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"Maker Culture for Teachers": a MOOC-Based Hybrid Course Project.

"Cultura Maker para Educadores": um Projeto de Curso Híbrido Baseado em MOOC.

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Abstract

The growth of maker culture in education and the grown of maker spaces in schools has provided a demand for teacher training. The objective in this research is describe the development the hybrid MOOC project for educators. The course has as goals to introduce the maker culture and highlight its potential in education, presenting the main tools and equipment, illustrating notions of operation, exemplify its applications in teaching and apply the acquired knowledge in the classroom. The development methodology of the course project was based on the ADDIE model. The result is a course that combines theory with practice in face-to-face and on-line moments, which can contribute to the training of teachers from various areas and to the field of research still recent in Brazil of hybrid MOOCs.

Keywords: Distance education. Hybrid MOOC. Maker movement. Teacher training.

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"Cultura Maker *para Educadores": um Projeto de Curso Híbrido Baseado em MOOC.*

Resumo

O crescimento da cultura maker *na educação e implementação de laboratórios maker em algumas escolas tem proporcionado uma demanda para formação continuada de professores. O objetivo desta pesquisa é descrever o desenvolvimento do projeto de um curso híbrido baseado em MOOC para educadores. O curso tem como metas introduzir a cultura* maker *e destacar suas potencialidades na educação, apresentar as principais ferramentas e equipamentos, ilustrar noções de funcionamento, exemplificar suas aplicações voltadas ao ensino e aplicar os conhecimentos adquiridos à prática em sala de aula. A metodologia de desenvolvimento do projeto do curso foi baseada no modelo ADDIE. O resultado é um curso que une teoria e prática em momentos presenciais e on-line, e que pode contribuir para a formação de professores de diversas áreas e para o campo de pesquisa ainda recente no Brasil dos MOOC híbridos.*

***Palavras-chave**: Educação a distância. MOOC híbrido. Cultura maker. Formação de professores.*

1. Introducton

The maker culture considers that everyone is capable of creating projects with their own hands, using creativity and available resources (whether analog or technological). This concept was built on movements such as Arts & Craft (1900), Hack (1960) and Do It Yourself (1990), which promote the appreciation of craftsmanship, technology and "do it yourself", respectively. In education, the maker culture manifests itself through "learning by doing", i.e. the development of pedagogical practices aimed at the integral development of the student, based on their protagonism when building, repairing and/or modifying objects.

The growth of the maker culture in education has led to a demand for continuing teacher training. In the state of Rio de Janeiro, there are several public and private initiatives to disseminate this area of interest, among which the following stand out: the construction of Experimental Technology Gyms[1] linked to the Rio de Janeiro City Hall; the "Maker Culture Project" (Seeduc RJ)[2], from which makerspaces were built in state schools in Rio de Janeiro; o Edital nº 35/2020 Setec/ MEC[3], which provided equipment for the implementation of 82 maker labs in the Federal Network of Professional, Scientific and Technological Education and philanthropic actions such as the Casa do Pai Institute Technology Center, located in the metropolitan region of Rio de Janeiro.

The locus of this research is a maker lab set up through the Setec/MEC call for proposals No. 35/2020. The lab (or LabMaker) has equipment such as: 3D printers, laser cutting machines, laptops, Arduino kits, Lego kits, 3D pens, virtual reality (VR) glasses, vinyl plotters, 3D scanners, among others.

1 The Technological Experimental Gymnasium is an institution with a hands-on education model, where students have contact with technology and knowledge in the Municipal Department of Education (SME-RJ) network. Available at: https://prefeitura.rio/educacao/prefeitura-inaugura-dois-novos-ginasios-experimentais-tecnologicos-em-santa-cruz/

2 The Maker Culture Project is a program run by the Rio de Janeiro State Department of Education. It involves a maker space learning environment and Maker Culture resources in all schools. Available at: https://www.facebook.com/1630562883890344/posts/3038672819746003/

3 Public Notice 035/2020 from the Ministry of Education's Department of Professional and Technological Education (Setec/MEC) aims to "support the creation of Maker Laboratories in the Federal Network of Professional, Scientific and Technological Education (Rede Federal de EPCT).

In order to deal with the challenges of learning in makerspaces, basic education teachers are expected to act as mediators of knowledge, being able to create learning environments that combine technological development and active methodologies in the classroom, using a variety of equipment. Rabello and Tavares (2017) point out that, traditionally, continuing teacher training takes place autonomously, with teachers searching for their own materials and organizing their own studies. In the distance education (DE) modality, there are training courses that address the theme of maker culture in education - most of them connected to federal institutes, such as Ifes (Federal Institute of Espírito Santo) - but the content presented usually only includes theoretical training, without the practical part, i.e. using equipment in laboratories.

For this reason, it is necessary to create a continuing education course that seeks to introduce the maker culture and highlight its potential in education, present its main tools and equipment, illustrate notions about how it works, exemplify its applications in teaching and apply the knowledge acquired to teaching practice. This research therefore aims to present and describe a proposal for a continuing education course for teachers on maker culture in education. It proposes a hybrid course model based on a MOOC (Massive Open On-line Course), entitled "Maker culture for educators".

Other authors have carried out related research. Costa, Lima and Santiago (2023) address the teaching of computational thinking as a preparation for programming subjects, in "Computer Technician" training, through a MOOC course applied in a hybrid way. The project points out the problem of low retention in MOOC courses and focuses on hybrid teaching as a solution. Among the instructional design (ID) tools adopted was the ADDIE model (analysis, design, development, implementation and evaluation).

Oliveira, Silva and Rodrigues (2022) report on a similar initiative also aimed at teaching introductory computational thinking. This course was divided into: face-to-face moments (workshops with tutors); on-line moments without tutoring in MOOCs and moments that integrate face-to-face and on-line (with the physical presence of students and tutors and the telepresence of the teacher). It is worth highlighting the original project: "MOOC course on accessible lovelace of computational thinking" (Oliveira et al., 2020), which emphasizes the potential of MOOCs for continuing education and their inclusive nature, since the course is aimed at the deaf community.

The course described by Andrade, Oliveira and Battestin (2023) has a similar structure and derives from the previous study, but is focused on the creation of applications and differs by using the terminology "bMOOC" or "hybrid MOOC", instead of "hybrid course based on MOOCs". According to the authors, "bMOOC, also known as hybrid MOOC [...], uses active methodologies, such as Project-Based Learning and Maker Culture, to promote the development of programming skills and competencies" (2023, p. 137-138). According to the authors, this proposal differs from others in that it promotes a directed internship (lasting up to three months) for the training and professional guidance of students who perform well.

Therefore, this research can contribute to teacher training with regard to maker culture, guide the proposal of other courses, as well as broaden the field of research into hybrid MOOCs. As far as methodological aspects are concerned, this study is characterized as exploratory and descriptive, since it looks for references in other studies of similar proposals and describes the planning stages of the course. The idealized training is characterized as a hybrid course based on MOOCs, and encompasses two possibilities for the course-taker: taking only the theoretical part (based on MOOCs) or combining theory and practice, obtaining an extended certificate. The methodology for creating the MOOC course was based on the ADDIE model (Gava; Nobre; Sondermann, 2014), while the practical activities are based on the flipped classroom model, in which students work with theoretical content on-line based on MOOCs and then carry out the practical activities in a maker environment. However, due to the limited number of pages in an article, the study only describes the design of the first two stages of the methodological model adopted, ADDIE: analysis and design.

2. Theoretical Foundations

Wasem (2021) highlights several thinkers who have contributed to the inclusion of the foundations of the maker movement in education, including Piaget's theories of constructivism and Papert's theory of constructionism (2008). According to Soster (2018, p. 37), Piaget's constructivism is a theory that "understands children's learning as an individual and active process of interaction between the external and internal worlds, based on their own interests". In this scenario, it occurs from the experience of producing something, with the educator taking on the role of mediator.

Based on these principles, the South African mathematician Seymour Papert - considered to be the father of the maker movement in education - developed the constructionist theory, which differs by valuing the cultural environment. Students build knowledge based on their interests, emphasizing the creation of real objects in the production of this knowledge and using technology as a resource (Medeiros, 2018; Silva, 2020; Paraol, 2018; Raabe et al., 2018). The student does and, through this experience, learns. The emphasis is not on the content covered, but on how students learn to learn.

The theory of constructionism (Papert, 2008) is increasingly present in education, due to the ease of acquisition and use of technological equipment such as computers, robotics kits and 3D printers. However, the structuring of these spaces must be accompanied by other policies, such as teacher training. Because of their reach and ease, MOOCs can be a training possibility, but the need for practice, which is inherent to maker culture, represents a challenge.

MOOCs are self-study courses, without tutoring, which take place on-line and can be offered to many students. They usually have no prerequisites for participation, selection processes or compulsory certification. Gonçalves (2017) describes the term MOOC as a type of distance education with the potential to "evolve" (or even revolutionize) learning, as it makes the learning process more dynamic and reduces obstacles such as distance and time, as well as allowing for an individualized learning pace.

A hybrid course based on MOOCs represents an alternative, already consolidated in the literature (Oliveira; Silva; Rodrigues, 2022), to make teaching more dynamic: it expands access to knowledge and manages to align theory with practice, which is so necessary in the maker culture. Hybrid teaching, on the other hand, is described as "[...] an integrated learning experience" (Christensen; Horn; Staker; 2013, p. 7) that transcends the combination of face-to-face and distance learning modalities. In this approach, digital technologies are seen as facilitators and enhancers of teaching. They are therefore integrated in such a way as to enrich the content taught in the classroom.

As a sub-model of hybrid teaching (Bacich; Tanzi Neto; Trevisani, 2015), the flipped classroom is a learning strategy in which the teacher uses hybrid methods: access to information is assimilated before the classroom - students study the content at home, for example, through videos, texts and other sources. In the case of this research, students will have contact with the theoretical part of the course through a MOOC. Face-to-face classes are used for practical "hands-on" activities, handling equipment and group discussions. The benefits of the inverted classroom include flexibility, as students can learn at their own pace and ask questions of the teacher during lessons.

Among the hybrid initiatives that integrate MOOCs with face-to-face activities (Delgado et al., 2015 apud Pérez-Sanagustín et al., 2016), the flipped classroom is one of the most popular. Finding study sources is seen as one of the biggest challenges in implementing this strategy, but a successful flipped classroom depends on planning class time: study time must be in line with the materials provided.

As the course's target audience is educators, we sought to adapt the MOOC's teaching materials to the modality, as in Araújo (2020), and to the generally busy routine of a teacher. Therefore, we drew theoretical inspiration from microlearning (or microlearning), which is characterized by a design that distributes content in small doses, i.e. the content of the class is worked on in a segmented way - in "small portions" - with a shorter duration than traditional classes, in order to facilitate learning (Machado, 2020; Honorato; Marcelino, 2020; Garcia; Costa, 2021; Cruz; Gomes; Azevedo Filho, 2022). According to Garcia and Costa (2021, p. 7), "the contents are distributed with a view to learning by key elements, the so-called micro-contents". This is an active and agile methodology, which aims for consistent learning that is both meaningful and enjoyable.

3. Methodology

The course is characterized as a hybrid course based on a MOOC, in which the student will have two certification options: the first referring to the theoretical part (carried out only via the MOOC) and the second referring to the complete course (theoretical and practical classes), which must be carried out at the LabMaker research location, by prior appointment. The choice to include the practical part was due to the need for "hands-on" experience of the maker culture and the handling of equipment. In addition, each teacher will have the flexibility to do the practical activities on days when they are available. The way these activities are carried out will be autonomous and inspired by the inverted classroom model (the teacher will have prior contact with materials and tutorials for the practical part), but with support (if necessary) from the laboratory team.

The course was structured using the ADDIE model (Gava; Nobre; Sondermann, 2014), which establishes five phases:

- analysis, in which the course project is created;
- designer, when building an activity map;
- development, in which the course media and activities are selected and/or built;
- implementation in the virtual room (Moodle) and checklist;
- evaluation by experts and students.

The documents that guided the preparation of the course project and the activity map were made available by the commission for the creation of MOOC courses at Ifes (Battestin; Santos, 2022). In their article, the authors named a specific extension of the ADDIE model for MOOCs, ADDIEM. However, we understand that a MOOC is already an on-line course and there were no significant differences between the models.

Due to its hybrid nature, the activity map (Figure 1) was adapted. A column was added to the original model to estimate the time taken for each activity. In addition, it was necessary to add a timeline column, in which the expected duration for each module was determined, taking into account the three-month period for the course and the total time for the complete course (theory and practice) of 60 hours.

ACTIVITY PLAN	
Course's name:	
Teacher:	
Date (Year/Semester) - Don't fill it!	
Course load :	
Program:	

No.	Titles	Descriptions and Objectives	Program content	Activity and resource	Time (min)	Grade	Status
1							Incomplete / In progress / Complete
2							
3							

Figure 1: Adjusted activity map
Source: adapted from Battestin and Santos (2022).

The proposed content is spread over eight modules. At the end of each module, there will be a quiz with objective questions and a "hands-on" challenge, which will be done in the laboratory and is aimed at practicing the content. The forum will be the tool used to share doubts and experiences of the practical activities. In the last module, students will have to draw up a lesson plan based on one of the tools studied, the final project. These projects will be made available in a database for teachers in subsequent editions of the course.

The virtual learning environment (VLE) chosen for the MOOC was Moodle (Modular Object-Oriented Dynamic Learning Environment), as it is open source and can be modified by the user. In addition, it has various computer tools that make it possible to make content available and carry out activities and interactions between users. Its interface is customizable and extensible, with free extensions capable of increasing the resources available.

The preparation of study materials takes into account the resources made available by the Moodle platform (Figure 2) and microlearning strategies, in order to take advantage of the popularization of mobile devices and the mentality that values agility and punctual content. The materials were based on scientific articles, videos, blogs, podcasts and other media. The texts were written objectively and the videos were fragmented. The Moodle platform itself provides responsive resources and adapts the visualization of the page and resources to different types of devices. Another aspect to be highlighted is the ephemeral nature of the content made available on the web, which led to the creation of a database on Google Drive [4], containing the original videos and images.

4 Google Drive is a cloud storage tool where files are stored remotely and can be accessed and shared from different devices. More information at: https://www.google.com/intl/pt-BR/drive/.

ICON	RESOURCE	DESCRIPTION
	File	Makes it possible to show a file (in different formats) directly in the course week or topic, to be viewed and/or downloaded by participants.
	Book	Displays the course contents divided into chapters and subchapters. It can contain texts, website/video links, images, and other multimedia elements.
	Page	It shows a webpage that may contain texts, website/video links, images and other multimedia elements.
	Folder	It shows a folder with various files for participants to view or download. It is mainly used to create the course library.
	Label	It allows inserting texts, images, and videos among the links of a week or topic; it can be used as a header or separator.
	URL	It provides a link to a webpage.

Figure 2: Resources available on the Moodle platform
Source: Lima (2021). https://www.nucleodoconhecimento.com.br/educacao/plataforma-moodle#google_vignette

The evaluation of the course, according to the ADDIE model, is characterized as a time to review and update the content. The first course evaluations are planned for before and after the pilot edition. However, minor corrections can be made during the course.

4. Results and discussion

The course is planned to last three months. The target audience will be laboratory fellows, teachers and staff from the institution where the research is taking place. There are a total of eight modules, the themes of which are described in the table below:

Chart 1: Content of the "Maker culture for educators" course

Thematic	Module	Objectives
Maker culture in education	Module I - Maker culture in education	Introducing the maker culture and highlighting its potential in education.
Makerspace: tools and equipment	Module II - Augmented and virtual reality	Introducing the main tools and equipment, illustrating notions of how they work and exemplifying their applications in teaching.
	Module III - Programming in Scratch	
	Module IV - Robotics with Lego	
	Module V - Arduino: robotics and automation	
	Module VI - 3D modeling and printing	
	Module VII - Laser Cutting Machine (CNC)	
Active methodologies	Module VIII - Active methodologies: creative learning and project-based learning	Apply the knowledge acquired to classroom practice.

Source: authors (2023).

The first module, themed "Maker culture in education", aims to introduce this culture (presenting the evolution of the Maker Movement, the manifesto developed from it, the four pillars of this thinking and maker spaces) and highlight its educational potential, conceptualizing Education 5.0 and exemplifying it through educational projects and the experience shared by teachers who took part in a classroom course on "Maker culture applied to education".[5]

Modules II to VII aim to present the "Maker Space" by introducing the main areas: Computational thinking and programming, Robotics and automation, 3D modeling and printing, and Virtual and augmented reality, with an emphasis on the most commonly used tools and equipment. Each module seeks to establish the first contact and arouse interest for further study. For this reason, the interfaces, basic commands and some educational projects using a particular tool are presented. It should also be noted that possibilities for developing educational maker activities without the existence of a specific laboratory will be highlighted, such as unplugged activities, cardboard automata, among others.

As an assessment activity, students will have to answer quizzes to fix the content and carry out practical activities. In each module, small projects will be developed based on the tool presented. The aim is for the teacher to be able to carry them out independently and for the experience to be shared with colleagues via the forum. The maker lab at the research institution will be available to carry out these projects by prior appointment. However, it is being considered that they can also be carried out in other laboratories or using their own resources, using video recordings and photos of the projects carried out.

The final module is designed to consolidate the knowledge acquired and direct its application in educational projects. To this end, active methodologies will be covered, with a focus on creative learning (Resnick, 2020) and project-based learning (Bender, 2015). The final practical activity "Maker project" is based on drawing up a lesson plan for the content explored. This module also has a bonus activity (not scored) that guides the planning of a maker fair.

5 The "Maker Culture Applied to Education" course was taught by professors from the institution where the research was carried out as part of the Faperj 45/2021 call for proposals to train local teachers. To this end, theoretical and practical lessons were given and the course participants developed Maker projects in their respective schools.

The course is currently in the development phase of the "Maker Space" module. Specialists in each area are developing and/or selecting tutorials, videos and other media and preparing the practical activities - it should be reiterated that they are designed so that the trainee can carry them out independently. Even so, during the practicals scheduled in the laboratory, there will be monitors available to help with their execution and answer questions.

The feasibility of a non-mandatory face-to-face meeting is also being studied, with the aim of sharing experiences between course participants. In future versions, a virtual meeting - in the style of a live stream - is envisioned, so that students in the theoretical mode can also share their information. The plan is for this meeting to be recorded and made available on social media such as YouTube and Instagram.

4. Final considerations

In the current scenario of LabMakers being introduced in various schools, a hybrid course based on a MOOC represents a promising alternative to the urgent demand for training basic education teachers, with the aim of not only using the maker culture, but also handling the different pieces of equipment in a laboratory set up for this purpose. It is worth noting that a MOOC course allows for a greater number of students, due to its flexibility, and has low creation and maintenance costs. The possibility of carrying out practical activities in a maker space allows for an organic presentation of the main tools and equipment and their applications in the field of education.

The proposal presented comprises the planning and design process of the "Maker culture for educators" course. In continuity with the sequence established by the ADDIE model, the following future research is suggested: the first, with an emphasis on the process of developing the course materials, reporting on the experience of developing dynamic and self-study materials, and the second, with a focus on evaluation, in which the experience with the teachers who took the course and the consequences of the course on teaching practice will be highlighted.

In future versions, the expectation is to create a hybrid MOOC course, with the support of programming tools, with a view to enhancements such as automation of corrections, accounting and automatic presence in the laboratory, as well as the creation of a "virtual tutor" based on artificial intelligence. We also see the interface with IT professionals as a limitation of this research, since a multidisciplinary team would help with both instructional design and process automation.

It is also hoped that the "Maker culture for educators" course will become a precursor to others of the same format aimed at more advanced practices in the laboratory, and that the model will be used even for other subjects and content relevant to secondary, technical and higher education.

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