

# Biomedical informatics: characterization of the offer of massive open online courses

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## Abstract

### Introduction

Informatics applied to health sciences has brought cutting-edge solutions to healthcare problems. However, the number of health professionals trained in "Health Informatics" is low. Virtual education, such as massive online open courses, provide the opportunity for training in this field.

### Objective

To estimate the global offer of massive online open biomedical informatics courses and characterize their content.

### Methods

A search for massive online open courses was conducted throughout December 2021 on 25 platforms offering these courses. The search strategy included the terms "health informatics" and "biomedical informatics". The application areas of biomedical informatics, platform, institution, duration, time required per week, language, and subtitles available for each course were evaluated. Data were analyzed descriptively, reporting absolute and relative frequencies.

### Results

Our search strategy identified 1333 massive online open courses. Of these, only 79 were related to health informatics. Most of these courses (n = 44; 55.7%) were offered through Coursera. More than half (n = 55; 69.6%) were conducted by U.S. institutions in english (n = 76; 96.2%). Most courses focused on areas of translational bioinformatics (n = 27; 34.2%), followed by public health informatics (n = 23; 29.1%), and clinical research informatics (n = 13, 16.5%).

### Conclusions

We found a significant supply of massive online open courses on health informatics. These courses favor the training of more professionals worldwide, mostly addressing competencies to apply informatics in clinical practice, public health, and health research.

## MAIN MESSAGES

- ◆ Healthcare professionals require knowledge and skills in biomedical informatics.
- ◆ The results reported in this paper present an overview of massive online open courses in biomedical informatics.
- ◆ Massive online open medical informatics courses are offered on other platforms not included in this paper (considering blended learning, mobile learning, and virtual learning environment), which is a limitation.

## INTRODUCTION

The American Medical Informatics Association (AMIA) defines biomedical informatics as the interdisciplinary field that studies and promotes the effective use of biomedical data, information, and knowledge in scientific research to improve human health [1].

Massive volumes of health data are generated daily worldwide. Hence, healthcare professionals need informatics knowledge and skills to use and interpret data to prevent, detect, and monitor health problems, such as emerging diseases [2,3]. In addition, developing biomedical informatics skills and knowledge is described as useful for clinical research. This facilitates using electronic medical record data to identify potential research cohorts and eligible patients for clinical trials and data collection [4]. Despite its usefulness, there is a low number of professionals trained in biomedical informatics, as well as a low supply of training courses in this area during medical education and specialization; this is mainly seen in middle and low-income countries, where the infrastructure and political agendas discourage development and sustainability in this area [5,6]. Considering this, online courses provide valuable tools to meet this learning need in different areas [7–9].

Fast technological progress has allowed the development of new helpful learning tools through the internet in multiple areas, including those related to health. Massive Online Open Courses (MOOCs) are free online courses that allow many people to learn about different topics in an area [10]. The original idea of these courses is to offer world-class education (delivered by experts) to a (massive) number of participants around the globe who have access to the internet (online) at low or no (open) cost [11]. However, internet access, computer literacy, and language proficiency are essential for their use [12].

Massive online open courses are considered a disruptive innovation in education and a great learning opportunity for students and professionals worldwide [13]. Learning in biomedical informatics can be promoted through massive online courses, overcoming the inequalities in access to information that may be occurring in different regions of the world. With this, it is possible to meet the need for training professionals in this field. Therefore, the objective of this study was to estimate the global offer of massive online open courses in biomedical informatics and to know the characteristics of their content, as well as the

opportunities, barriers, and lessons offered in the platforms that currently exist for the continuing education of professionals.

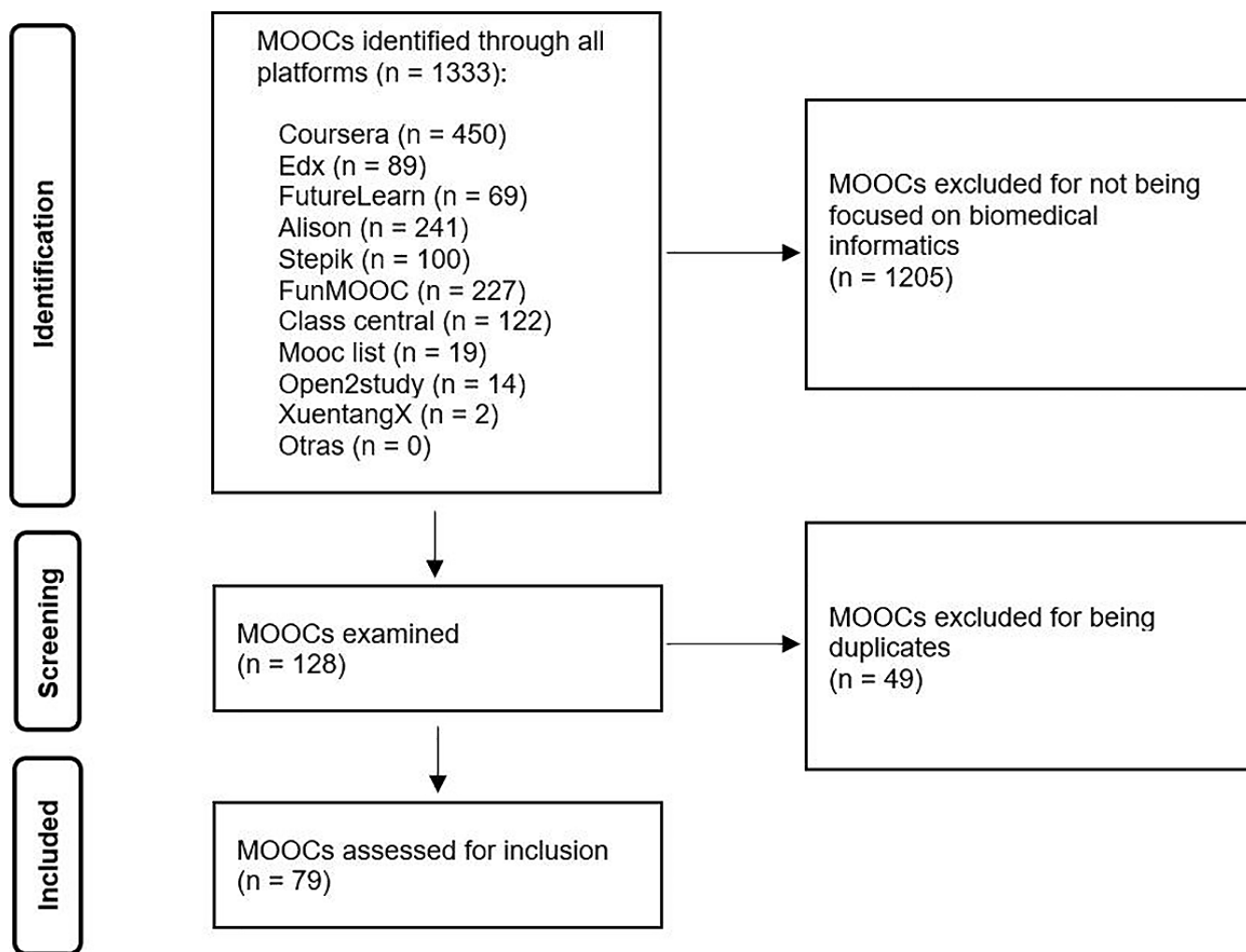
## METHODS

We searched for massive online courses on biomedical informatics between December 1st and 6th, 2021, in e-learning platforms that provide this type of training. This study corresponds to an update of the results previously presented in poster format at the first regional congress on Information and Communication Technologies (ICT) in health, held in Lima in September 2017. This congress was organized by the Information and Communication Technologies Committee of the Regional Council of Lima, a member institution of the Peruvian Medical Association [14]. At that time, the search performed until August 31, 2017, identified 60 online massive open courses on biomedical informatics. The area with the highest number of courses was translational bioinformatics, with 42 (70%), followed by clinical informatics, with 10 (16.67%). Most of the courses came from academic institutions in the United States (75%), were offered in English (95%), and up to 40% of the massive online open courses are part of a specialization (series of related courses oriented to the mastery of a specific topic).

Given that massive online open courses from different platforms are not systematically integrated into any database, an individual search was conducted in various platforms, including Coursera, edX, FutureLearn, Canvas Network, Miriadax, iversity, Blackboard Open Education, NovoEd, Udacity, Crypt4you, Alison, Stepik, FUN MOOC, openHPI, NPTEL, Independent, UPV[x], OpenWHO, Udey and XuentangX. Additionally, a search was conducted on two websites that compile courses from different massive online open course platforms (Class-Central and MOOC List). The use of the platforms of these courses to identify them has been used previously for other health-related topics [7,15–17], so this methodology was employed.

The terms "health informatics" and "biomedical informatics" were used to search for massive online open courses in each platform previously described. In the first stage, this search term was used in English because, to date, the largest number of courses and platforms for massive online open courses are

Figure 1. Chart summarizing the search and selection process for MOOCs in biomedical informatics.



MOOCs: massive online open courses.  
Source: Prepared by the authors based on the results of the study.

in that language [18]. Subsequently, a complementary search in spanish was performed, using the terms "informática de la salud" and "informática biomédica". The inclusion criteria for massive online open courses in this study were having a total or partial focus on health informatics, and being supported by an academic or scientific institution, regardless of language, year of publication, or whether the course was free or had a cost. In the english and spanish searches, variants of the terms described above were used to identify massive online open courses.

Each of the massive online open courses found on the platforms was screened independently by five authors (MLS, MAAH, RCR, BCC, and DFG). The pre-established inclusion criteria were followed to identify massive online open courses in health informatics. In case of discrepancies, the inclusion or non-inclusion of these courses was resolved by consensus of all authors (decision by simple majority after discussion). Once the massive online open courses on health informatics had

been identified, duplicates were identified and eliminated. After the elimination of duplicates, the following characteristics of each course were compiled in an Excel spreadsheet (Microsoft Corporation, United States): platform where the massive online open courses are offered, supporting institution, country of the institution, available language, presence of subtitles/transcription, subtitle/transcription languages, duration and estimated hours per week, main application area of health informatics as proposed by the American Medical Informatics Association (AMIA) [19], and whether the course is part of a specialization program. Finally, the data recorded for each online, massive and open course were exported to Stata v16.0 software (Stata Corporation, College Station, Texas, United States) for descriptive analysis, reporting absolute and relative frequencies.

## RESULTS

Of the 1333 courses found with the search strategy proposed in the different massive, online, and open course platforms, 128 were related to biomedical informatics. Of the latter, 49 were excluded for being duplicates. Thus, the characteristics of 79 courses were analyzed (Figure 1).

Regarding the massive online open courses included, the majority were on the Coursera platform ( $n = 44$ ; 55.7%), followed by Edx ( $n = 12$ ; 15.2%) and FutureLearn ( $n = 9$ ; 11.4%). North America, as the region of origin, accounted for more than half of the online, massive open courses found ( $n = 55$ ; 69.6%), followed by Europe ( $n = 16$ ; 20.3%). No courses on biomedical informatics of the sort were found in the Latin American region or Africa. Only five massive online open courses came from Oceania and three from Asia.

As related, 55 (69.6%) of the massive open online training programs were conducted by institutions in the United States, followed by Australia ( $n = 5$ ; 6.3%) and England ( $n = 5$ ; 6.3%). Regarding the institutions that developed the massive online open courses, Johns Hopkins University ( $n = 8$ ; 10.1%) and the University of California, San Diego ( $n = 8$ ; 10.1%) were the institutions that conducted the largest number of massive online open training in biomedical informatics (Table 1).

As for language, 76 (96.2%) of the courses were offered in english. Only three courses were found in a language other than english (two in russian and one in chinese). Regarding the option of transcription or subtitling of the courses, nine languages were available, with 30 (38.0%) online, massive and open courses subtitled in russian, 29 (36.7%) in french and 28 (35.4%) in spanish and portuguese (Table 2).

Regarding course duration, the median duration was five weeks (interquartile range: 4 to 12 weeks), and the median time required per week to complete the massive online open courses was three hours (2 to 4.5 hours). Regarding the access condition, it was found that 68 (86.1%) of the massive online open courses offered free access to the course resources. Regarding the area where the competencies taught on biomedical informatics could be mainly applied, most of them are focused on translational bioinformatics ( $n = 27$ ; 34.2%), followed by public health informatics ( $n = 23$ ; 29.1%) and clinical research informatics ( $n = 13$ ; 16.5%). Clinical informatics was the least offered ( $n = 4$ ; 5.1% for both courses).

## DISCUSSION

In general, massive online open courses in biomedical informatics are offered in english, and transcripts are available in other languages. This finding is consistent with what was described previously in the 2017 study. As part of the philosophy of massive online open courses is to bring knowledge to anyone who has access to the internet, the fact that most courses are heavily focused on english-speaking audiences limits this reach. Worldwide, part of the academic community does

**Table 1.** Characteristics of biomedical informatics MOOCs.

Characteristics	Frequency	Percentage
	(n = 79)	100%
<b>Platform</b>		
Coursera	44	55,7
Edx	12	15,2
FutureLearn	9	11,4
Open2study	6	7,6
Stepik	3	3,8
FunMOOC	3	3,8
NPETL	1	1,3
XuentangX	1	1,3
<b>Region</b>		
North America	55	69,6
Europe	16	20,3
Oceania	5	6,3
Asia	3	3,8
<b>Country</b>		
United States	55	69,6
Australia	5	6,3
England	5	6,3
Spain	3	3,8
France	3	3,8
Other <sup>a</sup>	8	10,2
<b>Institution</b>		
Johns Hopkins University	8	10,1
University of California, San Diego	8	10,1
University of Colorado	6	7,6
University of Minnesota	6	7,6
Georgia Institute of Technology	5	6,3
University of Tasmania	5	6,3
Wellcome Connecting Science	4	5,1
University of California, Davis	3	3,8
Others*	34	43

MOOCs: massive online open courses.

<sup>a</sup>Less than 3 MOOCs.

Source: Prepared by the authors based on the results of the study.

not know english and, at the same time, has poor or no quality local education about online, massive online open courses. Cultural and linguistic barriers affect the extensive use of these courses in different contexts, as they are mainly used by people with adequate access to educational offerings [7,20]. English proficiency is crucial in some countries as a tool to improve their economies, and some governments are promoting policies to improve it in their population [21,22]. However, the current scenario of a scarce number of human resources trained in biomedical informatics makes it necessary to improve the linguistic offer of these courses. In the case of the development of new massive online open courses oriented to developing countries, it is essential to consider the cultural context and the local language to reach a wider audience.

Massive online open courses on translational bioinformatics were the most frequent. This finding is also consistent with

**Table 2.** Content characteristics of biomedical informatics MOOCs.

Characteristics	Frequency (n = 79)	Percentage 100%
<b>Audio language</b>		
English	76	96,2
Russian	2	2,5
Chinese	1	1,3
<b>Transcription - subtitles</b>		
English	76	96,2
Russian	30	38
French	29	36,7
Spanish	28	35,4
Portuguese	28	35,4
Arabic	12	15,2
Others <sup>a</sup>	12	15,2
<b>Is part of a specialization program</b>		
No	49	62
Yes	30	38
<b>Duration<sup>b</sup></b>		
Duration of the course (weeks)	5	4 a 12
Estimated time per week (hours)	3	2 a 4,5
<b>Access</b>		
Open	68	86,1
Paid	11	13,9
<b>Certification fee</b>		
Yes	69	87,3
No	10	12,7
<b>Biomedical informatics domain</b>		
Translational bioinformatics	27	34,2
Public health informatics	23	29,1
Clinical research informatics	13	16,5
Consumer health informatics	12	15,2
Clinical informatics	4	5,1

MOOCs: massive online open courses.

<sup>a</sup>Less than 3 MOOCs.

<sup>b</sup>Expressed as median and interquartile range.

Source: Prepared by the authors based on the results of the study.

what was found in the review of massive online open courses in biomedical informatics conducted in 2017. This result could be explained by the growing interest in this interdisciplinary area of study due to the exponential increase in clinical and biological data, the development of genomic analysis, and other techniques such as big data and machine learning [18,23,24]. In other areas of health, such as disease control, an increased number of massive online open courses have been reported in the presence of disease outbreaks [25,26]. As a disruptive educational tool, this type of courses have a huge potential for growth in areas of current interest or technological advances. Likewise, the fact that a large part of them (38.0%) are part of specialization programs points to the individualization of the

demand for training in biomedical informatics identified by academic institutions that produce massive online open courses.

The average duration of these courses is nearly a month and a half, requiring approximately three hours per week to complete course assignments. One of the concerns about massive online open courses as a learning tool is the low completion rate, which is usually between 2 and 10% [27]. The user of massive online open courses must have a high level of digital literacy and be independent to complete these courses successfully [28]. Therefore, the development of tools that allow interaction (in real-time or not) of learners and the improvement of their technical skills in the use of technological devices increase the probability of course completion [29,30]. Thus, the use of massive online open courses on biomedical informatics as a learning tool should stipulate the number of hours that a student or professional requires for development and adjust the course content according to the available workload of the interested parties.

Massive online open courses would serve as a diverse source of training to provide knowledge in the field of biomedical informatics, also providing valuable tools for developing scientific research using information and communication technologies. However, massive online open courses have limitations like any learning model. Engaging a massive group of participants is essential to find a model to sustain these initiatives since many students do not complete these courses [31]. In addition to the high cost of carrying out one of these training programs, considering that they are free of charge, many universities do not bet on developing them because they do not see a return on investment. However, massive online open courses allow wide visibility and positioning for professors and institutions. Many students and educators recognize massive online open courses as an interesting learning experience. But they do not necessarily recognize them as quality courses, considering that a traditional course must be more structured than a massive open online course [15]. Likewise, it is important to promote the creation of more massive online open courses in low and middle-income countries such as Latin America, offering courses in local languages with an adequate structure and duration since they favor the development of professionals in these regions. Therefore, generating and offering massive online open courses in low-income regions should prioritize areas of interest for public health, such as biomedical informatics competencies.

Regarding the limitations of our findings, it is worth mentioning that there is an online educational offer on biomedical informatics different from the massive and open online courses, which include blended learning, mobile learning, and virtual learning environment, among others. For this study, only massive and open online courses were considered. In addition, some of the courses identified may be available unlimitedly, others are offered during certain periods of the year, and others are no longer available. Despite this limitation, the reported results present the landscape of massive online open courses in biomedical informatics.

## CONCLUSIONS

The purpose of this study was to characterize the supply of massive online open courses on biomedical informatics. After reviewing different platforms that offer this type of courses, we found about 80 courses with content on biomedical informatics. We found many massive and open online courses on biomedical informatics and its main application areas. The most significant number of massive online open courses were in translational bioinformatics and public health informatics. Most of these courses are offered in English. The United States is the country whose institutions have developed the largest number of massive online open courses in biomedical informatics. Massive online open courses aim to increase access to education through the internet and are very useful as educational tools for healthcare professionals.

There is a significant supply of massive online open courses in biomedical informatics, offered mainly by US institutions, predominantly in translational bioinformatics and public health informatics. Extending the language or subtitle offerings to languages other than English would facilitate and enhance the participation of people with language barriers in countries where training in the area is limited or non-existent.

## Notes

### Contributor roles

GBQ: conceptualization, methodology, formal analysis, writing (preparation of the original draft), writing (review and editing). MLS: formal analysis, writing (preparation of the original draft), writing (review and editing). MAAH: formal analysis, writing (preparation of the original draft), writing (review and editing). RCR: formal analysis, writing (preparation of the original draft), writing (proofreading and editing). DFG: formal analysis, writing (preparation of the original draft), writing (proofreading and editing). BCC: formal analysis, writing (preparation of the original draft), writing (proofreading and editing). DUP: formal analysis, writing (preparation of the original draft), writing (review and editing). AGBM: formal analysis, writing (preparation of the original draft), writing (review and editing).

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### Competing interests

The authors declare no conflict of interest.

### Funding

The study was self-funded.

### Ethics

The data source on massive online open courses (MOOCs) in biomedical informatics came from websites that make all

this information available to the general public. Therefore, obtaining prior approval from an institutional review board was not necessary to conduct this study.

### Origin and refereeing

Not commissioned. Externally peer-reviewed by two reviewers, double-blind.

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# Informática biomédica: caracterización de la oferta de cursos abiertos masivos en línea

## Resumen

### Introducción

La informática biomédica ha traído consigo soluciones innovadoras a problemas sanitarios. Sin embargo, el número de profesionales sanitarios capacitados en informática biomédica es bajo. La educación virtual, como los cursos masivos abiertos en línea, brindan la oportunidad de formación en este campo.

### Objetivo

Estimar la oferta global de cursos masivos abiertos en línea sobre informática biomédica y conocer las características de su contenido.

### Métodos

Se realizó una búsqueda de cursos masivos abiertos en línea durante diciembre de 2021 en 25 plataformas que ofertan estos cursos. La estrategia de búsqueda incluyó los descriptores “health informatics” y “biomedical informatics”. Se evaluaron las áreas de aplicación de informática biomédica, la plataforma, la institución, la duración, el tiempo requerido por semana, el idioma y los subtítulos disponibles para cada curso. Se analizaron los datos descriptivamente, reportándose frecuencias absolutas y relativas.

### Resultados

Nuestra estrategia de búsqueda identificó 1333 cursos masivos abiertos en línea. De ellos, solo 79 estaban relacionados con informática de la salud. La mayoría de estos cursos ( $n = 44$ ; 55,7%) se ofrecieron a través de Coursera. Más de la mitad ( $n = 55$ ; 69,6%) fueron realizados por instituciones de Estados Unidos y en el idioma inglés ( $n = 76$ ; 96,2%). La mayor parte de los cursos se centraron en áreas de bioinformática traslacional ( $n = 27$ ; 34,2%), seguido de informática de la salud pública ( $n = 23$ ; 29,1%), e informática de la investigación clínica ( $n = 13$ ; 16,5%).

### Conclusiones

Se encontró una importante oferta de cursos masivos abiertos en línea sobre informática biomédica. Estos cursos favorecen la formación de más profesionales en todas las regiones del mundo, abordando en su mayoría competencias para aplicar la informática en la práctica clínica, la salud pública y la investigación en salud.



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