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Development and Validation of Scale using Rasch Analysis to Measure Students' Entrepreneurship Readiness to Learn Embedded System Design Course

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Abstract

Embedded systems are growing rapidly as the technology paves the way for the rise of future of smart manufacturing through a wide range of industries. The intensity demands of innovation required a steady supply of innovative and entrepreneurship engineers to ensures the industry players have a sustainable supply of talent to fuel their growth and investments. The university acknowledge the current and future demand of the labour market by offering embedded system course that are developed to equipped the next generation engineers with innovation and entrepreneurship skills to enable them to turn their ideas into reality. This paper developed and validated a scale to measure the student entrepreneurship skills readiness for embedded systems design course using the Rasch analysis.The content validity results show that CVR is 0.92 and CVI is 0.96 indicating an excellent content validity. The pilot test result show that the scale Cronbach alpha is 0.80 indicating excellent scale reliability. The construct validity of the scale was evaluated using WINSTEPS version 3.92.1, with results indicated that all the items of the scale fit the Rasch model with satisfactoryfit index and showedexcellent consistency, with reliability alpha of 0.99 foe items and 0.75 for persons. The findings depicted that most of the students have poor business and entrepreneurship skills, such as marketing and negotiation abilities. Therefore, higher learning institutions need to embed acquirable entrepreneurial skills in the prerequisites courses to provide adequate training to the students, increasing their creativity and maximizing their potential to be successful entrepreneurs.

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*Keywords:*Embedded-System Design; entrepreneurship; Rasch; Readiness; Reliability

1. Introduction

Embedded Systems have became as increasingly important systems in the manufacturing sector due to their wide applications in digital electronics and smart devices. They are everywhere. In our daily lives, ranging in complexity

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from a single device such as Personal Data Assistant (PDA) to large weather prediction systems [1, 2]. Embedded Systems market was estimated in 2015 at USD 159.00 billion, and predicted to make a USD 225.34 billion revenue of by end of 2021, which require a steady supply of skilled talent to meet the current and future demands [3].The escalating small-scale business management skills via entrepreneurship education has been directly associated with enhancement of general living conditions. Besides, entrepreneurship education prepares one not only to be gainfully employed, but also to be self-employed. In this context, fresh university graduates have been reported to penetrate into the labor market at an annual basis [3, 4].In this regard, the universitiesrecognizethe importance for proposing Embedded Systems Design course to meet the demands of the talent in the field.In the engineering education, learning outcomes are usually focused on the knowledge and skills, which are designed to develop the students. Nowadays, innovation and entrepreneurship are main drive in engineering world, therefore, this scale assesses students' motivation and capacity to identify opportunity and to pursue it, in order to produce new value or economic success as well as to find out whether they are ready for the market challenges and risk taking which are part of entrepreneurial activities. Hence, this study contributes to the engineering education by assessing the student entrepreneurship skills required to learn the Embedded System Design course[3, 4].

2. Methodology

This study is implemented using a sequential exploratory hybrid development of qualitative and quantitative methods. Ten (10) items (B10-B23), 5-point Likert type format scale in which the items are generated based on course outcomes (CO) and program outcomes (PO) of the curriculum from selected universities was used for data collection. Data was collected from engineering undergraduate students in nine universities. 426 questionnaires were distrusted to eligible respondents and from which 426 were returned to the research with a response rate of 97.1%. As an early proof of the validity, the scale content validity was evaluated by measuring the Content validity index (CVI) and content validity ratio (CVR) via a panel of 13 experts. A pilot test was conducted using SPSS 23.0 to measure the scale reliability while Rasch model using WINSTEPS 3.92.1 was used to measure the construct validity by measuring the scale fit statistics, unidimensionality analysis, and Wright map. The students' readiness measured based on the results obtained from respondent' to the scale. Students' readiness to learn Embedded System Design course is evaluated using SPSS 23.0 and Rasch analysis using WINSTEPS 3.92.1. To presentclear insights on the student readiness, the assessment model by Akaslan and Law [5, 6] was used in this study in which the readiness threshold was 3.40 since it was coded as 1, 2, 3, 4 and 5, as in a five-point Likert scale format similar to the scale format. The result is readas Not-Ready if the mean score is less than required 3.40 and as Ready if the mean score is equal to or greater than 3.40.

3. Results

3.1. Content Validity

The experts' response on the scale is shown in Figure 4.11.Table 4.10 shows I-CVR and I-CVI ranging from 0.69 to 1.00 and 0.85 to 1.00 respectively. The S-CVR is 0.92 and S-CVI is 0.96. These results show that the scale have an excellent content validity.The panel of experts agreed that the scale is well structured, clear, complete, comprehensive, and could adequately measure the students' entrepreneurship readiness to learn the Embedded Systems Design course.

Table 1. Content validity of entrepreneurship skills scale

Item	Label	Validation		Decision
		I-CVR	I-CVI	
B14	I am able to identify job opportunities.	1.00	1.00	Accepted
B15	I am able to convert a new idea or invention into a successful innovation and start an enterprise.	1.00	1.00	Accepted
B16	I am able to be self-employed.	1.00	1.00	Accepted

B17	I am able to conduct market research and analysis for a new product or technology.	1.00	1.00	Accepted
B18	I am able to develop a product or technology for a real client/customer.	1.00	1.00	Accepted
B19	I am able to take part in an entrepreneurship-related competition (e.g., product development, business plan).	0.85	0.92	Accepted
B20	I am able to identify the concept and limits of a technology well enough to see the best ways to use it.	1.00	1.00	Accepted
B21	I am able to change user needs into requirements for a design that users prefer.	0.85	0.92	Accepted
B22	I am able to influence a customer or client to try a new product for the first time.	0.69	0.85	Accepted
B23	I am able to write a clear and complete business plan.	0.85	0.92	Accepted
		S-CVR	S-CVI	Accepted
		0.92	0.96	

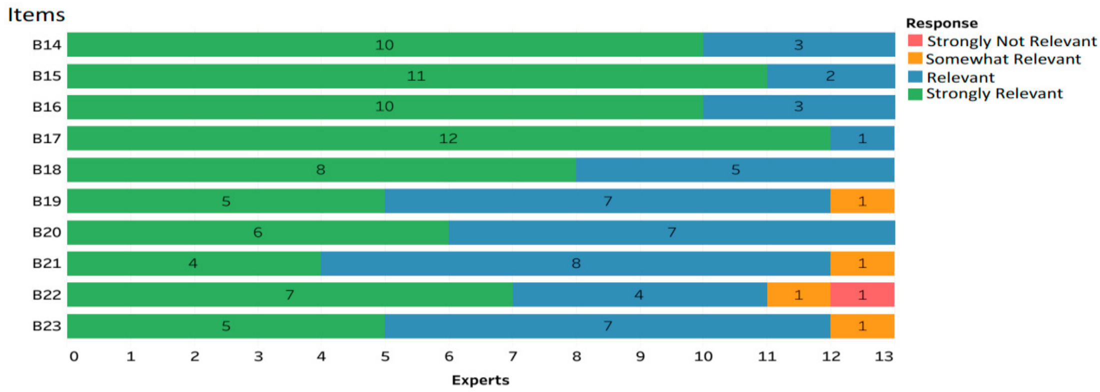

Fig. 1. Experts' response of entrepreneurship skills scale

3.2. Pilot Test

Data collected from 40, fourth year UTM students through a hardcopy paper survey was used to perform the scale pilot test analysis where SPSS 23.0 and WINSTEPS 3.92.1 were used to analyze the collected data. A reliability coefficient (alpha) of 0.70 or higher is considered acceptable [7]. The pilot test result for the scale is shown in Figure 2. The results indicate that the INFIT and OUTFIT MNSQ and ZSTD for the scale are within the range. The item reliability coefficient of the scales is also higher than 0.70.

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-----------------------------------------------------------------------------
| PERSON      40 INPUT      40 MEASURED               INFIT          OUTFIT  |
|          TOTAL     COUNT      MEASURE  REALSE     IMNSQ  ZSTD  OMNSQ   ZSTD|
| MEAN      32.8      10.0        1.11     .49       .99   -.2   1.00    -.2|
| P.SD       5.3        .0        1.00     .08       .63   1.5    .63    1.5|
| REAL RMSE    .50 TRUE SD     .86  SEPARATION  1.74  PERSON RELIABILITY  .75|
|----------------------------------------------------------------------------|
| ITEM      10 INPUT      10 MEASURED                 INFIT          OUTFIT  |
|          TOTAL     COUNT      MEASURE  REALSE     IMNSQ  ZSTD  OMNSQ   ZSTD|
| MEAN     131.1      40.0         .00     .23       .98   -.2   1.00    -.1|
| P.SD      10.9        .0         .52     .03       .39   1.7    .39    1.7|
| REAL RMSE    .24 TRUE SD     .47  SEPARATION  1.98  ITEM   RELIABILITY  .80|
-----------------------------------------------------------------------------
```

Fig. 2. Pilot test result of the scale

3.3. Construct Validity

3.3.1. Statistical Analysis

Statistical Analysis: Figure 3 shows the person and item statistical analysis result of the scale. The results show the reliability of 0.75 for person, 0.99 for item, and 0.78 for Cronbach's alpha, indicating an excellent scale reliability. The MNSQ INFIT value is 0.00 for person and 1.01 for item. The MNSQ OUTFIT value is 1.01 for both person and item. Both ZSTD INFIT and OUTFIT value for person is -0.2 indicating that the MNSQ INFIT and OUTFIT values are within the acceptable range of 0.6 to 1.4. Meanwhile the ZSTD INFIT value for item is -0.1 and the ZSTD OUTFIT value is -0.2 which are within the acceptable range of -2.0 to +2.0, indicating that the scale is a reliable construct and statistical fit [8]. The scale item separation is 8.2, which indicates that the person sample is large enough to distinguish the item difficulties. However, the small person separation of 1.72, resulting in strata of 2.63 shows the scale is able to distinguish two level of person abilities as suggest by [9].

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-------------------------------------------------------------------------------
|           TOTAL                          MODEL        INFIT        OUTFIT    |
|           SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN       26.7      10.0       -.43      .43       .99    -.2   1.01    -.2 |
| P.SD        5.2        .0        .96      .05       .65    1.5    .67    1.5 |
| S.SD        5.2        .0        .96      .05       .65    1.5    .67    1.5 |
| MAX.       46.0      10.0       3.23      .79      4.06    4.6   4.24    4.8 |
| MIN.       12.0      10.0      -4.55      .39       .10   -3.8    .11   -3.6 |
|------------------------------------------------------------------------------|
| REAL RMSE     .48 TRUE SD     .83  SEPARATION  1.72  PERSON RELIABILITY  .75 |
|MODEL RMSE     .43 TRUE SD     .86  SEPARATION  1.98  PERSON RELIABILITY  .80 |
| S.E. OF PERSON MEAN = .05                                                    |
  CRONBACH ALPHA   = .78                                                       |
-------------------------------------------------------------------------------
|           TOTAL                          MODEL        INFIT        OUTFIT    |
|           SCORE     COUNT     MEASURE    S.E.      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN     1043.2     415.0        .00      .07      1.01    -.1   1.01    -.2 |
| P.SD      124.8        .0        .60      .00       .21    2.9    .22    3.0 |
| S.SD      131.6        .0        .63      .00       .22    3.1    .23    3.2 |
| MAX.     1211.0     415.0       1.24      .08      1.38    4.8   1.40    5.0 |
| MIN.      800.0     415.0       -.75      .06       .76   -3.9    .75   -4.1 |
|------------------------------------------------------------------------------|
| REAL RMSE     .07 TRUE SD     .59  SEPARATION  8.20  ITEM   RELIABILITY  .99 |
|MODEL RMSE     .07 TRUE SD     .59  SEPARATION  8.63  ITEM   RELIABILITY  .99 |
| S.E. OF ITEM MEAN = .20                                                      |
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Fig. 3. Summary of entrepreneurship skills scale analysis

3.3.2. Unidimensionality Analysis

Unidimensionality and Local Independence: The scale unidimensionality result shown in Table 2 indicates that the amount of the variance explained by different components in the data is 40.3% with 14.3% explained by persons and 26.0% explained by items and unexplained variance in the first contrast of 13.0% and the eigenvalue of 2.17. The ratio of the variance explained by measure to the unexplained variance in the first contrast is 3.1:3, which meets the 3:1 criterion for unidimensionality [9, 10, 11].Therefore, the scale is a unidimensional construct and exhibited adequate fit data to model and is unidimensionality through analysis of the residuals

Table 2. Standardized residuals of entrepreneurship skills scale

Entrepreneurship Skills	Empirical (Observed)		Modeled (Expected)	
Total variance in observations	16.76	100.0%		100.0 %
Variance explained by measures	6.76	40.3%		40.5%
Variance explained by measures(Persons)	2.39	14.3%		14.4%
Variance explained by measures (Items)	4.36	26.0%		26.1%
Unexplained variance (Total)	10.0	59.7%	100.0%	59.5%
Unexplained variance in first contrast	2.17	13.0%	21.7%	

3.3.3. Wright Map

Wright Map: Figure 4 shows the entrepreneurship skills scale's Wright map. The result shows that all items fall into the middle score zones of the map. The item mean is measured at +0.00 and the person mean is located at -0.43, indicating low competencies among the respondents.

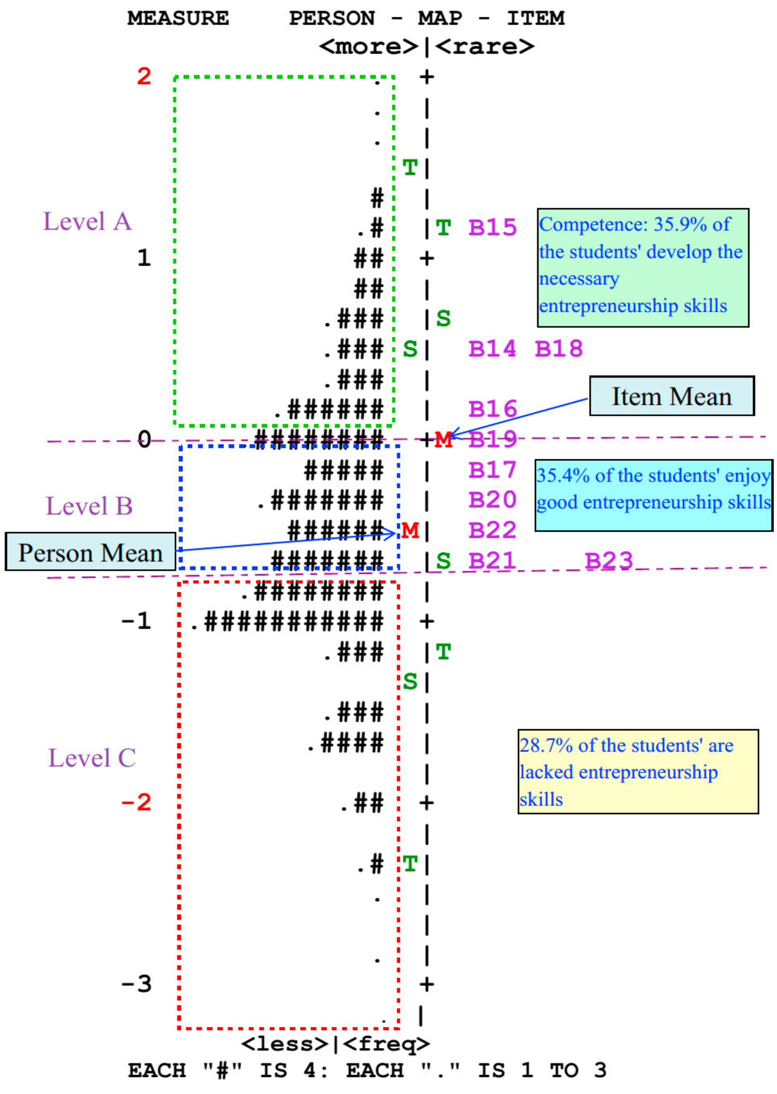

Fig. 4. Wright map readiness analysis of entrepreneurship

All the scale items fit the model well (-2 to +2) t value, as suggested by Bond and Fox [8] and there is no redundancy or overlap in the items. The Wright map shows that the easiest item is B15 which is located at 1.24 logit above the item mean, indicating that most of the respondents are able to convert new ideas into a successful innovation and establish enterprises. However, item B21 which is located at -0.75 logit below the item mean is the difficult item to be endorsed by the respondent, indicating that the respondents are facing difficulties in changing the user needs into requirements for a design which indicates that they lack entrepreneurial abilities and general business knowledge.

3.4. Readiness Assessment

The students' readiness measured using the Wright map is shown in Figure 4. The map depicted that over 28.7% of the respondents did not endorse any of the ten items of the scale. There are 35.4% of the respondents in level B who could endorse six of the scale items (B23, B22, B21, B20, B19, and B17). This finding suggests that these students have acquired the skills to develop market research in identifying the consumers' needs and altering the product accordingly. It is clear that majority of the students (64.1%) lack the skills that enables them to convert new ideas or inventions into a successful innovation and develop a product or technology for a real client/customer. As such, these students have less job opportunities and cannot potentially start an enterprise in the future. Additionally, there are 35.9% of the respondents in level A, who endorse all the scale items, indicating that they are equipped with the essential entrepreneurship skills.

4. Conclusions

Content validity, reliability and construct validity evaluation of the scale areessential to guarantee accurate measurement analysis. In this research study,Rasch analysis showed that the scale was reliable and valid to generate accurate measures of students' entrepreneurship readiness learning embedded systems design. The findings showed that the students lack the ability to integrate various skills due to the disconnection between tertiary education and real-world business requirements. In addition, they lack various social resources demand for enterprise establishment, market expansion and product publicity. Therefore, higher learning institutions need to embed acquirable entrepreneurial skills in the prerequisites courses to provide adequate training to the students, increasing their creativity and maximizing their potential to be successful entrepreneurs.

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