

MOOC Affordances Model

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Abstract— Although there is a great interest on MOOCs, it is not clear what a MOOC should provide to learners enabling them to achieve their objectives. This paper proposes the MOOC Affordances Model (MOOC-AM) for characterizing a MOOC. The MOOC-AM consists of eight dimensions of affordances: 1) Massiveness, 2) Openness, 3) Interaction, Communication, Cooperation & Collaboration, 4) Personalization & Adaptation, 5) Autonomy, Choice & Control, 6) Support, Scaffolding, Help, Facilitation, Assistance, Feedback & Recommendations, 7) Mobility & Ubiquity, and 8) Accreditation, Certification & Assessment. In order to illustrate the application of the MOOC-AM, MOOCs on Programming in Python were examined regarding the affordances they provide. The findings reveal that none MOOC excels in all eight affordances. Learners, educators, designers, developers, and policy makers could consider this MOOC-AM to make appropriate decisions.

Keywords— Accreditation, Adaptation, Assessment, Autonomy, Certification, Collaboration, Control, Feedback, Mobility, Personalization, Python, Recommendations, Support.

I. INTRODUCTION

Massive Open Online courses (MOOCs) offer an opportunity to open education to all. The accelerated development of MOOCs manifested the learners' interest for this disruptive innovative educational method.

Initially, MOOCs have been developed in order to provide open and unrestricted access to education to massive number of learners via the web. Two MOOCs categories have emerged: i) xMOOCs that resemble a traditional course organization where the teacher has a central role, and ii) cMOOCs that emphasize the collaboration among the learners [1]. Usually, in xMOOCs, there are pre-recorded video lectures, slide presentations, e-textbooks assignments and automatic assessments. Correspondingly, in cMOOCs, the learners learn by communication and collaboration with their educators and other learners. Learners and educators co-create the course organization, the educational material and the assessments. They use blogs, social media, video-conferencing, e-communities to communicate and collaborate. In engineering education, hands-on laboratories and experimentations are also important [2-6].

In recent years, the number of offered MOOCs has been exploded from 3,562 (2016) to 5,924 (2017), at a growth rate of 66% [7, 8]. Currently, more than 550 MOOCs are offered in engineering. Among all offered MOOCs, about 6% of them are

in engineering and about 17% in computer science, data science and programming. As of September 2017, there were offered 547 MOOCs in engineering, 675 in computer science, 330 in data science, and 645 in programming, among other subjects. In October 2017, 2600 MOOCs are starting and 224 of them are new: 38 in engineering, 48 in computer science, 25 in data science and 54 in programming, among other subjects.

This massive acceptance by people is not without problems. It has been repeatedly mentioned the high drop-out rates, the low retention and completion rates, the high development costs (e.g. \$150,000-\$250,000), the questionable assessment methods, the learners' frustration and stress, as well as the teachers' overload.

In the early days, the MOOC's Massiveness and Openness were nonnegotiable. However, MOOCs are gradually losing the Massiveness and Openness affordances. Many MOOCs managers start restricting the number of enrollments or even participants (e.g. 150 participants; [1]). Also, many MOOCs managers are offering the certifications for a fee (e.g. \$50). In parallel, an ambiguity has been developed regarding the affordances of the offered MOOCs. A large variety of MOOC types has emerged. Many educators and researchers developed and gave various MOOC derivative names to their courses. For example, Lane distinguished Network MOOCs (similar to cMOOCs), Content MOOCs (similar to xMOOCs), and Task MOOCs (focused on problem-based learning) [9]. Clark categorized MOOCs as Transfer MOOCs, Made MOOCs, Synch MOOCs, Asynch MOOCs, Adaptive MOOCs, Group MOOCs, Connectivist MOOCs, and Mini MOOCs [10]. Others defined SPOC (Small Private Online Course; [11]), DOCC (Distributed Open Collaborative Course; [12]), POOC (Participatory Open Online Course; [13]), BOOC (Big Open Online Course; [14, 15]), MMOL(Massive Open Online Laboratory; [6]).

Currently, there is a lot of confusion as to what it really is a MOOC, and what it should offer to the learners [16-20]. Although various taxonomies have been proposed [10, 11, 17, 18], classifying a MOOC into one of the proposed categories does not exclude it from other categories. Sanchez-Gordon and Luján-Mora present various MOOC types [18]. A BOOC (Big Open Online Course) combines distributed learning and personalized feedback for a limited number of students (e.g. 500). In a COOC (Community Open Online Course), the community decides the content and develops its own way of

learning. A DOCC (Distributed Online Collaborative Course) assumes that expertise is distributed throughout all the participants, distributes the same core course materials to students but there is not a specific syllabus. A MOOR (Massive Open Online Research) puts an emphasis on research done by students under the guidance of experts around the world, while teaching assistants grade the assignments. A SMOC (Synchronous Massive Online Course) broadcasts live lectures and students are encouraged to ask questions and interact with instructors and classmates through interactive chat rooms. In a SPOC (Small Private Online Course), a limited number of online students are allowed along with regular enrolled on campus students. In a SPOC (Self-Paced Online Course), students can join the course at any moment, work independently and complete it at their own pace. A POOC (Personalized Open Online Course) establishes personalized learning path, assessment and feedback according to the learner's profile. Similarly, aMOOC (Adaptive MOOC) adapts the content and the feedback to the individual learning preferences. Conole [17] suggests a classification of MOOCs in terms of twelve dimensions: the degree of openness, the scale of participation (massification), the amount of use of multimedia, the amount of communication, the extent to which collaboration is included, the type of learner pathway (from learner-centred to teacher-centred and highly structured), the level of quality assurance, the extent to which reflection is encouraged, the level of assessment, how informal or formal it is, autonomy, and diversity.

In order to resolve these ambiguities, this paper proposes the MOOC Affordances Model (MOOC-AM). This MOOC-AM describes the affordances that a MOOC could efficiently provide to the participants. It aims at providing a common language and framework for categorizing a MOOC, and comparing it to other relevant MOOCs. It is a tool that helps people to evaluate the affordances offered by a MOOC. However, it is not an evaluation framework for evaluating the quality of a particular MOOC or even comparing the quality of several MOOCs with respect to various quality dimensions, such as usability, content quality etc. [e.g. 21, 22, 23]. It is rather a model for classifying a MOOC across a well-defined space of fundamental affordances that it provides to the participants.

II. BACKGROUND RESEARCH

Rather than presenting a fixed classification of MOOCs, this paper proposes a multi-level classification of MOOCs across eight affordances. A MOOC could provide (or not) each one of these affordances at a certain level (e.g. out of 10 levels). A MOOC should provide these affordances at the max levels in order to enable the participants to efficiently achieve their goals. These affordances are based on Connectivism, Self Determination Theory (SDT) of Motivation, and research results on MOOCs learners' requirements. Connectivism - the cMOOCs supporting theory - considers autonomy, connectedness, diversity, and openness as important elements of successful learning networks [24, 25]. According to SDT of Motivation [26], autonomy, competence, and relatedness must be satisfied in order to increase intrinsic motivation. Autonomy refers to the desire to self-initiate and self-regulate own behavior. Competence refers to the desire to feel effective

in attaining valued outcomes. Relatedness refers to the desire to feel connected to others. SDT has been successfully applied to e-learning [27] and mobile learning [28].

Although the Massiveness and Openness affordances should be standard and not negotiable in MOOCs, the reality shows that MOOC providers started to question their necessity.

Regarding cooperation and collaboration, a review study found that “the most significant factors that cause high attrition rate of MOOCs are ... lack of learners’ motivation, feelings of isolation and the lack of interactivity in MOOCs, ..., and finally hidden costs” [29]. Similarly, another study found that the number of dropouts decreases as cooperation level increases [30]. Finally, students in cMOOCs mainly prefer the most common social networks to collaborate, while students in cMOOCs become more autonomous in selecting tools and resources [31].

The design of a MOOC platform should support adaptive and personalized learning as well as autonomy, creativity, social interaction and collaboration [32]. Lack of access to teaching staff and difficulty of adaptation to individual student characteristics trouble the students [33]. Participants in an adaptive platform for MOOCs value most the adaptation to the pace of personal work and diversity in levels of difficulty offered to obtain different objectives [34, 35].

Regarding learners' support, scaffolding and feedback, a study found that “having no one to turn for support” was a reason for students to drop out MOOCs [36]. Also, the quality of assessing students' work was problematic. Correspondingly, fewer learners disengaged from the formal assessment in the course with highest degree of student autonomy, high learning support and scaffolds [37]. Personalized feedback (e.g. cognitive, affective and motivational) could support effective learning [38, 39, 40].

Recently, mobile and wearable devices have gained a great popularity. People are continuously using their smartphones for everything anywhere anytime. So, MOOCs should support and exploit the mobility, context-awareness, ubiquity and pervasiveness offered by these devices [41, 42]. Finally, a study found that perceived reputation and perceived openness were the strongest predictors for attending MOOCs [43].

III. THE MOOC AFFORDANCES MODEL

Based on the needs analyzed in the previous section, this paper proposes the MOOC Affordances Model (MOOC-AM) that consists of the following eight (8) affordances:

Massiveness affordance is defined as the largest number of the participants that could efficiently participate in the particular MOOC in order to achieve a specific educational goal.

Openness affordance is defined as the degree to which the particular MOOC could provide free access to, participation in, interaction, use, creation and sharing (distribution, delivery) of free information, knowledge, competences, skills, resources (e.g. hardware, software, networking, power), outcomes, artefacts, communications and collaborations with other people

without restrictions anywhere anytime in order to achieve a specific educational goal.

Interaction, Communication, Cooperation & Collaboration affordance is defined as the degree and quality to which a participant in the particular MOOC could efficiently, easily, authentically interact, communicate, cooperate, collaborate, relate, and play with any other participant (e.g. teachers, tutors, co-learners, avatars, virtual agents) via a variety of tools, modes (e.g. text, voice, video, haptic; synchronous: chat, phone, videoconferencing; asynchronous: email, sms, alerts, discussion boards; 1-1, 1-many, many-many: forums, shared workspaces, wikis, social media, communities, sharing multimedia, tagging, bookmarking) in order to achieve a specific educational goal.

Personalization & Adaptation affordance is defined as the degree and quality to which the components of a particular MOOC (i.e. its interface, appearance, learning path, schedule/timeline, educational content, feedback, activities, functionalities, tools, communications, collaborations, assessments, communities, resources, data, operations, fees and payment options) could be efficiently tailored (adapted) to a participant's personal characteristics (e.g. preferences, interests, abilities, competencies, gender, age, language, location, time, measurement units, currency, culture, etc.), as well as to her/his devices' characteristics (e.g. sensors, hardware, software, networking, power energy, security vs. privacy etc.) in order to achieve a specific educational goal.

Autonomy, Choice & Control affordance is defined as the degree and quality to which a participant in the particular MOOC could easily and efficiently control (e.g. manage, manipulate, regulate, select, act, alter, create, develop) its interface, appearance, learning path, schedule/ timeline, educational content, feedback, activities, functionalities, tools, communications, collaborations, assessments, other participants (e.g. ability to select teachers, tutors, co-learners), resources (e.g. software, hardware, networking, power energy), data, operations, security vs. privacy, fees and payment options during usage in order to achieve a specific educational goal. Note that this affordance includes the affordance to create, make, develop, construct and generate resources, artefacts, activities, experiences, assessments etc.

Support, Scaffolding, Help, Facilitation, Assistance, Feedback & Recommendations affordance is defined as the degree and quality to which a participant in the particular MOOC could receive effective, helpful, accurate, on-time educational support (e.g. from tutors, facilitators, peers, avatars), technical support (e.g. helpdesk, documentation, troubleshooting) and administrative support (e.g. certificates, financial issues) anywhere and anytime in order to achieve a specific educational goal. Note that this affordance includes psychological support (e.g. motivational feedback).

Mobility & Ubiquity (Seamlessness, Invisibility, Continuity, Non-Intrusiveness, Unobtrusiveness) affordance is defined as the degree and quality to which a participant in the particular MOOC could be able to easily and efficiently access and use it continuously, without any interruption or disturbance anytime and anywhere as s/he moves from one environment (i.e. location, time, people, objects, hardware, software,

networks) to another in order to achieve a specific educational goal. It also includes location-based and context-aware capabilities.

Accreditation, Certification & Assessment is defined as the degree and quality to which a participant in the particular MOOC could receive a valid and widely accepted Accreditation, a valuable, credible, and reputable Certification after passing Assessments that are of high quality, validity, reliability, diversity (e.g. Self-Assessment, Group Assessment, Peer Assessment; Location-based, Work-based, Game-based, Simulations, Multiple Choice Questions, Matching, Fill-in, Open-ended, Project-based; Various Difficulty Levels, Various Skills), relevant to the content, of appropriate duration and difficulty.

IV. MOOC-AM QUEESTIONNAIRE

In this section an appropriate Questionnaire was developed in order to determine the affordances offered by a particular MOOC. For simplicity, it uses a 4-level scale.

Massiveness

The largest *number of the participants* that could efficiently participate in the particular MOOC is: i) low (below 1000), ii) medium (1000 - 10 000), iii) high (more than 10 000)

The largest *number of the participants* that could efficiently participate in *synchronous videoconferencing* in the particular MOOC is: i) not available, ii) low, iii) medium, iv) high

The largest *number of the participants* that could efficiently participate in any educational activity (e.g. brainstorming, debate, lab experiment, project, game, field trip) in the particular MOOC is: i) not available, ii) low, iii) medium, iv) high

The largest *number of small groups* that could efficiently co-exist in the particular MOOC is: i) not available, ii) low, iii) medium, iv) high

Openness

The quantity and quality of *Open Information, Open Educational Resources (OERs) and Open Educational Practices (OEPs)* that the particular MOOC provides to a participant is: i) not available, ii) low, iii) medium, iv) high

The degree (incl. duration) of *Open Access* to information and resources that the particular MOOC could provide to a participant: i) not available, ii) low, iii) medium, iv) high

The degree (incl. duration) of *Open Use* of information and resources that the particular MOOC could provide to a participant: i) not available, ii) low, iii) medium, iv) high

The degree (incl. duration) of *Open Creation* of information and resources that the particular MOOC could provide to a participant: i) not available, ii) low, iii) medium, iv) high

The degree (incl. duration) of *Open Sharing* (distribution, delivery) information and resources that the particular MOOC

could provide to a participant is: i) not available, ii) low, iii) medium, iv) high

The degree (incl. duration) of *Open Interaction and Communication* of a participant with other participants (e.g. peers, teachers, tutors, avatars) that the particular MOOC could provide to a participant is: i) not available, ii) low, iii) medium, iv) high

Interaction, Communication, Cooperation & Collaboration (with whom, how many, when, how often, how long etc.)

The degree and quality to which a participant in the particular MOOC could efficiently and easily interact, communicate, cooperate and collaborate with other participants (e.g. peers, teachers, tutors, avatars) *via a variety of asynchronous tools* (e.g. email, sms, alerts, discussion boards, forums, shared workspaces, wikis, social media, sharing multimedia, tagging, bookmarking) is: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which a participant in the particular MOOC could efficiently and easily interact, communicate, cooperate and collaborate with other participants (e.g. peers, teachers, tutors, avatars) *via a variety of synchronous tools* (e.g. chat, phone, videoconferencing, instant messaging) is: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which a participant in the particular MOOC could efficiently and easily interact, communicate, cooperate and collaborate with other participants (e.g. peers, teachers, tutors, avatars) *via a variety of modes* (e.g. text, voice, video, haptic, virtual reality, augmented reality, immersion) is: i) not available, ii) low, iii) medium, iv) high

The degree (e.g. frequency, duration, responsiveness), quality and number of *teachers and tutors* with whom a participant in the particular MOOC could interact, communicate, cooperate and collaborate is: i) not available, ii) low, iii) medium, iv) high

The degree (e.g. frequency, duration, responsiveness), quality and number of *peers* with whom a participant in the particular MOOC could interact, communicate, cooperate and collaborate is: i) not available, ii) low, iii) medium, iv) high

The degree (e.g. frequency, duration, responsiveness), quality and number of *staff* (e.g. psychologists, counselors, technicians, administrators, secretaries) with whom a participant in the particular MOOC could interact, communicate, cooperate and collaborate is:

The degree and quality to which the particular MOOC could provide *tools for efficiently matching participants, group formation, group management and other collaborative activities* (e.g. brainstorming, discussions, negotiations, debates, interviews, role-playing, games) is: i) not available, ii) low, iii) medium, iv) high

Personalization & Adaptation

The degree (e.g. how many characteristics, which characteristics) and quality (i.e. correctness) to which a *participant's personal characteristics as well as to her/his devices' characteristics are measured* (e.g. using questionnaires, log files, sensors, learning analytics): i) not available, ii) low, iii) medium, iv) high

The degree (e.g. how many components, which components, how many characteristics, which characteristics) and quality (i.e. effectiveness, correctness, on-time) to which the *components of the particular MOOC could be efficiently tailored (adapted) to a participant's personal characteristics as well as to her/his devices' characteristics* is: i) not available, ii) low, iii) medium, iv) high

For example, some components of the MOOC (e.g. appearance, multimedia, learning path, schedule, timeline, educational content, resources, activities, Feedback, recommendations, communications, collaborations, assessments) could be tailored (adapted) to some characteristics of a participant (e.g. language, preferences, interests, location, abilities, competencies, expertise, hardware, software, network, energy-power, security-privacy).

Autonomy, Choice & Control

The degree and quality (e.g. effectiveness, accuracy) to which a participant in the particular MOOC could easily and efficiently *control*:

- a) *the components of the particular MOOC* is: i) not available, ii) low, iii) medium, iv) high,
- b) *the selection of other participants* (e.g. peers, teachers, tutors, avatars) for communication and collaboration is: i) not available, ii) low, iii) medium, iv) high,
- c) *the creation and sharing of educational resources and outcomes* is: i) not available, ii) low, iii) medium, iv) high,

The degree and quality to which a participant in the particular MOOC could easily and efficiently control, select, decide on:

- how it will look (e.g. appearance, presentation, aesthetics) is: i) not available, ii) low, iii) medium, iv) high,
- what personal information (privacy) to disclose is: i) not available, ii) low, iii) medium, iv) high,
- how to navigate through the course content is: i) not available, ii) low, iii) medium, iv) high,
- which order to study the course modules, to perform the activities, or to answer the assessment questions is: i) not available, ii) low, iii) medium, iv) high,
- what resource to explore or activity to perform is: i) not available, ii) low, iii) medium, iv) high,

- how much time and effort to allocate to each module, activity, or assessment question, is: i) not available, ii) low, iii) medium, iv) high,
- when to study, perform the assignments, the interactions, communications, collaborations, the activities, the assessments is: i) not available, ii) low, iii) medium, iv) high,
- what location to study or perform an activity is: i) not available, ii) low, iii) medium, iv) high,
- whom to interact, communicate, or collaborate is: i) not available, ii) low, iii) medium, iv) high,
- whom to be advised or be consulted is: i) not available, ii) low, iii) medium, iv) high,
- which group, conversation, or activity to join is: i) not available, ii) low, iii) medium, iv) high,

Support, Scaffolding, Help, Facilitation, Assistance, Feedback & Recommendations

The degree (e.g. quantity, frequency, duration, variety, multi-level) and quality (e.g. effective, helpful, accurate, on-time) to which a participant in the particular MOOC could receive:

- a) *educational support* (e.g. from tutors, facilitators, peers, avatars) is: i) not available, ii) low, iii) medium, iv) high,
- b) *psychological support* (e.g. encouragement, motivational feedback) is: i) not available, ii) low, iii) medium, iv) high,
- c) *technical support* (e.g. helpdesk, documentation, troubleshooting) is: i) not available, ii) low, iii) medium, iv) high,
- d) *administrative support* (e.g. certificates, financial issues) is: i) not available, ii) low, iii) medium, iv) high,

The degree and quality of the *Visualizations* that the particular MOOC could provide to a participant is: i) not available, ii) low, iii) medium, iv) high,

Mobility & Ubiquity (Seamlessness, Invisibility, Continuity, Non-Intrusiveness, Unobtrusiveness)

The degree and quality to which a participant in the particular MOOC could easily and efficiently access it, use it, interact with it, communicate and collaborate with others *via various devices and networks*: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which a participant in the particular MOOC would be able to easily and efficiently access it, use it, interact with it, communicate and collaborate with others *continuously*, without any interruption or disturbance *anytime* is: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which a participant in the particular MOOC would be able to easily and efficiently access it, use it, interact with it, communicate and collaborate with others *continuously*, without any interruption or disturbance *anywhere* is: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which a participant in the particular MOOC would be able to easily and efficiently access it, use it, interact with it, communicate and collaborate with others while *unobtrusively switching from one environment (i.e. device, network etc.) to another environment* is: i) not available, ii) low, iii) medium, iv) high

The degree and quality to which the particular MOOC could efficiently *interact, communicate and collaborate with various other systems* is: i) not available, ii) low, iii) medium, iv) high

Accreditation, Certification & Assessment

The degree to which the particular MOOC could provide *secured Assessments* is: i) not available, ii) low, iii) medium, iv) high

The degree to which the particular MOOC could provide *accurate, valid, reliable and fair Assessments* is: i) not available, ii) low, iii) medium, iv) high

The degree to which the particular MOOC could provide *authentic, relevant and appropriate Assessments* is: i) not available, ii) low, iii) medium, iv) high

The *diversity of the Assessments types* in the particular MOOC is: i) not available, ii) low, iii) medium, iv) high

The degree to which the particular MOOC could provide *valuable, credible, reputable and wide accepted Certifications and Accreditations* is: i) not available, ii) low, iii) medium, iv) high

V. MOOCs ON PROGRAMMING IN PYTHON

The proposed MOOC-AM has been applied to evaluate the affordances provided by a sample of MOOCs on Programming in Python. More concretely, the following list of aggregators and search engines (Table 1) has been used in order to identify MOOC providers which offered related MOOCs.

Table 1. MOOC Aggregators/search engines

| MOOC Aggregators/search engines | LINKS |
|---------------------------------|---|
| 1. MOOClist | https://www.mooc-list.com/initiative/opencourseworld?static=true |
| 2. Class central | https://www.class-central.com/ |
| 3. Coursade.com | http://coursade.com/ |

| | |
|----------------------|---|
| 4. My education path | http://myeducationpath.com/courses |
| 5. MOOCSE | http://moocse.com/ |
| 6. OpenupEd | http://www.openuped.eu/ |
| 7. EMMA | http://platform.europeanmoocs.eu/ |
| 8. Oeru | http://oeru.org/how-it-works/ |

Research findings have shown that over 10 MOOC providers (Table 2.) have offered courses of different levels on Programming in Python and mostly in English language. There were few exceptions like the French provider *FUN* and the Greek *Mathesis* that both offer courses in their own language and the case of *Coursera* which offers courses in 4 languages (English, Chinese, Spanish Russian) and *Udemy* in 16 languages including less spoken languages such as Turkish and Polish.

Table 2. Programming in Python MOOC providers

| MOOC PROVIDER/LINK | N. PYTHON COURSES |
|--|-------------------|
| 1.UDEMY (USA) https://www.udemy.com | 100+ |
| 2.COURSERA (USA) https://www.coursera.org/ | 34 |
| 3. EDX (USA) https://www.edx.org/ | 16 |
| 4. ELIADEM (FI) https://eliademy.com/ | 16 |
| 5.UDACITY(USA) https://www.udacity.com/ | 13 |
| 6.ALISON (USA) https://alison.com/courses | 7 |
| 7. FUTURELEARN (UK) https://www.futurelearn.com | 5 |
| .8. CANVAS (USA) https://learn.canvas.net/ | 2 |
| 9. FUN (FR) https://www.fun-mooc.fr/ | 2 |
| 10. COURSESITES (USA) https://www.coursesites.com/ | 1 |
| 11. OPENCLASSROOMS (FR) https://openclassrooms.com/ | 1 |
| 12. KHAN ACADEMY (USA) https://www.khanacademy.org | 1 |

| | |
|---|---|
| 13. MATHESIS (GR) https://mathesis.cup.gr | 1 |
| 14. Open Initiative Learning (OLI) (USA) http://oli.cmu.edu/ | 1 |

The next step of our research was to choose 10 characteristic MOOCs focusing on Programming in Python (level I, II) and to evaluate the affordances that they provide according to the MOOC-AM using the following scale: High, Medium, Low and None. The selection was made randomly. In order to collect the data, we have also created a form called “Individual MOOC EVALUATION FORM based on MOOC-AM”. Such an example is the following evaluation form of the MOOC “Python Programming for Everybody”¹ offered by the MOOC provider *Canvas* (Fig.1.).

| Individual MOOC EVALUATION FORM based on MOOC-AM | | | | |
|---|--|--------|-----|------|
| MOOC Title-Provider/Platform | Python Programming for Everybody by CANVAS | | | |
| DIMENSION | LEVEL OF AFFORDANCES | | | |
| | HIGH | MEDIUM | LOW | NONE |
| 1. Massiveness | X | | | |
| 2. Openness | | | X | |
| 3. Interaction, Communication, Cooperation & Collaboration | | | X | |
| 4. Personalization & Adaptation | | | | X |
| 5. Control - Autonomy | | | X | |
| 6. Support, Scaffolding, Help, Assistance, Feedback and Recommendations | X | | | |
| 7. Mobility & Ubiquity (Seamlessness, Invisibility, Continuity, Non-Intrusiveness, Unobtrusiveness) | | | X | |
| 8. Certification & Assessment | X | | | |

Fig.1 Individual MOOC EVALUATION FORM based on MOOC-AM

More concretely, we have tried to check the level of affordances of the following 10 MOOCs based on the model MOOC-AM:

- 1) “Introduction to Python: Fundamentals”² offered by the MOOC provider *Edx* and supported by the *Microsoft*.
- 2) “Introduction to Programming with Python”³ supported by the MOOC provider *Alison* and supported by the *Khan Academy*.
- 3) “Introduction to Python Programming”⁴ offered by the MOOC provider *Udemy*.

¹ <https://www.canvas.net/browse/canvasnet/courses/python-for-everybody>

² <https://www.edx.org/course/introduction-python-fundamentals-microsoft-dev274x-0>

³ <https://alison.com/course/introduction-to-programming-with-python>

- 4) "Programming Foundations with Python"⁵ offered by the MOOC provider *Udacity*.
- 5) "Object-oriented Programming in Python: Create Your Own Adventure Game"⁶ offered by the MOOC provider *Futurelearn* and supported by the *Raspberry Pi Foundation*.
- 6) "Learn to program: The fundamentals"⁷ offered by the MOOC provider *Coursera* and supported by the University of Toronto.
- 7) "Python Programming for Everybody"⁸ offered by the MOOC provider *Canvas* and supported by MIT.
- 8) "Introduction to Python"⁹ offered in Greek by the MOOC provider the *Mathesis (based on openEdX)* which is supported by the *University of Crete*.
- 9) "Learn to programme in Python"¹⁰ offered in French by the MOOC provider *Openclassrooms* and supported by *INTECH*.
- 10) "Introduction to Computer Science and Programming"¹¹ offered by the Finnish MOOC provider *Eliademy* and based on MIT OpenCourseWare OER.

The main idea was not to evaluate all these MOOCs in order to find the one which offers more affordances but to map the variety of the affordances offered by MOOCs of representative MOOC providers. For that reason, we have collected all the data using a collective evaluation form called "Overall MOOC EVALUATION FORM based on MOOC-AM" (Fig.2) in which the names of the MOOCs have been replaced by letters (A- J) to anonymize them.

The overall research findings reveal that none of the evaluated MOOCs succeed in providing all proposed affordances. Most of the MOOCs provide some of these affordances to a certain level.

| OVERALL MOOCs EVALUATION FORM based on MOOC-AM | | | | | | | | |
|--|----------------|-------------|--|---------------------------------|---------------------|--|---|-------------------------------|
| MOOC | 1. Massiveness | 2. Openness | 3. Interaction, Communication, Cooperation & Collaboration | 4. Personalization & Adaptation | 5. Control-Autonomy | 6. Support, Scaffolding Help, Assistance, Feedback and Recommendations | 7. Mobility & Ubiquity (Seamlessness, Invisibility, Continuity, Non-intrusiveness, Unobtrusiveness) | 8. Certification & Assessment |
| A | 2 | 2 | 1 | 0 | 1 | 1 | 2 | 0 |
| B | 2 | 2 | 1 | 0 | 1 | 1 | 2 | 2 |
| C | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 |
| D | 3 | 2 | 2 | 2 | 2 | 2 | 2 | N |
| E | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 |
| F | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 3 |
| G | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| H | 3 | 2 | 3 | 1 | 2 | 1 | 2 | 1 |
| I | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| J | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |

Fig.2 Overall MOOCs EVALUATION FORM based on MOOC-AM

1. *Massiveness*: Findings have shown that most of the evaluated MOOCs offer the possibility of learning to a huge number of participants. A characteristic example is the case of the MOOC "Introduction to Python Programming" offered by the MOOC provider Udemy in which 87,068 learners have participated. In case of low participation in the evaluated MOOCs we considered this factor as negative.

2. *Openness*: Findings have shown that most of the examined MOOCs offered Openness but with few limitations. Even though in most cases there was a possibility of free access to the content, learners had to pay for the course in order to have access to the course after its completion (i.e. Coursera) or in case they wanted a certification (i.e. Edx, Mathesis, Futurelearn). Another finding that deserves to be highlighted is that only very few MOOCs (i.e those provided by Eliademy or Openclassrooms) offered openly licensed content (i.e. Creative Commons licenses) but we didn't find any MOOC in which learners could co-create and share their content openly and licensed.

3. *Interaction, Communication, Cooperation and Collaboration*: Findings have shown that only few MOOCs offer tools, methodology and activities that could enhance collaboration, interaction, cooperation in a successful way (1.e. "Introduction to Python: Fundamentals" offered by the MOOC provider Edx and supported by the Microsoft). In most MOOCs learners could collaborate or just discuss in forums or in discussion areas.

4. *Personalization & Adaptation*: Findings have revealed that this affordance scores low in most of the evaluated MOOCs. Only in few cases (i.e. MOOCs provided by Edx, Alison, Udacity) learners had the possibility to find few course features which could be adapted to their preferences.

⁴ <https://www.udemy.com/pythonforbeginnersintro/>

⁵ https://www.udacity.com/course/programming-foundations-with-python--ud036?utm_medium=referral&utm_campaign=api

⁶ <https://www.futurelearn.com/courses/object-oriented-principles>

⁷ https://www.coursera.org/learn/learn-to-program?utm_campaign=gotocourse&utm_medium=coursepage&utm_source=CourseTalk

⁸ <https://www.canvas.net/browse/canvasnet/courses/python-for-everybody>

⁹ https://mathesis.cup.gr/courses/course-v1:ComputerScience+CS1.1+2017_T4/about

¹⁰ <https://openclassrooms.com/courses/apprenez-a-programmer-en-python>

¹¹ <https://eliademy.com/app/a/courses/baaa33ad00>

5. Learner Autonomy, Choice and Control: Findings have shown that the examined MOOCs don't facilitate the learning process of the participants in the most efficient way. In few cases (i.e MOOCs provided by Canvas, Udemy, Udacity, Edx) they give control of the learning path to the learners via a personal dashboard which informs them about their modules, progress, assignments, grades, pinned discussions, topics of interest, badges, peers messages etc.

6. Support, Scaffolding, Help, Facilitation, Assistance, Feedback, and Recommendations: Findings have shown that there is a limited support and feedback offered by tutors and/or peers and in many cases the learners' support is mainly automated.

7. Mobility & Ubiquity: Findings have revealed that 90% of the examined MOOCs offered efficient mobile access in a medium level.

8. Accreditation, Certification & Assessment: Findings have revealed that in most cases learners can receive a valuable certificate of high reputation and credibility if they pay a fee that varies depending on the MOOC and/or the provider (i.e. Udemy, Alison, Edx). The assessment is mostly automated (quizzes, final tests) and rarely there is peer assessment of projects or other activities (i.e. "Introduction to Python Programming" offered by the MOOC provider Udemy).

Synopsizing, the findings revealed that none of the MOOCs provided the highest level for each one of the proposed affordances. Personalization & Adaptation was the least provided affordance. In order to illustrate how two of the examined MOOCs satisfy the proposed MOOC-AM, their provided affordances were plotted on the following Fig. 3.

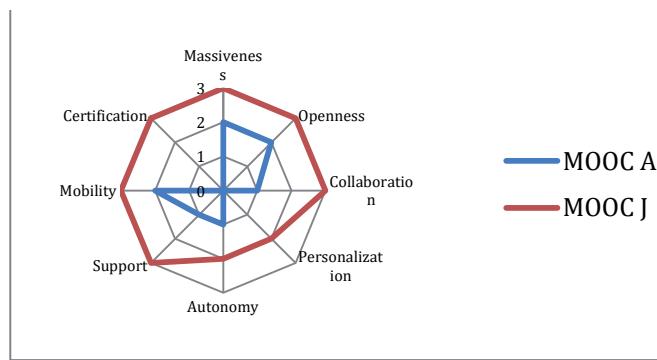


Fig. 3. Affordances provided by two MOOCs on Programming in Python.

VI. CONCLUSIONS AND FUTURE RESEARCH

This paper proposes the MOOC Affordance Model (MOOC-AM) to characterize a MOOC by the affordances that it provides to its participants. These affordances are spread across the following dimensions: 1) Massiveness, 2) Openness, 3) Interaction, Communication, Cooperation & Collaboration, 4) Personalization & Adaptation, 5) Autonomy, Choice & Control, 6) Support, Scaffolding, Help, Facilitation, Assistance, Feedback & Recommendations, 7) Mobility & Ubiquity, and 8)

Accreditation, Certification & Assessment. Learners could consider this MOOC-AM in order to evaluate the affordances of a candidate MOOC before they enroll in it. MOOC educators could consider this model in order to determine the status of their MOOC, to compare it to other relevant MOOCs, to determine what improvements are necessary and to make these improvements. Researchers could consider this model in order to monitor the MOOCs evolution, to record the status of MOOCs in a certain subject or compare MOOCs across different subjects. Designers and developers of MOOCs could consider this model as a guide for advancing their MOOCs or constructing new MOOCs. Educational organizations could consider this model to record the status of their offered MOOCs and analyze the competition. Educational policy makers could consider this model to plan and prescribe the desired MOOCs affordances. Finally, the model can be used as a standardized tool for benchmarking the affordances offered by a MOOC as well its comparison to other relevant MOOCs.

Since the affordances provided by a MOOC depend heavily on the MOOC platform, future research will analyze the affordances offered by the main platforms. However, even if a platform offers many affordances, a MOOC owner, designer or teacher may decide to not exploit all of these affordances. Further research will also analyze various MOOCs across other subjects and disciplines.

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