Realizing Industry 4.0 Through STEM Education: But Why STEM Is Not Preferred?

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Abstract. Since the 1760s, industrialization of the world has gone through four revolutions where the 4th revolution has expeditiously taken over from the traditional practices. The Industry 4.0 that embraces the computerization in smart factories requires improved capacities in science, technology, engineering, and mathematical (STEM) fields. Nevertheless, the present circumstances in Malaysia demonstrate that the numbers of youth who decide to follow STEM routes for tertiary education are far less encouraging. Thus, this study aimed to explore the factors affecting university students’ decisions. Data used in this study was obtained from a survey of 102 Diploma in Accountancy students from one of the public universities in Malaysia, who were selected using purposive sampling method. This study employed the descriptive statistical method, principal component analysis (PCA) and multiple regressions analysis. The PCA on the questionnaire measurement items yielded factors accounting for 68.22 per cent of the total variance. In the multiple regression model, low morale attitude, learning experience and return on investment explained 53 per cent of the total variance of perception. This study concludes that the roles of national workforce that consists of education system, culture, and government must be strengthened to enhance STEM education system in Malaysia.

1. Introduction

Industry 4.0 consists of physical cyber, Internet of things (IOT), knowledge, innovation and talent. These are the factors that will enable a developing country like Malaysia to become a developed nation. According to the National Council for Scientific and Research Development, Malaysia requires at least 500,000 scientists and engineers by the year 2020 but the current statistics shows that there are only 70,000 registered engineers, which is only 17 per cent of the figure [1]. Thus, to meet the demands of human capital in the high-tech economy, the higher education system in a country should be tailored according to the needs of Industry 4.0.

Transformation in education system is inevitable to sustain a strong economic growth and spurring investment in a country [2]. The education market structures will shape the behavior of the participants in the market that give an effect towards achievement and productivity [3]. The issues around the world including Malaysia is while countries exerting to enhance their science, technology, engineering and mathematical (STEM) education, the students’ interest in STEM is diminishing throughout their schooling period, resulting them to divert away from STEM field when pursuing higher education.
2. Literature Review

2.1. Perception and expectation of learning STEM
There are many factors that could shape the perception of students towards STEM courses in higher institution. Perceived internal barriers (confidence and preparation) are significantly related to a decrease in STEM career aspiration [4]. The internal barriers consist of structural barriers (the institution’s capacity), psychological barriers (the level of STEM courses’ difficulties) and perceived barriers of educational and career outcomes. Dustmann [5] found that the parental background such as parents’ profession, working environment, and peer group of the father and mother seem to play important roles for education of the child.

2.2. Interest, morale and attitude
Wang and Degol [6] conducted an intensive review with regard to the links of intellectual aptitude and motivational beliefs to performance, educational, and career choices. The authors found that motivational beliefs, which are informed by aptitudes in math and science, competence beliefs, interest, occupational, and life values clearly play a role in the decision to pursue STEM versus non-STEM fields. For instance, in comparison between genders, females prioritize family when they have children thus more likely to choose careers outside of STEM fields due to more career options.

2.3. Learning experience
Students spend their time between six to nine hours at school, thus experience of school science has a large influence on students’ choice to take science in the future [7]. Chong [8] criticized learning science in Malaysian classrooms of focusing on study of factual knowledge where students do not understand the nature of science. For Malaysian students, after studying mathematics for several years, the knowledge can only be applied after they enroll in science engineering stream at the age of 16. Therefore, there is a gap of time between knowledge and application which students fail to see how the knowledge should be integrated.

As for the teachers, Pimthong and Williams [9] explored the understanding of STEM among preservice teachers and found that the teachers are aware of the importance of STEM subjects but not able to explain how those subjects integrate. Hadi and Fred [10] suggested that mathematical and science subject should not be implicitly integrated. The curriculum should make mathematics more explicit, such as teaching mathematics into physics lessons through designed activities. Effective communication is vital in determining the efficacy of pedagogy and learning. Since 2003, Malaysia has implemented teaching science and mathematics in English. However, Thomas and Watter [11] found that the situation in Malaysia is contradicted with that of in India. Disadvantages among native Malay speaking teachers in delivering STEM knowledge in English resulted in failure of STEM education. Implementing constructive curriculum in Malaysia seems difficult as to change the traditional beliefs of the teachers [12].

In view of teacher effectiveness, Shirazi [7] highlighted that teachers’ personality and teaching style are one of the top three factors. However, even though we do have highly qualified teachers, the interaction between education and production is fundamentally impossible if student trainees have no access to modern technology and equipment. The outcome must be varied across the nation in terms of urban versus rural areas. In Malaysia, class sizes are large (40–50 students) and poorly furnished [11]. The lack of access to science resources and facilities, high quality teachers, and advanced coursework would affect the quality of teaching STEM subjects [13].

2.4. Making Money Worth (Return on Investment Education)
In Malaysia, most students whose parents are not able to provide education fund will use educational loan from Perbadanan Tabung Pendidikan Tinggi Nasional (PTPTN) to pursue their study. Thus, students perceive their loan to be worthwhile investment for career opportunities as to outweigh their debt burdens [14]. By using 2007 Malaysian Household Income Survey (HIS), Husaina [15] found that due to current job market demands, completion of primary and lower secondary schooling does not
result in higher returns to education in the market, resulting in the youths being further to the university level in order to capture higher returns to education.

3. Methodology
This study aims to examine factors that influence university students, who used to be a science stream student in secondary school, in opting for non-sciences field at university. This study employed quantitative approach using purposive sampling technique. The respondents were accounting students of Universiti Teknologi MARA (UiTM) Cawangan Perak who used to be a science stream student in secondary school. They were identified as “undergraduates who migrated from STEM routes to non-STEM routes”. A total of 112 respondents were involved in this survey.

The descriptive questions for the first objective were designed based on Constantinou et al. [16], while the Likert-scale questions for the second objective were developed following Loren and Naltan [17]. In order to measure consistency of all items in the questionnaire, a reliability test using Cronbach’s alpha was undertaken. We used Principal Component Analysis (PCA) to transform correlated variables into uncorrelated variables. A total of 20 questionnaire items were filtered using dimensionality reduction to extract relevant components. Based on these components, this study examines the relationship between independent variables (low morale attitude, learning experience, return on investment) and dependent variable (perception) by applying multiple regression analysis.

4. Results and discussion
From the analysis, 96.9 per cent respondents decided which courses they want to pursue. In investigating where they got the idea to pursue the course, figure 1 shows the channel of references. The respondents were asked to put ranks between those options and most of them chose their own opinion and ideas as the first rank. This indicates that their decision to pursue in non-STEM course is based on their own ideas and opinion (respondents’ perception).

![Figure 1](source-of-references.png)

Figure 1. Source of references.

Figure 2 represents what are the criteria that influence them to pursue in accounting instead of STEM course. 84.6 percent believed that choosing accountancy would offer better future career prospects, followed by high salary. This is parallel with the range of salary for senior manager in accounting, and audit & tax services that is in the range of between RM10,444 to RM15,911 while the range salary for senior manager in consulting (IT, science, engineering & technical) is from around RM8,250 to RM11,000 [18].

In regard to their preferences in job scope, 55.4 per cent prefer to work in public sector, which gives better assurance. Meanwhile, there were 64.6 percent respondents who used to work during period of study but only 21.5 per cent of them claimed that work did influence their choice to pursue in accountancy.
In the observation of the roles of parents in the process of decision-making, figure 3 indicates that most of them do have frequent interaction with parents. However, figure 4 and figure 5 indicate that the roles of parents seem insignificant due to high percentage of parents who always accept the students’ idea instead of assuming a guidance role to them. This situation reflects that there are weaknesses in culture of guiding the children and lack of awareness on how important to emphasize the science education as to fulfill the requirement of 4th industry revolution. Regardless of teaching approach, the general culture provided by parents as a role model would attribute to the school ethos [19].

![Figure 2](image1.png)

**Figure 2.** Criteria that influence respondents to choose accounting course.

![Figure 3](image2.png)

**Figure 3.** How often do you discuss with your parents about your studies and professional development?

![Figure 4](image3.png)

**Figure 4.** What is the role of your parents?
Figure 5. Did your parents disagree with the course you chose?

In Table 1, the values of the Cronbach’s alpha, $\alpha$ for the first and second factor are strong, and the rest are acceptable ($\alpha > 0.5$) to explain the consistency of statements in measuring every component.

In order to investigate which factors that have the most variance, principal components analysis (PCA) was used. Bartlett’s test of sphericity was statistically significant ($p < .05$) and the Kaisser Meyer Olkin (KMO) value was 0.544, indicating that the sample is adequate to explain the case. The PCA on the questionnaire measurement items yielded 6 factors with eigenvalues greater than 1, accounting for 68.22 per cent of the total variance and the first factor accounted for 24.04 per cent for the variance. Component 1 in Table 1 clearly represents ‘Perception’, Component 2 referring to ‘Low Morale Attitude’, Component 3 assigned as ‘Learning Experience during Secondary School’, and Component 4 as ‘Returns on Investment’.

**Table 1.** Cronbach’s Alpha test.

| Component                                                                 | Component 1 | Component 2 | Component 3 | Component 4 |
|---------------------------------------------------------------------------|-------------|-------------|-------------|-------------|
| Cronbach’s Alpha ($\alpha$) = 0.757                                      | 0.706       | 0.604       | 0.565       |
| Law, Accountancy and Business give more immediate work results             | 0.849       |             |             |             |
| The demand of labor from the job provider in STEM field is quite rigid since the expectation is very high. | 0.808       |             |             |             |
| The level of syllabus will be tougher (it is highly elitist field).       | 0.604       |             |             |             |
| I have the inferior feeling of dropping out from university               | 0.432       |             |             |             |
| I might be interested in STEM courses if the teaching of subject is more engaging at young age |             | 0.914       |             |             |
| I felt discourage                                                       |             |             | 0.638       |             |
| I scored low marks in my entire test                                     |             |             |             | 0.792       |
| I had difficulties to understand the subjects                             |             |             |             | 0.729       |
| I did not see the real picture of how things (the concept, theory, exercise in class) actually work. |             |             |             | 0.827       |
| Teachers only talking at the front of a classroom while students taking notes and doing worksheet |             |             |             | 0.619       |
There were less practical science activities during lessons 0.445

I want to make my money worth so I chose non-STEM courses 0.75

Taking non-STEM courses ensure me graduate on time 0.619

The highest is value of statement in perception, revealed that undergraduates choose this course as they want to get hired immediately right after completion of study. They also have an opinion that the demand for a worker in STEM field might be rigid due to the expectation being very high. Besides, they also think that the level of syllabus will be lot tougher as they think it is a highly elitist field and have the inferior feeling of dropping out from university. In contradiction, the respondents are actually still having interest in STEM field. This can be identified from the highest value in the second components, which belongs to the statement that “I might be interested in STEM courses if the teaching of subject is more engaging at young age”. However, the weaknesses in teaching approach resulted in them feeling discouraged. Accompanied by low morale, these have led the students to score low marks due to the difficulties to understand the subject. Recalling the experience of learning STEM subjects during secondary school, the highest score stated that they actually did not see the real picture of how things actually work and teachers were still using traditional method and less practical science activities during lesson. Student are also concerned on the return on investment for assurance of their money’s worth by choosing the right track and able to grad on time.

From the regression analysis in Table 2, the concern on return on investment is the most driven factor that influences undergraduates to migrate from STEM courses. Most students are using educational loan to pursue their study. Given the rising cost and economics condition, the uncertainties of getting a job from STEM field could be a high risk for a borrower in repayment default [14].

Amongst of the barriers for a nation to accumulate the talents in STEM field are the internal barriers that exist due to weak learning experience, and fragile attitude. This is supported by Boon [20] who stated that our science lessons are no more focusing on hands-on scientific investigations as there is reduction in science practical works ever since the science practical examination was scrapped in the early 2000s.

### Table 2. Regression analysis.

| Variables                        | B     | Std. Error | t     | Sig.  |
|----------------------------------|-------|------------|-------|-------|
| Low Morale Attitude              | 0.165 | 0.098      | 1.679 | 0.098 |
| Learning Experience              | 0.239 | 0.094      | 2.538 | 0.014 |
| Return on Investment             | 0.289 | 0.081      | 3.552 | 0.001 |

\( R^2 = 0.53\%\)

5. Conclusions

The study result implies that the roles of national workforce that consists of education system, culture, and government must be strengthened to enhance STEM education system in Malaysia. This is important in order to cultivate and spur the interest in STEM in every young generation. Joseph [13], in his model of human capital for Smart Manufacturing and Industry 4.0 revolution, stated that the roles of national workforce which consist of education system, culture, and government are vital in forming the human capital equipped with education, knowledge, experience, skills, creativity, and motivation. The role of government is to provide the support system especially in educational fund for the STEM fields’ students. By providing financial aid, it could lower the educational cost and will increase the return on
investment since the market salary offered by the industry still do not outweigh the burden of cost studying since the salary range is somehow similar with the non-STEM groups’ income. At institutional level, finding the right formula of teaching STEM subjects could be the key factor. Even if numerous policies were formulated; the implementation at school level still requires interpretation and the ingenuity of the teachers. In terms of flourishing the STEM field in societies’ culture, parents must implicitly and explicitly value the science education. The priority is to create the worth of STEM field environment and children can choose their interest based on what they have experienced.

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