Potential application of a measurement tool for quality assurance of E-Learning content to a new MSc in Aerospace Engineering

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Abstract

While witnessing how rapidly and frequently the human life-sustaining structure of society has changed from the past to modern times, the effects of the Covid-19 pandemic presented us a unique challenge, moving a considerable part of our life more than ever online and showing us the signs that a new era has begun. While the access to information is enormous, there is a lack of proper skills in selecting the best options available to upgrade one's educational status. Considering how fast education tools are evolving, it has become important to carry out new studies in order to increase and boost the Quality Assurance for E-learning processes in Education.

In this context, recently in Malta a new Aerospace Programme kicked off through an MSc in Aerospace Engineering. This Master's has been structured as part-time and online, aiming to attract undergraduates and professionals in aeronautics from Europe, Asia and Africa, providing the skills required by national and international aerospace companies. For these reasons, the course has been chosen as a test case for the potential application of a measurement tool for its E-Learning content quality assurance.

This paper describes the preliminary analysis to assess the main Quality Measurement parameter. An uncertainty parameter will be associated with the measurement, which will be improved with the increasing size of the statistical sample and iterations. The uncertainty parameter includes measurement errors, sampling errors, variability, use of surrogate data and the combined effect of assumptions that will be necessary to do in the preliminary phase due to the novelty of the study.

Projections suggest that in the proposed study case of the MSc in Aerospace Engineering, the Quality Measurement parameter value will increase in the next few years, thanks to continuous investments, the sharpening of teaching and learning tools, and the growth of interest from the Maltese aerospace sector; it is expected that the uncertainty of the model will similarly decrease.

Keywords

Measurement tools in Education, MSc in Aerospace Engineering, Quality assurance of E-Learning

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Nomenclature

Ui	*Uncertainty parameter*

Acronyms/Abbreviations

Au	*Auditory*
Ks	*Kinesthetic*
MCAST	*The Malta College of Arts, Science and Technology*
QM	*Quality Measurement*
Vi	*Visual*

1. Introduction

Throughout the years, the education systems have seen many developments and improvements [1]. Despite the fact that many innovations were introduced, this is an area that needs continuous renewal [2].

Several socio-economic, historical, cultural, and political events have influenced the education systems and their content and have impacted the trajectory of people's learning paths [3]. Technology has advanced in ways that we could never have imagined until a few years ago. Its contribution to the learning process improved techniques and accelerated the teaching and learning processes.

Despite significant advancements in online Education, institutions have always prioritized traditional classrooms as the major learning method [4], improvements in this field are always considered as a backup plan [5]. Also, due to this mindset, it was impossible to properly train lecturers on how to teach online, use Edtech tools successfully, design and implement quality assurance requirements for online learning, data protection, consent details, and other related topics.

Nowadays, there are remarkable developments in the educational technology (EdTech) sector, which provides users with high-end technologic tools, such as:

- Grading Apps & Platforms,
- E-books,
- Virtual workshops,
- Learning Management Systems,
- Tools to create video content,
- Educational games,
- VR Technologies,
- Formative assessment tools,
- Learning Apps, Blogs, Forums.

The list above represents potential access to a massive amount of information to comprehend, absorb, apply, and teach.

Therefore, one crucial aspect to consider is how long it takes for education participants to get to the level where they are comfortable using these tools in their regular practices. Other points that need to be clarified, for example, are the success probability of being able to track inventions in a world where technology advances too quick to be easily followed; and the accuracy of structuring the participants' responsibilities while these changes are happening and further updates on the Curriculum and quality assurance standards.

Unfortunately, with the advent of the Covid-19 pandemic into everyone's life, the education system had to face an unprecedented situation in contemporary learning systems.

The fact that students, teachers, and administrators made such a quick transition to entirely online or hybrid education during this period brought to the fore the added issues of adaptability and process management [6]. This can be taken as an excellent opportunity for the entire education system to have a major change. There is a need to carry out more studies to fill the gaps in this field to achieve the best possible results.

The current state of the art in the field shows the following main issues [7]:

- Methodologies are outdated; thus, they do not consider the effects of the Covid-19 global pandemic [8].
- Data analysis was carried out before important technological changes, such as Virtual Reality and Artificial Intelligence [9].
- Quality Assurance is based mainly on qualitative parameters and not quantitative, which is mandatory for the development of a proper measurement tool [10].

From the analysis of the studies in the field [11], it emerges that in the present-day scenario, the main parameters for quality assurance of e-Learning are different in terms of:

- Statistical sample available,
- Boundary conditions, e.g. a very high number of students having e-learning solutions as their only choice,
- Technology improvement, e.g. software and hardware available,
- Social impact of a global pandemic,

The motivation behind this study is related to the fact that the personal and professional development opportunities are virtually unlimited, and the benefits of online training are more significant today than ever before. As a result, schools that embrace E-learning technologies are ahead of schools that still rely

exclusively on traditional approaches to learning.

The human brain is thought to be capable of remembering and relating to what is seen and heard in moving pictures or films. In addition to maintaining the student's attention, visuals have been discovered to be kept by the brain for extended lengths of time [12].

The brain is made up of a variety of networks that help to learn. Some people learn better by seeing, others by hearing, and others require action to discover new knowledge. The term "learning style" was first recorded in 334 BC by Aristotle; he said that "each child possessed specific talents and skills" [13]. The concept of learning styles has evolved ever since with invaluable research in this field [14,15].

Neil Fleming introduced an inventory called the VARK model in 1987 that was designed to help students and others to learn more about their individual learning preferences [16], more in detail:

- Visual learning (pictures, movies, diagrams)
- Auditory learning (music, discussion, lectures)
- Reading and writing (making lists, reading textbooks, taking notes)
- Kinesthetic learning (movement, experiments, hands-on activities)

This most accepted learning styles model was first developed as VAK; Visual, Auditory and Kinesthetic. Fleming later splits the Visual dimension into two parts, symbolic as Visual (V) and text as Read/write (R). This preliminary study will focus on 3 main styles.

Many interpretations of the Learning Styles hypothesis claim that teaching individuals using approaches that are tailored to their 'Learning Style' would result in improved learning [17]. According to neurolinguistics expert Michael Grinder, states that "In the first group of thirty students, about twenty people are able to learn quite effectively by means of visual, auditory, and kinetic so they do not need special attention" [18].

This shows that learning through the VAK approach can help students better understand the material that will be taught. Of course, the knowledge acquisition will be more enjoyable and more meaningful for students. Given that mirroring the learning styles in course content is advantageous to students' learning development, researchers recognize that using e-learning tools to create course content that appeals to all learning styles will move the institutions forward in Education.

With these main considerations, it became essential to develop a tool, i.e. a methodology, to measure the quality of E-modules applied in different contexts.

This paper will focus on the relation between the students' learning experience and materials used in the Aerodynamics and Measurements for Aerospace units of MSc in Aerospace Engineering course. The survey prepared for this focus group aims to have preliminary results on the course material used. A quantitative assessment was done on the material used to have the total numbers of how many pictures, slides, videos, texts, etc., are used in each unit to compare the students' replies based on these numbers. This research will serve as the first guide for teachers to evaluate their teaching materials and identify areas for improvement. Education facilities will have a numerical reference parameter value to demonstrate that they are supplying high-quality standards. Finally, this will provide students with assurances in their course selection.

2. Methodology overview

The proposed study's main methodology aims to measure the quality standards for online courses at MCAST and, potentially, of other higher education institutions. The previous research in this area mainly focused on qualitative results, but in this case the definition of quantitative results will be key for the research process.

The methodology will use techniques such as:

- Conceptual mapping: To design the measuring tool settings, the feedback of teachers and students will be evaluated. Analyzing the comments and surveys is a qualitative process, but measuring the quality with those parameters provides a quantifiable outcome.
- Parametric checklist definition: The material quality will be determined at this step. A list of the materials will be compiled, and the most effective settings will be checked.
- Mixed–method, which combines the qualitative and quantitative methods: The data from the case study will be reviewed to see the correlation between the teaching materials used in the lecture and the students' learning style to build the core of the measurement tool.

3. Case study – MCAST MSc in Aerospace Engineering

The MCAST MSc in Aerospace Engineering aims to allow candidates to deepen their knowledge to be able to design and implement aerospace projects, dealing with the highest standards using environmentally friendly technologies taking into consideration safety and social responsibility. The course provides students with intense knowledge to develop the skills needed to conquer three highly sought-after fields: Structures and Measurements for Aerospace, Aerodynamics, and Space Technologies. The course has core units such as Aircraft Propulsion, Aerospace Structures, Aviation Maintenance Management and Law, Aerodynamics, and Measurements for Aerospace. While the global pandemic is still affecting our lives, MCAST decided to move courses online more than ever, including this course. This Master's has been structured purposely for part-time and online delivery, aiming to give an opportunity to students in Europe, Asia, and Africa.

For these reasons, the course has been targeted for a preliminary study to develop the fundamentals of the measurement tool. The collected data is analyzed to see how effective the MSc is at providing knowledge to understudies in a course that aims to prepare students for various disciplines using e-learning tools.

1.1. Measurement parameters definition

In this study, the starting point considers the QM parameters measurable as a function of 3 main parameters; V_i, A_u, K_s.

This tool will measure how the course uses the technology to adapt the content to the three learning styles to maximize the students' learning potential and allow organizations to improve their educational success rate.
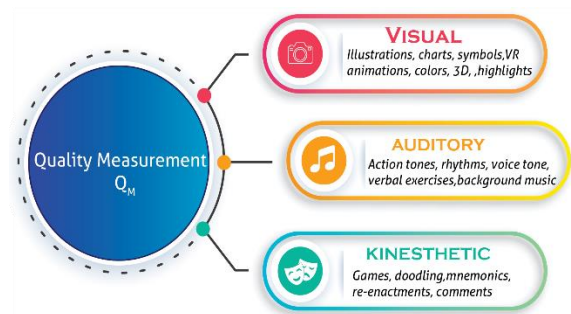

Figure 1. Overview of the measurement parameters for Q_M methodology.

Once assessed the value of the main QM parameter for a given E-learning course content, an U_i will be associated with the measurement, which will be improved with the increasing size of the statistical sample and iterations in the process. The uncertainty parameter includes measurement errors, sampling errors, variability, use of surrogate data, and the combined effect of assumptions necessary to do in the preliminary phase, due to the study's novelty.

1.2. Analysis procedure

Based on the previous measurement parameters described, a first analysis has been defined, based on the following steps:

- Quantitative analysis design of the teaching material: Materials have been categorized to address three learning styles, and total numbers and percentages for each lesson were identified.
- Survey design and implementation: The survey has been structured with 30 questions for two units of the MSc and with an anonymous online format.
- A first assessment of the parameters to measure has been performed.
- The first feedback to start the development of the measurement model has been retrieved.

The two selected units are Measurements for Aerospace and Aerodynamics 1, carried out during the first semester of the MSc, for the first intake of students.
Figure 2 provides an overview of the parameters assessed, while Figure 3 shows a sample of the online survey.
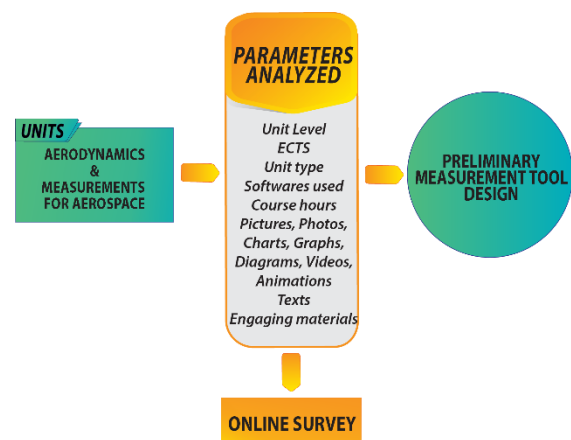

Figure 2. Overview of the analysis performed

Were the visual materials used in this unit enough to help you understand and
learn? (Illustrations, charts, symbols, Powerpoint presentations, videos, VR,
animations, colours, 3D, , highlights, etc.) *

○ Extremely

○ Very

○ Moderately

○ Slightly

○ Not at all

Figure 3. Sample of the online survey

1.3. Data analysis

This paragraph presents the analysis carried out on the preliminary set of data retrieved.
Being the first time this procedure has been applied, the focus has been on the development of the tool itself and the design of the measurement parameter for future study iterations.

With reference to Figure 2, the two sets of parameters assessed and the survey results have been correlated with the aim of describing the dependent variable Qm as a function of the three independent variables Vi, Au, Ki. The reference polynomial model selected as the starting point is the one of Eq. 1.

$$y = ax_1 + bx_2 + cx_3 \quad (1)$$

With:

- X_1 (Visual content);
- X_2 (Auditory content);
- X_3 (Kinesthetic content).

The two sets of data were analyzed thanks to Matlab^{TM} software for curve fitting of data, using regression techniques. For each parameter the standard deviation was also evaluated. Moreover, the overall R-squared (R2) was calculated. R2 is a statistical measure representing the proportion of the variance for a dependent variable explained by an independent variable.

Finally, usually standard relations from literature, the Qm function was determined with its associated Ui, the design stage uncertainty analysis, that provides an estimate of the minimum uncertainty based on method chosen, according to the relation of Eq. 2.

$$Y = Y_{\text{measured}} \pm U_i \quad (P\%) \quad (2)$$

4. Results

The first outcome in applying the described procedure shows that the course meets the requisites to pass the acceptance criteria, the value being 6 on a scale from 1 to 10, and that there is still a good margin for improvement.

The final Qm equation results to be, Eq.3:

$$Qm = 0.4Vi + 0.3Au + 0.1Ki \quad (3)$$

The evaluation of Ui provided: Ui=1.53.

The final relation for Qm results is to be:

$$Qm = 6.34 \pm 1.53 \, (95\%)$$

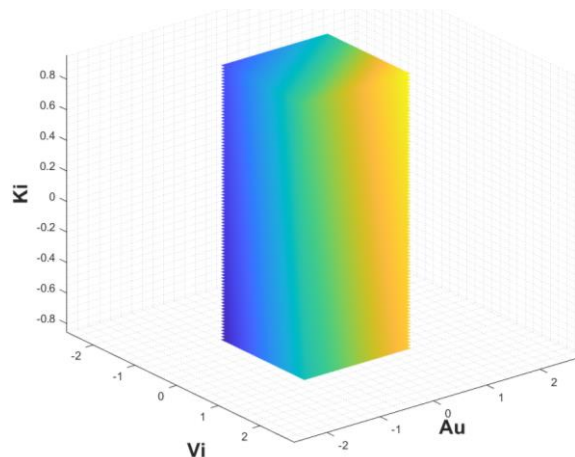The 3d plot done in Figure 4 shows the correlation between the three parameters and their relative weight for Qm.

Figure 4. Qm= Quality measurement parameter

5. Conclusions

This study shows that the initial parameters for quality assurance measurement for e-learning content have been defined.
Following a process similar to the continuous improvement of the Lean methodology, over the years, the technique will be refined, and the statistical pool will be significantly more prominent, and it is reasonable to imagine that the same course will achieve better results. This will be considered an accepted "plateau" limit in the improvement curve of the course, where the course is considered to be at a very high level and where a higher QM value will be considered not feasible from an economic point of view, in the evaluations done by the educational institution providing the course. It is important to highlight that this methodology is scalable, modular and can be improved iteration after iteration.

The research has met its primary objective to contribute to a study to develop a measurement tool for the quality assurance of e-learning content.

The conceptual mapping on the parameters that will be used to develop the measurement tool has been defined. This study offers an example of the course material evaluation process based on the learning style.

The case study, MCAST MSc in Aerospace Engineering, has been selected for being an online course providing specific and intense content. The first promising results show that the development of a measurement tool for e-learning content is feasible.

The next stage will assess the quality of each material used under these three topics and conduct a quantitative analysis to determine the most effective settings to utilize. After this stage, more surveys will be carried out with more extensive samples to develop the complete checklist with the parameters evaluated in detail.

Acknowledgements

References

[1] L. A. Rowe, D. Harley, P. Pletcher, S. Lawrence, Bibs: A lecture webcasting system, 2001.

[2] D. Archibald, S. Worsley, The father of distance learning TechTrends, 63(2), 100-101, 2019.

[3] S. Downes, Places to go: Connectivism & connective knowledge. Innovate: Journal of Online Education, 5(1), 6, 2008.

[4] L.P. Tichavsky, A. N. Hunt, A. Driscoll, & K. Jicha, " It's Just Nice Having a Real Teacher": Student Perceptions of Online versus Face-to-Face Instruction. International Journal for the Scholarship of Teaching and Learning, 9(2), n2., 2015.

[5] A. E. Dunbar, Genesis of an online course. Issues in Accounting Education, 19(3), 321–343, 2004.

[6] A. K. Halabi, Accounting tele teaching lectures: issues of interaction and performance. Accounting Forum 29, 207–217, 2005.

[7] J. Grifoll, E. Huertas, A. Prades,S. Rodriguez, Y. Rubin, F. Mulder & E. Ossiannilsson, Quality Assurance of E-learning. ENQA Workshop Report 14. ENQA (European Association for Quality Assurance in Higher Education). Avenue de Tervuren 36-38-boite 4, 1040 Brussels, Belgium, 2010.

[8] M. Misut, K. Pribilova, Measuring of Quality in the Context of e-Learning. Procedia-Social and Behavioral Sciences, 177, 312-319, 2015.

[9] A. Inglis, M .H. Abdous, E-learning quality assurance: A Process-Oriented Lifecycle Model. Quality Assurance in Education, 2009.

[10] Eurydice European Unit, Information and Communication Technology in European Education Systems, D/2001/4008/14 ISBN 2-87116-324-3, 2001.

[11] S. Goksoy, Quality Standards and Quality Standard Areas in Educational Systems. 21. Yüzyılda Eğitim Ve Toplum Eğitim Bilimleri Ve Sosyal Araştırmalar Magazine, 3(7), 85-99, 2014.

[12] L. Standing, J. Conezio, & R., N. Haber, Perception and memory for pictures: Single-trial learning of 2500 visual stimuli. *Psychonomic science*, *19*(2), 73-74, 1970.

[13] J. Haswell, A Close Look at Learning Styles, 2017.

[14] D. A Kolb, The Kolb learning style inventory. Boston, MA: Hay Resources Direct, 2007.

[15] SK, M. S. SREENIDHI, & M. T. C. HELENA, Styles of Learning Based on the Research of Fernald, Keller, Orton, Gillingham, Stillman, Montessori and Neil D Fleming. International Journal for Innovative Research in Multidisciplinary Field, 3(4), 17-25, 2017.

[16] N. Fleming, & D. Baume, Learning Styles Again: VARKing up the right tree!. Educational developments, 7(4), 4, 2006.

[17] H. Pashler, M. McDaniel, D. Rohrer, & R. Bjork, Learning styles: Concepts and evidence. Psychological science in the public interest, 9(3), 105-119, 2008.

[18] T. Astari, Improvement Of Student Learning Result Using Strategy Accelerated Learning Through Vak Approach, 2019.