Towards Defining a Place and Role of Community Engaged Robotics MOOCs in a South African Higher Education ODeL Context from a Curriculum Responsiveness Perspective

P.M. Gouws
https://orcid.org/0000-0001-9820-8544

H.H. Lotriet
https://orcid.org/0000-0002-0353-5073

M.G. Kanakana-Katumba
https://orcid.org/0000-0001-7475-2131

D. Chetty
https://orcid.org/0000-0002-4749-8788

Abstract

This study identifies and discusses the place and role of Robotics as a subset of Science, Technology, Engineering and Mathematics (STEM) Massive Open Online Courses (MOOCs) as part of community engagement in a South African Open Distance e-Learning (ODeL) institution of Higher Education. The study adopted a dual approach. Firstly, a systematic review was undertaken of existing scholarly literature on Robotics MOOCs. The survey yielded limited results and mainly highlighted potential for future research. Secondly a curriculum responsiveness lens was applied in order to understand the implications of context on determining the role and positioning of Robotics MOOCs. Contextual factors at macro level include economic requirements, sustainability, Africanisation and technology (robotics) as a potential econo-

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mic disruptor. At meso (institutional) level considerations include ODeL practices, Open Education, language, engaged tuition and learning. At micro (individual) level context includes diversity and student needs. From a knowledge perspective consideration needs to be given to the rapidly developing knowledge around robotics and the implications for Robotics MOOCs. The paper concludes with a specific example of how the University of South Africa (the largest ODeL institution in Africa) is implementing Robotics MOOCs by means of a curriculum responsiveness approach.

Keywords: Robotics education, ODeL, Science Engagement, Curriculum Responsiveness, South Africa

1 Introduction

Robotics is a major disruptor within the context of the Fourth Industrial Revolution (4IR) (Schwab 2017). Robotics education has long been an effective entry point for tuition-related activities in Science, Technology, Engineering, and Mathematics (STEM) (Johnson 2003: 16) and thus has significant potential to interest learners in career paths in computing related areas (Beyers & van der Merwe 2017:1) and to provide learners with the skills required to benefit from the economic advantages associated with 4IR. It has also been argued that robotics education can benefit youth development in lower socio-economic areas and contribute towards female engagement with STEM subjects (Asinobi *et al.* 2015:6).

However, competent digitally skilled robotics coaches (educators, mentors and community leaders) are essential for the achievement of this ideal (Alimisis 2019:279). As members of a community of coaches, robotics coaches require access to robotics training to be equipped, mentored, and empowered in robotics (Shannon 2015:179). The confident and competent core of robotics coaches, in turn, will train and educate the learners in robotics. The robotics coaches require access to other like-minded coaches, access to robotics resources to address the challenges of time and distance constraints to attend robotics training, and, in recent times access to the resources to address the additional challenge of the COVID-19 constraints.

Massive Open Online Courses (MOOCs) hold the potential to be used as a robotics training tool. MOOCs offer an opportunity for higher education institutions to provide open digital learning opportunities for large numbers of learners where financial constraints exist (Yuan & Powell 2013:4). Furthermore, it offers the potential for novel education opportunities for those on the disadvantaged side of the digital divide (Bonk *et al.* 2015: xxix) and for transformative development in developing countries (Bonk *et al.* 2015: xxx). Although surrounded by some controversy, MOOCs can nevertheless be seen as a new development within the context of the bigger Open Distance e-Learning (ODeL) landscape (Deimann *et al.* 2015:67). Nevertheless, the relationship between MOOCs and traditional ODeL is problematic and needs both more research to be clarified and more experimentation with MOOCs within the context of ODeL institutions (Deimann *et al.* 2015:70). Closely associated with this is the need to understand the implications of MOOCs within specific contexts (Bonk *et al.* 2015:xxx), which for this paper is ODeL in South African higher education.

The education crisis resulting from the COVID-19 pandemic in 2020 accelerated the movement towards online offerings by universities in South Africa. Also, at the University of South Africa (UNISA), which is the largest Open Distance e-Learning (ODeL) institution in Africa (Letseka *et al.* 2018: 122), the choice under these circumstances was to take the community engaged robotics training project online in the form of Robotics Massive Open Online Courses (MOOCs) that are hosted as part of the university's open learning offerings.

This study aims to provide an improved understanding of the role and place of STEM MOOCs, specifically for robotics, in an ODeL environment in a developmental context. This paper therefore reflects on the fundamental considerations related to the positioning and role of Robotics MOOCs that are offered in a community engaged context by an ODeL institution. The paper adopts a two-pronged approach. A systematic review on Robotics MOOCs in the context of STEM MOOCs was conducted to identify relevant insights that may be provided by the existing scholarly literature around various aspects of robotics MOOC delivery. In order to understand the impact of the context of our robotics MOOCs we went one step further and adopted a curriculum responsiveness (CR) lens to understand the contextual dimensions that may shape the role and place of robotics MOOCs in a community engaged higher education ODeL context. Curriculum responsiveness is discussed in more detail in a further section in this paper, but essentially it can be understood as a uniquely South African higher education response 'in relation to the need to ensure that the African experience is at the core of the curricula' (Dowling & Seepe 2003:52). The concept implies transformation that relates to socio-economic development and addresses specific elements such as poverty (and economic development), rural development, African cultural heritage (include-ing the issue of language) (Dowling & Seepe 2003:48 – 49). Unfortunately, existing literature on Robotics MOOCs is limited, as may be seen in section where we present the findings of the systematic review. The outcomes of the review in fact mostly indicate gaps and opportunities for further Africa-based research into robotics MOOCs. Applying a curriculum responsiveness lens however led to various insights into requirements emanating from the South African context that could be collated. Based on these insights, we thus present a framework for a context-sensitive implementation of robotics MOOCs in a South African ODeL environment and present the Robotics MOOCs project at UNISA as an example of such an implementation.

The main research question in this paper is:

- What is the potential place for Robotics MOOCs in support of STEM engagement within a South African ODeL institution to increase community outreach and engagement impact?

To address this question, two sub-questions are posed:

- How does scholarly literature on Robotics MOOCs inform defining the place for Robotics MOOCs in support of stem engagement within an ODeL institution?

- How does context inform defining the place for Robotics MOOCs in support of stem engagement within an ODeL institution?

This paper is structured as follows: The context of the community engaged project which led to the creation of the robotics MOOCs that are the focus of this paper is presented. This is followed by a literature review of the key concepts related to this paper and a description of the research methodology for the systematic review. The results of the systematic review of robotics MOOCs in scholarly literature is presented. Curriculum responsiveness as a lens is introduced and discussed. The implications of adopting a curriculum responsive approach for community engaged robotics MOOCs at a South African ODeL institution (where offerings are predominantly online - such as

UNISA) are discussed and the specifics of how it was implemented at Unisa are demonstrated. The paper ends with a brief conclusion.

2 Context – The I-SET Robotics Community Science Engagement Project at UNISA

The context of this paper relates to Inspired towards Science, Engineering and Technology (I-SET), a community science engagement flagship project of the College of Science, Engineering and Technology (CSET) at UNISA. The I-SET project has deployed a range of opportunities for equipping and empowering coaches and their robotics teams of learners in robotics education for more than a decade (since June 2009). However, the increasing and urgent national demand for robotics education for all learners is hindered by access, time, distance, commitment, and funding constraints. These challenges have been exacerbated by austerity measures (trimmed budgets) of higher education institutions where budget cuts were implemented for all community engagement projects. This has been worsened by COVID-19 constraints, where travel has been halted, funding has been limited, and face-to-face workshops and expos have been cancelled.

The austerity measures implemented within the community engagement projects of UNISA, the ODeL institution, necessitated that the I-SET project team explore and experiment with alternative implementation opportunities for robotics engaging, equipping, and training. One such opportunity presented was developing and using STEM MOOCs on the Unisa Open Learning (UOL) portal, specifically robotics for science engagement. Since the implementation of COVID regulations in South Africa, these robotics STEM MOOCs have been enhanced by, and supplemented by regular online meetings (on MS Teams) with (online) engagement communities to fur-ther equip and empower robotics coaches. The schedule for these I-SET Robo-tics Live Online Learning sessions is revised and published each month. The recordings of all sessions are available on the I-SET Yammer site for registered I-SET Community members.

Thus, given the current COVID pandemic and the lack of science engagement within the realm of face-to-face robotics workshops of the I-SET project at UNISA, MOOCs provide a potentially viable solution for providing access and equipping a community of coaches for robotics education content. This is currently the role and place of robotics MOOCs in ODeL. As MOOCs currently are the only point of access for the I-SET robotics engagement, a need arose to ensure that the development and implementation of these MOOCs are understood in a quality scholarly way, and that lessons that could be learnt from scholarly papers on MOOCs are considered. Conversely, the question arose on the potential contribution to scholarly discourses on teaching and learning in STEM MOOCs from research on the I-SET MOOCs.

Therefore, to align the development and implementation of these STEM MOOCs in robotics with current literature and to understand the current state of knowledge around STEM MOOCs (including robotics MOOCs), a systematic literature review of STEM MOOCs was initiated and will be ongoing into the foreseeable future. This paper presents the details of a subset of the reviewed literature, specifically relevant to the teaching and learning of robotics within a MOOC space. However, the multi-disciplinary domain of robotics also includes the subject domains of programming, engineering, and physics. Thus, these three knowledge domains were also included in the current focussed study. For a complete initial overview of the state of research on STEM MOOCs see Gouws *et al.* (2022).

3 A Brief Literature Review on Main Concepts Guiding this Paper

The literature included in the systematic literature review focussed on STEM MOOCs specifically, categorized into the specific subject domains STEM (including robotics, physics, engineering, and programming). In the following sub-sections, we briefly engage with the main concepts that guide this paper. These are robotics education, access to robotics resources, MOOCs (as a form of online offering compatible with ODeL), and MOOC and access to robotics education.

3.1 Robotics Education

Robotics education is the teaching and learning of the knowledge domain of robotics. Robotics education provides impactful learning in both formal and informal settings (Anwar et al. 2019:30). In their review of educational robotics research Anwar et al. (2019, op. cit.) found a significant body of research related to robotics their systematic education. Their study highlights that although much is already known about aspects of robotics education such as the benefits of robotics education, professional development and equipping teachers and mentors, there exist significant opportunities for further research.

Areas that need further investigation include online teaching of robotics, understanding which aspects of courses have the most impact, and understanding the impact of culture and social issues on robotics education.

3.2 Access to Robotics Resources

The resources for the teaching and learning of robotics to develop robotics education need to be accessible to all, especially training tools for robotics educators. Pozzi, Prattichizzo, and Malvezzi (2021:1) indicate that a plethora of online educational resources are available (e.g. YouTube videos, podcasts, TED talks) and that demand for online resources has increased in these times of COVID-19. However, it is also noted that the use of these online resources is under-utilized and that guided access to relevant and quality resources is required. Robotics is interdisciplinary; thus, required resources are needed in programming, physics, and engineering.

3.3 MOOCs and Access to Robotics Education

In theory, MOOCs can improve access to educational opportunities, however this potential can only be fully realised when access is enabled for all in terms of aspects such as internet connectivity, language, and digital literacy (Ichou 2018:116). From the literature, it was noted that MOOCs are largely limited to European languages (Pozzi, Prattichizzo, and Malvezzi 2021:1). This poses a critical research question in terms of the audience for whom the MOOCs are created. It is also noted that rich diversity needs to be reflected in MOOCs in Africa (Adam 2020:171). Such analysis reveals potential for the Africanizing of MOOCs, in terms of language, design and curriculum. Oyo & Kalema (2020:1) propose a MOOC implementation strategy within the resource constrained African context.

4 Research Methodology

Because of the nature of the research question and sub-questions, a two-pronged approach was followed. *Firstly*, a systematic literature review was undertaken as the most appropriate research method for understanding scholarly discourses on Robotics MOOCs. *Secondly* a curriculum responsiveness perspective was applied using an interpretive hermeneutic approach.

Undertaking the systematic literature review consisted of the following steps:

(1) determination of the research question;

(2) determination of search terms;

(3) compilation of inclusion and exclusion criteria;

(4) selection of databases to be used;

(5) searches conducted;

(6) screening of papers on the title and abstract, and full text;

(7) coding of selected full-text papers. Each of these aspects is discussed in the following paragraphs.

The original search terms that were used (for the wider study on STEM MOOCs, which this study forms part of) are shown in Table 1. The search focused on the intersection of three main areas of interest, thus MOOCs, STEM disciplines, and engagement. For this paper, environmental and agricultural sciences were not part of the present study. From the search results obtained from this search sources of specific interest to Robotics MOOCs were extracted for the purpose of this paper.

Table 1: The systematic review terms

Topic String 1	Search Strings
MOOCs	‘MOOC*’ OR ‘Massive Open Online Course’ OR ‘Non-formal Education’ OR ’Informal education’
STEM	‘STEM’ OR ‘science’ or ‘physics’ OR ’math*’ OR ‘engineering’ OR ‘chemistry’ OR ‘astronomy’ OR ‘statistics’ OR ‘programming’ OR ‘computer science’ OR ‘computing’ OR ‘informatics’ OR ‘robotics’ OR ‘AI’ OR ‘artificial intelligence’ OR ‘astronomy’ NOT ‘social science’ OR ‘political science’ OR ‘consumer science’ OR ‘life science’ OR ‘medical science’ OR ‘animal science’ OR ‘geography*’ OR ‘biolog*’
Learning Engagement	‘complet*’ OR ‘attrition’ OR ‘engagement’ OR ‘participat*’ OR ’throughput’ OR ‘success’ OR ‘dropout’ OR ‘retention’ OR ‘experience’

Inclusion and exclusion criteria took into consideration the period of existence of MOOCs (2008 onwards), language, and types of publications.

MOOCs only became active in 2008, thus research pertaining to MOOCs only became relevant thereafter. The team thus selected 2008 as a reference year to gather relevant literature for the review.

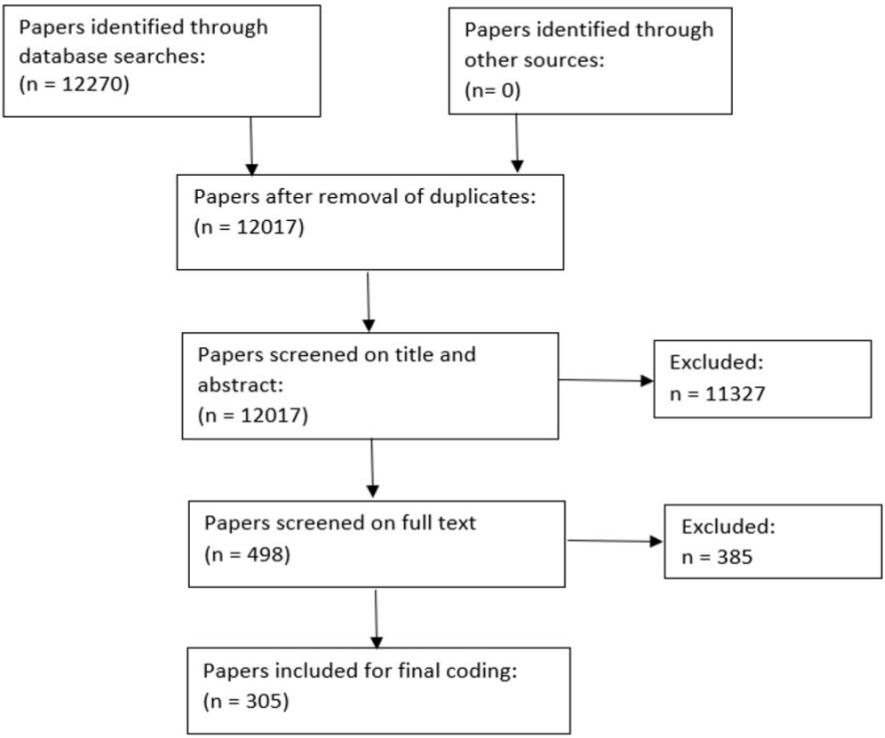
The inclusion and exclusion criteria were used to ensure a level of academic quality assurance in the papers and articles selected for this paper.

The inclusion and exclusion criteria used for this systematic review are presented in Table 2.

Table 2: The inclusion and exclusion criteria	
Include	Exclude
Published from 2008 onwards	Published before 2008
English language	Not in English
Primary, empirical research	Grey literature
Theoretical articles	Reviews
Conference papers	
Journal papers	

Databases that were used for the search were Web of Science, Scopus, and ERIC. These three databases were selected because of the educational nature of the research, and the focus in science, engineering, and technology.

The steps followed during the extraction process include the searching of the chosen databases using the search strings shown in Table 1; the exporting of the search results into EPPI; the exclusion of duplicate articles; the screening of titles and abstracts for relevance; the uploading of the full papers; the screening on the full papers; the further exclusions; the coding of the papers; and the querying of the codes. The process is set out in Flow Diagram 1 below.



Flow Diagram 1: PRISMA diagram for the original systematic review (Adapted from Moher *et al.* 2009:3)

The intention of the systematic review was to present an overview of the global research activity around STEM MOOCs. The researchers therefore developed a coding system to reflect the activity. The coding included the author demographics, subject focus, learner levels (schools, undergraduate), and the aspect of the MOOC that was the focus of the paper. The coding scheme is shown below in Table 3.

Table 3: The coding scheme for the systematic review

Author demographics	Africa, Europe and UK, Asia, North America, South America, Australia and New Zealand
Subject focus	Physics, Engineering, ICT and Programming, Astronomy, Mathematics and Statistics, Robotics, STEM generic, Chemistry, Nanotechnology, Other
Learner level	School, undergraduates, postgraduates, working persons, general public (no prerequisites), other, more than one group of learners
Aspect of MOOC that was focused on	Design of MOOC, MOOC content, MOOC engagement, completion/attrition, MOOC assessment, evaluation of MOOC quality/success, future proposals for MOOCs, technology, other

5 Findings

As indicated in the previous section, the systematic literature review focused on a high-level understanding of STEM MOOCs in terms of author demographics, subject focus, learner level, and MOOC aspect that was focused on by the researchers. The following results were recorded.

5.1 Programming and ICT, Engineering, Physics and Robotics - Subject Focus

The relative presence of the literature for the subject focus code is presented. The subject focus code of the 305 papers in the study are highlighted.

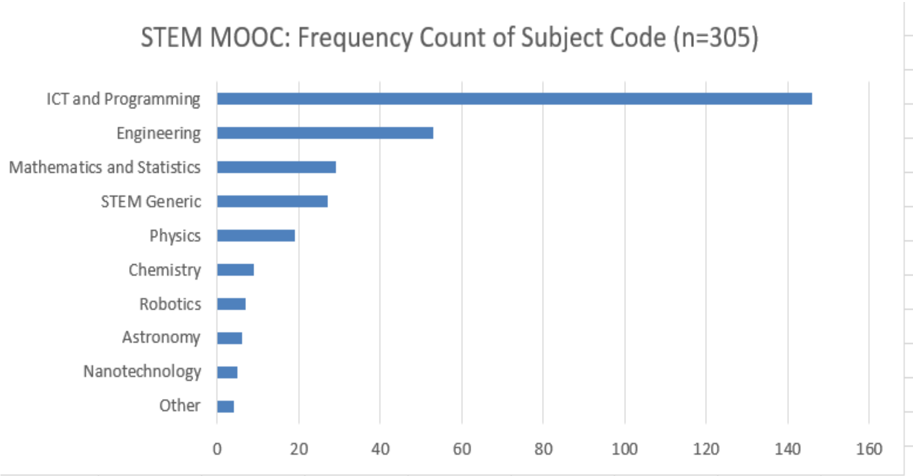


Figure 1: STEM MOOC: Frequency Count of Subject Code (n=305)

From Figure 1 it may be noted that the most articles refer to programming and ICT MOOCs (146), whilst the least articles refer to robotics (7). Figure 1 indicates that the top three areas in which MOOCs are being researched within the STEM fields are ICT and programming, Engineering and Mathematics, and statistics. The lack of research in Robotics is concerning. From Figures 1 and 2, it is noted that programming and ICT articles are in the majority (48%), whilst the robotics articles are in the minority (2%). The selected literature articles were coded on subject, focus, demographics of author and on target audience.

5.2 Robotics MOOCs – Distribution of Subject Code

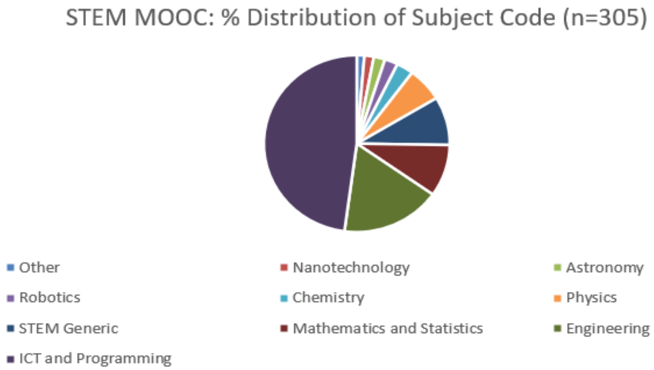


Figure 2: STEM MOOCs: % Distribution of Subject Code (n=305)

5.3 Robotics MOOCs – Author Demographics

Robotics MOOCs made up a very limited sub-set of the total STEM MOOC papers that were found for the overall literature search. The authorship of the articles pertaining to robotics MOOCs is presented in Figure 3.

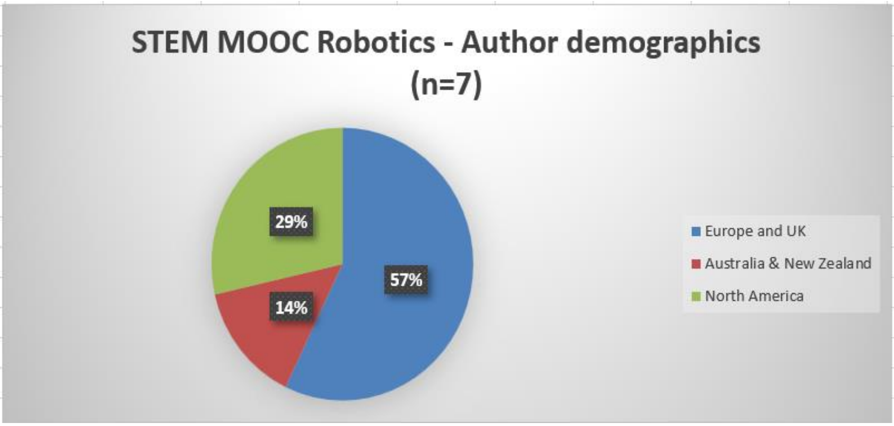


Figure 3: STEM MOOC Robotics research - author demographics (n=7)

Most of the publications are authored in Europe and UK (57%), and the fewest of the publications are authored in Australia and New Zealand (14%). However, of concern (or an opportunity) is that the literature review did not include any research pertaining to the use of robotics MOOCs in Africa.

5.4 Robotics MOOCs – Learner Focus

The learner focus of the articles pertaining to robotics MOOCs is presented in Figure 4.

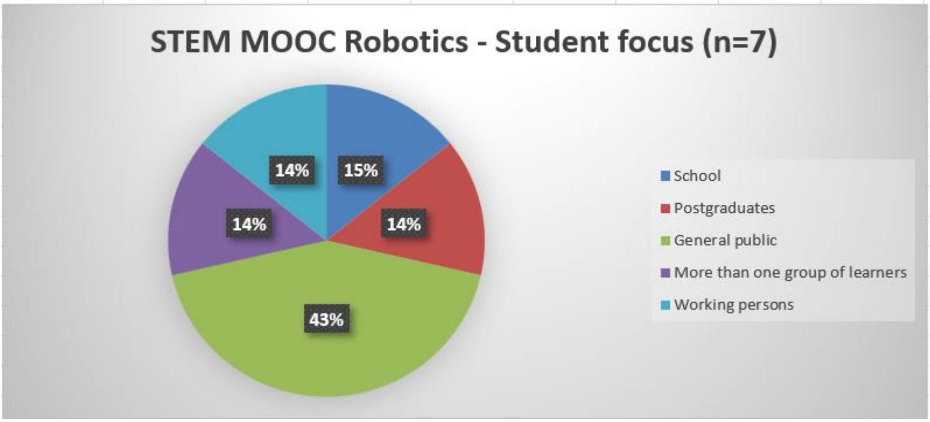


Figure 4: STEM MOOC Robotics - Student Focus (n=7)

Most of the robotics MOOCs focused on the public (43%), which is one of the characteristics of MOOCs.

5.5 Robotics MOOCs – Research Focus

The research focus of the articles pertaining to robotics MOOCs is presented in Figure 5.

Most of the robotics MOOCs publications focused the design of the MOOC (72%). Given the growing trend of MOOCs, it is in line with trends to develop the knowledge base of good design practice for robotics MOOCs. There is however clearly a need for more extensive research on MOOC engagement, as student throughput in MOOCs remain an issue.

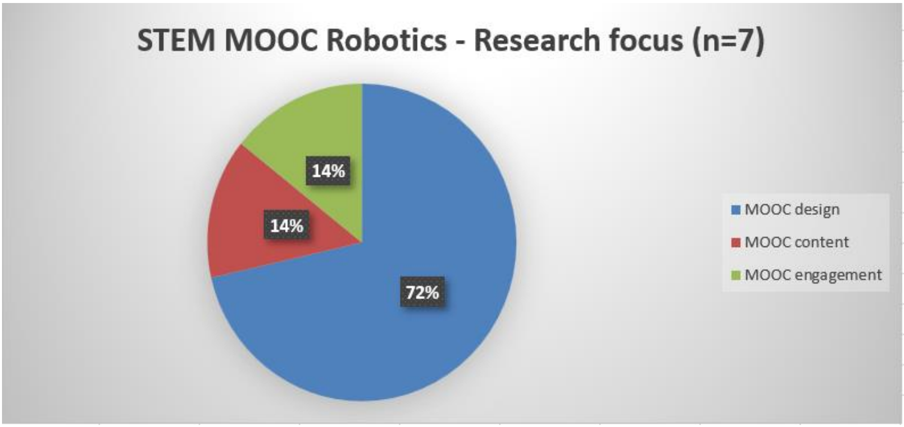


Figure 5: STEM MOOC Robotics - Research focus (n=7)

5.6 Conclusions from the Systematic Literature Review

It can clearly be seen that the extent of research on Robotics MOOCs that could inform the research question is extremely limited, with no research focusing on Africa and its contexts and challenges. This highlights potential future opportunities but provides no information that significantly informs the current research paper.

6 Curriculum Responsiveness as a Lens

To understand the impact of context on our research focus, we adopted a curriculum responsiveness lens. Curriculum responsiveness became prominent early in the 21st century in South Africa as a response by universities to deal with expectations for transformation of higher education (Griesel 2004: i) in order to make higher education a more open and accountable system (Moore and Lewis 2004, 39). The curriculum responsiveness model proposed by (Moll 2004:17) highlights the need for university curricula to be responsive to four main layers of elements, being economic demands/ government policies (macro level), institutions and culture (meso level), epistemological development (i.e. knowledge development in disciplines) and responsiveness towards learners/tuition and learning (micro or local level). The model is shown in Figure 6. (Moll 2004:17 op. cit.) clearly argues that none of the layers can be viewed in isolation.

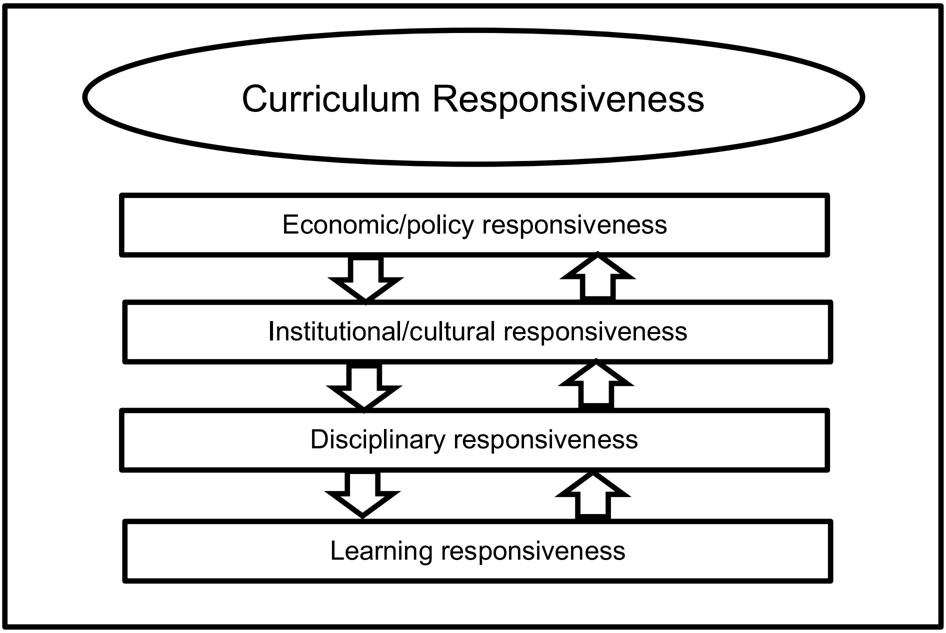


Figure 6: A curriculum responsiveness model (Moll 2004:17)

Each of the dimensions in the model is briefly discussed below.

6.1 Economic/ Policy Responsiveness

This element of the framework represents responsiveness to macro elements of the teaching environment. A significant driver at higher education level is governmental policies and frameworks (Moll 2004:17). In the case of South Africa, the expectations expressed by government relates strongly to universities supplying labour to support the economy (Moll 2004:17 op. cit.). However, this cannot be viewed in isolation from the other dimensions of curriculum responsiveness, described later. Although the ideal exists that education of a potential labour force will lead to benefits in terms of jobs, the reality is complex as it requires not only curriculum responsiveness from the universities. The ways in which students and potential employers relate to the skills on offer are often inconsistent and relate inter-alia to institutional factors at the universities that offer the skills (Wedekind 2014:79). Furthermore, factors such as the economic environment at a given time also plays a mediating role, making assessment of a particular curriculum response rather challenging (Wedekind 2014:80).

A disruptor of significant potential at macro level in South Africa is the endorsement of the Fourth Industrial Revolution (4IR) agenda as part of the economic vision by the South African government (Lotriet & Twinomurinzi 2021:164). African tertiary institutions need to be responsive to this in preparing students with appropriate skills (Fomunyam 2020:27). An important dimension at macro scale in the context of 'local vs. global' discourses is the strong discourse on decolonization of the curriculum, with related discourses on caring and social justice (Fomunyam and Teferra 2017:196). Sustainability has become a significant factor that need to be accounted for in higher education (Bell 2016:49) and robotics courses at universities will have to find ways to engage with sustainability discourses. It has been argued that all curricula should include content on the UN Sustainable Development Goals (SDGs) and the accompanying priorities and required actions (Hong 2020:49).

6.2 Institutional/ Cultural Responsiveness

Several themes that relate to the way in which institutions of higher education need to be responsive (Griesel 2004:i). These relate to dimensions such as the (1) continuous development of novel models of curriculum management, pedagogy, and academic development; (2) academic language policies, and (3) requirements related to ODeL and open education (which are significantly important from the perspective of this paper). Wedekind (2014:79) argues that the institutions have three significant dimensions relating to curriculum responsiveness, namely regulatory, normative, and cognitive-cultural. For meaningful capacity building and curriculum responsiveness, strengthening and building off all three dimensions are required (Wedekind 2014:91). The integration of digital culture into the organizational culture to ensure effective MOOC designs and implementation is imperative to respond to global and local needs.

6.3 Responsiveness at Individual (Tuition and Learning) Level

Curricula need to be responsive to factors related to the students. These include diversity issues (culture, language and levels of preparedness) (Griesel 2004:i). Students do need caring lecturers, however, in the South African context, basic material needs of the student do become an issue, for example food, housing and transport (Wedekind 2014:83). It is important to keep in mind the importance attached by students to affordable education – it is only a number of years since the #FeesMustFall demonstrations disrupted higher education in South Africa (Lange 2017:31). The use of MOOC potentially plays a pivotal role to promote access to education in general. In Africa, the need for contextualized MOOCs is evident hence the importance of the gap (and associated opportunities) related to low MOOCs outputs in Africa.

6.4 Epistemic Responsiveness

Knowledge and the organization thereof do periodically undergo significant paradigm shifts. The shifts would require a responsive approach in terms of the organization and structuring of a particular curriculum (Griesel 2004:i). A challenge is that the traditional disciplinary approach of universities do not correspond well to the inter-and-transdisciplinary nature of real-life and universities have to cater for this challenge (Moll 2004:17). In the South African context, there are also discourses around epistemological emancipation (Ngubane and Makua 2021:1).

7 Towards the Place and Role of Robotics MOOCs Based on Curriculum Responsiveness

Based on the previous section, several considerations emerge that define the role and place of Robotics MOOCs in an ODeL institution within the South African context. These considerations are summarised in Table 4.

Table 4: Positioning of robotics MOOCs in a curriculum responsive manner

Responsiveness level	**Specific dimension**	**Requirements in terms of place and position of Robotics MOOCs**
Macro	Economic viability and supplying the labour market	Robotics skills need to lead to sustainable jobs and careers, both in industry and government (Moll 2004:3 - 4). Qualifications need to be recognized and accredited by all role players and policy makers in terms of content and quality.
Macro	Africanisation and decoloniality	Robotics MOOCs need to be situated within programmes that are explicitly African in approach and focus.
Macro	4IR as potential economic disruptor in Africa	Robotics is per definition part of 4IR, but 4IR cannot be viewed in isolation and must be viewed in the context of African needs (Africa 2063).
Macro	Sustainability and the United Nations Sustainable Development Goals	SDGs are important in Africa. Robotics skills need to be linked in explicit ways to skills related to SDGs.
Meso (Institutional)	Requirements related to ODeL	Robotics MOOCs need to be presented with due consideration of all institutional systems required for effective ODeL functionality (Moore and Lewis 2004:39).

Table 4: Positioning of robotics MOOCs in a curriculum responsive manner		
Meso (Institutional)	Open Education	Robotics MOOCs need to strive towards openness, both in terms of access and development of educational resources.
Meso (Institutional)	Institutional language policies	Institutions need to consider both the epistemological, and pedagogical dimensions of language on implementation of Robotics MOOCs.
Meso (Institutional)	Engaged tuition and learning	The content and presentation of the MOOCs need to be sufficiently community focused, and community linked.
Micro (Individual)	Dealing with student diversity (culture, language, preparedness)	The Robotics MOOCs need to be accessible for students from a diverse background. There needs to be learning scaffolding in place to cater for different levels of student preparedness. The Robotics MOOCs need to be sufficiently engaged with diverse cultural groups' cultural backgrounds and resources (Moll 2004:5).
Micro (Individual)	Dealing with basic student needs	Robotics MOOCs need to be affordable, preferably free in line with the initial purpose of MOOCs to provide access to education.

Table 4: Positioning of robotics MOOCs in a curriculum responsive manner		
Epistemic (Knowledge)	Dealing with knowledge organization in the field of robotics	Robotics is a rapidly evolving knowledge area. The MOOCs need to be agile to respond to rapid changes in knowledge in the field, and also adequately linked to inter- and transdisciplinary approaches (Moll 2004:6).

7.1 The Role and Place of Robotics MOOCs at Unisa

Robotics MOOCs may be a sustainable practical solution to improve community engagement with science under the conditions and challenges experienced during the COVID-19 pandemic. There exists an opportunity to use STEM MOOCs to increase the access to robotics through science engagement, where the target audience may include all levels of public, thus coaches (educators, mentors, and community leaders). The use of STEM MOOCs to support the tuition in robotics, may include a focus on engineering, a focus of programming and a focus of physics for all levels, from school to university. Based on curriculum responsiveness, we conceptualize the role and place of STEM MOOCs in the ODeL environment as follows:

- For the current students (under-graduate and post-graduate) in the ODeL institution, the STEM MOOCs provide free additional or enhanced learning for robotics content not included in the curriculum.

- For the public, including the coaches (educators, mentors, and community leaders), the STEM MOOCs provide equipping for the development of robotics education and for the development of learners' 21st century skills that are required.

- For the learners (the future students of the ODeL institution) that are in robotics teams, STEM MOOCs provide an opportunity to engage with learning (specifically in robotics) prior to registration of formal qualifications in an ODeL institution of Higher Learning.

Not all students can embrace and register for a formal qualification that requires the completion of thirty modules over multiple years due to time and fund constraints. The STEM MOOCs provide an alternative learning path to an opportunity to access free learning and continue lifelong learning (Blaschke 2012:56). Thus, an opportunity exists for service of humanity that urgently requires the development of robotics education for all coaches (educators, mentors, and community leaders). From the literature, it was noted that MOOCs are limited to European languages (Pozzi, Prattichizzo, and Malvezzi 2021:1). Thus, the role and place of robotics MOOCs at UNISA, the ODeL 'in service of humanity in Africa', is to address the need to Africanise the MOOC content in the UNISA ODeL environment.

This section presented STEM MOOC implementation at Unisa, as a specific example of a context-aware approach. There is the possibility for other South African tertiary institutions to use similar context-aware approaches to the development of MOOCs for STEM learning. Although MOOCs represent largely uncharted territory in South Africa (Twinomurinzi & Msweli 2020:10), there are indications that MOOCs may play a meaningful role in affording persons in developing areas and communities a pathway towards qualifications (Fatumo & Ngwenya 2020:1).

Within the South African digital skills development context (under the banner of the National Electronic Media Institute of South Africa, NEMISA) important discourses are taking place around the national recognition, accreditation and quality control measures that would facilitate the creation of a sustainable MOOC ecosystem in South Africa (Twinomurinzi & Msweli 2021).

8 Conclusion

From the findings of this systematic literature review, it may be concluded that there exists a role and place for STEM MOOCs, specifically in robotics in ODeL, but that there is a knowledge gap on Robotics MOOCs in Africa that needs to be addressed by local researchers. From the analysis of the curriculum responsiveness investigation that was undertaken, it is clear that the place and the position of Robotics MOOCs need to be highly responsive to contextual factors relating to global and national imperatives (such as the 4IR revolution, UN SDG's, the need to Africanise curricula in South Africa and economic labour demands), institutional imperatives (ODeL and open education discourses) and individual characteristics of learners (preparedness, language, culture). The final discussion briefly detailed the specifics of the Robotics MOOC implementation at the University of South Africa, where it is necessary to position the content and presentation of the MOOCs within an Africanised curriculum, while taking due cognizance of the other contextual factors to which the content and presentation of the MOOCs need to be responsive. It is recommended that in future research relating to MOOCs, student success and the integration of MOOCs with other ODeL technologies should be explored.

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Patricia Gouws
Department of Information Systems
University of South Africa
Gouwsmp@unisa.ac.za

Hugo Lotriet
Department of Information Systems
University of South Africa
Lotrihh@unisa.ac.za

Mukondeleli Grace Kanakana-Katumba
Faculty of Engineering and the Built Environment
Tshwane University of Technology
KanakanaMG@tut.ac.za

Denzil Chetty
Academic Development Open Virtual Hub
University of South Africa
Chettd@unisa.ac.za