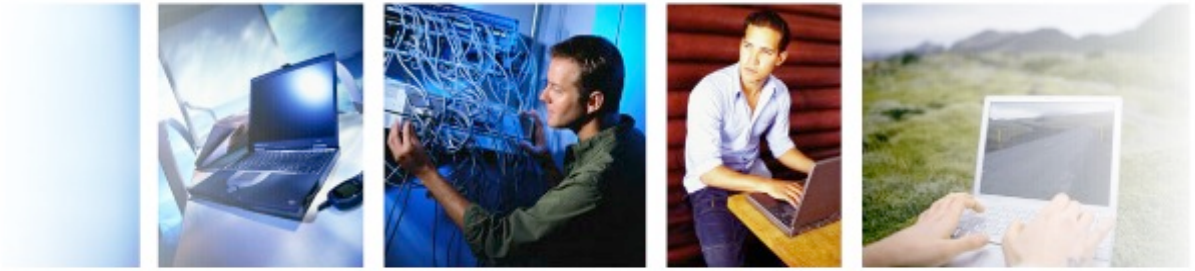
Evaluation of the Mathematics Performance of Distance Education Students with Rasch Model in Higher Education: Sakarya University Case Study



Elif Dulger & Christine Merrell

- ✓ **Distance Education**
- ✓ **Quality Assurance**
- ✓ **Evaluation of Distance Education Students Performance with Rasch Analysis**
- ✓ **Conclusions**

SAKARYA UNIVERSITY

Number of Students..... 86.900

Staff 3.300

Foreign Students 3.348

Departments/ Programs .. 515

DS LABEL

ECTS LABEL

Quality journey of Sakarya University started in 2000 and the institution being the only university to received EFQM award at Turkey.

Technology is key to the future of higher education. E-learning can also lower barriers to higher education by offering flexibility with respect to when, where, and how students learn and faculty teach (Susan, 2016).

Distance education is defined as a planned teaching–learning process that uses one or more technologies as a conduit for learning when students are separated from the instructor, requiring regular, substantive, and supportive instructor–student and student–student interactions. Interactions may be in real-time (synchronous) or delayed (asynchronous) (Griffiths, 2016)

E-learning means electronic learning or learning based on technology. It is a process of learning that is implemented in cooperation with web-based learning, virtual classes, digital techniques (Geray, 2007).

Susan G. (2016). "Digital Capabilities in Higher Education, 2015: E-Learning.", Research report. Louisville, CO: ECAR, 2016

Griffiths B. (2016). "A Faculty's Approach to Distance Learning Standardization", Teaching and Learning in Nursing 11 (2016) 157–162

Geray C.(2007), Distance Education in Turkey, international Journal of Educational Policies, Vol.1(1),2007,33-62, ISSN:1307-3842

Distance education is not new in Turkey. It has been started by private educational institutions (namely FONO and Limasollu Naci) and as a public service, governmental authorities in early 1950's. First correspondence course was started, within higher education, by the Institute of Banking and Commerce, in the year 1954, Law Faculty of Ankara University.

1950s

The Ministry of National Education, in 1982, established its open distance education program at Anadolu University, which was supported, by Radio and Television Institution of Turkey (cited as TRT) made eligible to use its channels (Geray, 2007).

1980s

By year of 2015 be about different levels such as associate degree, undergraduate, graduate there were found to have total of **505** different programme in Turkey (Kocdar and Dogan, 2015).

2015

Geray C.(2007), Distance Education in Turkey, international Journal of Educational Policies, Vol.1(1),2007,33-62, ISSN:1307-3842
Kocdar S. and Dogan T.G."Türkiye'deki Açik Ve Uzaktan Öğrenme Programlarinin Bir Analizi: Eğilimler Ve Öneriler", Journal of Research in Education and Teaching, Vol.4, 2015, No:4

At Sakarya University, the internet-based education activities **started in 1999** and in 2001 it was developed with Associate Programs in Computer Programming and Information Management.

In 2003, in Turkey the **first** school present e-learning was established called Adapazari Vocational School.

After these experiences, programs in various numbers were opened in different level. As of today, there are 56 different programs under various faculties.

- 7 associated degree programs
- 10 bachelor degree
- 18 master degree
- 9 common courses
- 12 certificate programs

More than 700 e-course

And in these days, Sakarya University has busy with the MOOCs distance learning model on the **SAUX** platform through collaboration with Harvard.

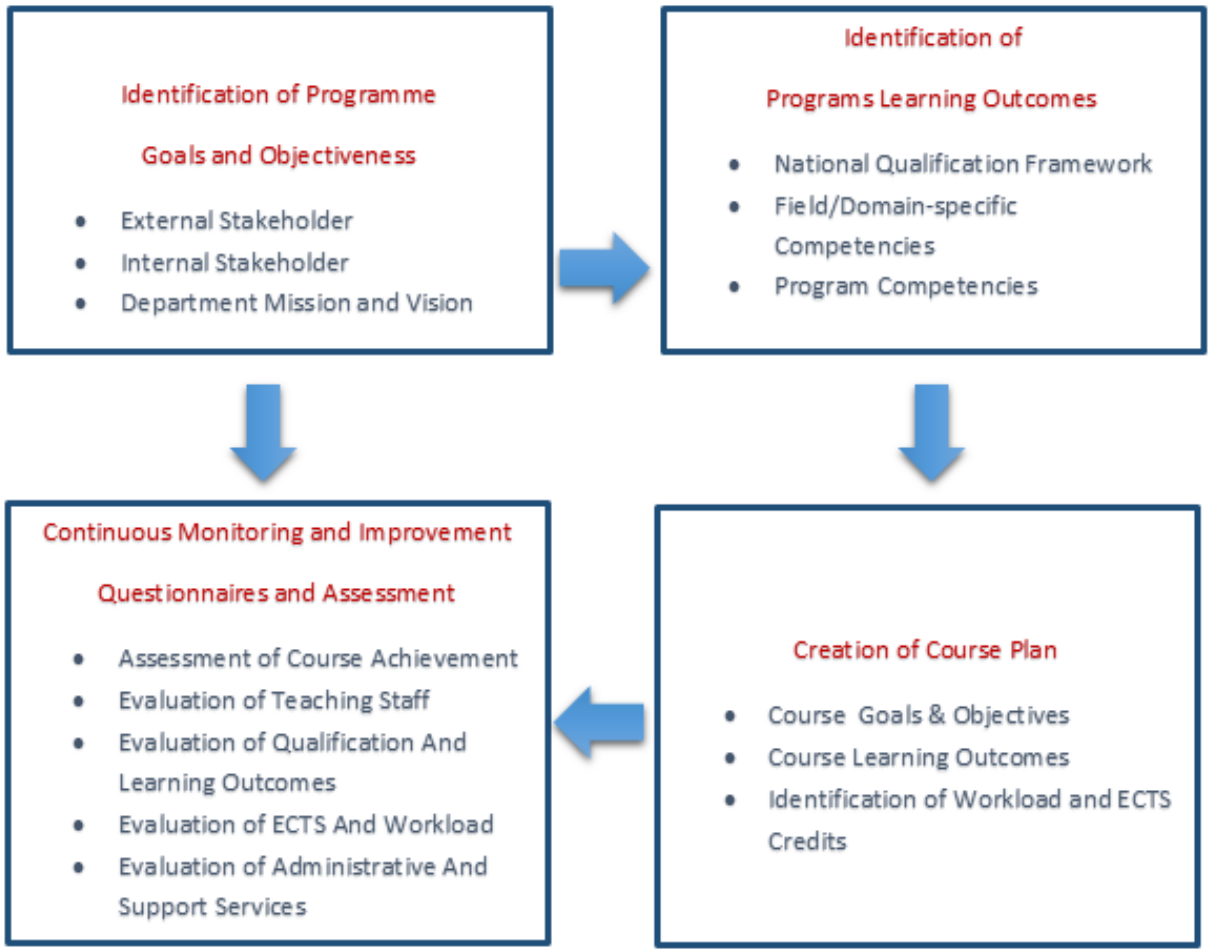


Figure. Programme Improvement Steps

Restructuring in Higher Education, Council of Higher Education Publications, 2010.

With the increasing use of the Bologna process, the Higher Education Qualifications Commission was established in 2006 to determine the Higher Education Qualifications Framework in Turkey.

The Commission sets out general learning outputs by taking into account the criteria of the European Higher Education Area (QF-EHEA) and the European Life Long Learning Qualifications Framework (EQF / LLL).

Q.NO	Prg Qualifications	Qualifications						
1	Posses theoretical and practical knowledge supported by textbooks...	1.1. To be able to make comments on the data, to establish cause-effect relationship	1.2. To have mathematical knowledge to calculate technical data such as volume, cutting speed, flow rate, stroke					
2	The data needed to solve well defined problems in mechatronic systems	2.1. To be able to read technical drawings and to draw computer-aided technical drawings	2.2. Having knowledge about the processes of obtaining and processing data related to the problems occurring in mechatronic systems	2.3. To be able to recognize and use hydraulic and pneumatic circuit elements	2.4. To be able to choose suitable electric motors for driving mechanical systems	2.5. To be able to recognize and use control and control elements of mechatronic systems	2.6. To make computer aided 3D design	2.7. Being aware of computer-aided manufacturing
3	They learn independently and learn in the field of mechatronics	4.1. To carry out individual researches on the subjects related to the field	4.2 Apply the findings to the study area by blending them with personal experience	4.3. By following the dynamism in the sector (fair, symposium), evaluating the developments in this area and adapting what they learn to their own business				
4	Problems related to unforeseen situations in mechatronics studies	4.1. To anticipate possible problems and to take precautions, to intervene in the failure of the authority						
5	To have sufficient foreign language knowledge in the field.	5.1. Having enough english knowledge to follow menu and commands of mechatronics related computer software						

chart

In development and updating of education programs based on qualification framework, the DACUM (Developing A Curriculum) method used in many countries was used. A skill profile of a profession is revealed by DACUM method.

In this study

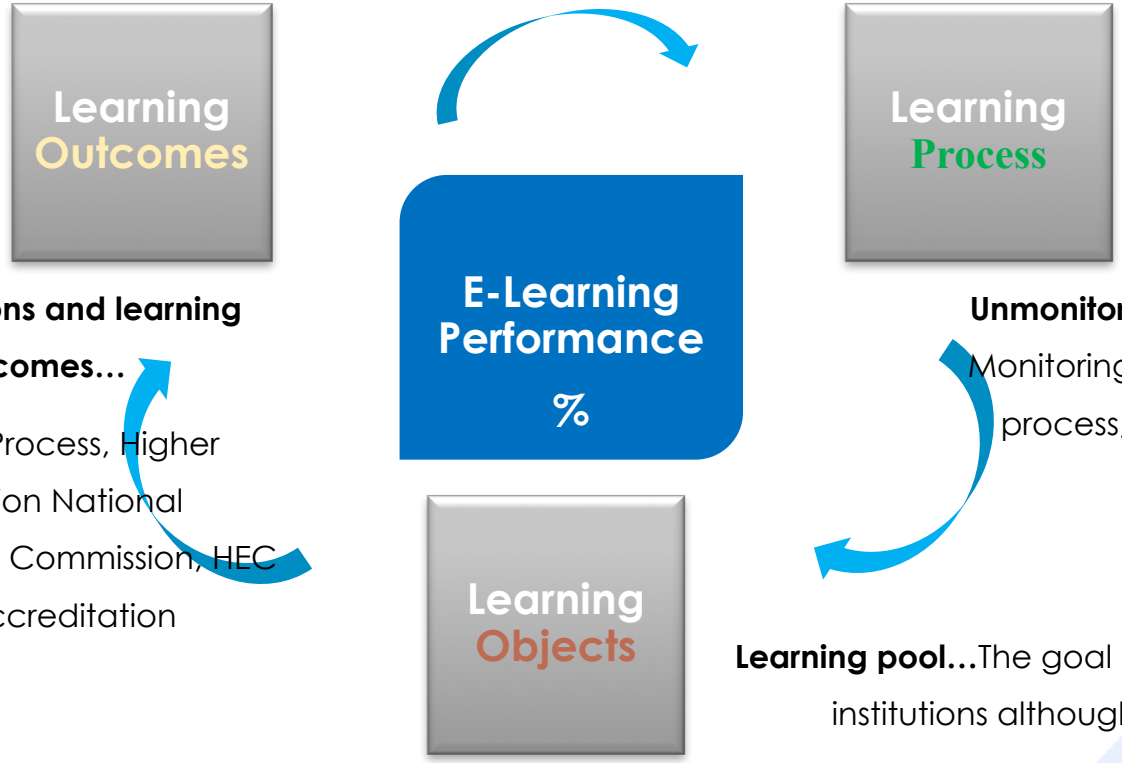
In this study, we used Rasch method to evaluate the mathematics assessment and the performances of distance education students in higher education.

Thus, on the one hand, to seeing the application achievement at distance education of the quality assurance system, on the other hand improving of the existing evaluation system had aimed.

The results had been evaluated with Rasch to improve psychometric properties for the test.

… a modular solution based on **learning objects**

controlling **learning outcomes** and **e-learning process** …



Qualifications and learning outcomes…

Bologna Process, Higher Education National Qualifications Commission, HEC and Accreditation

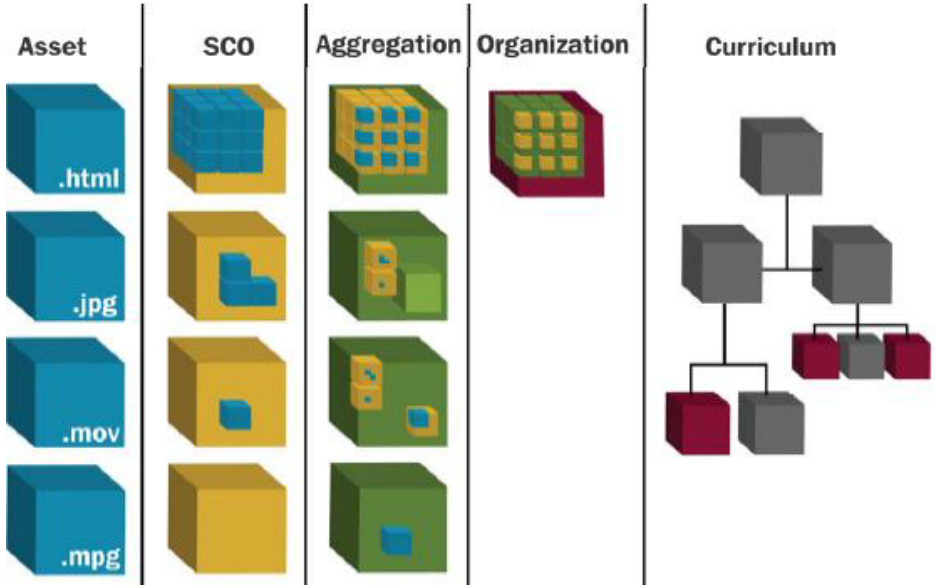
Unmonitoring process cannot be controlled…

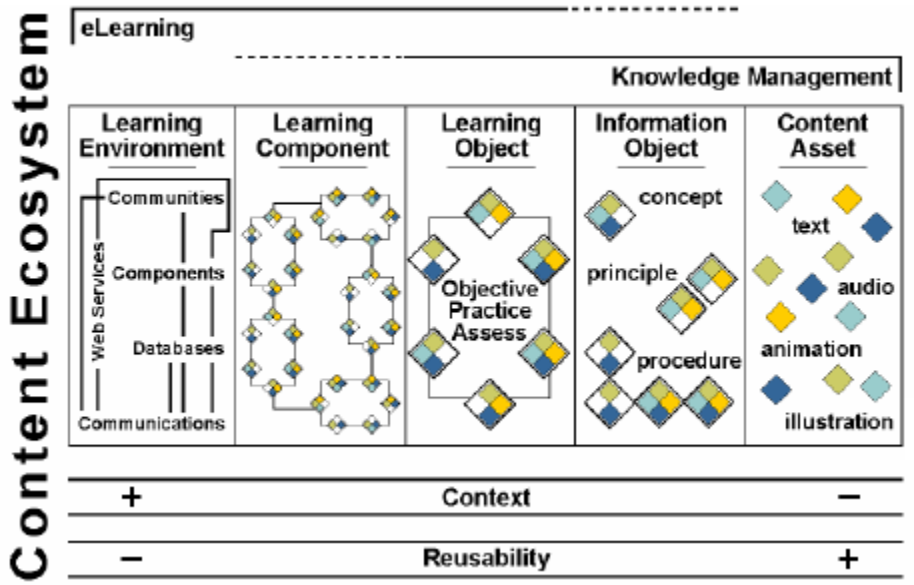
Monitoring further the individuated e-learning process, measurement and evaluation of performance

Learning pool…The goal of many distance education institutions although difficult coordination

…configured as independent of one another one, reusuable for different purposes and contexs, updatable, may be combinable for content creating, tagged with identifying information, pieces of information can be accessed over the network…

Learning Objects





ADL Guidelines For Creating Reusable Content With SCORM 2004, Versin 1.0 For Public Comment, July 2008

Reusable Learning Object Strategy: Designing and Developing Learning Objects for Multiple Learning Approaches, Cisco Publications, 2003

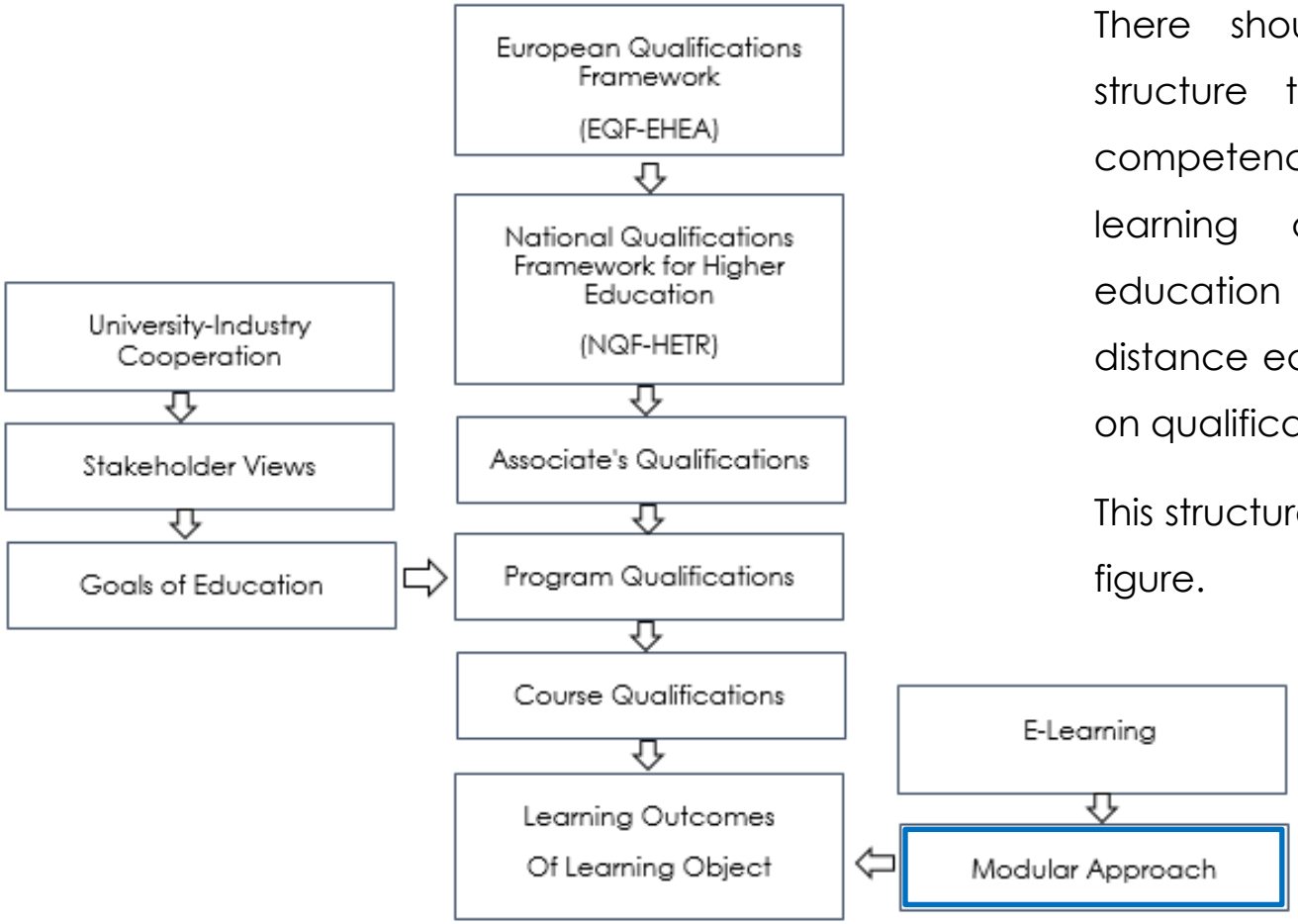
In this study, the learning performance of students of the **Mathematics** course of Sakarya University distance education students was examined.

This course was chosen because of its features such as being taught jointly at Sakarya University's technical programs at level of associate degree, establishing technical infrastructure and being one of the most challenging courses for distance education students in e-learning system.

The reason of mathematics course chosen

The mathematics course under 7 units to be sets, numbers, algebra, equations, functions, logarithm and trigonometry was first further developed to with a modular approach divided into 28 RLOs (Reusable Learning Object) and 81 RIOs (Reusable Information Object) below it.

Further developed of mathematics course with a modular approach



There should be a hierarchical structure that from the general competencies to specific one's of learning objects in a higher education system which use distance education methods based on qualification framework.

This structure can be shown as in the figure.

Figure. Identifying Learning Outcomes of Learning Objects based on Qualification Framework

	UNIT		RLO	Learning Outcomes of RLO		RIO	Learning Outcomes of RIO
2	NUMBERS	2.1	RATIONAL NUMBERS	To be able to solve four operation and ranking problems in rational numbers	2.1.1	Fraction, fraction types, simplification and expansion of fraction	He/she can make operations related to fraction concept and features
					2.1.2	Four Operations in Rational Numbers	He/she solves problems related to rational numbers
					2.1.3	Infinite Fractions	He/she solves problems when the numerator and the denominator of a fraction goes infinite
					2.1.4	Ranking in Rational Numbers	He/she ranks rational numbers in different formats
		2.2	DECIMAL NUMBERS	To be able to do decimal fraction operations given by decimal numbers, to be able to do conversion in repeating decimal numbers and in too big - too small numbers	2.2.1	Four Operations in Decimal Numbers	He/she solves problems related to decimal and repeating
					2.2.2	Too Big - Too Small Numbers	He/she converts numbers which positive and negative powers of "10" to decimal fractions
		2.3	EXPONENTIAL NUMBERS	To be able to be operation using exponential numbers and its features, to be able to solve related to exponential equations and inequalities	2.3.1	Exponential Numbers and Features	He/she recognizes the concept of exponential numbers and express its features
					2.3.2	Operations with Exponential Numbers	He/she solves problems related to exponential numbers
					2.3.3	Exponential Equations and Inequalities	He/she solves problems related to exponential equations and inequations
		2.4	ROOT NUMBERS	To be able to interpret the relationship between root and exponential numbers, to be able to use the root number properties and perform operations, to be able to solve problems related to root equations and inequalities	2.4.1	Root Numbers and Features	He/she recognizes the concept of root numbers and
					2.4.2	Operations with Root Numbers	He/she solves problems related to root numbers
					2.4.3	Root Equations and Inequalities	He/she solves problems related to root equations and inequations
					2.4.4	Operations with Exponential&Root Numbers	He/she can interpret relationship between exponential and root numbers
		2.5	ABSOLUTE VALUE	To be able to be operation related to the concept of absolute value, to be able to solve problems of absolute value inequalities	2.5.1	Concept of Absolute Value and Operations	He/she solves problems belong to absolute value of a real number
		2.6	NUMBER SYSTEMS	To be able to make transactions about binary, octal, hexadecimal numbers, to be able to solve the problem by number converting from ten base to wanted base	2.6.1	Decimal-Binary-Octal-Hexadecimal Number Systems	He/she can make operations related to binary, octal, hexadecimal numbers in number systems
					2.6.2	Convert from decimal base	He/she converts from decimal base to wanted base

7 UNITS → 28 RLO → 81 RIO

From Learning Outcomes of Learning Objects…

…To Learning Outcomes of Information Object

- ✓ Firstly, a learning performance test was developed for each RIO and RLO.
- ✓ After the test items that measure the intended learning outcome were first applied to the Computer Prog. students (subject group).
- ✓ Item analysis was performed (with ITEMN).
- ✓ Then, the best questions which most fit for purpose were selected and applied to the students of the Electronics Tech. Prog.
- ✓ The aim was to measure the performance of this revised test with a view to it being used more extensively.

	Item Statistics			Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Disc. Index	Point Biser.	Prop. Endorsing Alt.	Total	Low	High	Point Biser.	Key
8	1-8	.45	.85	.72	A	.06	.07	.04	-.10	
					B	.09	.15	.00	-.24	
					C	.45	.07	.92	.72	*
					D	.22	.30	.04	-.25	
					E	.13	.30	.00	-.29	
					Other	.05	.00	.00	-.32	

N of Items 14

N of Examinees 82

Alpha 0.852

SEM 1.478

Mean P 0.532

Mean Item-Tot. 0.583

Mean Biserial 0.761

- ✓ The results were analysed using the Rasch model and a refined version was administered to the students of the Electronics Technology Program wanted to know more about their own learning for formative purposes.

- ✓ Data consists of responses from The Electronic Technology Program students which provide distance learning at associate degree level in the fall semester of the 2010-2011 academic year.

	Number of Person	Number of Item	Person Reliability	Item Reliability	Performance of DE Students
Sets	107	25	.76	.94	.73
Numbers	93	24	.74	.92	.68
Algebra	101	38	.80	.80	.65
Equations	89	26	.81	.85	.79
Functions	105	25	.72	.81	.60
Logarithm	88	21	.69	.72	.51
Trigonometry	88	45	.61	.74	.40

The purpose of these tests is inform the e-learning students who wanted to know more about their own learning performance for formative purposes.

Since participation in the developed tests is not compulsory, it is enough that person reliability range is between .65 and .75 (low stakes tests).

```
TABLE 12.2 Numbers.sav                    ZOU069WS.TXT  Jan  9 2017 10: 2
INPUT: 93 PERSON  24 ITEM  REPORTED: 93 PERSON  24 ITEM  2 CATS  WINSTEPS 3.90.0
-------------------------------------------------------------------------------

MEASURE   PERSON - MAP - ITEM
          <more>|<rare>
   3          X  +
                 |
                 |
                 |
                 |
                 |
                 |
                 |
                 |
                 |
                 |
          XXX    |  Q6
                 |
   2             +
                 |
          XX     |T
                 |
                 |
             T   |
                 |
                 |
                 |
                 |
                 |
                 |  Q1
   1             +
                 |S
       XXXXXX    |  Q5
                 |  Q24
       XXXXXX  S |  Q17
                 |  Q11    Q12
        XXXX     |  Q16    Q21
                 |
       XXXXX     |  Q23
                 |  O2     O4
   0    XXXXX   +M Q22
                 |  Q8
       XXXXXXX   |  Q10    Q13    Q19
                 |
       XXXXXX M  |  Q20    Q3
                 |  Q14
   XXXXXXXXXXXX  |
                 |
       XXXXXXX   |  Q18
             XX  |S
  -1   XXXXXXXXXX +
                 |  Q7
                 |
       XXXXXXXXX S
                 |
          XXX    |  Q15
                 |
                 |
          XXX    |T
                 |
  -2             +
                 |
           X T   |
                 |
                 |  Q9
                 |
                 |
             X   |
                 |
                 |
  -3             +
          <less>|<freq>
```

- ✓ 24 item, 93 person was analysed in this test.
- ✓ The item closest to 3 is the item with the highest level of difficulty. Hence, the most difficult item is Q6. As to Q9, it is the easiest item.

```
TABLE 12.2 TRIGONOMETRY.sav               ZOU329WS.TXT  Jan  9 2017 18: 3
INPUT: 88 PERSON  45 ITEM  REPORTED: 88 PERSON  45 ITEM  2 CATS  WINSTEPS 3.90.0
-------------------------------------------------------------------------------

MEASURE PERSON - MAP - ITEM
          <more>|<rare>
   2          X  +
                 |
                 |
                 |
                 |
                 |
                 |  Q33
                 |
                 |
                 |
                 |
                 |T Q39
   1             +  Q41
              X  |
                 |
                 |  Q27    Q29    Q30
              X  |
                 |S Q25
                 |  Q37
                 |  Q43
              X  |
                 |
                T|  Q10    Q28    Q35    Q40    Q8
                 |  Q18    Q23    Q26
                 |  Q19    Q2     Q9
   0             +M Q14
          XX     |  Q15    Q16    Q22    Q32    Q38    Q44
           X     |  Q11    Q13    Q17
          XX     |  Q21    Q34    Q36    Q45
        XXXXX    |  Q42    Q7
        XXXXX  S |  Q12    Q24
           X     |  Q20
                 |S Q31
          XX     |  Q6
         XXXX    |
       XXXXXXX   |  Q3     Q4
           X     |  Q5
  -1    XXXXXX   +
        XXXXX M  |T
     XXXXXXXXXX  |
              X  |
       XXXXXXX   |  Q1
                 |
          XXX    |
       XXXXXXXX  |
                 |
        XXXXXX S |
                 |
                 |
  -2       XXX  +
              X  |
              X  |
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              X  |
              X  |
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  -3             +
          <less>|<freq>
```

- ✓ 45 item, 88 person was analysed in this test.
- ✓ The item closest to 2 is the item with the highest level of difficulty. Hence, the most difficult item is Q33. As to Q1, it is the easiest item.
- ✓ We need better targeted questions to improve the person reliability.

"E-learning is becoming increasingly prominent in tertiary education, with universities increasing provision and more students signing up"

- ✓ In this study, the performances of Mathematics course of distance education students of Sakarya University and the test items of mathematics course were tried to be analysed with Rasch analysis.
- ✓ During the development of learning tests, writing, application and evaluation of the materials there had been working group consisting of four people that a subject specialist, a measurement & assessment expert, a education technology expert and one of the authors.
- ✓ Firstly, math course has been re-structured and generated test items for each object. Then, it has been measured performance of DE student. Finally, test items analysed with Rash model.

E-Learning in Tertiary Education, OECD Policiy Brief, December 2005

Conclusions

- ✓ Data consists of responses from distance learning at associate degree level in the fall semester of the 2010-2011 academic year.
- ✓ In total 204 questions were put questions during fall semester.
- ✓ To be valid for the students of the Electronic Technology Program; at the point of acquisition of learning outcomes of Mathematic course the results of 62.3% were obtained.
- ✓ One of the consequences is the logarithm and trigonometry of the units that are the most challenging for the Electronic Technology Program students, with the lowest performance.
- ✓ One result is we need improvement existing tests, as such in trigonometry.
- ✓ It can be said that since this study was carried out by sharing knowledge and experience of different disciplines (industrial engineering and educational sciences) is important in order to emphasize the necessity of interdisciplinary studies.

- Dulger, E. (2012) "Yükseköğretimde Uzaktan Eğitim Performansinin Ölçme Ve Değerlendirilmesi İçin Bir Model Önerisi" (Doctoral dissertation). Retrieved from CoHE National Bibliography Database in Turkey (Accession No.304749)
- Susan G. (2016). "Digital Capabilities in Higher Education, 2015: E-Learning.", Research report. Louisville, CO: ECAR, 2016
- Griffiths B. (2016). "A Faculty's Approach to Distance Learning Standardization", Teaching and Learning in Nursing 11 (2016) 157–162
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- Kocdar S. and Dogan T.G."Türkiye'deki Açik Ve Uzaktan Öğrenme Programlarinin Bir Analizi: Eğilimler Ve Öneriler", Journal of Research in Education and Teaching, Vol.4, 2015, No:4
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Thank you!

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