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# Multidimensional analysis of the Effectiveness of a Massive Open Online Course on covid-19 in the training of health professionals

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## ABSTRACT

This study tested the Effectiveness of a Massive Open Online Course on covid-19 and associations with alumni characteristics and their evaluation of the course. Through an analytical cross-sectional study with 1,135 participants who answered a structured questionnaire via Google Forms, from July to September 2020. The outcome was the latent multidimensional Effectiveness, deducted from the Skills, Attitudes and Motivation indicators. Socioeconomic characteristics, professional training, time working in health and course evaluation were analyzed to analyze associations with the outcome. Stata version 15.0 and Mplus® version 8 were used in the analyses. The best model showed Effectiveness with factor loadings above 0.8 ($p<0.001$). Time working in sector health (PC=0.106; $p=0.014$) and course evaluation (PC=0.542; $p<0.001$) were the variables associated with Effectiveness. The educational offer was a resource that effectively qualified health professionals who graduated from the course to combat the covid-19 pandemic.

**KEYWORDS:** Continuing education; Covid-19; Distance Education.

## INTRODUCTION

The Coronavirus Disease 2019 (covid-19) pandemic is a public health problem that has generated significant challenges for public health systems in several countries (WHO, 2020), including the Brazilian Unified Health System (translating into Portuguese, Sistema Único de Saúde - SUS). Some of these challenges were related to physical resources because of the insufficient infrastructure to support the high care demand, and human resources, because of the lack of professional qualification in the face of a new disease (BHATTACHARYA; SINGH; HOSSAIN, 2020; NASCIMENTO; PACHECO, 2020).

While the weaknesses of the SUS have become more evident in the pandemic, its potential has also been made explicit. Continuing Education in Health is one of these potentialities and can promote the workers' reflection on their work process and the instrumentalization for their transformation, resulting in improved professional performance (BRASIL, 2022; OLIVEIRA *et al.,* 2016).

Faced with health recommendations for maintaining social distancing, the use of technology-mediated education has been an alternative to the provision of classroom courses (BHATTACHARYA; SINGH; HOSSAIN, 2020). The Massive Open Online Course (MOOC) can contribute to professionals' massive and fast continuing education, allowing unrestricted time-and-space access and an expressive number of enrollments (BALBINO; PINTO; BRAZ, 2020; LIU; KANG; MCKELROY, 2015).

While a self-instructional course meets the emerging needs of the pandemic (BHATTACHARYA; SINGH; HOSSAIN, 2020), some gaps concerning factors associated with the effectiveness of professional training are observed, especially considering its multidimensionais attributes (BALBINO; PINTO; BRAZ, 2022). Effectiveness is the professional ability to satisfy concrete community demands and can be weighted by alumni-centered attributes, such as developing skills, attitude, and motivation (GOMES *et al.,* 2020; NOGUCHE; SANDER, 2007).

Considering that effectiveness is a complex phenomenon and that it is challenging to measure this factor by any of its indicators alone, structural equation modeling emerges as a method that can analyze latent variables, which are deduced by the variances shared by its indicators, reducing measurement errors of multidimensional factors (KLINE, 2016).

This study tested Effectiveness as a multidimensional latent variable and analyzed the association of alumni characteristics and their course evaluation with the Effectiveness of a MOOC on covid-19.

## METHODS

This analytical cross-sectional study collected data from the MOOC "General Guidelines for Patients with Covid-19 in Primary Health Care", that aimed to train health professionals to describe guidelines for patients with covid-19 in Primary Health Care (PHC).

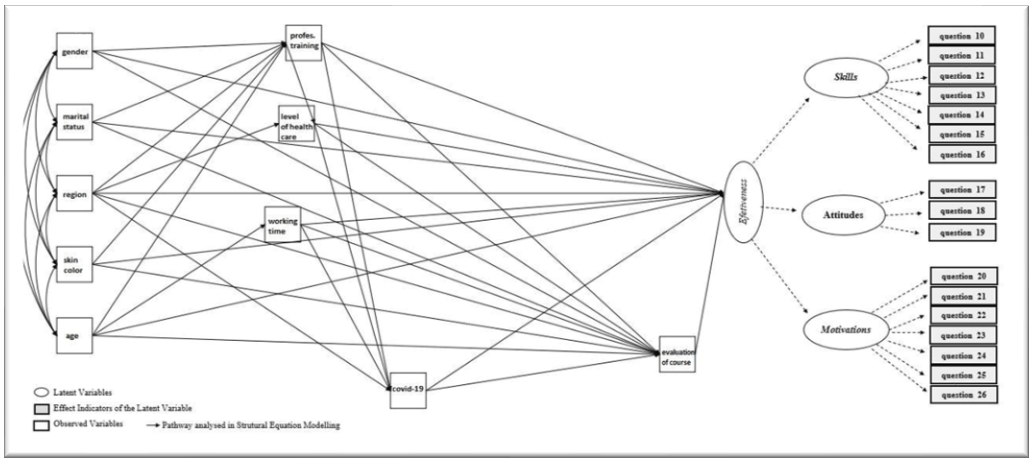
The 15-hour workload course was developed by the Universidade Aberta do Sistema Único de saúde vinculada à Universidade Federal do Maranhão (UNA-SUS/UFMA), in partnership with the Secretaria de Gestão do Trabalho e da Educação na Saúde (SGTES-MS), starting from April 2020.

Data were collected from July to September 2020, which included 67,073 enrolled individuals, of which 34,867 completed the course. The structured instrument of this study was sent after course completion, with the response of 1,811 individuals. A total of 1,656 individuals remained, excluding those who did not consent to participate in the study and duplicate responses. Then, we arrived at a final sample of 1,135 participants, excluding individuals who did not respond to the outcome.

## Theoretical model and variables

The theoretical model adopted, considering the outcome Effectiveness of the course as a multidimensional latent deduced from the shared variances between the Skills, Attitudes, and Motivation variables. The characteristics of the graduates (gender, age, self-reported ethnicity/skin color, region, marital status, professional training, working time, level of health care organization, role in caring for people with suspicion or diagnosis of covid-19) and the course (general evaluation) were explored to assess possible associations with Effectiveness (figure 1).

**Figure 1 -** Theoretical model and variables




**Source:** own authorship (2020).

## Data collection and analysis

The socioeconomic and enrollment data used were extracted from the XXXXX® platform of the Brazilian Health Professional Information System, which provides different educational offers aimed at qualifying SUS workers and financed with public resources.

Socioeconomic data were categorized into gender (male, female, did not respond); self-declared ethnicity/skin color (non-white and white, did not respond); marital status (without a partner, with a partner, did not respond); Brazilian regions of residence (North, Northeast, Midwest, Southeast, South, did not respond) and schooling (Elementary School, High School, mid-level technician, undergraduate, specialization/residence, masters, doctorate, did not respond).

Regarding professional training, the categorization considered the level of contact with covid-19, ranking participants by direct or indirect action in the frontline of care and considering the training level (nursing technician/assistant,

doctor/nurse, dentist/occupational therapist/physiotherapist/nutritionist/social worker/psychologist, pharmacist/physical educator/others, University student).

A structured questionnaire was developed with Google Forms® software and sent to individuals by e-mail from the virtual learning environment platform (Saiteava)®. This study evaluated 21 of the 27 available questions in the instrument, including those regarding health work (3), the course's overall evaluation (1), and the course's effectiveness (17).

Health work-related data were categorized regarding work seniority (<1 year, from 1 to less than 5, and 5 or more years), work in caring for people suspected or diagnosed with covid-19 (no, yes), and level of health care organization (Primary Health Care, Medium-Complexity, High-complexity, and not applicable). This organization of health care in levels of care refers to PHC as the preferred gateway to the SUS and care regulator with other points of care (BRASIL, 2017); medium-complexity as actions and services that demand specialized professionals and technologies for therapeutic support and diagnosis, and high-complexity as procedures that involve higher costs and technologies (ARAÚJO; NASCIMENTO; ARAÚJO, 2019; BRASIL, 2021).

The course evaluation was categorized as insufficient, fair, good, very good, excellent, and I don't know how to evaluate, and was obtained from the question "How do you evaluate the course?". Exploratory variables were addressed as categorical and presented by relative and absolute frequencies, using the Stata software version 14.0.

## Outcome variable and Structural Equation Modeling

The questions in the questionnaire sent to the participant to assess the course's Effectiveness originated from an instrument validated by Gomes et al. (2020) to assess the effectiveness of professional training through Distance Learning (DL) courses. The instrument proposed by Gomes and collaborators considered issues related to the development of skills (1 to 7), attitudes (8 to 10), and motivation (11 to 17) resulting from professional training. Its theoretical validation included the following steps: 1) integrative review for building the construct's definitions and its materialization in evaluative items; 2) theoretical analysis of the items using the Delphi technique (GOMES *et al.,* 2020).

The questionnaire sent to individuals included a Likert-type scale of disagreement/agreement in the questions about skills (10 to 16), attitudes (17 to 19), and motivation (20 to 26), which led to the categorization of these items as totally disagree, disagree, agree and totally agree.

Considering the difficulty in evaluating the course's effectiveness by a direct factor and that it became necessary to evaluate the multiple exposures associated with the outcome to test the hypothesis of this study, we employed the Structural Equation Modeling (SEM). SEM is a statistical method that includes latent, not directly observed variables, using the Confirmatory Factor Analysis (CFA) and simultaneously estimating a series of regression equations, evaluating variables' direct and indirect effects on an outcome (KLINE, 2016). Thus, we could include Effectiveness as a multidimensional outcome deduced from the Skill, Attitude, and Motivation variables.

Mplus® version 7 (Los Angeles, CA, USA) was the statistical software used for SEM. The models were evaluated for the quality of their fit, considered good depending on the values of the indices: upper limit of the confidence interval 90% <0.08 and p > 0.05 for the Root Mean Square Error of Approximation (RMSEA); Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) > 0.95 (KLINE, 2016).

The modindices command was used to verify the need for modifying the model fit, adopting a modification index value greater than 10 as suggestive of a model change (WANG; WANG, 2012).

## Ethical aspects

All participants agreed to participate in the research after reading the Free and Informed Consent Term according to Resolution nº 466/2012 of the National Health Council (CNS) and Operational Standard. In addition, all methods were performed in accordance with the relevant guidelines and regulations. We confirm that all ethical aspects and operational protocols were approved by the Research Ethics Committee of the do Hospital Universitário da UFMA (HUUFMA), which approved this study under CAAE nº 08686819200005086.

## RESULTS

The study participants mainly consisted of female individuals (70.31%), without a partner (56.30%), self-declared non-white (50.84%), with a significant percentage of work in PHC (51.01%) and the care of people suspected or diagnosed with covid-19 (49.87%) (Table 1).

**Table 1** – Sociodemographic characteristics of students in the self-instructional course on COVID-19. Brazil. 2020

| Variable | n | % |
|---|---|---|
| **GENDER** | | |
| Male | 262 | 23.08 |
| Female | 798 | 70.31 |
| No information | 75 | 6.61 |
| **AGE** | | |
| 18-29 | 346 | 30.48 |
| 30-39 | 354 | 31.19 |
| 40-49 | 232 | 20.44 |
| 50 and over | 128 | 11.28 |
| No information | 75 | 6.61 |
| **ETHNICITY** | | |
| Non-white | 577 | 50.84 |
| White | 469 | 41.32 |
| No information | 89 | 7.84 |
| **MARITAL STATUS** | | |
| Without partner | 639 | 56.30 |
| With partner | 421 | 37.09 |
| No information | 75 | 6.61 |
| **REGION OF RESIDENCE** | | |
| North | 103 | 9.07 |
| Northeast | 353 | 31.10 |
| Midwest | 53 | 4.67 |
| Southeast | 360 | 31.72 |
| South | 130 | 11.45 |
| No information | 136 | 11.45 |

| Variable | n | % |
|---|---|---|
| **SCHOOLING** | | |
| Elementary School | 3 | 0.26 |
| High School | 90 | 7.93 |
| Technical High School | 107 | 9.43 |
| Higher education | 519 | 45.73 |
| Specialization/Residency | 278 | 24.49 |
| Masters | 43 | 3.79 |
| Doctorate | 20 | 1.76 |
| No information | 75 | 6.61 |
| **PROFESSIONAL/ACADEMIC** | | |
| Nursing technician/assistant | 136 | 11.98 |
| Doctor/Nurse | 286 | 25.20 |
| Dentist/OT/Physiotherapist/ Nutritionist/Social Worker/ | 153 | 13.48 |
| Psychologist | | |
| Pharmacist/Physical Educator/Other | 222 | 19.56 |
| University student | 263 | 23.17 |
| **HEALTH WORK SENIORITY** | | |
| < 1 year | 100 | 8.81 |
| 1-5 years | 225 | 19.82 |
| >5 years | 549 | 48.37 |
| No information | 261 | 23.00 |
| **ORGANIZATIONAL LEVEL** | | |
| PHC | 579 | 51.01 |
| Medium-Complexity | 148 | 13.04 |
| High-Complexity | 116 | 10.22 |
| No information | 292 | 25.73 |
| **WORK IN COVID-19 SERVICE/DIAGNOSIS** | | |
| No | 569 | 50.13 |
| Yes | 566 | 49.87 |
| **TOTAL** | **1135** | **100** |

**Source:** own authorship (2020).

Approximately 50% of the participants rated the course as excellent. The Effectiveness analyzed as a multidimensional latent variable was advantageous, based on the shared variance of its Skills, Attitudes, and Motivation indicators, reducing the measurement error of this construct and showing a good fit (Table 2).

**Table 2** – Adjusted model indicators. Brazil, 2020

| Indicators | Recommended Parameters | Final model |
|---|---|---|
| Chi-square (χ2) (p-value\|) | >0.05 | <0.001 |
| RMSEA (90% CI) | Upper limit <0.08 | 0.062 -0.069 |
| p-value | <0.05 | <0.001 |
| Comparative Fit Index (CFI) | >0.95 | 0.977 |
| Tucker-Lewis Fit Index (TLI) | >0.95 | 0.973 |

**Source:** own authorship (2020).



Effectiveness was a good latent variable, with all dimensions with factor loadings above 0.8, which were significant (<0.001) (Table 3).

**Table 3** – Standardized coefficient, standard error, and p-value of latent variables. Brazil, 2020

| Latent Variable | Indicator Variables | SC | SE | p-value |
|---|---|---|---|---|
| | Quest10 | 0.750 | 0.017 | |
| **Skills** | Quest11 | 0.824 | 0.014 | <0.001 |
| | Quest12 | 0.745 | 0.017 | |
| | Quest13 | 0.763 | 0.017 | |
| | Quest14 | 0.920 | 0.009 | |
| | Quest15 | 0.900 | 0.012 | |
| | Quest16 | 0.873 | 0.012 | |
| **Attitudes** | Quest17 | 0.770 | 0.016 | |
| | Quest18 | 0.778 | 0.014 | <0.001 |
| | Quest19 | 0.891 | 0.010 | |
| | Quest20 | 0.831 | 0.011 | |
| **Motivation** | Quest21 | 0.873 | 0.011 | <0.001 |
| | Quest22 | 0.903 | 0.012 | |
| | Quest23 | 0.840 | 0.010 | |
| | Quest24 | 0.887 | 0.010 | |
| | Quest25 | 0.867 | 0.011 | |
| | Quest26 | 0.755 | 0.014 | |
| **Effectiveness** | Skills | 0.897 | 0.008 | |
| | Attitudes | 1.013 | 0.008 | <0.001 |
| | Motivation | 0.924 | 0.008 | |

SC=Standardized Coefficient SE=Standard Error
**Source:** own authorship (2020).

Health work seniority (SC=0.106; p=0.014) and course evaluation (SC=0.542; p<0.001) were the characteristics associated with Effectiveness, identifying greater effectiveness of training for professionals with longer health work seniority and greater course evaluations (Table 4).

**Table 4** – Standardized coefficient, standard error, and p-value of the total effect. Brazil, 2020

| Course effectiveness to | SC | Total Effect SE | p-value |
|---|---|---|---|
| Age | 0.004 | 0.045 | 0.922 |
| Gender | -0.046 | 0.032 | 0.151 |
| Ethnicity | -0.012 | 0.037 | 0.736 |
| Marital status | 0.001 | 0.035 | 0.972 |
| Region | -0.025 | 0.036 | 0.492 |
| **Work seniority** | **0.106** | **0.043** | **0.014** |
| Profession | -0.043 | 0.041 | 0.294 |
| Organizational level | 0.084 | 0.045 | 0.064 |
| Working in COVID-19 service | 0.080 | 0.046 | 0.078 |
| **Course evaluation** | 0.004 | 0.045 | 0.922 |

SC= Standardized Coefficient SE= Standard Error
**Source:** own authorship (2020).

## DISCUSSION

The results of this study show the effectiveness of the MOOC on covid-19, standing out for its understanding as a multidimensional latent variable, capable of considering different not directly observable attributes but which are developed by the participants after training (Skills, Attitudes, and Motivation). Moreover, the characteristics of health work seniority and the students course evaluation were associated with the Effectiveness of the participants training.

All attributes underlying Effectiveness had factor loadings above 0.8, emphasizing the Attitudes attribute, which had a higher factor loading. Attitude is related to the individuals behavior vis-à-vis something, producing choices that can even interfere with their work environment (ODELIUS *et al.,* 2016).

The questions that underlie Attitudes had high and similar factorial loadings, highlighting the one that proposed, "I have taken advantage of opportunities to put into practice what was taught in the course". Understanding this fact may result from the relationship of this attribute with professionals' willingness to change the way they operate (CUBAS *et al.,* 2017).

This study enabled us to identify that longer health work seniority was associated with greater effectiveness of training, suggesting that the accumulated experiences over the years worked can favor greater resoluteness in the face of emerging demands, for example, when identifying the essentiality of an experienced and trained team for managing the airways of patients with covid-19 (FERNANDES *et al.,* 2021).

The importance of longer work seniority in the same team/work environment is reiterated to obtain better results and improve professional practices, especially in PHC, which serves as a preferred gateway to the health system and should offer a robust longitudinal follow-up to users (OLIVEIRA *et al.,* 2016).

The positive alumni feedback on the course evaluation recognizes that the pedagogical planning and course implementation were well designed. Professionals recognize the importance of quality professional training in developing PHC attributes (LEÃO; CALDEIRA, 2011). Health education with quality educational processes allow applying the knowledge acquired in the professionals' realities and can result in health care problem-solving and user care qualification (GOMES; LIMA, 2019; REYES; ALVAREZ; POMAREDE, 2016).

A limiting factor in this study concerns the profile of the professionals who responded to the data collection instrument, as it is possible that the most motivated participated in the course evaluation. However, the proposed multidimensional analysis of Effectiveness was not restricted to Motivation, avoiding errors in measuring the result and standing out as a pioneering study in identifying factors associated with the effectiveness of a MOOC aimed at Covid-19. Another limitation is related to the students learning curve, which is unique. However, the methodology adopted in the course's pedagogical project sought to facilitate the path taken by students, with the use of active teaching methodologies, such as problem situations. This could impact the student experience and, consequently, the results of the study.

## CONCLUSION

Effectiveness analyzed as a multidimensional latent variable was advantageous, based on the shared variance of its indicators, reducing the measurement error of this construct. The MOOC format educational offer was presented as a resource that effectively qualified to fight the Covid-19 pandemic, highlighting the longer health work seniority time and the positive course evaluations as characteristics associated with greater Effectiveness.

The Attitudes attribute stood out among the others, showing the ability to reflect the satisfaction of social demands by health professionals. However, it is necessary to consider all the attributes included in this study to assess the Effectiveness of other MOOCs, as evidenced by the good fit of the proposed multidimensional model.

Finally, the MOOC format educational offer was effective in the qualified human resources training, standing out for its capillarity, pioneering spirit, and essentiality in a context of ignorance established at the onset of the Covid-19 pandemic.

# Análise multidimensional da efetividade de um *Massive Open Online Course* sobre Covid-19 na formação de profissionais da saúde


## RESUMO

Este estudo testou a Efetividade de um Curso Massivo Online Aberto sobre Covid-19 e associações com características dos ex-alunos e sua avaliação do curso. Por meio de um estudo transversal analítico com 1.135 participantes que responderam um questionário estruturado via Google Forms, no período de jul a set/2020. O desfecho foi a Efetividade multidimensional latente, deduzida dos indicadores Competências, Atitudes e Motivação. Características socioeconômicas, formação profissional, tempo de atuação na saúde e avaliação do curso foram analisadas para verificar associações com o desfecho. O Stata versão 15.0 e o Mplus® versão 8 foram utilizados nas análises. O melhor modelo evidenciou a Efetividade com cargas fatoriais acima de 0,8 ($p<0,001$). Tempo de trabalho na área da saúde (CP=0,106; p=0,014) e avaliação do curso (CP=0,542; $p<0,001$) foram as variáveis associadas à Efetividade. A oferta educativa foi um recurso que efetivamente qualificou os profissionais de saúde egressos do curso de combate à pandemia da Covid-19.



**PALAVRAS-CHAVE:** Educação continuada. Covid-19. Educação a distância.

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