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The first printed issue of the journal was published in 1996 and the last (Vol. 12) in 2007. The publication of Xjenza was then ceased until 2013 when a new editorial board was formed with internationally recognised scientists, and Xjenza was relaunched as an online journal, with two issues being produced every year. One of the aims of Xjenza, besides highlighting the exciting research being performed nationally and internationally by Maltese scholars, is to provide a launching platform into scientific publishing for a wide scope of potential authors, including students and young researchers, into scientific publishing in a peer-reviewed environment.

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- 1. Research Articles
- 2. Communications
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- 4. Notes
- 5. Research Reports
- 6. Commentaries
- 7. News and Views
- 8. Invited Articles and Special Issues
- 9. Errata

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Editorial

A Time to Celebrate

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Dear readers and authors of Xjenza Online, as Editorin-Chief, I am very pleased to announce the release of the second issue of 2021 of Xjenza Online. This year has been quite a rollercoaster, but as we are now entering 2022 it is the time to embrace the new and celebrate the past achievements of the journal and, moreover, of the scientific community it serves .

I would like first to thank our team of copy editors who contributed to this issue: Luke Collins whose contributions for the past two years have been invaluable to ensure the publishing continuity of the journal during difficult times while upholding quality and accuracy of content, Yun-Yun Tseng for her enthusiasm, proficiency and hard work, and Julia Curmi who has recently joined our team in her wider role of Science Officer of Malta Chamber of Scientists.

The issue opens with a follow-up study by McBerry et al. on tooth whitening procedures which focuses on the participants' self-reported subjective evaluation of their experience. In the following empirical paper, Ayrton Zarb investigates the impact of larger class sizes on the academic performance by students and, hence, encourages management teams in schools to design smaller classes to enhance students' academic wellbeing and advance the economic and social development of society.

The issue concludes with an insightful article by Grech et al. on the supply-side and demand-side shocks inflicted by the COVID-19 pandemic.

I would like to take the opportunity to wish all readers and contributors of Xjenza Online, a New Year 2022 with good health, happiness and scientific achievements! To continue in the festive spirit, the Editorial Board of Xjenza Online is delighted to announce that two special issues of the journal dedicated to the celebration of Malta's top scientists will be released soon. Xjenza Online: Science Journal of the Malta Chamber of Scientists www.xjenza.org DOI: 10.7423/XJENZA.2021.2.01

Research Article



Patient-reported Subjective Outcomes on Tooth Whitening Procedures

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Abstract. Introduction: Tooth whitening procedures have gained popularity. Whilst it is important to evaluate the clinical effectiveness of these bleaching products, the patients' opinion on their clinical experience should be investigated.

Aims and Objective: This second article aims to report on the participants' self-reported subjective evaluation of their tooth whitening experience.

Material and Methods: 127 participants were invited to join the study and 77 were enrolled in the study according to the selection criteria. They were randomly divided into 8 groups, each group receiving a different tooth-bleaching product. Clinical data collection was performed at 4 different time points. Patients' subjective outcomes were measured before and at the end of the observation period with pre-piloted questionnaires.

Results: Significant changes between products, from pre-treatment (T0) to 1-month after treatment (T3), were observed, with two products clinically underperforming(p < 0.05). Eighty-two percent of participants reported that they would undergo another whitening procedure, whilst 42.5% indicated that tooth whitening was a motivational factor for them to improve and maintain their oral health status.

Patient-reported sensitivity was significantly highest for the Ultradedent Opalescence PF HK group ($P \leq 0.001$). Bi- and multi-variate analyses of patients' self-reported levels of satisfaction indicated that patients were able to discern clinical changes. They reported the highest satisfaction rates for Philips Zoom ($P \leq 0.001$) and dissatisfactions with two of the bleaching products.

Conclusions: Patients detected clinical changes and their satisfaction was overall very positive, although some products performed below expectations. Tooth whitening procedures appeared to be a motivational tool.

Keywords: tooth whitening, patient-reported outcomes, oral health

1 Introduction

People are constantly judged by their physical appearance and attractiveness (Hassebrauck, 1998). The issue of appearance goes beyond just mere beauty; it affects psychological well-being as well as social interactions (Patzer, 1997). Evidence shows that the perception of attractiveness lies in a triangular shape with emphasis mainly on eyes, nose and mouth (Mondelli et al., 2012). The individual's smile is pivotal when evaluating facial attractiveness and overall assessment (Otta et al., 1996). Indeed, subjects are more self-aware of their tooth discolouration, and younger people attribute higher importance to colour shade as compared to older individuals (Alkhatib et al., 2004). This great demand for facial appearance has transformed dentistry from a profession that addresses 'functional needs' to one driven by 'aesthetic requisites' of the patient (Reis et al., 2011). Unlike Europe, millions of people in the United States have whitened their teeth over the past two decades without any serious adverse reactions reported in the literature (G. C. Heymann et al., 2010). The American Academy of Cosmetic Dentistry had declared that at the beginning of the year 2015, the annual revenue in the tooth whitening sector rose to eleven billion dollars. In New Zealand, a study was carried out to investigate the response of people opting for aesthetic intervention. The response rate was that of 81.2% with 77.8% opting for tooth whitening as opposed to veneers that were selected by 54.8%. This study continued to elaborate that 97% of patients reported asking for a tooth whitening treatment while the percentage of dentists re-

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commending a whitening treatment to their patients was 37.9%. Since the demand for a 'perfect smile' especially in Western society is on the increase, the dental profession should be better prepared (Comunidade et al., 2012). Even though tooth whitening is not destructive to teeth, it still has its disadvantages such as tooth sensitivity and gingival irritation. These appear to be dose and technique related (Hatherell et al., 2011). Evidence has shown that as long as protocols are adhered to, tooth whitening results can last up to 17 years. Some people like to top-up after three years while others like to top up every month. Topping up every month is not required as long as the initial treatment of whitening had been reached effectively and proper maintenance is instituted (Greenwall, 2016). In a previous study, we reported on the clinical effectiveness of In-Office and At-Home tooth whitening kits. One of the most important findings of this study was that a considerable number of the participants who volunteered and who were eligible for the study required prior dental treatment to optimise their oral health. This underscores a very important issue that tooth-whitening procedures should be carried out by properly qualified professionals who can diagnose oral health issues. Regrettably, Over Counter (OTC) products are readily available in various settings, beyond properly registered dental clinics. Patients might not be aware of ongoing oral health issues and failure to interact with a dental professional may allow oral pathology to go unnoticed and preclude timely dental treatment. In this study, we report participants' subjective evaluation of their tooth whitening experience by exploring post-treatment sensitivity and satisfaction.

2 Materials and Methods

The study design was a prospective cohort study. Ethical approval for the research project was obtained. (UREC-DP 1801011DSG - DSG-2017-18-008). Details of the recruitment process and clinical procedures were discussed previously (Alzoubi et al., 2020). The participation was voluntary following a social media posting and all eligible subjects were selected based on inclusion and exclusion criteria (see table 1).

Participants were randomly allocated to one of the eight 'Tooth Whitening Product' groups as outlined in table 2.

All patients received a clinical examination, oral prophylaxis and oral health instructions. Pre-treatment questionnaire was completed. Subsequently, impressions were taken for those patients allocated to the products requiring customised whitening trays for home use. Each whitening treatment was carried out according to the manufacturer's instructions. A one-use demonstration, following the manufacturer's directions, was given to the participants allocated the home kit. All participants received oral hygiene instructions and whitening maintenance advice based on the manufacturer's direction.

Shade measurements using the VITA Easyshade[®] V digital spectrophotometer (VITA Zahnfabrik, Germany) were carried out 1 month before the treatment (T0), on the day of treatment after bleaching (T1), 2 weeks after the treatment (T2) and 1 month after the treatment (T3). Sequential shade readings were compared and the change in shade from the original pre-treatment reading was calculated to obtain the change in bleaching scores. The participants were asked to complete a second posttreatment questionnaire at the 1-month visit (T3). The pre-treatment (Before-BT) and post-treatment (After-AT) questionnaires included open and close-ended questions, which were later categorised for statistical analysis. The first section collected demographic data such as age, gender and occupation. Subsequent sections questioned medical health conditions, dietary habits, smoking history, oral hygiene self-care (OHSC) habits, knowledge on professional oral prophylaxis and knowledge of EU law regarding tooth whitening procedures.

The AT questionnaire was relatively similar to the BT questionnaire however it further asked participants if they would consider future whitening procedures. It also included two scales measuring tooth sensitivity and patient satisfaction with the results of the whitening procedures. Both questions utilised a scale from 0-10 with zero (0) indicating no sensitivity or unsatisfied with the whitening outcomes, whilst 10 signified extreme sensitivity resulting in pain or complete satisfaction with the whitening outcomes. Both questionnaires were previously piloted on a small group of patients prior to their use in the study.

2.1 Statistical Analysis

All data was put on an Excel sheet. The results were tabulated and analysed with computer software (SPSS software IL, USA). Demographic data collected were analysed to establish homogeneity between the different groups. Data derived from the history and examination of each patient were analysed per group, to assess the effectiveness of the product. The shade readings (VITA Bleaching Score Index) for all the groups were compared together. Questionnaires were used to assess the patients' subjective points of view. Categorical data were analysed by the Chi-square test. The Kruskal-Wallis H Test allowed between groups analysis of the non-parametric continuous scores derived from the various groups. Statistical significance was set at p < 0.05

3 Results

One hundred twenty-seven (127) subjects agreed to participate in the study. Following dental examination, 77 sub-

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Inclusion Criteria	Exclusion Criteria
Be at least 18 years of age.	Medically compromised patients.
Able to voluntarily consent.	Smoking Habits.
Willing to participate in the post-whitening phase and no prior whitening treatment experience.	Requiring dental treatment due to caries and/or poor oral hygiene.
Presence of all maxillary and mandibular teeth.	Oral pathology requiring immediate care.
Anterior teeth have no restorations.	Previous stains due to Tetracycline.
Absence of Hypersensitivity.	Pregnancy or lactating.

Table 1: Inclusion and Exclusion Criteria to participate in the study

Group	Intervention
Group 1	Philips Zoom Speed In Office; 6% HP
Group 2	Beyond Osmo In Office; 6% HP
Group 3	Philips Zoom Home-kit (daywear); 6% HP
Group 4	Beyond Corewhite Home-kit (daywear); 6% HP
Group 5	Ultradent Opalescence PF for at-home use (night wear); 18% CP
Group 6	Ultradent Opalescence GO for at-home us (day wear); 6% HP
Group 7	PearlSmile Standard Treatment on cosmetic chair; <0.1 $\%$ HP
Group 8	Pearl Light Home-Kit at home; <0.1% HP

Table 2: Whitening Products allocated to each Group

jects (61%) were eligible for this study, based on the inclusion and exclusion criteria. Participants were excluded due to dental decay, suboptimal oral hygiene and the need for the dental treatment necessary before tooth whitening procedures. The eligible participants in the study (44 females and 33 males) varied in age from 18 to 60+, however, 65% were between the ages of 18 and 25 years. Normality Tests revealed that gender distribution, medical health conditions, dietary habits, smoking history, oral hygiene self-care (OHSC), knowledge on professional oral prophylaxis and knowledge of EU law on tooth whitening procedures were normally distributed.

3.1 Participants' Change in Bleaching Scores

Figure 1 presents the average change in the bleaching scores as measured with the 3D Master Bleaching Score. Significant differences in results between products, from pre-treatment (T0) to 1-month after treatment (T3), were observed, with two products clinically underperforming.

3.2 Participants' opinions for future tooth whitening treatment

The majority of participants, 82%, reported that they would undergo another whitening procedure. 42.5% of the participants indicated that tooth whitening was a motivational factor for them to improve and maintain their oral health status (see figure 2).

3.3 Patient Self-reported Knowledge of EU legislation on Tooth Whitening

Figure 3 clearly shows that the vast preponderance of the participants are unaware of or have poor knowledge of legislation governing the use of tooth whitening products.

3.4 Patient Self-reported Tooth Sensitivity

Figure 4 presents the patients' self-reported posttreatment levels of tooth sensitivity. Patients reported the highest tooth sensitivity with Ultradedent Opalescence PF HK.

3.5 Patient Self-Reported Treatment Satisfaction

Patients' post-treatment satisfaction scores are presented in figure 5. Philips Zoom Home kit showed the highest satisfaction as opposed to the Pearl light Home kit which had the least satisfaction average.

Table 3 shows that the linear regression model for posttreatment patient satisfaction. The model is significant and the patients' self-reported satisfaction levels is explained by the type of bleaching product, the individual's educational level and the initial change in the shade as measured by the Bleaching score for the upper right canine.

Table 4 shows the generalised linear model differences for the type of bleaching products and clearly shows that two particular types of bleaching agents performed much worse than the rest.

4 Discussion

A rise in the demand for tooth whitening procedures has been observed over these past two decades (Kwon et al., 2015). In North America, teeth whitening procedures are common, with no serious adverse reaction reported in the literature (H. O. Heymann, 2005). This study was carried out to evaluate patients' self-reported subjective outcomes on tooth whitening procedures. The levels of tooth sensitivity and patient satisfaction when comparing eight tooth-whitening products together- five At Home kits (HK) and three In-office Kits (IO), were explored. The objective measurements of the clinical effectiveness of the tooth whitening products studied were reported in a previous paper (Alzoubi et al., 2020).

In this study, patients reported the highest levels of tooth sensitivity with the Ultradent Opalescence PF home kit product. The latter has 18% Carbamide Peroxide (CP) and had to be applied for 4-6 hours for two weeks. Although patients reported these findings, the tooth sensitivity per se may not necessarily be linked with the teeth whitening products as the patients may have had a previous history of sensitive teeth and the procedure might have exacerbated it (Perdigão et al., 2004). One must also consider that as the product is a home kit, the clients may have overused the product with respect to the dosage and time exposure, leading to increased sensitivity (Li et al., 2013). Notwithstanding, one must also point out that these trends were not observed with other the home kits used in this study.

Moreover, this study observed that patients still reported tooth sensitivity with products that had lower hydrogen peroxide concentrations. Indeed, patients who received both Pearl Light HK and PearlSmile Standard Treatment still reported tooth sensitivity despite having 0.1% or less Hydrogen Peroxide (H₂O₂) concentrations. This result is not in accordance with evidence that peroxide concentration and procedural time had an impact on the reported sensitivity (Kossatz et al., 2011). This study's finding, that patients still reported tooth sensitivity even with the use of a product with a dosage of 10.1%HP product, underscored certain points: firstly, it is in accordance with what was reported earlier that the concentration of HP had no impact on tooth sensitivity (Mondelli et al., 2012), secondly, that the relation between tooth sensitivity and bleach concentration in tooth whitening products is still a grey area that requires further clin-



Average Change in Bleaching Scores of Upper Right Canine

Figure 1: Average change in Bleaching Score compared to other Products (Tooth 13) T0- pre-treatment; T1- immediately after treatment; T2- two weeks after treatment; T3- one month after treatment.

Variable	Parameter Estimate (eta)	Standard Error	<i>p</i> -value
(Constant)	11.246	2.582	.000
Type of Bleaching Product	473	.149	.002
Age	514	.388	.190
Gender	.157	.650	.810
Nationality	.186	.764	.809
Educational Level	619	.318	.051
Occupation	044	.142	.757
$Results_T0_T1_BLEACHINGSCORE1$.188	.091	.044
$Results_T0_T1_BLEACHINGSCORE2$	010	.125	.937
Results_T0_T1_BLEACHINGSCORE3	028	.122	.819

$F = 4.042; p = 0.0001; R^2 = 0.374$

Table 3: Linear Regression Model for Post Treatment patient's self-reported Satisfaction Levels.

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Figure 2: Participants' Opinions for future tooth Whitening Treatment.



Figure 3: Participants' Knowledge on tooth Whitening Treatment under EU law.



Post Treatment Sensitivity

* Kruskal–Wallis Test: p = 0.037. (Opalescence PF Home kit/ Opalescense GO Home kit) * Kruskal–Wallis Test: p = 0.040. (Opalescence PF Home kit/ Pearl Light Home kit)

Figure 4: Mean Scores of Tooth Sensitivity.



Patient-Reported Post Treatment Satisfaction

Kruskal–Wallis Test: $p = 0.015$. (Zoom in-office/Pearl Smile Standard Treatment)
Kruskal–Wallis Test: $p = 0.011$. (Zoom in-office/Pearl Light Home-kit)
Kruskal–Wallis Test: $p = 0.002$. (Zoom Home-kit/Pearl Smile Standard Treatment)
Kruskal–Wallis Test: $p = 0.002$. (Zoom Home-kit/ Pearl Light Home kit)
Kruskal–Wallis Test: $p = 0.011$. (Beyond Core White/ Pearl Smile Standard Treatment)
Kruskal–Wallis Test: $p = 0.008$. (Beyond Core White/Pearl Light Home kit)
Kruskal–Wallis Test: $p = 0.05$. (Ultra Dent Opalescence PF Home Kit /Pearl Smile Standard Treatment)
Kruskal–Wallis Test: $p = 0.008$. (Ultra Dent Opalescence PF Home Kit /Pearl Light Home kit)
Kruskal–Wallis Test: $p = 0.038$. (Opalescence PF/Pearl Light Home kit).

Figure 5: Mean Scores of Patient-reported Satisfaction with Whitening Products.

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Type of Bleaching Product	Mean	Std. Error	95% Wald Confidence Interval		Sig.
			Lower	Upper	
(Intercept)					.000
Philips Zoom Speed In Office	8.00	.694	6.64	9.36	.000
Beyond Osmo In Office	6.56	.731	5.12	7.99	0.13
Philips Zoom Home kit	8.88	.775	7.36	10.39	.000
Beyond Core White Home kit	8.22	.731	6.79	9.66	.000
Ultradent Opalescence PF Home kit	7.67	0.731	6.23	9.10	.000
Ultradent Opalescence GO Home kit	6.80	.694	5.44	8.16	.005
PearlSmile Standard Treatment in Office	4.11	.731	2.68	5.54	.914
Pearl Light Home kit	4.00	.731	2.57	5.43	.926

Dependent Variable: Post-treatment Patient Satisfaction. p = 0.0001

Table 4: Linear Regression Model for Post Treatment patient's self-reported Satisfaction Levels.

ical studies to explore the underlying reasons and, lastly, that these products should be curtailed to professional use only, as adverse reactions can only be dealt with by dental professionals. The implications of the latter observation are more pronounced when one considers that 39% of the patients who attended these tooth-whitening procedures were clinically unsound and required optimisation of their oral health prior to the application of these whitening procedures. Additionally, omitting the dental examination stage might mean missing serious conditions such as pre-malignant or malignant lesions in the oral cavity. Furthermore, foregoing oral prophylaxis prior to teeth whitening also decreases the effectiveness of the bleaching product. When using an over the counter preparation, this stage is more often than not, skipped. This could lead to unsatisfactory outcomes. Patients reported reasonably high levels of satisfaction with the procedures for most of the products, irrespective of the delivery mode. The improvement in aesthetics was perceived by the participants and was a motivational factor to maintain their oral and general health (Richins, 1991). When comparing all products, one can suggest that the Philips Zoom home kit outperformed the other products-patients reported the highest mean satisfaction levels along with the lowest levels of tooth sensitivity. The linear regression model, which was statistically significant, explored the reasons for post-treatment patient self-reported satisfaction. The model identified that patient satisfaction was explained mainly by the type of bleaching product, the educational level of the participant and the initial change in the shade as measured by the Bleaching score. This model explained 37% of the variability observed in the study population. Moreover, when the type of bleaching

product was further explored, the generalised linear model differences for the type of bleaching products clearly shows that two particular products performed much worse than the rest. Indeed all the products were significantly better than these two products. The Pearl Light home-kit and Pearlsmile Standard Treatment both have lower hydrogen peroxide concentrations, and this study suggests that concentrations of 0.1% hydrogen peroxide or less, are not clinically effective for tooth whitening. This indicates that tooth whitening is indeed dependant on HP concentration and also on the duration of treatment, as suggested in previous studies (Meireles et al., 2012).

5 Conclusions

Within the limitations of the study, it can be concluded that patients can detect clinical outcomes. Their satisfaction with the bleaching products was overall very positive, although some products performed below the expectations. There is poor patient knowledge of EU legislation regulating these products. Tooth whitening appears to be a motivational tool. The fact that roughly a third of the study participants required preprocedural optimisation of their oral health highlights the need that these procedures are provided by properly trained oral health care professionals.

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Research Article



Assessing the impact of Class Sizes on the Educational Performance by Business, Management and Commerce students: A Vocational Education and Training Case Study

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Abstract. This empirical paper follows the ongoing economic literature investigating the impact of larger class sizes on the academic performance by students. This study uses secondary data involving 874 business, management, and commerce students who followed an educational course between 2018/2019 and/or 2019/2020 at the Malta College of Arts, Science and Technology (MCAST). Several variations of the proposed Ordinary Least Squares (OLS) regression model have been tested to produce the best possible model intended to test for a scientific relationship between the two variables, whilst controlling for a set of academic and socio-economic characteristics affecting students' academic performance. Results suggest that larger class sizes lead to lower endof-course scores obtained by students. Furthermore, a statistically significant positive relationship is also evident between the end-of-course score and the students' age, level of studies, and attendance rate. Also, students' family background and the distance from college are proved to be significant indicators to explain changes in the dependent variable. Such findings encourage management teams in schools to design smaller classes to enhance students' academic wellbeing and advance the economic and social development of society.

Keywords: Class sizes, Regression, Wellbeing

1 Introduction

The importance of investing in human capital to improve the quality of the labour force to attain economic development has been acknowledged by several economists and researchers, including the acclaimed Robert Solow (1957). Such relationship is reciprocal since social and economic development within the country is also linked to better educational performances as the government affords to invest more to improve the quality of educational institutions (Maganga, 2016).

1.1 Background to the Subject

The most common technique adopted by employers when hiring workers, especially amongst fresh graduates, is to assess the academic scores obtained by students at the end of the course followed. To this extent, as from the late years of the 19th century, policymakers, teachers and parents have been pushing for Class Size Reduction (CSR) proposals as an attempt to improve the academic performance by students (Rice, 1902). Intuitively, smaller classes should result in better learning outcomes compared to those in larger classes since the educator can provide more individualised attention and classroom discipline is more easily implemented with fewer students. The adoption of this suggestion leads to a substantial increase in the amount of financial resources from the national budget to be spent in education as it requires more classrooms, teachers and potentially schools (Shin et al., 2009). In fact, Mitchell (2001, p.5) argues that,

"class size reduction is provided to be one of the costliest, if not the costliest, of state-level education policies ever implemented."

Between 2012 - 2018, the Maltese government allocated 14% of the national budget on the education sector, al-though this cost is increasing every year (Figure 1).

Despite these efforts, latest publications by the OECD compared the performance of Maltese students to that of international learners as part of their Programme for International Student Assessment (PISA) and concluded that

"students in Malta scored lower than the

OECD average in reading, mathematics and science." (OECD, 2021, p.1)

Moreover, although there has been a drastic decrease in the number of youths between 16 - 18 years as being Not in Employment, Education and Training (NEETs), Malta is still classified as one of the least performing countries in terms of early school leavers from formal education. In fact, in 2019, 16.7% of youths between 18 - 24 years left formal education.







1.2 Scope of the Study

The educational debate revolves around the concept of maximising the amount of student learning given finite resources such as class time, number and availability of teachers, and the percentage of financial resources dedicated to education.

The rationale behind this study is to examine whether students perform better academically when assigned in small classes compared to when they are assigned in a larger class. Using data from students who have followed a course at the Institute of Business, Management and Commerce (IBMC) at MCAST between scholastic years 2018/2019 and/or 2019/2020, this paper will showcase a Vocational Education and Training (VET) perspective by forming regression models to compare the end-of-course scores obtained by students assigned in different class sizes, whilst controlling for other determinants that have an impact on academic scores.

2 Materials and Methods

Over the past years, numerous researchers and academics from the fields of education, psychology, and economics (amongst others), have investigated the impact of class sizes (or the teacher-pupil ratio) on the average scores attained by students in their assessments (Ehrenberg et al., 2001; Kukreja et al., 2013; Olufemi et al., 2018; Talib et al., 2012).

2.1 The Impact of Class Size Reductions

Studies about class sizes and student achievements have been performed since the late 1890s (Rice, 1902). Over the years, separate nationwide class reduction programmes have been implemented, namely Project STAR (Student-Teacher Achievement Ratio) in Indiana and Project SAGE (Student Achievement Guarantee in Education) in Wisconsin. Apart from exploring the intended benefits associated with class size reductions (referring to the actual number of students taught by a teacher at a particular time), being an improvement in students' academic performance (referring to the outcome of the teaching and learning process in terms of knowledge and skills); researchers have also examined the external benefits and costs of such reduction programmes.

Each student gets a proportion $\frac{1}{n}$ of the teacher's time and attention. Hence, smaller classes allow for instructional improvements through frequent assessments, more discussions, more writing and more help to individual students. This translates into

"more individual tailored questions, instructions, examples, referents, etc. (better scaffolding) when responding to individual students." (Zahorik, 1999, p.211)

Furthermore, student socialisation is enhanced by making it easier for teachers to intervene when anti-social and inappropriate behaviour is exhibited (R. Mitchell, 2001). This conclusion supports Krueger's (1999) and Blatchford's (2000) findings that lower achieving and marginalised students benefit more than higher achievers from reduced-sized classes. Such advancements occur since learners,

"may pay better attention when there are fewer students in the room" (Ehrenberg et al., 2001, p.21)

whilst "managing student misbehaviour is easier" (Molnar et al., 2000, p.165), being fundamental problems faced by educators to maintain order in their classrooms (Goodlad, 2004).

However, contrasting arguments to the above believe that the returns of smaller classes are subtle and unlikely to result in significant differences in students' academic performance (Slavin, 1989). In fact, Pollard and Yap (1995), and Sturm (1997) believe that large classes are correlated with higher academic achievements. R. Mitchell (2001) extends these thoughts and hypothesizes that although better democratic citizens can be created in return, as well as a more productive workforce, there are no returns in the form of increased test scores. Furthermore, the researcher argues that possible pair and collective interactions decrease as the class size is reduced, an argument that contrasts Epstein et al.'s (1984) earlier conclusions. Also, unlike Ehrenberg et al. (2001), Shapson et al. (1980) firmly believes that there are no statistical differences in student engagement in small vis-à-vis large classes. Such results concur with Jepsen's (2015) view that

"other education policies, such as tutoring, early childhood programs, or improving teacher quality would be better investments".

2.2 A Review of Past Methodologies

Lab and field experiments were mostly adopted by past researchers to examining the impact of manipulating one independent variable (class size) on the dependent variable (students' test scores). The acclaimed Tennessee experiment in the 1980s involved the random assignment of 11,000 students between small classes (15 students) and regular classes (23 students) (Jepsen, 2015). Results from this field experiment proves that students in smaller classes improve their test scores by 0.048 standard deviations. Opposing results were acclaimed by Fredriksson2013 whilst adopting the same methodology when finding "little, if any, improvement in achievement". Consistent results were revealed by Shapson et al. (1980) whilst performing a quasi-experiment in Toronto. In this experimental design, students were randomly assigned in classes consisting of 16, 23, 30 or 37 students. Results prove that there are no consistent differences between smaller and larger classes.

In Sweden, results by Chingos (2012) show that on average, a reduction of one student is associated with an increase in test scores of 0.023. Such benefits were also claimed in Gary-Bobo and Mahjoubs (2013) publication on students in France as well as Urquiola (2006) among learners in Bolivia. However, most of the literature using regression models in Europe prove substantial crosscountry variations with most countries finding small or no benefits from smaller class sizes (Woessmann et al., 2006). Still, when Urquiola (2006) repeated the study among pupils in Kenya, he uncovers contrasting findings to the above, proving that a class reduction programme from 82 to 44 students per class is not associated with improved academic achievements.

2.3 Determinants Behind Academic Scores

The cross-country research surveyed performed by academicians in various fields of study have identified numerous internal and external classroom determinants that significantly affect the academic score obtained by students in their studies (Maganga, 2016). These group of independent variables can be classified in three:

Category 1. Demographic characteristics

Category 2. Academic characteristics

Category 3. Socio-economic characteristics

Dependent variable: Academic score

Most empirical research measure students' academic performances using their end-of-course test scores, being a weighted average value of the accumulated final grades earned during the course (Kukreja et al., 2013; Yigermal, 2017). Using such a holistic approach enables this research to quantify the impact of class sizes on the academic scores attained by learners throughout the course, rather than its individual impact in every subject. This variable will be obtained from administrative records based on the average unweighted mark obtained by each student in his/her studies.

Demographic characteristics

• Student's gender:

This parameter has been quoted in the literature and proved to be a statistically significant determinant that explains variations in academic performances among students (Alhassan et al., 2019; Hansen, 2000; Weldegiorgis et al., 2011; Yigermal, 2017). Using primary data, analysed under an econometric model, Yigermal (2017) found that males perform better than females ($\beta = 0.1727$). Card and Krueger 1996, Koh and Koh 1999, and Matamande et al. (2013) support this conclusion by proving that males outpace females in their studies. Opposing views to these were presented by several authors, including Tyson et al. (n.d.), Mutchler (n.d.), and Dayioğlu et al. (2007). This gender-gap has been acknowledged in Cheesman et al.'s 2006 study performed among upper division accounting students, when finding that males underperform when compared to the opposite sex, potentially due to females' biology which makes them more mature during teenage years (Pekkarinen, 2012). The last interpretation of this variable was presented in Kukreja and Aali's (2013) publication where gender was not a statistically significant variable to explain changes in students' academic performance.

• Student's age:

In their studies, Koh and Koh Koh et al. (1999), Hansen (2000), and Aripin et al. (2008) have all acknowledged that the student's age influences the average grade obtained during the course. Furthermore, in their study, Reilly and Woodfield (2009) found that mature students tend to attain marginally higher grades vis-à-vis their peers, potentially due to being equipped with more life-experience. However, Nyikahadzoi et al. (2013) produced a contradictory argument when finding that younger students outperform their older counterparts with a beta coefficient equivalent to -0.3301. The econometric model produced by Yigermal (2017) produced a non-significant coefficient for this variable, meaning that age was not scientifically important to explain changes in students' scores.

• Minnority students:

Minority students (foreign students) are taught in an environment different than the one to which they are accustomed in their home country. In fact, Mwinsheikhe (2003) pointed out that students perform better when they are taught using their country's official language, an argument which is supported in Finn et al.'s (2001) earlier publication. Such positive attributes are also acknowledged in Robinson and Wittebols (1986), and R. Mitchell (2001) who proved that class reduction programmes are promising for disadvantaged students. In a similar study involving a regression model, Hruz (2000) noted that African American students in North Carolina (minority students) benefited much more from this reduction programme whilst white students (major cohort) did not benefit. Hence, the author concludes that race is an important determinant that needs to be controlled for in econometric models.

Academic characteristics

• Student's grade of studies:

Several researchers identified the grade/level of study of the assessed students to influence the programme effectiveness. In fact, according to Ehrenberg et al. (2001, p.13), the positive returns associated with designing smaller classes are most effective in elementary grades as they help pupils to

"develop working habits and learning strategies that would enable them to better take advantage of learning opportunities in later grades".

Such results corroborate with Jepsen's publication (2015) who finds that the class reduction programme in Japan was effective among students in grades four and six, whilst being ineffective when implemented among higher grade students. In fact, a common finding by researchers is that the returns of class reduction programmes diminish as grade levels in-

creases, whilst positive effects are mostly found at early stages (Glass et al., 1978; R. Mitchell, 2001; Robinson et al., 1986).

• Enrolment status:

The type of admission followed by students was proved in the literature to have an impact on the academic performance by students. Part-time employees typically have work-related or family commitments which require such individuals to exert extra effort, compared to full-time employees, to attain the same marks (**BournerRace1990**; Nyikahadzoi et al., 2013; Zeidler et al., 2005).

Socio-economic characteristics

• Family background:

The positive influence of family on students' academic scores has been acknowledged by several authors (Farooq et al., 2001; Florence, 2012; Sakho, 2004). In fact, Noble et al. (2006) and Aldin et al. (2011) identified the positive impacts of household attributes such as family income, education, and support on the composite scores attained by students. Similar conclusions were reached by Considine and Zappalà (2002, p.20) in their study among students in Australia, finding that

"families where parents are advantaged socially, economically and educationally foster a higher and higher level of achievement in their children".

Conversely, students coming from deprived socioeconomic backgrounds, including financial, social, and interpersonal problems at home experience negative impacts on test scores (Hansen, 2000). In fact, students coming from low-income households must strive harder to succeed since they incur higher living expenses whilst richer families are able to provide their children important and necessary facilities to produce better learners (Ermisch et al., 2001). However, opposite to these views, Karemera et al. (2003) found no statistical evidence between family income and the final scores by students.

Distance:

The distance between the student's hometown and the school attended contributes to differences in academic scores. In fact, Raychauduri et al.'s (2010) study presented a negative link between the distance to school and the end-of-course scores obtained by students due to higher effort being exerted by students who live far.

2.4 Research Rationale

This paper utilises a linear regression model intended to answer the research question, *"Does class size matter for business, management and commerce students' academic achievements?"* Based on the publications surveyed, this study will contribute to the growing library and developments on the subject by applying the regression model among business, management and commerce students in Malta following vocational courses at MCAST. To this extent, the following hypothesis was formed which can be expressed algebraically:

 H_0 : The class size has no or a positive impact on the academic score of students.

 H_A : The class size has a negative impact on the academic score of students.

2.5 Data Collection

In total, a dataset involving 874 full-time students was received involving the population of students who have followed a course within IBMC between the scholastic years 2018/2019 and/or 2019/2020 (Table 2). These administrative records comprise of graduates who had followed educational programmes at the following levels:

- Awards (Malta Qualifications Framework (MQF) level 1)
 - MCAST Award in Basic Office Skills
 - MCAST Award in Hospitality
 - MCAST Award in Retail
- Foundation certificate (MQF level 2)
 - MCAST Foundation Certificate in Business
- Diploma (MQF level 3)
 - MCAST Diploma in Business
- Advanced diploma (MQF level 4)
 - MCAST Advanced Diploma in Business Administration
 - MCAST Advanced Diploma in Insurance
 - MCAST Advanced Diploma in Accounting
 - MCAST Advanced Diploma in Financial Services
 - MCAST Advanced Diploma in Marketing
 - MCAST Advanced Diploma in Administrative and Secretarial Studies
- Bachelor's degree (MQF level 6)
 - Bachelor of Science (Honours) in Financial Services Management
 - Bachelor of Science (Honours) in Business Enterprise

2.6 Data Transformation

The surveyed literature has identified a set of independent variables that need to be included in the Econometric model to control for their influence on the dependent variable and hence minimise the noise in the data. The inclusion of such parameters will allow this study to solely quantify the impact of class size on students' test score, being the rationale behind this study.

The surveyed papers approve that minority students are at a disadvantage versus other students (Cook et al., 2000; Robinson et al., 1986). To this extent, the model will be assuming that all students who do not have a Maltese nationality or study the subject 'Maltese as a foreign language', and have followed a programme between 2018 - 2020, were a minority within their classrooms. Such assumption enables this model to examine whether there are variations in marks between local and foreign students. The variable 'FOREIGN' will be capturing this difference by taking a value of '1' if the student is a foreigner and '0' if the person has a Maltese identity card.

The distance between the student's locality and the IBMC institute in Paola will be captured by the variable 'DISTANCE'. Google Maps was used to calculate the average shortest driving distance in kilometres that students travelled to arrive to the college.

Also, the literature surveyed is skewed in favour of controlling for the economic status since students coming from families who enjoy relatively higher income levels typically produce better learners (Considine et al., 2002; Hansen, 2000). Data from the European Union Statistics on Income and Living Conditions (EU-SILC) will be used to estimate the economic status of students. The indicator 'At-Risk-Of-Poverty or Social Exclusion' (AROPE) corresponds to the

"sum of persons who are either at risk of poverty, or severely materially deprived or living in a household with a very low work intensity." (Eurostat, 2020)

Data from the National Statistics Office (NSO) at a district level will be used to portray the distribution of AROPE individuals in Malta and Gozo. Data conversion will be performed by first changing the locality of the students into districts based on the guidelines from the Electoral Commission of Malta. Then, these districts will be numerically transformed depending on the percentage of the population in that district who are AROPE.

The end-of-course score was obtained by taking an unweighted average score of all the units attempted by the students through the course (Table 1). However, the mark obtained in the final dissertation for level 6 students was not included in the average given the nature of this unit which is not influenced by the class size. Moreover, students who failed in all the units that they attempted were assigned a score of '0' as their end-of-course mark.

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2.7 Empirical Plan

The multiple linear regression model (with a constant) will be adopted using OLS to minimise the stochastic errors (Table 4). This technique was mainly chosen due to being already used in past studies, as well as due to its ability to deal with several independent variables (Kukreja et al., 2013).

$$\begin{aligned} SCORE_{i} &= \beta_{0} + \beta_{1}Class_{i} + \beta_{2}GENDER_{i} + \beta_{3}AGE_{i} \\ &+ \beta_{4}FOREIGN_{i} + \beta_{5}LEVEL_{i} + \beta_{6}AROPE_{i} \\ &+ \beta_{7}DISTANCE_{i} + \beta_{8}ATTENDANCE_{i} + \varepsilon_{i} \end{aligned}$$

Several variations¹ of the generic regression model will be tested to choose a final model that produces the highest score based on A.C. Harvey's model specification criteria (1981).

2.8 Methodological Limitation

One of the shortcomings associated with the collection of data using administrative records from an educational institution is that the class size might have been chosen as small or large on purpose based on pre-entry qualifications and tests. Such limitation was also present in Olufemi et al.'s (2018) and Adeleke et al.'s (2013) studies which hence creates a degree of bias in the results.

Another limitation resulting from the adopted methodology is that this technique does not ensure homogeneity between classes for comparison purposes. This study was performed whilst students were already assigned in their respective classes and hence factors such as subject difficulty, group dynamics, student's IQ and teaching effectiveness could not be accounted for in the adopted model. Such common limitation in the literature is referred to as omitted variable bias (Shin et al., 2009).

3 Results

3.1 Dataset Overview

Due to shortcomings in retrieving data, especially among students who completed their studies during the scholastic year 2018/2019, some variables contain missing observations as shown in Table 3. Although a data imputation exercise could be completed, such technique is criticised by Van Wicklin et al. (2020) since it leads to:

- 1) A decrease in the variance of the imputed variables.
- 2) A decrease in the standard errors, leading the hypotheses test to be made invalid.

3) A separation between variables which hence creates problems for causations.

Hence, the study proceeded by using the collected data and leaving missing records empty.

In order to undertake a deeper investigation of the collected data, a descriptive statistics exercise is performed in Table 5 to explore the structure of the dependent, core, and control variables across levels. It is evident that as students progress to higher levels, the minimum score recorded in the respective level increases, indicating higher commitment and dedication by more mature students.

3.2 Preliminary Analysis

Following Mukaka's (2012) guidelines, the result in Figure 2 identifies a weak negative correlation between foreign students who followed courses within MCAST during the scholastic year 2019/2020 (since no data was available for 2018/2019 students) and their attendance.

	Correlations		
		Attendance	FOREIGN
Attendance	Correlation Coefficient	1.000	179 ^{**}
	Sig. (2-tailed)		.000
	Ν	391	391
FOREIGN	Correlation Coefficient	179**	1.000
	Sig. (2-tailed)	.000	
	N	391	874
	Attendance	Correlations Correlation Attendance Correlation Coefficient Sig. (2-tailed) N FOREIGN Correlation Coefficient Sig. (2-tailed) N N N	Correlations Attendance Attendance Attendance Correlation Coefficient 1.000 Sig. (2-tailed) . FOREIGN Correlation Coefficient

**. Correlation is significant at the 0.01 level (2-tailed)

Figure 2: Correlation between 'ATTENDANCE' and 'FOREIGN'

Moreover, there is no statistically significant correlation in Figure 3 between the AROPE rate and students' attendance, meaning that the socio-economic background experienced by commerce students does not link with higher absenteeism.

		Contonationa		
			Attendance	AROPE
Spearman's rho	Attendance	Correlation Coefficient	1.000	032
		Sig. (2-tailed)		.540
		N	391	370
	AROPE	Correlation Coefficient	032	1.000
		Sig. (2-tailed)	.540	
		N	370	670

Correlations

Figure 3: Correlation between 'ATTENDANCE' and 'AROPE'

3.3 Main Empirical Findings

The dependent variable 'SCORE' will be gradually regressed against several variables to test different variations of the model. Prior to including any independent variable in the regression, the variables were examined for multicollinearity to check the correlation between variables. Since no variable experienced high correlation of

¹The paper also attempted to transform the variable that captures the class size into a binary variable, taking a value of '1' when the class includes less than 17 students.

0.8 or higher based on Franke's (2010) criteria, the models could proceed with the listed variables. White adjusted standard errors are used for results to be heteroscedastic consistent.

Table 6 produces a summary output of the regression models tested. Results from regression 1 indicate that class sizes have no significant relationship to explain changes in the end-of-course scores among students. The first model does not include any control variables, thereby leading to low R^2 values. Hence, model 2 added a group of academic and socio-economic determinants of educational attainments. Demographic control variables have been added in regression 2 however, the variables 'DIS-TANCE' and 'AROPE' were not included due to significant missing observations. The goodness of fit value (R^2) increased substantially in this model, while 'CLASS' became significant. Results from regression 2 indicate that larger class sizes have a statistically significant negative correlation with the end-of-course scores obtained by business students at MCAST. Regression 3 includes all the variables identified in the literature. Results reaffirm that that larger classes correlate with lower students' academic performance.

An evaluation exercise was performed to decide the optimal model between regressions. A.C. Harvey's criteria was used to choose between regressions and model 3 was preferred since it has more statistically significant indicators and all the signs of coefficients follow the surveyed papers². The constant term (28.16) suggests the average 'SCORE' obtained by a student when all other determinants are equal to zero. Except for the variables 'GENDER' and 'FOREIGN', all the variables are highly significant in the model. The chosen model is explaining 61.98% of all the changes in the dependent variable.

4 Discussion

The chosen regression produced the following coefficients:

 $SCORE_{i} = 28.16 - 0.27CIass_{i} - 0.31GENDER_{i}$ $+ 0.72AGE_{i} - 4.80FOREIGN_{i} + 1.64LEVEL_{i}$ $+ 1.05ATTENDANCE_{i} - 0.84AROPE_{i}$ $- 0.59DISTANCE_{i} + \varepsilon_{i}$

Results suggest that on average, larger classes are associated with lower average end-of-course scores, and vice-versa. Subsequently, for every additional student registered in each class, the average 'SCORE' of each student typically decreases by 0.27 marks; meaning that having 10 more students in each class decreases the class average score by 2.7 marks, assuming Ceteris Paribus. Therefore, this conclusion leads this study to reject the null hypothesis:

 H_0 : The class size has no or a positive impact on the academic score of students.

 H_A : The class size has a negative impact on the academic score of students.

4.1 Comparison with the literature

The results produced provide guidelines to policymakers and educational management teams when designing classes and programmes. This finding corroborates with Molnar et al. (2000) when arguing that smaller classes are more effective since they enable teachers to include more educational activities. Furthermore, Zahorik (1999) adds that smaller classes lead to more individual attention, more examples, and more instructions, all leading to higher test scores.

Small class designs are especially important for disadvantaged and marginalised students, especially those following courses at levels 1, 2, and 3 within IBMC. Results from the employed regression reveal that smaller class sizes also helps these disadvantaged students, an argument which corroborates with Krueger (1999) and Blatchford's (2000) studies.

Moreover, another reason behind higher grades in smaller classes may be attributed to stronger interpersonal relationship between teachers and students. Such arguments were presented by Epstein et al. (1984) who conclude that educators can provide better explanations when teaching in a smaller class.

The student's gender, although including a negative sign which indicates that on average, females obtain higher scores than males, is not statistically significant. Therefore, this contradicts Yigermal's (2017) paper who argues that males outperform females, as well as Mutchler et al.'s (n.d.) publication who argue the contrary.

According to Reilly and Woodfield (2009), students' 'AGE' causes higher 'SCORE'. This finding, although contradicted by Nyikahadzoi et al. (2013), is proved in this study, which signals that mature students are equipped with more life skills that enable them to perform better academically. This is part of MCAST's strategy to include apprenticeship programmes, intended to link academia with the industry to equip its students with more life skills.

The variable 'FOREIGN' contradicts the surveyed literature, especially Mwinsheikhe's (2003) conclusions who argues that since foreign students are not taught in their

²The Ramsey Reset Test was performed on the chosen model as a diagnostic test. Since the p-value of the produced results is less than 0.05 and the F-statistic exceeded the critical value, the model is well specified. Furthermore, the Wald test results confirm that the chosen model best explains changes in the dependent variable.

official language, it acts as a hurdle for them, leading to lower end-of-course scores. In this study, being a local or a foreign student had no significant impact on the average test score obtained during the course of studies.

Furthermore, when students progress to higher 'LEVELS', on average, they obtain higher scores than their counterparts in lower levels. Such conclusion may be linked to Nyikahadzoi et al.'s (2013) argument that mature students have more skills, experiences, and are more academically committed, enabling them to obtain better scores. In fact, the degree of commitment was tested using the variable 'ATTENDANCE' which signalls that by missing less lectures, students obtain higher final scores.

Moreover, following the surveyed literature, students who are living in localities that hosts individuals with a higher probability of being At-Risk-Of-Poverty or Social-Exclusion ('AROPE') tend to obtain lower scores compared to students from other localities. This finding corroborates with Hansen's (2000), Noble's (2006) and Nayebzadeh et al.'s (2011) findings that family income, background, and the level of education by parents is proved to have an influence on student's academic performance. Also, similar to Raychaudhuri et al.'s paper (2010), the further away the student's locality from the college, the lower the final score, potentially due to students exerting more effort prior to arriving at the college which creates fatigue and stress.

4.2 Policy Recommendations

Defining the determinants that affect students' academic performance is vital for a number of stakeholders, including students, their parents/guardians, academicians, college management, the Ministry for Education, and other institutions related to educational policy. These findings can help academics to develop tailor-made teaching strategies and pedagogies to ensure better student engagement which ultimately results in higher scores. Besides educational organisations, the industry is also interested in knowing these factors since they are considered as the end users of graduate students once they officially enter the labour market (Alfan et al., 2005).

These findings could be generalised to other academic institutions following similar programmes. Based on these results, by designing lower class sizes, ideally including less than 17 students (as advocated by Glass and Smith (1978), and M. Mitchell et al. (2016), the institute (IBMC) will be aiding its business students to obtain higher scores, leading to higher employment prospects, better reputation for the college for producing better quality students, as well as saving students' money and effort by helping them to perform better academically. Accord-

ing to Mushtaq and Khan (2012, p.1), this might also lead to a change in the attitude of students towards learning by "facilitating students and improving the teaching procedures".

The first set of recommendations are targeted towards MCAST Administration, in particular IBMC. Currently, larger classes are more common among level 4 and 6 students, reaching cases of 34 students per class. This goes against Glass and Smith's (1978), and Mitchell et al.'s (2016) recommendation of having up to 17 students per class. Although it is crucial to retain small class designs for elementary grades (levels 1 - 3) since students attending these courses left secondary school with limited qualifications, it is equally important to support students in their final years of study in order to produce effective workers. Moreover, to minimise the skills gap between mature and young adults as identified by the variables 'AGE' and 'LEVEL', apprenticeship programmes should continue so to equip students, especially teenage students, with more life skills, including employment-related competencies.

Furthermore, such initiatives could potentially decrease the number of students resigning from the course or not passing from most of the units as they feel more valued and supported by their teacher and their peers in class. In fact, both Rwegoshora (2011) and Maganga (2016) corroborate that students feel more content in a small class vis-à-vis a larger class. Therefore, by designing smaller classes, IBMC can contribute towards decreasing the percentage of early school leavers in which Spain and Malta currently top the charts.

The institute should be stricter with regards to the number of school days that students miss. The positive correlation between students' 'ATTENDANCE' and the 'SCORE' should serve as a standard for lecturers, institute management and students on the importance of attending the lectures. Ongoing reviews on a monthly/semester base will help decrease the formation of a pattern of absenteeism.

Moreover, a set of recommendations is targeted towards the Ministry for Education which should recruit more teachers, expand schooling facilities for the business institute within MCAST so to accommodate more classrooms, as well as encourage the design of more courses and subjects to better segregate students into smaller classes. Such proposition, as explained by Shin et al. (2009), creates positive spillover effects by better responding to the industry's demands as well as better serving students' interests by designing courses closer linked to their areas of interest. Furthermore, the campus in Gozo should expand its list of business courses to better accommodate Gozitan students, as well as start attracting students located in the Northern district, especially following the government's plan to link the two islands through the construction of a tunnel.

5 Conclusion

Using a rich panel dataset composed of 874 students from two scholastic years (2018/2019 and 2019/2020), this study explored the degree of association between class sizes and the end-of-course scores by students, whilst controlling for other academic, demographic, and socioeconomic attributes in the employed models. Following the set hypotheses, empirical results from the chosen OLS regression produced a significant negative relationship between larger class sizes and the average end-ofcourse score obtained by students, signalling that students perform better when assigned in smaller classes vis-à-vis larger classes.

This study could be reproduced by future researchers to understand whether this trend is only common among business students following a VET course, or whether students from other institutes perform better when assigned in smaller classes. Also, this paper focused on the academic benefits of designing smaller classes. However, the surveyed literature also exploits non-school related attributes, such as interpersonal skills, teamwork, and the presence of bullying. Therefore, a study could be undertaken to study the impact of class sizes on these nonacademic factors. Furthermore, a Cost-Benefit-Analysis (CBA) could be undertaken to quantify whether the potential benefits of smaller classes exceed their costs (additional teachers, the classroom space, as well as operating costs such as electricity bills). Such proposal should be compared against alternative calls for more effective teaching, such as improving the classroom ambience, providing more technical training and workplace opportunities to students.

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Appendices

Grade	Boundary	Median mark
A*	90 - 100	95
A	80 - 89	85
В	70 - 79	75
С	60 - 69	65
D	50 - 59	55
U	0 - 49	25

Table 2: Collected data segregated by level and year

	2018/2019	2019/2020
Level 1	14	13
Level 2	50	55
Level 3	108	122
Level 4	205	135
Level 6	106	66
Total	485	391

Table 3: Missing observations

Variable	Missing observations	Percentage of missing observations
ATTENDANCE	874	55%
DISTANCE	204	23%
AROPE	204	23%
AGE	119	14%

analysis
Variables'
Table 4:

Variable name	Acronym	Description
Dependent Variable		
Academic score	SCORE	End-of-course result
Central Variables		
Class size	CLASS	Number of students registered in the class
Control Variables		
Demographic characteristics		
Student's gender	GENDER	1 - Male; 0 - Female
Student's age	AGE	Age of student in 2020
Minority students	FOREIGN	1 - Student is foreign; 0 - Otherwise
Academic characteristics		
Student's grade of studies	LEVEL	Grade that the student has graduated in
Student's attendance rate	ATTENDANCE	Student's attendance during the scholastic year (%)
Socio-economic characteristics		
Family background	AROPE	AROPE rate of the student's district (%)
Distance	DISTANCE	Distance between the student's locality in 2020 and the college

	Variable	ATTENDANCE	CLASS	GENDER	DISTANCE	AROPE	AGE	FOREIGN	SCORE
	Minimum	32.6	З	0	1.70	14.20	17	0	0
Level 1	Maximum	56.80	10	1	14.70	22.10	37	1	95.5
	Mean	47.44	6.50	0.70	7.50	17.90	19.10	0.04	78.25
	Minimum	2.10	13	0	1.70	14.20	17	0	0
Level 2	Maximum	58.20	18	1	15.50	22.10	26	1	93.5
	Mean	30.70	15.62	0.51	7.10	19.92	18.10	0.43	50.75
	Minimum	0.50	16	0	1.90	14.20	14	0	0
Level 3	Maxium	56.90	24	1	40.50	22.10	29	1	89.17
2	Mean	32.34	20.24	0.44	8.07	19.56	18.10	0.25	47.78
	Minimum	3.30	2.0	0	1.70	14.20	17	0	25
Level 4	Maximum	72.4	21	Ц	42.40	22.10	38	1	90.56
	Mean	43.50	15.77	0.42	7.89	19.18	19.84	0.06	66.96
	Minimum	12.20	17	0	1.70	14.20	21	0	52.39
Level 6	Maximum	52.10	34	1	42.4	22.10	29	1	90.20
	Mean	40.17	25.91	0.43	9.59	18.71	22.52	0.02	72.58

Table 5:	
Descriptive	
Statistics	
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Table 6: Econometric models

Note: Robust standard errors in parentheses: *** indicates significance at 1% (p < 0.01); ** at 5% (p < 0.05) and * at 10% level (p < 0.1)

Variable	Regression 1	Regression 2	Regression 3
Technique	OLS	OLS	OLS
Constant	59.08***	5.6158	28.1591***
Constant	(2.1500)	(5.7702)	(9.3936)
	0.1257	-0.2857**	-0.2662**
CLASS	(0.1021)	(0.1281)	(0.1308)
CENDED		-0.2252	-0.3142
GENDER		(0.8847)	(1.6165)
ACE		0.7957**	0.7225**
AGE		(0.3438)	(0.3459)
FODELCN		5.6658	4.7983
FOREIGN		(5.0441)	(5.3817)
		1.9713***	1.6407**
		(0.6994)	(0.7357)
ATTENDENCE		1.0459***	1.0484***
ATTENDENCE		(0.0579)	(0.0571)
			-0.8369***
AROPE			(0.3254)
			-0.5876***
DISTANCE			(0.2257)
SER	22.0757	13.3910	13.3884
Adjusted R ²	0.0001	0.6039	0.6198

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Research Article



COVID-19 more than an ill-health: combined supply-side and demand-side shocks

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Abstract. COVID-19 mitigation restrictions have avoided countless deaths and infections while simultaneously disrupting livelihoods and economies. The global loss of gross (world) product is unprecedented as COVID-19 has inflicted both supply-side and a demand-side shocks. While public health measures have mitigated morbidity and mortality with positive effects on cross-country economic results, the decline in global Gross Domestic Product is leading to diminished spending on healthcare, the environment, and social wellbeing. In addition to the current challenges, there will also be various long-term implications of lasting illness ("long COVID") which are still to be determined. Numerous and varied economic stimuli packages have been instituted by different countries aiming to revive economies in the short term and thereby also mitigate long-term implications. In line with these measures, as a result of the COVID-19 vaccine roll-out, European countries have initiated discussions on vaccineimmunity passports to enhance mobility and assist economic recovery. However, this will not resolve the economic scars, the impaired innovation outcome and the healthcare fatigue that are expected to linger for years. While uncertainty is certain, this very uncertainty highlights the need for unbiased and rigorous quantitative evaluations of all possible decisions. A "nuanced approach" to the easing of restrictions must take into account the balance of immediate mortality and both shortand long-term morbidity versus the even longer-term risks of widening health, education and wealth inequalities and decreased life expectancy among the more socially and economically vulnerable.

Keywords: COVID-19, recession, depression, economics, health economics

1 Introduction

COVID-19 continues to plaque the globe and the presence of effective treatments and vaccines is reducing spread and death. Other treatments by non-pharmaceutical interventions (NPIs), so-called community mitigation strategies are also assisting in reducing pandemic spread (Ferguson et al., 2020). These include hygiene, social distancing, self-isolation and travel restrictions. The application of these interventions has not been consistent across countries, with countries like Sweden, the United States (US) and the United Kingdom (UK) imposing social distance restrictions cautiously, a so-called "sacrifice lives to save economy" approach (Born et al., 2020; Casey, 2020; Krueger et al., 2020). Others imposed strict lockdowns after high infectivity and fatality rates, as seen in Italy and Spain (Brauner et al., 2021; Farboodi et al., 2020). Indeed, these initially unprepared localities experienced devastating COVID-19 morbidity and mortality that overwhelmed their respective healthcare systems, as witnessed in Italy early in 2020 (Fagiuoli et al., 2020). On the other hand, in Germany and Denmark, lockdowns were imposed due to perceived insufficient voluntary social distancing by the population (Brauner et al., 2021). Strict restrictions imposed by countries such as Japan, China, South Korea, Norway and Finland among others were considered to "sacrifice economy to save lives" (Casey, 2020). These mitigation measures resulted in a flattened curve in the early summer months of 2020 in the Northern hemisphere, preventing millions of infections and saving millions of lives (Flaxman et al., 2020; Hsiang et al., 2020). However, these positive effects were reversed when the measurements were relaxed, especially

when done hastily (Cuschieri et al., 2020). This narrative review will discuss the direct and indirect economic impact of COVID-19 and the public health implications.

1.1 Mitigation measure effects on the economy

Mitigation measures have had detrimental effects on global healthcare systems and a disruptive ripple effect on literally every aspect of human endeavour and economic activity. There have been unprecedented levels of disturbance to individual lives and even more importantly for the long term, to general economic activity, both at national and at global levels (Nicola et al., 2020). Employment challenges occurred across all economic sectors, although not in a consistent manner. Some sectors such as tourism, wholesale and retail have been badly hit compared to others. Certain areas of economic activities proved to be resilient by shifting to new forms of work such as remote working. Schools have closed, piling additional pressure on carers and economic activity in general. From a consumption perspective, some sectors experienced a lower expenditure during lockdowns, with households who managed to retain their employment, experiencing increases in their saving rates. Indeed, in March 2020, the US reported that personal savings surged as a percentage of disposal income from 7.5% (normal level) to 34% during lockdown (Copper, n.d.). This led to an anticipated postlockdown economic spree with the anticipated inflation pressures never truly materialising (Copper, n.d.), probably because the post-lockdown phase was not extensive in most countries. Households mainly used their income on food related products, and the sector faced increased demands due to panic-buying and stockpiling (Nicola et al., 2020). On the other hand, the general demand for commodities and manufactured products has significantly decreased while demand for specific medical supplies has risen.

In economic terms, COVID-19 has inflicted both a supply-side and a demand-side shock. A shock is a sudden and unexpected change which can be both negative and positive. A supply shock is an unexpected increase/decrease in the supply of goods/services due to non-price determinant factors. Demand shocks are sudden increased/decreased demands for goods or services. Since the supply of a commodity/good/service is usually not very flexible (inelastic in economic terms), all of these COVID-19 affected factors can and have wreaked economic havoc.

Almost all countries are constantly reducing and increasing NPI restrictions, but these actions will not undo the damage already done and the evolving domino collateral damage. Indeed, due to ongoing effects including decimated tourism, the World Travel and Tourism Council (WTTC) has averred that COVID-19 is threatening the livelihoods of 300 million people – one in 10 of the global workforce – employed in the tourism/hospitality industry, an industry which accounts for 300 million jobs and almost 10% of global gross domestic product (GDP) (Broom, 2020; "UNWTO World Tourism Barometer and Statistical Annex, January 2019", 2019).

1.2 The impact of COVID-19 on GDP

The Gross Domestic Product (GDP) is defined as the total amount of goods produced and services provided, typically quoted or cited per country, for a one year period (Callen, 2008). Annual growth is invariably given as a percentage of the previous year's GDP. The world's GDP was \$85.9 trillion in 2018 (The World Bank, 2018). As an example and for the sake of perspective, the largest economy in terms of GDP is that of the United States at almost \$19.5 trillion/year (Worldometer, 2019), with an annual budget for 2019 of almost \$4.45 trillion (USA Spending, 2019).

Health issues are inextricably intertwined with GDP and other economic indicators such as social wellbeing. In fact, it has been estimated that in the developed countries, if GDP drops by circa 6%, more years of life would be lost due to recession than would be gained through lives saved at this tipping point since there is a link between GDP and life expectancy. This is because affluent countries are able to spend more on healthcare, safety and the environment and this expenditure would be restricted due to decreased funds available if GDP falls (Thomas, 2020).

Income is causally related to health not only via a direct effect on the material requirements necessary for simple survival, but also by influencing the ability to participate in society, including at work and hence the opportunity to control life circumstances. Indeed, the fewer the goods and services publicly made available by the community, the more important individual income becomes for health (Marmot, 2002).

This can even be shown in relation to COVID-19 in that case fatality rates (CFRs) have varied widely in different countries, from 0 to 8.91%. An analysis of the effect of socio-economic and health indicators showed that GDP, more specifically a low GDP per capita among other indicators were significant contributors to CFR. Developing countries are therefore particularly vulnerable (Asfahan et al., 2020).

GDP and mitigation measures

A modelling study comparing the UK with European countries of similar income and healthcare resources showed that when applying a quality-adjusted life year (QALY) value of \pounds 30,000 (the maximum under national (NICE) guidelines), the cost of the imposition of further strict lockdown would only be justified with a QALY value of at $\pounds 220k - \pounds 3.7m$ (much higher than NICE values, x7 - x125). The authors concluded that clearly, the costs of continuing draconian restrictions are so great in relation to lives saved that a quick easing in restrictions was highly warranted (Miles et al., 2020). A study conducted in the US had shown that with a value of \$125,000 per QALY, assuming COVID-19 vaccine availability by April 2021, QALY benefits from averted deaths by continued social distancing and limited reopening. This exceeds full reopening with projected increased GDP gains. The authors concluded that a limited reopening to achieve partial economic mitigation of COVID-19 would be more cost effective than a full reopening (Schonberger et al., 2020). Another study explored the effects of GPD growth in relation to changes in lockdown strategies across 42 countries, over the first three-quarters of 2020. It was reported that although strict government measures had a negative economic activity impact, these kept the fatality rates low. Therefore, from an economy perspective, lockdowns and low fatality rates were the second-best policy to limit economy damage secondary to high fatality rates. It was concluded that changes in lockdown strategies have dominant effects on in-country GDP, while low fatality rates have a positive effect on cross-country economic results (König et al., 2021).

Long COVID and the economic implications

In addition to acute morbidity and mortality, "long COVID" is a novel term that describes lasting illness in patients who have either recovered from COVID-19 but still experience lasting symptoms or who have had symptoms for longer than expected. Up to 90% of symptomatic patients may go through this, with 90%, 32% and 55% were still experiencing at least one, two, or three or more symptoms respectively 60 days after onset (Carfi et al., 2020). It has been estimated that due to residual functional disability, the cumulative post-discharge healthcare costs/patient/year are comparable to those of elderly patients with severe chronic diseases (Ambrosino et al., 2020). The additional complication of long COVID-19 is that relatively young and previously healthy individuals who lack important comorbidities, do not return to their previous baseline functional status. This has enormous public health implications, particularly in the context of a pandemic (Ambrosino et al., 2020). These complications will weigh most heavily on those least equipped to shoulder them and their families and friends: lower-income earners, the uninsured/underinsured, and the homelessness (Jiang et al., 2020). All of these costs must also be factored in when weighing the pros and cons of removing restrictions.

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Of course, this will have serious economic implications not only in terms of the quality of life of these individuals, but also in terms of economic activity. The faster the workforce recovers, the faster will be the economic rebound to the new economy post-COVID.

1.3 Reviving the economy

It has been reported that COVID-19 contributed to a number of positive long-term outcomes on companies, as these were forced to change their daily operations and consumer behaviour. Indeed, businesses that survived the initial COVID-19 economic shock are more likely to be resilient and flexible in the future. It has also accelerated digitalization, increased e-commerce and virtual selling apart from enhancing health and safety (Maqui et al., 2021).

Economic stimulus and forecasts

Individual countries have varied in the degree of stimulation that they have internally provided in their attempts to ameliorate the negative economic effects of the pandemic, and this has ranged from 2.5% - 50% of GDP (Danielli et al., 2020). These include immediate fiscal impulse, deferrals, and other liquidity and guarantee measures.

In order to assist economies and attempt to avoid a recession of the magnitude witnessed in the 1930s during the Great Depression (Romer, 1990), countries have pledged various stimulus packages, including a \$10 trillion internal aid boost (Cassim et al., 2020). This is more than three times more the 2008-2009 crisis. The European Union initially planned 1.8 EUR trillion a recovery package which is mainly aimed at greening the economy and transformation through investments in digitalization, (European Commission, 2020) and this has been increased to \$2.2 trillion backed by joint debt (Dendrinou et al., 2020). The equivalent stimulus package for the USA is \$1.9 trillion (Wasson et al., 2021). Despite the extraordinary efforts to counter the evolving recession/depression with fiscal and monetary policy support, forecasts vary but are overall bleak.

World Economic Outlook

"A Crisis Like No Other, An Uncertain Recovery" (World Economic Outlook Update, 2020). Global growth is projected at 5.5% in 2021, after shrinking by 3.5% in 2020 according to the latest IMF projections (World Economic Outlook Update, 2021). In 2022 global growth is projected at 4.2%. Despite the growth projections, the "adverse impact on low-income households is expected to be particularly acute, imperiling the significant progress made in reducing extreme poverty in the world since the 1990s" (World Economic Outlook Update, 2020).

Eurozone

Meanwhile, according to the latest statistics published by the European Commission, GDP growth in the euro area decreased by 6.8%, less than the 9.1% anticipated last year. This is even better than the 5.5% contraction in 2009 as the Eurozone dealt with the financial crisis (OECD, 2020). In 2021 and 2022, the Eurozone economy is expected to grow my 3.8% per year (European Commission, 2021).

Despite the relatively positive economic outlook for the coming years, and with the use of the vaccine, COVID-19 will leave "lasting scars through lower investment, an erosion of human capital through lost work and schooling, and fragmentation of global trade and supply linkages" (The World Bank, 2020). Additionally, innovation will be affected through the impaired of financial contribution to research and development (Martin Fuentes et al., 2021). Furthermore, healthcare fatigue that will affect healthcare services and output (Adibe, 2021). Finally, ongoing waves of infection (even in countries with relatively high vaccination rates) may derail all estimates. This is particularly important as viral spikes have been witnessed in Chile and the Seychelles despite relatively high vaccine uptake (39% and 67% respectively) (Balicer et al., 2021). Indeed: "How fast will economy recover? It depends on businesses reopening, vaccination, COVID-19 third wave" (Nangia, 2021).

Hyperinflation

Economic stimulus packages and increased family savings due to ability to spend on holidays and entertainment is also raising the spectre of hyperinflation, a rapid, excessive, and out-of-control general price increases in economies (Asia Times, 2021). Furthermore, the initial drop in COVID infections in Europe earlier in 2021 followed by further waves of infection has triggered a double-dip i.e. a recession followed by a short-lived recovery, followed by another recession (also known as a W-shaped recovery) (Financial Times., 2021). These factors will also mostly impact low-income earners.

1.4 Immunity-vaccine passports

The recovery of the hospitality industry is crucial to all economies and tourism plays a crucial role (Grech et al., 2020). COVID-19 vaccines roll-out have initiated across most European countries (March 2021) resulting in a debate for the introduction of a vaccine passport among countries. Those fully vaccinated, tested negative or recently recovered from COVID-19 will be eligible for this certification (BBC News, 2021b). These passports aim to enable mobilisation and relaxation of restrictions so as to revive economies. However, these initiatives are faced

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by a number of debates including ethical concerns and privacy concerns and the possibility that this will exacerbate inequalities and discrimination (Brown et al., 2021). Naturally, increased travel also risks viral spread from one country to another by asymptomatic (albeit certified) carriers but the newly approved pan-European vaccine passport may mitigate these risks (Schengenvisainfo News, 2021).

1.5 Positive outcomes and forecasts

Not all appears to be gloom and doom and for example, China's economy grew 18.3% in the Q1 2021 compared to the same quarter of 2020, the largest rise in GDP from 1992 when China started keeping records. This should be contrasted with a 6.8% reduction for the same country in Q1 2020 due to lockdowns (BBC News, 2021a).

Similarly, in the United States, retail sales have spiked by 9.8% in March 2021 due to pandemic relief cheques, and a successful vaccination program and the rollout of a \$1.9 trillion rescue package. All of these factors are positioning the USA's economy for the fastest growth spurt this year in decades (Aljazeera, 2021). Indeed, a surplus of cash in the financial system has reduced interest rates (The Economic Times, 2021) and it is estimated that business have accumulated billions of dollars and euros (Bharti, 2021). Not all households have done badly and overall, it is estimated that households have saved the equivalent of 6% of global GDP since the pandemic began, a staggering \$5.4 trillion (Romei, 2021). These has led to bullish market with fears of a bubble forming and perhaps the best example is the surge in cryptocurrency (Gutscher et al., 2021; Raimonde et al., 2021).

All these estimates may be disrupted by additional waves of infection. For example, the planned (at the time of writing) UK reopening and relaxation of all measures may lead to between 1000-2000 hospital admissions daily and 100-200 deaths daily in England when cases peak, based on the assumption that the public's behaviour will change slowly over several months, rather than suddenly (Vaughan, 2021).

2 Public Health Implications – Conclusion

The oft-repeated 'COVID-19 does not discriminate' is patently incorrect – it certainly does and has in fact high-lighted the stark wealth and health inequalities within so-ciety and exacerbated them (Patel et al., 2020).

COVID-19 continues to pose a dynamic challenge for both governments and policymakers who have been pingponging degrees of restrictions to reduce viral morbidity and mortality through social distancing interventions over economic growth. However, travel and mobility restrictions and shuttered businesses have triggered an economic collapse with an inbuilt uncertainty.

While uncertainty is certain, this very uncertainty highlights the need for unbiased and rigorous quantitative evaluations of all possible decisions. A "nuanced approach" to the easing of restrictions must take into account the balance of immediate mortality and both short- and longterm morbidity versus the even longer term risks of widening health and wealth inequalities and decreased life expectancy from poverty (Danielli et al., 2020), particularly in the more socially and economically vulnerable strata since public health measures disregard the most economically disadvantaged (Patel et al., 2020).

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Conflict of Interests

All authors have no conflict of interest to declare.

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