FEATURES OF SUSTAINABILITY IN PRE SCHOOLERS MORAL LEARNING SERIOUS GAME

Hairulliza Mohamad Judi, Nurul Syifa Ramli,

Wan Nur Iffah Wan Nazri

Fakulti Teknologi dan Sains Maklumat

Universiti Kebangsaan Malaysia

ABSTRACT

Game development framework that applies the theory of learning and embodied the theory in games is required to guide developers in delivering moral learning content to preschool children. Sustainability features in game development framework should be identified to address the identified learning content, instructional design and game features. Sustainable related issues such as eco impact elements and application reusability receive minor concerns among game developers. It shows warrant for more studies to support the game industry practices including sustainable issues and eco aspects.With the wide use of serious game to enhance learning, it is important to make serious game application development continuously visible and sustainable. The objective of this paper is to propose Sustainable and green model of game learning application for pre-schoolers. The proposed model is expected to address the debate of how particular sustainable game development methodology can be comprehended, flexibly applied in development contexts in an optimized way.

1. INTRODUCTION

The world has started giving attention to the depletion and exploitation of earth resources.

Part of the strategies aim to find temporary and long term solution to sustain a balanced

environment, and to identify ways to cater to current and future of related needs

(Katsaliaki & Mustafee 2012, 2015). In software development, a profound solution to this call adopts sustainable development practices. Sustainable software development concerns with the procedure to optimize the use of natural resources in software development cycle (Arslan 2021; Deshmukh et al. 2021). Sustainable software development concerns the responsible interaction with the natural resources and protect global ecosystems to support health and wellbeing in the society.

Sustainable software development makes use of innovative integration of ICT and education, such as using serious games (Paracha et al. 2013). Serious games offer great opportunities to enhance teaching and training by integrating education and entertainment. The benefits of serious games enable users to engage in learning without compromising enjoyment and fun experience (Paracha et al. 2019). Serious games are also able to attract users from preschool children group through the urge to transfer the knowledge and experience gathered through games to real-world applications (Ouariachi et al. 2018). Therefore, many educators and developers make use of serious game to augment instructions in various real-life environments, such as moral education for preschool children.

Preschool education is an important element in a nation's development to ensure a sustainable social and economic development of the country (Lamrani et al. 2018). Moral education for preschool children aims to up bring future generations by instilling necessary values and conducts (Catalano et al. 2014). Moral education instils the system of values, to create awareness of preschool children in the context of sociological, psychological, pedagogical and organizational capabilities to interact with fellow members in society. Children's educational games are beneficial to a child's growth and development, moral values and social practices. Therefore, it is important for the present

generation to preserve, promote and relive moral values and to pass them on to the next generation (Kun & Nayan 2019).

There are always needs to establish the most effective ways of forming a general system of values in preschool children. Various forms of methods of moral and ethical education of three to six year-old children would contribute to the child's optimal understanding of basic moral principles of mankind (Zdanevych et al. 2020). The learning content requires careful identification of learning resources to ensure sustainable concept to be applied in real life context (Paracha et al. 2013). Among the challenges in the serious game design include the need to consider contextual learning experience, a learning experience platforms for sustainable social and daily conduct with others (Neimann et al. 2020). Another important issue is the measurement of the learning impact over time, i.e. the ability of sustaining learning in the medium and long period (Catalano et al. 2014).

Due to high dependability to learning technology, a pedagogical model that support sustainable learning is somehow forgotten (Serdyukov 2017). The scenario leads to the threat that the technology may block educational innovations instead of facilitate them to help children learning. The questions of how particular sustainable game learning application models of game development methodology can be comprehended, flexibly applied in development contexts in an optimized way have not been taken seriously enough.

Serious game development requires an understanding of sustainable features independent from software development. Although software development and game development share a number of features in their process models, the software engineering models work successfully supporting the software development, unlike in the game development

(Kasurinen et al. 2017). Software engineering principle and practice application for game development is frequently unsuccessful. In terms of development methodology, many serious game designers and developers express a gap that have not taken into account some pedagogical and psychological concepts to different learning environments (Ávila-pesántez et al. 2017). The need to integrate educational innovation to address learning problems that merge game elements with educational content to ensure serious game usefulness is not entirely fulfilled.

Game development framework that applies the theory of learning and embodied the theory in games is required to guide developers in delivering learning content to users. Sustainability features in game development framework should be identified using a systematic learning procedure to also address learning content, instructional design and game features (Nadiah & Norasikin 2020). Sustainable related issues such as eco impact elements and application reusability receive minor concerns among game developers. It shows warrant for more studies to support the game industry practices including sustainable issues and eco aspects (Kasurinen et al. 2017).

This research embarks to understand sustainable aspects of serious game development in the context of moral education learning for preschool children. With the wide use of serious game to enhance learning, it is important to make serious game application development continuously visible and sustainable. The objective of this paper is to propose Sustainable and green model of game learning application for pre-schoolers.

2. SUSTAINABLE SERIOUS GAME APPLICATION DEVELOPMENT

Tremendous progression in serious game application development includes the recent attention to the positive influence of playing games has taken place (Christen et al. 2012).

More attention is given on studies focusing on the use of games in the teaching moral values among younger generation including preschool children (Khan & Rasheed 2020). Educating these group may consider serious games to create meaningful and exciting learning environments to engage children with interesting ethical concept (Anwar et al. 2020).

To create an engaging learning environment using serious game application is a challenging task in the game application industry (Law et al. 2011). Sustainable game development plays an important role to drive the successful and practical game development to cater current and future energy resources needs (Kasurinen et al. 2017). Part of the sustainable development applies Green IT principles to promote good practice of environmentally sustainable computing and IT. The principles aim to support developing an application that will remain relevant for a long time (Law et al. 2011). In this case, this action would involve continuous system update, changes in market dynamics, changes in people's needs and demands and the increasing in competition.

Green Hosting appear to offer sustainable facilities as the technology are developing rapidly in the last decade (Montagliani 2020). The daily use of technology services such as websites, social media platforms and applications has led to an increase in power consumption (Karyotakis & Antonopoulos 2021). The consumption of energy to run game application suggest optimise data host, to minimise power consumption. The principles also apply to unnecessary data and redundant files such as videos and photos. Suggestion to use green hosting may support to put back 3 times the power they consume into the grid in form of renewable energy..

2.1. Agile Methodology In Sustainable Software Development

Developing sustainable software are important as it is to create a life-long application that meets users' needs and at the same time to reduce ecological impacts (Pappa & Pannese 2010). Green and sustainable software is the production of software that avoiding direct or indirect negative impact on economy, society and environment. Changes are needed in the existing methodology that can motivate towards green and sustainable software by reducing carbon emission, power, and paper usage (Hygerth 2016).

Most models that has already existed does not consider the Requirement, Design, Coding, Testing and Implementation for green software engineering. Agile methodology is the most suitable approach in developing sustainable software. This methodology requires less efforts for development and consumes less energy (Rashid & Khan 2018). Furthermore, agile methodology requires lots of communication and collaboration between software engineers and stakeholders, making it go through less changes. This also helps in reducing the manpower and workload in order to develop a sustainable software systems (Kasurinen et al. 2017). Thus, this proves that agile methods are energy efficient.

Agile methods also promote less documentation. As this method requires more face-to-face communication between stakeholders and developers, written documentation are less used (Rashid & Khan 2016). This is because it tends to avoid non-important deliverables during software development which caused the greener methodology. More focuses on the working software may avoid immense documentation. Agile method also implements continuous validation where important elements are being reviewed in every stages. This gives the developers confidence their product meets the user's requirements, thus increases the chances of producing sustainable application systems (Rashid & Khan 2018).

3.   SUSTAINABLE GAME MODEL

Sustainable development calls for deliberate design of eco-friendly and sustainable products to support a cohesive use of IT in human lives. Green game learning does not only focus on digital games, but representing a serious game that engage people and change behaviour, and apply it to sustainability issues. Elaborated sustainability issues in game development focus on six problems (Carolina et al. 2014). 1) "Architectural debt" from a poor design phase which can affects the lifespan of the game, 2) Undisclosed details about how agile process integrate specific software engineering practices, 3) High number of code parts which are thrown away instead of being reused, 4) Maintenance delay for non-cloud games (the game is only maintained if it is successful), 5) Development of physically demanding output characterized by long hours work, and lastly 6) Suboptimal effects from games testing such as motion sickness.

To overcome the game development problems, sustainability principles could be applied (Penzenstadler et al. 2012). 1) A responsible use of ecological, human and financial resources, 2) Quality and knowledge management continuously monitor the development process, 3) Green IT principle is used and sustainable produced hardware components and 4) Responsible on the impact in society, economy and ecology. As of now, there isn't a specific body of knowledge of sustainability in the software engineering which can provide specific guidance to fulfil all sustainability aspects from a development perspective. However, common research areas such as green IT, efficient algorithms, code recycling, smart grids, agile practices and knowledge management could be effectively used to improve on the sustainability aspects

4.   SUSTAINABILITY FEATURES IN MORAL EDUCATION GAME

In educational game development, sustainability features play significant roles to gain the learning impact (Nadiah & Norasikin 2020) as the game approach contain elements to promote application of high moral values in real life (Flogie et al. 2020). The sustainability features are described as six elements.

First, the game should act as tutor so users may learn how to play from the game itself to sustain assistance in "just-in-time" fashion. Players learn and gain incredible learning experience by accomplishing the game. Preschool children have the ability to explore the game with minimum instruction given that the application is easy to be learned (Penzenstadler & Fleischmann 2011).

Second, it is necessary for the game to contain clear learning objective including the types of players, suitable game interface, clear learning progress and game status. Practical information such as the remaining time left should be delivered to players to keep track of the current state of the game and continuously engage in the game. State of the game can work in terms of some response from the game, such as acknowledging certain actions and progress (Nikolova & Georgiev 2021).

Third, appropriate instructions should be given so the significant learning activities of the game could be delivered systematically. The instruction is supported by carefully selected and integrated media including animation to produce the desired learning results. Using physical effort for an exercise stimulates learning more successfully than reading or listening only, and the end result is better when using such technologies and devices (Nikolova & Georgiev 2021).

Forth, fun instructional development in the game to incorporate entertaining and enjoyable learning activities. The appropriate instruction helps to create engagement in

informal learning which involves emotions and imaginations to boost meaningful concept construction. The serious game incorporates sound cognitive and learning that include a fun learning experience (Alaoui et al. 2021).

Fifth, stimulating and self-contained game without any dependency to any manuals, and facilitator. Without stimulating element, the target audience will fail to keep their attention, unsatisfied with the experience and provide a poor rating, and eventually fail economically. The capability of game to stimulate children's interests in learning should benefit young learners. By providing interactive learning contents, exploration, and quizzes in the form of high-quality multimedia elements with a user-friendly interface that integrate fun learning element.(Mohamed Zain et al. 2020).

Sixth, game products are designed close-to-reality. The learning environment that considers the player's familiar surrounding enhance their acceptance and absorbent. The learning background may suits the context of psychological, pedagogical, organizational, and methodical capabilities of the players (Zdanevych et al. 2020). Young people can easily establish a connection to their real life when they are given enough indicators. This feature appears to be important in teaching about sustainable product design because raising awareness and changing attitudes is more essential for this topic than learning simple facts.

5. CONCLUSIONS AND FUTURE WORK

The design and development of moral education serious game for preschool children requires a concern regarding sustainability element. Such element is even more important when the targeted users of this product represent a group who will bring changes and give impact on our future community to serve their functions harmonily. Sustainable game

development calls for deliberate design of eco-friendly and sustainable products to support a cohesive use of IT in human lives. The intended moral education game does not only focus on fun and entertainment learning through digital game, but representing a serious game that engage people and change behaviour.

In this paper, we have described how we have embedded sustainable features in the serious game by considering the common problems in serious game development and utilising sustainable principles to address the difficulties. We have adapted the sustainable features to better fit with the process of serious game development and support the learning aim to motivate the children to apply high moral conducts in everyday dealings in modern life as young Muslims. We have proposed the instrument for the sustainable model to be tested among experts in the future.

REFERENCES

[1]   Lee, S.hyun. & Kim Mi Na, (2008) "This is my paper", ABC *Transactions on ECE*, Vol. 10, No. 5, pp120-122.
[2]   Gizem, Aksahya & Ayese, Ozcan (2009) *Coomunications & Networks*, Network Books, ABC Publishers.
Alaoui, Y., Achaak, L. El & Bouhorma, M. 2021. Methodology to Develop Serious Games for Primary Schools. *Ahmed, Mohamed Ben Santos, Domingos Sergeyeva, Olga (eds) Innovations in Smart Cities Applications*, hlm. Vol. 4, 195–205. doi:10.1007/978-3-030-66840-2
Anwar, N., Kristiadi, D. P., Novezar, F. A., Tanto, P. A., Septha, K., Ardhia, P., Evan, K., et al. 2020. Learning Math through Mobile Game for Primary School Students. *Sylwan* 164(5): 346–352.
Arslan, B. 2021. *Ecological Sustainability in Software Development: The Case of a Technical Consultancy Firm*. KTH Royal Institute of Technology, Sweden.
Ávila-pesántez, D., Rivera, L. A. & Alban, M. S. 2017. Approaches for Serious Game Design : A Systematic Literature Review (December).
Carolina, N., Hill, E. M.-, Zimmerman, T. & Nagappan, N. 2014. Cowboys , Ankle Sprains , and Keepers of Quality : How Is Video Game Development Different from Software Development? *Proceedings of the 36th International Conference on Software Engineering*, hlm. 1–11.
Catalano, C. E., Luccini, A. M. & Mortara, M. 2014. Guidelines for an effective design of serious games. *International Journal of Serious Games* 1(1). doi:10.17083/ijsg.v1i1.8
Christen, M., Faller, F., Götz, U. & Müller, C. 2012. Serious Moral Games. Zurich:

Institute for Design Research. Retrieved from https://www.zhdk.ch/fileadmin/_migrated/content_uploads/SeriousMoralGames_Christen_Faller_Goetz_Mueller_2013_en.pdf%5Cnhttp://www.zhdk.ch/index.php?id=39457

Deshmukh, M., Jain, A. & Arun, P. 2021. Fuzzy Inference System for Evaluating Leanness index of Software organizations Turkish Journal of Computer and Mathematics Education. *Turkish Journal of Computer and Mathematics Education* 12(13): 285–298.

Flogie, A., Aberšek, B., Aberšek, M. K., Lanyi, C. S. & Pesek, I. 2020. Development and evaluation of intelligent serious games for children with learning difficulties: Observational study. *JMIR Serious Games* 8(2): 1–16. doi:10.2196/13190

Hygerth, H. 2016. Sustainable Software Engineering: An Investigation Into the Technical Sustainability Dimension. *Master of Science Thesis Stockholm, Sweden*.

Karyotakis, M. A. & Antonopoulos, N. 2021. Web communication: A content analysis of green hosting companies. *Sustainability (Switzerland)* 13(2): 1–15. doi:10.3390/su13020495

Kasurinen, J., Palacin-Silva, M. & Vanhala, E. 2017. What Concerns Game Developers? A Study on Game Development Processes, Sustainability and Metrics. *International Workshop on Emerging Trends in Software Metrics, WETSoM* 15–21. doi:10.1109/WETSoM.2017.3

Katsaliaki, K. & Mustafee, N. 2012. A Survey of Serious Games on Sustainable Development. *Proceedings - Winter Simulation Conference*.

Katsaliaki, K. & Mustafee, N. 2015. Edutainment for Sustainable Development: A Survey of Games in the Field. *Simulation and Gaming* 46(6): 647–672. doi:10.1177/1046878114552166

Khan, F. Q. & Rasheed, S. 2020. Investigating the Use of 3D Mobile Games for Teaching Ethics & Basics to Children. *J. Inf. Commun. Technol. Robot. Appl* 11(1): 65–75.

Kun, O. H. & Nayan, S. M. 2019. Jom Main! (Let's Play!): Promoting The Values Of Malaysia Traditional Children's Games Through The Media. *Media Literacy and Academic Research* 2(2): 52–84.

Lamrani, R., Abdelwahed, E. H., Chraibi, S., Qassimi, S. & Hafidi, M. 2018. Gamification and serious games based learning for early childhood in rural areas. *Communications in Computer and Information Science*, hlm. Vol. 929. Springer International Publishing. doi:10.1007/978-3-030-02852-7_7

Law, F. L., Kasirun, Z. M. & Gan, C. K. 2011. Gamification towards sustainable mobile application. *2011 5th Malaysian Conference in Software Engineering, MySEC 2011* (2): 349–353. doi:10.1109/MySEC.2011.6140696

Mohamed Zain, N. Z., Mohamad Yatim, M. H., Husna Azizan, U. & Baharum, H. 2020. Development of a Mobile Learning Application of Malay Vocabulary for Lower Secondary School Level. *The International journal of Multimedia & Its Applications* 12(6): 1–16. doi:10.5121/ijma.2020.12601

Montagliani, B. 2020. 8 principles of Green IT applied to App Development. *Green IT*.

Nadiah, R. & Norasikin, F. 2020. The Importance of Game Development Framework (GDF): Proposing an Islamic Game Development Framework with Sustainability Features. *International Journal of Academic Research in Business and Social Sciences* 10(3): 633–644. doi:10.6007/ijarbss/v10-i3/7078

Neimann, T. D., Felix, J. J., Reeves, S. & Shliakhovchuk, E. 2020. Stagnancy Issues

and Change Initiatives for Global Education in the Digital Age, hlm. Vol. IGI Global. doi:10.4018/978-1-7998-4993-3

Nikolova, A. & Georgiev, V. 2021. Using Serious Games in E-Learning for Kids. *INTED2021 Proceedings* 1(March): 621–625. doi:10.21125/inted.2021.0155

Ouariachi, T., Elving, W. J. L. & Pierie, F. 2018. Playing for a sustainable future: The case of We Energy Game as an educational practice. *Sustainability (Switzerland)* 10(10). doi:10.3390/su10103639

Pappa, D. & Pannese, L. 2010. Effective design and evaluation of serious games: The case of the e-VITA project. *Communications in Computer and Information Science* 111 CCIS(PART 1): 225–237. doi:10.1007/978-3-642-16318-0_26

Paracha, S., Clawson, K., Mitsche, N., Hall, L. & Jehanzeb, S. 2019. Usability Evaluation of a Serious Game Intervention on Japanese School Bullying. *College of Asia Pacific Studies* (February): 3–16.

Paracha, S., Jehanzeb, S. & Yoshie, O. 2013. A Serious Game for Inculcating Islamic Values in Children. *Proceedings - 2013 Taibah University International Conference on Advances in Information Technology for the Holy Quran and Its Sciences, NOORIC 2013*, hlm. 172–177. doi:10.1109/NOORIC.2013.44

Penzenstadler, B., Bauer, V., Calero, C. & Franch, X. 2012. Sustainability in software engineering: A systematic literature review. *IET Seminar Digest* 2012(1): 32–41. doi:10.1049/ic.2012.0004

Penzenstadler, B. & Fleischmann, A. 2011. Teach sustainability in software engineering? *2011 24th IEEE-CS Conference on Software Engineering Education and Training, CSEE and T 2011 - Proceedings* (May 2011): 454–458. doi:10.1109/CSEET.2011.5876124

Rashid, N. & Khan, S. U. 2016. Developing green and sustainable software using agile methods in global software development: Risk factors for vendors. *ENASE 2016 - Proceedings of the 11th International Conference on Evaluation of Novel Software Approaches to Software Engineering* (Enase): 247–253. doi:10.5220/0005913802470253

Rashid, N. & Khan, S. U. 2018. Using agile methods for the development of green and sustainable software: Success factors for GSD vendors. *Journal of Software: Evolution and Process* 30(8): 1–28. doi:10.1002/smr.1927

Serdyukov, P. 2017. Innovation in education: what works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning* 10(1): 4–33. doi:10.1108/jrit-10-2016-0007

Zdanevych, L. V., Syrova, Y. V., Kolosova, S. V., Pyvovarenko, M. S. & Kurhannikova, O. O. 2020. Instilling the system of values in preschool children in the cultural and educational space. *Universal Journal of Educational Research* 8(11 B): 5991–5999. doi:10.13189/ujer.2020.082235