Body of Knowledge on IoT Education

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Abstract: The Internet of Things (IoT) has taken an important boom in different areas of knowledge, especially in education. The inclusion of new technologies has impacted the education sector and changed the ways of teaching. Thus, the curricula that are taught in the context of engineering and knowledge areas should be aligned to such change. In this paper, an information mapping was carried out as a scientific methodology to establish the base elements to create a book of knowledge (BOK). This information mapping is aligned with IoT for a standardized education.

1 INTRODUCTION

The Internet of Things, the connection of devices (other than standard products such as computers and smartphones) to the Internet, is in the process of transforming numerous areas of our everyday lives especially in the education.

The rise of mobile technology and the IoT allows schools to improve the safety of their campuses, keep track of key resources, and enhance access to information. Teachers can even use this technology to create "smart lesson plans," rather than the traditional stoic plans of yesteryear.

As mentioned above, the great potential of IoT in educational contexts lies in the creation of environments marked by the "hyper situation", which is defined as the ability to amplify knowledge based the geolocation of the user, allowing his

contextualization (Moreira et al., 2018).

One of the main concerns of the software industry is to develop the talent of its human resources, since the quality and innovation of its products and services depend to a great extent on the knowledge, abilities and talent of software engineers. The knowledge already exists; and the goal is to gain consensus on the core subsets of the knowledge characterizing the software engineering discipline (Penzenstadle et al., 2013).

According to the SWEBOK 2014 guide for software engineering to be fully known as a legitimate engineering discipline and a recognized profession, consensus on a Core Body of Knowledge (CBOK) is imperative.

Achieving consensus by the profession on a CBOK is a key milestone in all disciplines and has been identified by the IEEE Computer Society as crucial for the evolution of Software Engineering towards professional status"

Moreover, according to (Quezada et al., 2016) “articulating a BOK is an essential step toward developing a profession because it represents a broad consensus regarding what a software engineering professional should know.

Nowadays, it does not exist a consensus for the development of Bodies of Knowledges (BOKs) about the structure and contents that it should have. This is the reason why, in this paper, the existing

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literature has been reviewed in order to identify guidelines and recommendations on the structure and contents in the context of engineering and supported by IoT.

2 METHODOLOGY

In 2004–2005, (Kitchenham et al., 2011) wrote three papers suggesting that the concept of evidence-based practice, (as initially developed in medicine, and subsequently adopted by many different disciplines including Economics, psychology, social science and most health care disciplines) should be adopted in software engineering.

According to (Budgen et al., 2008), mapping studies use the same basic methodology as Systematic literature review (SLR), but aimed at identifying and classifying all research related to a broad software engineering topic rather than answering questions about the relative merits of competing technologies that conventional SLRs address. Mapping study reviews a broader software engineering topic and classifies the primary research papers in that specific domain.

The domains of this paper are BOK Software Body of Knowledge and concepts of IoT education.

In (Kitchenham et al., 2011) and (Tingting et al., 2018) the mapping study procedures related to five stages (See Figure 1) is carried out.

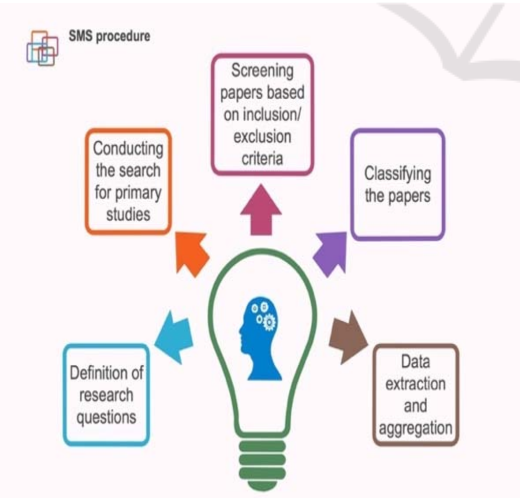

Figure 1: SMS procedure.

SMSs is performed to evaluate quantity and types of primary studies in an area of interest, in an unbiased and systematic manner. Proper procedures of executing required sound planning (Kitchenham and Charters, 2007).

Evidence in software engineering is getting much attention. SMS is some techniques of Evidence Based Software Engineering and has already been used in different sub-domains of software engineering such as: software testing and requirement specification among others (Soares et al., 2018).

Systematic mapping requires sound planning, executing and the analysis of a systematic map (Fernandez et al., 2009)

3 BACKGROUND BODY OF KNOWLEDGE (BOK)

3.1 BOK Context

A BOK is a collection of substantial concepts and skills that represent knowledge of a certain area in engineering or scientific discipline and ensures its common understanding (Manna and Usan, 2011).

A BOK is a list of knowledge, skills and abilities (competencies), organized into an integrated structure (taxonomy) with a specific level of accomplishment specified for each competency (proficiency) (Taguchi et al., 2013).

Professional communities have created and used BOKs to consolidate their discipline, standardize practices, improve processes, and warehouse community knowledge. Formal BOK have been used across different type of disciplines.

The BOK could also be used by individuals for extending their skills and for career development. Researchers may find it useful for identifying technology applicable to their research and to help define the skills required for research team (Quezada et al., 2018).

The process of building the BoK should assist in highlighting similarities across disciplines. For example, techniques used in materials science (Maxville, 2012). A BOK is normally used for certification and education or training (Quezada et. al., 2018) and (Eras et al., 2015). The knowledge must reflect current best practice, which inevitably changes over time. However, updates cannot be undertaken in an uncontrolled manner since associated lecture and other education material needs to be maintained in line with the BOK.

3.2 Core Body of Knowledge (CBK)

The CBOK includes all of the fundamental or core skills, knowledge, and experience to be taught in the curriculum to achieve the expected student outcomes. The primary source for developing the CBOK was the SWEBOK.

Knowledge elements were also derived from the Software Engineering 2004 curriculum guidelines [SE2004], the INCOSE Guide to Systems Engineering Body of Knowledge (INCOSE, 2014) and the INCOSE Systems Engineering Handbook Consensus on a CBOK is crucial to the development of a mature profession. It represents the generally accepted knowledge expected of a graduate with four years' experience.

In general, the IEEE-CS BOK is organized hierarchical into three progressively more detailed levels (ABET, 2003).

The final version will eventually be the most complete and will likely become the standard. It is derived from an analysis of software engineering textbooks and software engineering university programs (Quezada et al., 2017).

3.3 General Structure of Bodies of Knowledges based on the Developed SMS

BOK have a specific structure according the area of engineering or science. In this paper the general structure of the BOK is described in the context of engineering, science and Software Engienering.

Firstly, the general structure of the BOK is described, in order to establish the core (skills, knowledge, and experience to be taught in the curriculum to achieve the expected student outcomes). In the same way, the BOK established Knowledge Areas (KAs) Each KA descriptions should use the following structure: Acronyms, Introduction, Breakdown of Topics of the KA, Matrix of Topics vs. Reference Material, List of Further Readings, and References (Penzenstadler et al., 2013) and (Fairley et al., 2014); each area is broken down into smaller divisions called units, which represent individual thematic modules within an area. Unit is further subdivided into a set of topics, which are the lowest level of the hierarchy.

The topics depend on evolution and context of KA and discipline.

In the context of BOK, it is necessary a process of updating knowledge in function of the advance of the discipline and the necessities of the society.

In general, the BOK has different Committee, organizations and groups of collaboration that develop and update their contexts in functions of the advance of the science and engineering.

In this paper a general structure of BOK by levels was developed: Core BOK, KA, KU, KT, KST, capacities and organization of BOK is shown in the figure 2.

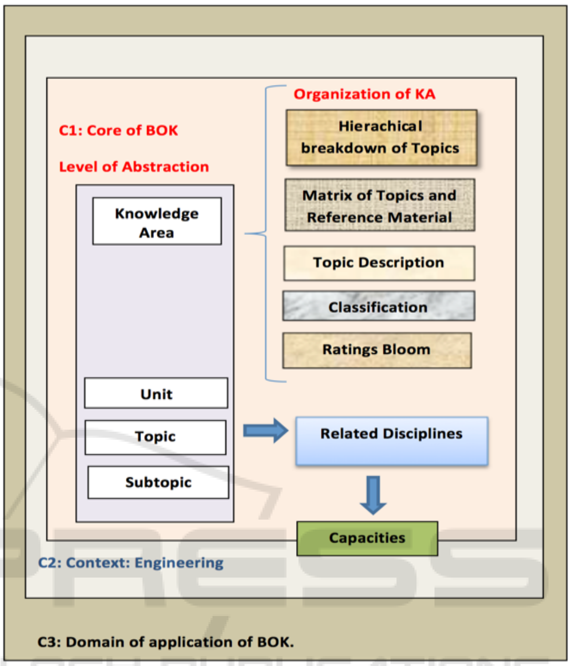

Figure 2: BOK Context.

The integration of news areas, unit and topics depend on different criteria that consider the organization and institutions (Quezada et al., 2016). On the other hand, it is necessary to consider another level in the structure of BOKs where the topics will be more detailed (sub-topics). These sub-topics have to address different knowledge and skills. In the same way, in order to develop a BOK, it is necessary consider: Process Model, Deliverables, Organization, Technology focus, Tools, Assignment focus, and Exercise domain (Thompson, 2001).

All domains are based on essential and common BOK that are necessary to master in order to succeed of in a particular profession. Software engineering is mainly based on common BOK such as Standard Body of Knowledge (SWEBOK), Computing Curriculum Software Engineering (CCSE) and Graduate Software Engineering 2009 (ABET, 2003). Initially, software engineering was viewed as a sub-discipline of computer science or computer engineering, but in the middle to late 1990s software engineering gained recognition as a discipline by itself. This culminated in the recognition of the first software engineering degree programs by the Accreditation Board for Engineering and Technology.

The scientific basis of Software Engineering disciplines consists of the following:

a) classical sciences (algorithm theory, set theory, proof theory, mathematical logic, etc.),
b) the theory of programming, and
c) the theory of construction of linguistic design tools at the level of abstract models and architectures of target software objects.

Software Engineering contains main basic concepts and objects, formal approaches, methods, programming tools, and Primary Studies production management methods (Petersen, 2008). According to the develop SMS, we consider the domain of application of the BOK in this case as software and IT engineering.

To consider Educational programs in engineering, engineering technology that have been developed to address many technical aspects associated with computers and IoT aspects.

In the same context, the ASCE BOK (Pyster et al., 2017) highlights the need for engineers to understand the impact of their solutions with society, culture, industry.

The BOK could also be used by individuals for extending their skills and for career development. Researchers may find it useful for identifying technology applicable to their research and to help define the skills required for research teams (Quezada et al., 2016).

The process of building the BOK should assist in highlighting similarities across disciplines, for example, techniques used in materials science.

With this work, it was possible to propose new areas of knowledge in the curriculum program of Informatic and Multimedia at the International University of Ecuador based on the structure and model of BOK and IoT education concepts (http://uide.edu.ec/media/2076/informa-tica-y-multimedia.pdf).

4 CONCLUSION

The results of this paper showed the criteria to develop the general structure and contents of the BOK in the field of engineering and IoT education. The proposal of the way of how to elaborate a BOK permitted to understand the real context of the Knowledge Areas and the relation with the related disciplines.

A BOK generally uses a tree structure to represent knowledge, and a certain limit is set to its height to help its understand ability and readability. In the same context, the main objective of a BOK s to provide classification of knowledge and its detailed explanation.

BOK provides the basis for curriculum development and professional development and current and future certification schemas. Lastly, it promotes integration and connections with related disciplines.

As a result of this research, it can be said that a BOK generally uses a tree structure to represent knowledge that provide the classification and detailed explanation of each knowledge area. In addition, each knowledge area presents the relationship between BOK and scientific disciplines, which allows to add new structure, concepts, and learned lessons to improve the perspective and projection of the BOK in the industry, science and IoT education.

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