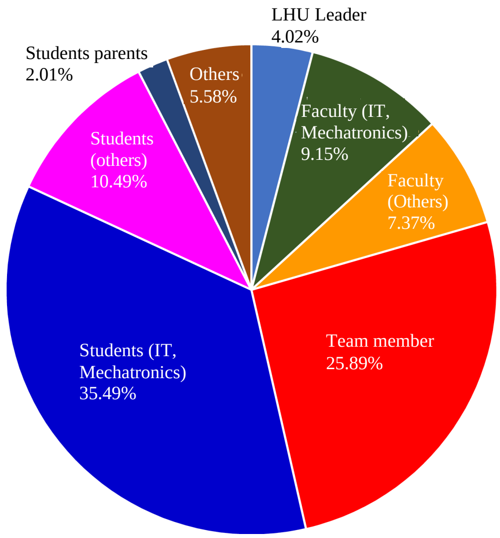

Fig. 1: Participant positions

OR3, OR5 and OT8 among the positions. To have a deeper understanding of the impacts of the positions on their evaluations, we conduct one-way ANOVA analysis whose results are shown in Table 3. Through the analysis, we found that there are 11 out of the 30 items to have such significant difference; particularly, P01, P03, P04, P05, OR1, OR3, OR5, OT3, OT4, OT5 and OT8. More importantly, by using post-hoc testing we explicitly identify which position evaluates differently from which position under which item as briefly demonstrated in Table 4.

From the results in Table 4, we need to move a further step to examine root causes of such different in their evaluations, so that, LHU can have proper actions or strategies to well attract its students to actively participate in technological challenges/ competitions for their learning and success. Moreover, from the mean values in column "MEAN" of Table 2, we can sort out top ten determinants of the student's success in ABU Robocon based on their impact levels shown in Table 5.

The great success in ABU Robocon in the case of LHU and its students over the last decade is resulted from various perspectives such as student's personal characteristics, team-work, encouraging support from their school and faculties, etc. Specifically, the personal passion in robotics and general innovations are two of the most important factors affecting their success because the passion helps to propel persistence, concentration and full engagement in making their robots. Our finding in the role of passion further agrees with those by Bonneville-Roussy *et al.* (2013), Ruiz-Alfonso and Leon (2016) and Ruiz-Alfonso *et al.* (2018). Moreover, such passion is critical for their deliberate practice and motivation to improve their robot performance through the learning-by-doing process. Therefore, passion is one of the key personal characteristics for the success in practice, meaning that inspiring student's interest in science and fostering their passion should be fully considered as the key role of a teacher in the 21st century.

In addition, the interest of the leaders, faculties/staffs in the ABU Robocon and their supports for student's makerspace are also the key determinants of the success. In preparing for their robots, students need professional advice and guidance from the faculties/staffs in the related fields. The interest in the field assures the faculties/staffs to be more active in offering their students with valuable comments and suggestions to improve their robots and it also helps the leaders to provide enough supports in terms of makerspace and flexible study schedule, so that, the students can stay focused in building their robots. Such supports from the leaders, relevant faculties/staffs help passionate students be more proactive in implementing their creative ideas/solutions.

Moreover, the student's success in ABU Robocon is significantly determined by the collaboration among team members, cumulative experiences learnt from previous teams from practice and trials with other teams. As working in team all members need to effectively collaborate to achieve their common goals in creating optimal performance for their robots, meaning that the students have the opportunity to develop their team-work skill. Learning from previous and self-experiences is a good learning strategy frequently used in student-centered education philosophy. Therefore, this implies that teachers in an education program need to promote a good interactive, cooperative and sharing atmosphere among students as well as alumni.

Last but not least, previous students participating in ABU Robocon were able to easily find good jobs with highly-paid salaries and high positions right after their graduation or several industrial companies get to LHU to directly contract with students who were in quarter-finals, semi-finals and finals, especially, those won champion titles. Such good opportunities urge more students to join the robotics teams and try to do their best, so that, they can learn more from the problems specified in the theme by the host country. These experiences help them well prepare for their future careers in the industrial fields, especially in robotics and mechatronics domain. That explains why this study finds "preparedness for future career" and "vision of the future development in robotics" as two key determinants of the student's success in ABU Robocon. This implies that key benefits in participating in a project should be well emphasized and promoted as incentives for fostering student's potentials, passions and success.

CONCLUSION

The great success of LHU and its students in ABU Robocon over the past decade is significantly affected by several factors. Among them, top key determinants identified in this study include: student's passion in robotics and in innovations; interest of school leaders, faculties and staffs in the field; school supports for students' makerspace; collaboration among team members and experiences from previous teams, their practice/trials; preparedness for future careers and vision of the development in robotics and mechatronics domains. These findings are important to have proper actions or strategies to motivate students in actively participating in technological challenges/competitions for their future success.

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