Review

on a doctoral defense procedure featuring a PhD Thesis entitled:

„INSTRUMENTS FOR MANAGEMENT AND EVALUATION APPLYING A USER-CENTERED APPROACH FOR THE DESIGN OF VIDEO GAMES FOR EDUCATION“

for awarding the PhD Degree

to

Candidate: **…… Yavor Ivanov Dankov …….,**

In the Professional field 4.6 Informatics and Computer Sciences,

(Doctoral program "Computer Sciences")

Section: **„Computation Systems,**

Faculty of Mathematics and Informatics (FMI),

Sofia University „St.. Kl. Ohridski“ (SU).

REVIEWER: Dr. Boris Blagovestov Shishkov, Assoc. Prof. in Context-Aware Information Systems at IMI – Bulgarian Academy of Sciences, Assoc. Prof. in Enterprise Information Systems at the University of Library Studies and Information Technologies.

I was elected a reviewer in the announced procedure on the 5th of April 2022, at a Scientific Jury meeting (Protocol No. 1/12.01.2022), summoned by Order № РД-38-170 / 30.3.2022 of the Rector of SU. In my capacity of reviewer, I have received the documents (in electronic form) as included in the application package of Yavor Dankov: the PhD Thesis, the Abstract (in both Bulgarian and English languages), publications an copies of certificates.

1. **General characteristics of the PhD Thesis and the presented materials**

   The Candidate has published a PhD Thesis of 134 pages, entitled „Instruments for Management and Evaluation Applying a User-Centered Approach for the Design of Video Games for Education” and organized in 6 chapters as follows: Introduction (6-8), The study area – state-of-the-art (9-37), Taxonomy of Instruments for Management and Evaluation (IME) of design of Video Games for Education (VGE) (38-54), Application of the specialized TIME-VGE taxonomy in the Apogee platform (55-91), Validation of the designed instruments (92-113), Conclusions (114-115), with 24 Figures presented as well as 17 tables and an appendix. The references list is featuring 130 items in English, from which it is seen that the Author is referring not only to books written by outstanding authors, such as Clark Abt but also to many journal/conference articles, including 10+ papers co-authored by Yavor Dankov. The contribution of his thesis is in several directions: (i) He has conducted analyses featuring IME concerning the design of VGE; (ii) He has proposed an IME taxonomy accordingly; (iii) He has developed particular instruments in this regard,

featuring especially maze games, and related to this – he has proposed an architecture concerning a video games design platform.

2. About the Candidate

In 2016, Yavor Ivanov Dankov has graduated (Master of Economics and Business) from the University of National and World Economy. Afterwards he was appointed as a PhD Student at SU and he has completed the 3-years doctoral course. Currently, Yavor Dankov works as Assistant Professor at FMI. He has published 14 articles that are SCOPUS-indexed; his SCOPUS h-index is 4.

I used to know Yavor Dankov and his former Supervisor, the late Assoc. Prof. Dr. Birov – they have contributed to a symposium that I have established and currently lead, namely BMSD – Business Modeling and Software Design (www.is-bmsd.org): (i) 11 years ago today, I was honored to attend in Sofia the inspiring BMSD'11 presentation of Prof. Birov, touching upon the model-driven software engineering; (ii) 7 years later, the PhD student of Prof. Birov, Yavor Dankov, has presented in Vienna his BMSD'18 paper entitled „General Architectural Framework for Business Visual Analytics" making it to the Springer proceedings where 35 papers were selected for publication, out of 76 submissions. The BMSD'18 presentation of Yavor Dankov was of high quality, considering Business Visual Analytics architectures. As it can be seen, his interests in the area of VISUAL ANALYTICS have evolved such that this is currently combined with a focus on video games.

3. Thorough analysis concerning the Author's scientific and application-oriented contributions as reflected in the PhD Thesis complemented by relevant publications

Being currently popular and widely accessible, video games are rooted in the technical and technological progress of the last two decades, that is in several directions: (i) Software technology advances (compared to the state-of-the-art at the end of the last century) concerning re-use, interoperability, and so on; (ii) Sensor technology developments; (iii) Progress related to telecommunications and the (wireless) computer networks; (iv) Multimedia developments; (v) "Miniaturization" of devices. This makes it possible for current video games to be used in a context-aware and flexible way, "where we are" and in tune with the current BYOD concept (Bring Your Own Device). Hence, it is not surprising that video games that concern ENTERTAINMENT appear to be hugely profitable for developers. This all leads to an increasing societal impact with regard to video games, that concerns not only individuals but also the Society as a whole. This in turn poses new REQUIREMENTS with respect to video games, in line with their societal impact: they are expected to stick to public values. This represents a justification as it concerns VGE – they are expected to be engaging and attractive, allowing for content incorporation featuring different disciplines. What's more – the abovementioned technical and technological developments give inspiring NEW POSSIBILITIES, especially relevant to learning, allowing for: (a) Adaptive and personalized learning; (b) Remote usage of resources; (c) Wide engagement in the learning process of many people, essentially considering their interests and capabilities, regardless of where they are; and so on.

As it can be seen from the PhD Thesis of Yavor Dankov as well as from the abovementioned publications, his research focus is exactly in that direction. This makes his work actual and relevant as it concerns problems that relate to current societal developments, in particular: developments in students' learning (at schools and universities) and employees' upskilling (at institutions and corporations).

An actual problem (considered in the thesis) concerns the need for instruments and platforms that allow for an AUTOMATED DESIGN OF VGE, with a particular stress on the instruments concerning the design, analysis, and evaluation of MAZE VGE. Such designs would have not only a conceptual perspective (concerning the games themselves) but also a practical (application) perspective – concerning the management and evaluation of the design.

The thesis mainly focuses on the **software instruments that allow for managing, designing, and evaluating VGE**.

The Candidate has studied and analyzed the design of VGE, instruments that allow for managing and designing such games, as well as relevant analytical instruments and corresponding concepts.

Taking this into account, the subject of study has been defined as follows: the analysis, design, integration (within a software architecture), and validation of concrete software instruments that allow for managing the design and evaluating maze VGE.

The research goal is defined as follows: **the design and validation of user-centered instruments that allow for managing the design and evaluating maze VGE, supported by a dedicated taxonomy developed accordingly**.

Considering the stated goal, the scientific contribution concerning Yavor Dankov's PhD Thesis, is in the following directions (as mentioned at the end of Section 1 of the current document):

- A **systematic analysis** has been conducted, featuring the **management and evaluation of the design of VGE**, reflected in the chapter entitled „The study area – state-of-the-art"; the first part of the chapter puts an adequate conceptual foundation as it concerns video games in general – touching upon concepts, such as game semantics, game process, meta-rules, genre and mechanics of games, dimensions and perspectives, avatar, and so on. On that basis, VGE have been analyzed as well as related categorizations – taking into account the way of creation, the way of distribution, technical indicators, the target, and so on, reaching as far as **serious games** and the DESIGN of VGE, as well as the identification of actual PROBLEMS in the area, including as follows: the need for a multi-disciplinary approach and the involvement of experts in pedagogy; the need for balance between the targeting of differentiated users (which represent a small "market") on one hand, and the economic viability concerning the developers, on the other hand; content personalization; and so on. The Candidate has considered three VGE design approaches, namely: „User-centered", „Player-centered", and „Game-centered". Based on this, the following around ten pages in the chapter present an ANALYSIS concerning the instruments that allow for managing the design of VGE, positioning them as ANALYTICAL instruments – categorized as Descriptive, Predictive, and Prescriptive; they have been thoroughly analyzed, with Table 2 depicting summarized characteristics concerning key categories of analytical instruments.

- A **general taxonomy** has been proposed, concerning instruments that allow for managing and evaluating the design of video games, as well as a **specialized taxonomy** featuring the management and evaluation of the (user-centered) design particularly of maze VGE. The general taxonomy's potentials mainly concern supporting the design of video games from different genres – from serious (education-oriented) video games to entertainment-oriented ones. On that basis, the specialized TIMED-VGE taxonomy has been worked out, featuring software instruments – they are directed towards the management and evaluation of the design of VGE. This taxonomy may be considered relevant as it concerns any maze VGE. All this is presented in the chapter entitled "Taxonomy of Instruments for Management and Evaluation of the design of VGE" that is of 17 pages and I would like to especially mention Figure 6 that reflects a proposed categorization of software instruments, that goes in two directions as follows – ASSISTIVE and ANALYTICAL. It is enriched, considering the specialized taxonomy, as visualized in Figure 7. In the remaining of the chapter, those two categories have been thoroughly analyzed.
- In the thesis, designs have been proposed, featuring: (i) Instruments that allow for managing and evaluating the design of maze VGE, complemented by specifications of functional requirements and business processes. (ii) A software architecture of the APOGEE platform that is about the creation of video games. The designed instruments are integrated with the platform that in turn has been "instantiated" based on this architecture. This is presented on 30 pages in the chapter entitled „Application of the specialized TIME-VGE taxonomy in the Apogee platform". This platform allows for the automated creation of maze VGE, this coming through a design (the information concerning the game is structured by means of an XML document), the game generation itself (via the Unity3D environment), and validation realized by the game designer(s). The TIMED-VGE taxonomy (mentioned above) is used; a user-oriented approach is followed – this is visualized in Figure 10. It is stressed upon the functional requirements towards the instruments that allow for managing and evaluating the design of maze VGE; this is done not only with regard to the category „Design Management" but also with regard to the categories „Game Design Validation and Game Generation", „Analytical Instruments for Education" (and category „Game-related Analytical Instruments"), and „Analytical User-related Instruments" (those categories are rooted in the taxonomy). The related to this BUSINESS PROCESS MODELING has been considered as well and a key visualization in this regard is presented in Figure 11; it offers a workflow featuring (among other things) the issue of authentication and the user profiling, establishing that depending on his or her profile, the user could either play or work on the design, or perform administrative tasks; all this is supported by the so called analytical and assistive instruments (mentioned above); the corresponding databases are considered as well as well as the generation of log files in the course of a game session (the analytical and assistive instruments are considered in more details further on in the chapter). Finally, the SOFTWARE ARCHITECTURE of the platform is visualized in Figure 15.

As it concerns proof-of-principle / proof-of-concept with regard to what is proposed in the thesis, partial validation is provided in the chapter entitled „Validation of the designed instruments", that is based

on so called „PRACTICAL EXPERIMENTS“, realized by means of questionaries. The data concerning registered answers has been processed and the results – presented and discussed at the end of the chapter.

4. Results' approbation

As already mentioned, there are 10+ articles submitted in the PhD application package of Yavor Dankov – those are articles in which he is a co-author; most of those articles are directly related to the content of the thesis, for example: Bontchev, B., Antonova, A. and Dankov, Y. (2022). Educational Video Game Design Using Personalized Learning Scenarios. In: Gervasi O. et al. (eds) Computational Science and Its Applications – ICCSA 2020, ICCSA 2020, Lecture Notes in Computer Science, Springer, Cham, vol 12254, pp 829–845. https://doi.org/10.1007/978-3-030-58817-5-59 - this publication concerns the business process model presented in Figure 11. Further, I would like to especially mention the following publication: Bontchev, B., Antonova, A., Terzieva, V. and Dankov, Y. (2022). "Let Us Save Venice"—An Educational Online Maze Game for Climate Resilience. In International Scientific Journal: Sustainability, 2022, vol 14, Issue 7, ISSN 2071-1050, MDPI, Switzerland. https://doi.org/10.3390/su14010007 (those two publications are reflected in the thesis' references list) as well as a '22 publication that is not reflected in the thesis' references list: Terzieva, V.; Bontchev, B.; Dankov, Y.; Paunova-Hubenova, E. How to Tailor Educational Maze Games: The Student's Preferences. Sustainability 2022, 14, 6794. https://doi.org/10.3390/su14116794.

Most of the presented publications (related to the thesis) in which Yavor Dankov is a co-author, are SCOPUS-indexed – hence he meets the requirements of both ADASRB and SU. In most of those publications Yavor Ivanov Dankov is a co-author (not the only author) – in those cases I assume equal contribution for each of the co-authors.

There is no plagiarism of the scientific works, proven accordingly following the legally established order.

5. Qualities of the abstract

In my opinion, the abstract meets in general the relevant requirements and correctly reflects the content of the thesis. I would like to mention nevertheless that I find the introductory part of the abstract insufficiently convincing. That is because in my opinion a clear and explicit statement is missing about the original scientific contribution of the thesis and how it relates to the identified problem. I have found a contribution statement on Page 35 but it is not related to the problem statement. So – I there is a problem statement in the introductory part of the abstract, without discussing the contribution, while at the end of the document there is a brief contribution statement, without discussing how the contribution relates to the identified problems.

6. Critical comments and recommendations

Yavor Dankov's research is actual and interesting and his PhD Thesis is complemented by SCOPUS-indexed publications. All this makes a good impression. Nevertheless, I have some critical comments at

the same time, that mostly concern the quality of the thesis, still stating my opinion that the main components (chapters) of the thesis are content-full and adequately related among each other:

- In my opinion, the thesis' Introduction is insufficiently convincing (similarly to the introductory part of the abstract, discussed above). It is my view (and I also see this to be recommended in Bulgaria and I see it in The Netherlands and other European countries) that the Introduction of a PhD thesis is to be more coherent and more thorough than what is presented in the abovementioned thesis that is of, two pages, not counting the third page that contains the outline of the remaining of the thesis. An actual problem is presented and analyzed; then the subject of study and the thesis goals are just mentioned. I reckon that it is important a PhD thesis' Introduction to come through the following: the area of research is to be introduced; an identified actual research problem is to be presented; it is to be mentioned what has been done by others (related work), concerning the problem and where exactly the thesis' focus is (and why); the thesis' goals are to be defined and it is to be explained how are those goals realized; it is to be stated what the original scientific contribution (derived from the formulated goals) is and how it (the contribution) is expected to (partially) contribute to „solving" the identified problem.
- Here and there in the thesis the reader would encounter long, too wordy, and insufficiently clear sentences; I think that a careful proofread would lead to improvements (in terms of clarity and conciseness) of some paragraphs.
- In some of the thesis' chapters, there are explanations that (partially) overlap with explanations done already in a previous chapter, for example: regarding the TIMED-VGE taxonomy, I find different partial explanations that are scattered in different places in chapters two and three.
- In some chapters of the thesis there are pieces of text where it remains insufficiently clear whether the content being presented represents author's original contribution or it is the author team's contribution, or state-of-the art information. Being convinced that all three should "co-exist" in harmony within a PhD thesis, I would recommend more clarity in this regard.
- It remains insufficiently clear why on one hand, the presented research is so strongly leaning towards the learning application domain but on the other hand, a solid pedagogy "component" is missing, such that it becomes clearer how exactly video games could be integrated in the process of educating students and/or upskilling employees. I would recommend to Yavor Dankov for the future to either build up further his research work from multi-disciplinary and interdisciplinary perspectives, in collaboration with experts in pedagogy, or to go beyond the "dominance" of the abovementioned application domain, for the sake of giving a broader perspective as it concerns the applicability of video games, to include application domains, such as transport, disruptive events, and so on.

7. Conclusions

After I have familiarized myself with the PhD Thesis and publications, submitted for the doctoral defense procedure and on the basis of my analyzing their significance as well as the scientific and application-

oriented contributions reflected in them, I **acknowledge** that the presented thesis and publications, and their corresponding quality and originality (as it concerns the results and achievements reflected in them) meet the requirements of ADASRB, the Regulation of Application of the ADASRB, the corresponding SU regulations as it concerns the awarding of PhD degrees in the Professional field 4.6 Informatics and Computer Sciences, (Doctoral program "Computer Sciences"). In particular, the Candidate meets the min. national requirements in the professional field and there is no plagiarism proven as it concerns the submitted materials.

Hence, I **suggest** that the Scientific Jury awards Yavor Ivanov Dankov with the educational and science degree of "Doctor" in the Professional field 4.6 Informatics and Computer Sciences.

04.06.2022

Reviewer: .....
(Assoc. Prof. Dr. Boris Shishkov)