Towards LA Adoption Maturity Framework

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***Abstract* - Student-centered learning in higher education (HE) was an important topic for years. Still, the COVID pandemic strongly emphasizes challenges with student-centered learning in a blended learning environment and, consequently, the need for rapid acceleration of innovative solutions. More focus is put on learning analytics (LA) that consider measurement, collection, analysis, and reporting data about learners and their contexts. The critical question is "How mature are higher education institutions in implementing LA?". This paper proposes a methodology for developing LA Adoption Maturity Framework (LAAMF) in a hybrid environment as well as developed LAAMF concept. The LAAMF aims to contribute to a better understanding of success factors and barriers to adopting LA in HE institutions with blended learning environments. In addition, it will provide a new methodology for assessing HE institutions' maturity for LA adoption. Using LAAMF, HE institutions will be able to (1) identify directions for the development of LA, (2) develop policy and strategic plans for LA adoption, implementation and deployment, (3) efficiently use LA in their environment; and finally, (4) accomplish their missions in the field of education. The paper elaborates both the practical importance of LA in HE and its grounding in the existing knowledge bases according to design science research principles. It also stresses the potential of LA application in the appropriate environment (relevance) and contribution to the existing knowledge base (rigor) if such a maturity model is developed. Finally, this paper's practical implications lie in guidelines for developing the LAAMF based on the five-step methodology for maturity model development, aligned with guidelines for design science in information systems research and requirements for the development of maturity models.**

Keywords* - *learning, analytics, LA, maturity, framework, higher education

I. INTRODUCTION

This paper has been prepared in the scope of the project HELA - Improving higher education institution (HEI) maturity to implement learning analytics (LA) which Croatian Science Foundation funds. The project aims to contribute to a better understanding and optimization of the teaching and learning processes supported by LA through improving HEI maturity to implement LA in blended learning environments. As the main goal, a maturity framework for LA implementation in a blended learning environment will be proposed [1]. In the HELA project, the goal is to create an LA adoption maturity framework (LAAMF). Using LAAMF, HEIs will be able to:

(1) identify directions for the development of LA – here, the maturity corresponds with readiness, and HEIs can quickly identify the aspects (elements) they have to upgrade to apply LA,

(2) develop policy and strategic plans for LA adoption, implementation and deployment,

(3) efficiently use LA in their environment; and finally,

(4) accomplish their missions in the field of education.

LA and educational data mining (EDM) are very young disciplines. The first paper related to LA was referenced in Web of Science Core Collection (WoSCC) in 2011, and the first paper related to EDM was published in 2006. However, the number of papers has increased rapidly since that time. The LA as the term was defined at the first LAK conference in 2011. It was defined as: "… the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" [2]. On the other hand, the definition of EDM is as follows: "Educational Data Mining is an emerging discipline, concerned with developing methods for exploring the unique and increasingly large-scale data that come from educational settings and using those methods to better understand students, and the settings which they learn in" [3]. The definitions of the terms LA and EDM are very similar, and the differences between them are often discussed in respected literature. In the HELA project, the term LA is being used as a comprehensive term that covers both definitions.

The goal of LA is to present student behavior which will enable making good decisions resulting in an adequate education. The education can be organized in several ways: traditional (face-to-face), online, blended and hybrid. In all those forms of teaching and learning, it is necessary and important to collect data about student behavior. In traditional (face-to-face) teaching, the content is delivered to students in person through lectures, seminars, labs, and other types of activities. In online settings, the content can be delivered in a synchronous or asynchronous way using learning management systems (LMS). In blended learning, face-to-face teaching is being combined with online education so that some teaching activities are delivered face-to-face, and other teaching activities are delivered online. In hybrid teaching, the same teaching activities are delivered both – face-to-face and online at the same time. The student behavior can be tracked in all mentioned forms of the teaching process. However, monitoring student activities is simpler when there are information and communication technology (ICT) supported elements in educational settings.

To be able to apply the LA, HEIs must be ready for LA application. The term readiness is often mixed and/or combined with term maturity. In the case of readiness, we analyze the possibilities of the certain system to implement some concepts. In our case, that would be analyzing the readiness of HEIs to adopt and apply LA (before LA application). In case of maturity, the system already implements the concept (the HEIs apply the LA), and we are investigating the level of the implementation in practice. The focus of this paper is on maturity.

In this paper, the methodology for LA Adoption Maturity Framework (LAAMF) development will be presented as well as developed LAAMF concept. The main contribution of this paper is in presenting developed LAAMF concept with a) application of multi-criteria decision-making methods to calculate weights of the areas and elements; b) using the rubric to determine how the maturity of each element will be gathered considering the real state in HE institution and c) using the composite index to aggregate the areas/elements weights and HE institution results into the total HE institution maturity level [1].

The paper is organized as follows: In Section 2, the need for the development of LAAMF is elaborated in the context of recent LA research directions. Section 3 describes the proposed methodology for developing LAAMF, while in Section 4, a very early concept of LAAMF is presented.

II. STATE OF THE ART

In order to address relevant research conducted in the field of LA in higher education (HE) in the last five years, the authors conducted a database search in Web of Science (WoS). The query *TI=("learning analytics" OR LA) and TI=(framework OR model OR instrument)* resulted in 1164 papers in WoS, out of which 409 were published in the last five years (2017-2021). A more focused search that included only papers related to higher education *(TI=("learning analytics" OR LA) and TI=(framework OR model OR instrument) and TS=("higher education"))* resulted in 17 papers that were analyzed in detail. By reading the abstract, three papers appeared not to be relevant as the abbreviation LA in the title did not refer to learning analytics. The analyzed 14 papers indicated several research directions related to learning LA in HE that can be summarized as follows:

- Strategic planning of LA in HE - [4], [5] developed a learning analytics policy and strategy framework within the project SHEILA (Supporting Higher Education to Integrate Learning Analytics), and put focus on enabling systematic adoption of LA through a policy framework [6]. Another example of a strategic framework is from [7], who proposed a framework focused on the realization of strategic value from LA for HEIs. Both frameworks are based on case studies and provide practical examples.
- Quality of LA in HE – another set of papers focuses on LA's quality from different perspectives. [8] proposed an instrument for students' evaluation of the quality of LA services, while [9] developed and applied the Questionnaire for Student Expectations of Learning Analytics (SELAQ). Another perspective on the quality of LA in HEI is presented by [10], who researched LA framework quality perception in HE from a broader perspective, including quality aspects in the dimension of content, process, and engagement.
- Usage of data in LA – usage of data in LA is also researched from different perspectives. Authors in [11], [12] advocate using documentation studies approach to make data in LA "better". Authors in [13] put focus on the issue of student privacy and autonomy in LA and proposed a model for establishing informed consent mechanisms related to those issues, while authors in [11] proposed a model for researchers aimed at using HE datasets for LA research.
- Application of LA – two papers presented the practical application of LA in HEI. [14] presented student LA framework that is course-adapted, and their experiment showed it enhanced student awareness on their performance, while [15] used LA to explore student motivation.
- Maturity models for LA in HE – finally, the most relevant recent research papers for this study are two papers from [16], [17] proposing a maturity model for the Adoption of Learning Analytics in Higher Education Institutions.

As can be seen from the short review of recent papers related to LA in HE, strategic planning of LA, quality of LA, and usage of data in LA are among the prevalent topics. Maturity models are extracted as a separate topic, but in a broader context, the maturity model can refer to any of the areas mentioned above. They are recognized as a powerful tool for strategic planning and quality assurance [18]. A systematic review of the application of maturity models, particularly in universities, identified nine categories of maturity model application in higher education in 23 papers, none of which focused on LA [19]. As the proposed maturity model for the adoption of LA in HEI [16], [17] is as well from 2020, it might be concluded that there is no other maturity model applied to LA in HE, as evident in the literature. A maturity model for the Adoption of Learning Analytics in HEI is based on the body of knowledge for the activities of Data Management (DMBoK), Data Management Maturity Model, TDWI (Transforming Data with Intelligence) Analytics Maturity Model and Data & Analytics Maturity Model [16], [17], as well as results of projects LARI [20] and SHEILA [4]. Accordingly, their initial proposed model consists of five categories: Data Management, Administration and Training, Pedagogical Support, Data Analysis and Legislation, Privacy and Ethics. Maturity levels in this model are defined as: *Ad hoc*, *Initial*, *Structured* and *Systematic*, but without a developed instrument that would provide mathematical and/or logical rules that describe how to measure each element and how to aggregate elements maturities into the maturity at the level of the concept.

Compared to the existing research related to LA maturity models in HE, we can elaborate the importance

of our proposed model as follows: 1) LAAMF is focused on LA in the blended learning environment, which is not the case with the existing model(s), 2) LAAMF will be accompanied with the instrument that will enable HE to measure the level of their maturity according to certain areas, but as well in global, 3) and the instrument will as well provide recommendations and instructions on how to achieve a higher level of maturity for certain areas/elements.

III. THE METHODOLOGY FOR LAAMF DEVELOPMENT

The methodology for LAAMF development follows Mettler's five-step design methodology [21] combined with the requirements for the development of maturity models [22] and with the design science research methodology (DSRM) [23][24], which is proven as a good methodology for maturity model development with application in HE [18]. Mettler's methodology consists of five steps [21]: 1) identify the need or new opportunity, 2) define scope, 3) design model, 4) evaluate the design, and 5) reflect evolution. In each of those steps, both relevance and rigor cycle methods will be used, so the final maturity framework is scientifically-grounded and applicable to practice, which is aligned with the principles of DSRM [23], as shown in Figure 1. A short description of five steps in LAAMF design and the connection with requirements for the development of maturity models [22] is described below, according to the process described in HELA project application [1]:

- 1) **Identify a new need or opportunity** that considers the requirement *Comparison with existing maturity models* will be done through the review of scientific papers, strategic documents, and projects related to the implementation of LA in the blended learning environment and consultations with international LA researchers. Additionally, different maturity models, adoption frameworks, and methodologies for their development will be compared. The expected result of this first phase is the *Identification of problem relevance*. The purpose of this step is to ensure that no artifact is developed for the same domain and the recognized research problem is both innovative and relevant to researchers and practitioners.
- 2) **Define scope** is the second step in LAAFM development and correlated with the requirement *Problem definition*. Scope definition assures that the application domain and intended benefits of the maturity framework are determined prior to the design phase. To some extent, this phase will lean on the results of step 1). The main LAAMF elements can be recognized from the literature. Additionally, the results could be amended with experts' opinions through interviews and focus groups. As a result of this phase, main LAAMF elements will be determined, such as the ones contained within Capability Maturity Model (CMM) [22, p. 29]:
    - Maturity levels indicate process capabilities and contain key process areas;
    - Key process areas achieve certain goals and are organized by common features;
    - Common features address implementation or institutionalization and contain key practices and
    - Key practices describe infrastructure or activities.

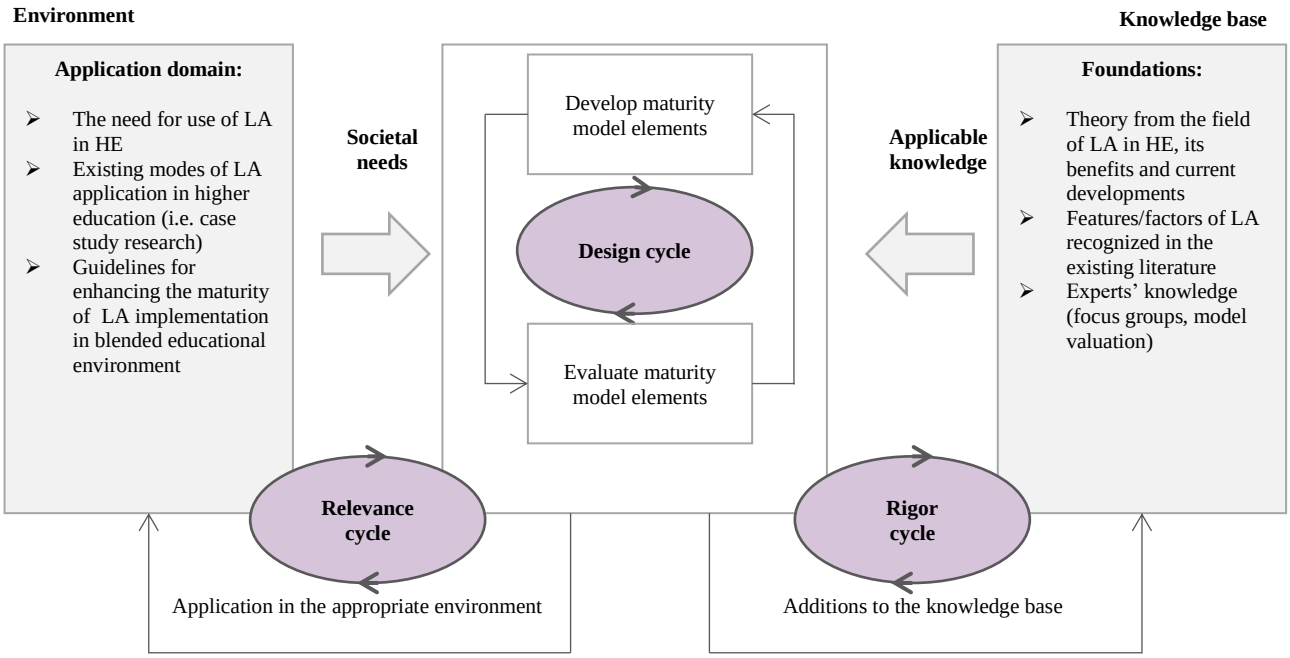

Figure 1. Design science research model for the development of maturity model - LA adoption maturity framework (LAAMF) in blended educational environment (adapted to LA from [23][24]) [1]

- 3) The design model is the most comprehensive step in LAAMF development, as it considers the combination of different research methods and multi-methodological and iterative procedures. It is important to stress that this step depends on the results of the previous two steps. Methods that might be used in the model design process include multi-criteria decision making (MCDM) methods, the AHP and the SNAP [26], brainstorming, focus groups, interviews, card sorting, and case study research, etc. They will include both rigor (evident from the use of such theoretical knowledge as scientific literature and expert knowledge in different phases of the model design) and relevance (review of relevant strategic documents and projects related to the application of LA in HE). In this step, LAAMF will be operationalized in the form of a survey or rubric. This will enable practical evaluation of the framework.
- 4) **Evaluating the design** is an iterative process that should be done in combination with step 3), which answers the requirement on *evaluation*. The evaluation of the LAAMF design will be done in two phases: a validity check and a reliability check. Expert evaluations, and focus groups with stakeholders will be used in this step. Methods for assessment of reliability and validity of the developed instruments will depend on the type of instrument [27]. LAAMF reliability will be assessed by testing the framework through case studies at several HEIs.
- 5) **Reflect the evolution** is the final step that indicates the changing nature of the environment in which LAAMF will be applied and, accordingly, the need for the redefinition of the framework in the future.

Requirement *Target publication of results* will be met through all five steps of LAAMF design as the results of certain steps will be published through appropriate scientific and professional publications and events.

IV. LAAMF CONCEPT

In this section, we present a very early concept (sketch) of future LAAMF that was developed based on the literature review, previous research, experience, and knowledge of project experts in the development of maturity models [18], [28], as well as the result of focus groups conducted in project meetings of HELA. The LAAMF consists of elements that are grouped into areas. Certain areas and elements are not equally important considering the HE maturity. To gather the importance of areas/elements, we need to apply multi-criteria decision-making methods, such as the analytic hierarchy process (AHP [29]), the analytic network process (ANP [30]–[32]), the decision-making trial and evaluation laboratory (DEMATEL [33], [34]), the social network analysis process (SNAP [26], [35], [36]) or other, for example, the Decision Expert method (DEX [37], [38]). The first four mentioned methods aggregate both qualitative and quantitative aspects of the research problem (here measuring the maturity) and result with quantitative results (areas/elements weighs, HEI element maturity). In opposite, the DEX method also aggregates both qualitative and quantitative aspects but result with the qualitative result. Since the area of LA maturity is characterized by the existence of influences (dependencies) between the elements/areas, it is much more convenient to apply network methods (ANP, SNAP, DEMATEL) [39], than hierarchical methods (AHP and DEX). However, applying the network methods is very complex if there are many elements in the systems, so – in the implementation phase of LAAMF development, it will be decided on the method(s) and/or their combinations that will be applied [40]–[42].

The second important aspect of the LAAMF model is to determine how the maturity of each element will be gathered considering the real state in HEI. There are several possible ways for that: direct assessment at the quantitative scale or a much more convenient rubric [43], [44]. In the rubric, the values of HEIs per each element should be described, and in the evaluation phase, the evaluator has to select the description that fits the state in HEI the best.

Finally, the question is how to aggregate the areas/elements weights, and HEI results into the total HEI maturity level. Again, several approaches are offered: composite index approach [45], identifying the most often rubric value from the assessment phase, or the weakest link principle [46].

The early sketch of the LAAMF is presented in Table 1. The LAAMF consists of *k* areas that cover a different

TABLE 1. LAAMF CONCEPT

Areas, elements and their weights				**Rubric description**					**HEI state (evaluation)**	**Total element priority**
Area	**Area weight**	**Element**	**Element weight**	**1**	**2**	**3**	**4**	**5**		
$Area_1$	$W(A_1)$	E_{11}	$W(E_{11})$						HE_{11}	TEP_{11}
		E_{12}	$W(E_{12})$						HE_{12}	TEP_{12}
		E_{13}	$W(E_{13})$						HE_{13}	TEP_{13}
		…								
		E_{1n}	$W(E_{1n})$						HE_{1n}	TEP_{1n}
$Area_2$	$W(A_2)$	E_{21}	$W(E_{21})$						HE_{21}	TEP_{21}
		…								
		E_{2m}	$W(E_{2m})$						HE_{2m}	TEP_{2m}
…										
$Area_k$	$W(A_k)$	E_{k1}	$W(E_{k1})$						HE_{k1}	TEP_{k1}
		…								
		E_{kl}	$W(E_{kl})$						HE_{kl}	TEP_{kl}
									Total maturity	**TM**

number of elements. Each area and each element has its weight. Each element can be described through five qualitative characterizations (maturity levels). One of them is selected in the evaluation phase that fits the particular HEI state the best. By multiplying the area weight, element weight and HEI state (transformed into a quantitative number), we can calculate total element priority for certain HEI. Finally, by summing all total element priorities, we can obtain the total maturity of an HEI.

V. Conclusion

In this paper, we presented a methodology for developing a maturity model that can support LA adoption in HEIs, related in particular to blended learning – Learning Analytics Adoption Maturity Framework (LAAFM). Creating this kind of framework is necessary to optimize the LA implementation process in HEIs since attempts of nonsystematic, noncomprehensive and ad-hoc LA implementation can result in expensive ventures that are not entirely effective and/or reusable. Even more, the need for a systematic approach to LA in a blended learning environment increased with the appearance of the COVID-19 pandemic that shifted teaching and learning processes in HEI to the online learning environment to a large extent.

Respecting the DSRP paradigm and proven methodologies and requirements for the development of a maturity model with application in HE, in this paper, we offered a methodology design for creating the LAAFM for blended learning in HEIs. Further work within the HELA project will ensure the final development of the proposed comprehensive LAAFM.

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