Serious Financial Games for Youth: An Evolutionary Action Design Science Approach

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Completed Research

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Abstract

Supporting lifelong financial education through games for youth requires intricate design consideration of immersion, persuasion, personalization, and evolution. This is important as it ensures the knowledge and skills learnt from the games can be applied in the long term. Furthermore, it serves as a foundation to enable learning, and to learn how to learn. Studying this phenomenon may require calibrated design science methodologies to appropriately address those challenges. Traditionally, a design science approach focuses on creating research artefacts limited to specific timeframes and socio-technological interactions. However, when a design study targets on the orientation of lifelong learning, extant research on design methodologies seem incompatible. This paper proposes methodological contributions that are philosophically oriented in design and are also compatible with lifelong learning.

Keywords

Serious games, youth, financial education, financial literacy, evolutionary design science, action design science, design science.

Introduction

Financial Illiteracy amongst Youth

Several studies have acknowledged financial illiteracy as a serious problem that is detrimental not only to the individual but also to society at large (Fernandes et al. 2014; Lusardi and Mitchell 2011a; Sherraden and Ansong 2016). Practically, the evidence is all around us as we see vulnerable households ill-equipped to deal with complex financial problems and situations including bankruptcy and high debt levels (Lusardi and Mitchell 2011a). While dealing with these situations can not be fully solved by financial education alone, research has shown that financial illiteracy is correlated with less wealthy households (Lusardi 2012; Lusardi and Mitchelli 2007). Research also suggests that there is a strong case for the betterment of financial education (Fox et al. 2005). In the US alone, Anthes (2004) claims that financial illiteracy is not only a disaster but a 'perfect opportunity'. Globally, every nation can also do a better job to ensure households are financially literate (Lusardi and Mitchell 2011a).

The damage of financial illiteracy is even more harmful for youth. Several studies have raised the urgency to protect the youth from foreseeable financial damage through financial education (Garg and Singh 2018; Johnson and Sherraden 2007). Research shows that one-third of young adults possess low levels of financial literacy (Lusardi et al. 2010). If youth of today remain unconscious of effective financial decision making, in the future, several harmful effects are bound to occur in our ageing populations, especially to the majority who are unprepared for retirement (Lusardi and Mitchell 2011b; Lusardi and Mitchelli 2007).

Using Serious Games as a Viable Medium of Financial Education for Youth

Several studies on serious games reveal that they are an effective medium of education (Lee et al. 2011; Michael and Chen 2005; Wouters et al. 2013). In fact, Michael and Chen (2005) argue that serious games are capable of educating, training and transforming individuals and groups. In light of youth's financial illiteracy today, research in this area is promising. While existing research shows that serious games can be effective facilitators of financial education (Liu et al. 2011; Rasco et al. 2020), games are also attractive to youth (Salen and Tekinbaş 2008). All in all, the intersection of serious games, financial education and youth seem to be an appropriate arena for research. Such research is further promising as we see the possibilities of extending gaming architecture into learning analytic systems, which may further enhance the viability of serious games as a financial educational medium (Chatti et al. 2013; Siemens 2012). For instance, the use of badges, points, leaderboard positions and other analytical configurations can further accentuate the effectiveness of serious games (Mekler et al. 2013).

An Immersive, Persuasive, Personalized and Evolutionary Approach

To enable an effective use of financial serious games on youth, this research argues that an immersive, persuasive, personalized, and evolutionary approach is necessary (Figure 1). Immersion is central to capturing and retaining youth's attention towards financial literacy and financial decision-making. Youth acclimation to the digital environment makes games and other digital content more comfortable and relatable for them (Davidson and Goldberg 2009). Therefore, introducing and reinforcing financial education concepts, which are initially unfamiliar to youth, can be realized through immersive games. Persuasion is paramount for outcomes such as influencing youth to reverse unsustainable and ineffective spending and saving habits (Ferrara 2013). Effective persuasion can be instrumental in redirecting and repurposing technology for the betterment of youth financial wellbeing. Personalization contributes to the betterment of immersion and persuasion. It is also important in bridging the gamification elements to unique requirements of youth, resulting in enhanced motivation for learning and transformation (Bakkes et al. 2012). Personalization leverages the effects of immersion and persuasion through continuous adjustment and mutual evolution in both the user and the game, resulting in a dynamic environment for change. The evolutionary component leverages the presence of persuasion, immersion and personalization through interweaving the concept with different loops of learning (Argyris and Schön 1978; Georges et al. 1999) and educational objectives (Bloom 1956). The nature of the evolutionary component is such that learning within the artefacts can explicitly support lifelong education rather than at a single point in time. The integration of these four key concepts, immersion, persuasion, personalization, and evolution, envision a prescriptive change for the future of financial education using serious games amongst youth.
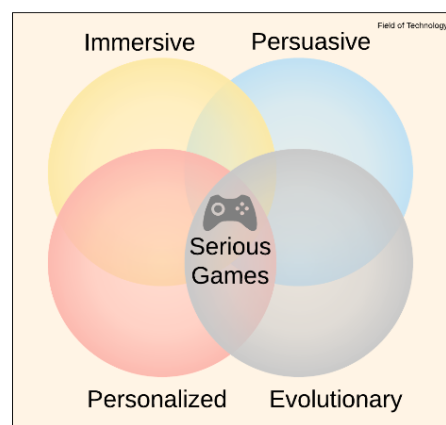

Figure 1. Immersive Persuasive Personalized and Evolutionary Games

This study was explicated using design science to create serious financial games. However, through using the immersive, persuasive, personalized, and evolutionary approach, the study seems incompatible with extant methodologies despite being created through design practices. This paper will then uncover how this incompatibility calls for new contributions in design methodologies that allow for evolving circumstances

especially scenarios that enable lifelong learning. The structure of this paper is as follows. The introduction section clarifies the focus of the study and the overall background of the research. Subsequently, the research objectives of the overall study are elaborated in the following section. The research objectives are then elucidated to rationalize the research philosophy. Next, upon justifying the appropriate use of the design philosophy, the significant components required by the study are expounded. Last, based on the requirements of the study, the methodological contributions of this paper are proposed.

Research Objectives

The interdisciplinary consideration of immersive, persuasive, personalized, and evolutionary aspects of gamification is paramount in molding the following research objectives:

1) Observe literature and systems related to immersive, persuasive, and personalized financial literacy games among young decision-makers.
2) Build and refine concepts, models, processes, and frameworks based on the observations of the literature and systems related to immersive, persuasive, and personalized financial literacy games among young decision-makers.
3) Design and implement systems artefacts in reflection of the theories and observations.
4) Evaluate artefacts created for the purpose of the study.
5) Generalise the concepts, models, processes, frameworks, architectures, and the systems to other novice financial decision-makers.
6) Evolve, and allow the capacity for ongoing open-source evolution within the concepts, models, processes, frameworks, architectures, and the systems, to cover the current study and other generalised studies at a deeper level.

Research Philosophy

Following on from our research objectives, it is best to understand the philosophical conditions that are most appropriate to our study. To do this, we will justify the appropriateness of design science research philosophy in the context of our objectives. Essentially, the study aims to solve the problems of financial illiteracy amongst youth through the provision of design artefacts. The design artefacts are then expected to help youth learn financial education, so that the skills and knowledge that they gain can be applied in the long term. Further, the design artefacts are also expected to guide youth into lifelong learning of financial education. This is so that they can eventually learn how to learn through the guidance of the design artefacts. Moreover, this study uses games and gamification as vehicles for financial education for youth.

At first glance, our study appears as a traditional design science study. It showcases many typical features through using artefacts with the concept of games and gamification as the central element of the design artefacts. The research effort also has shown great appreciation of the contemporary design process. The adductive and deductive contemplation of the environment of youth has led us to use games and gamification as suitable for problem-solving for financial education (Takeda et al. 1990). Ontologically, a design science research seems appropriate because our study deals with alternative world-states, which is characteristic of design philosophy (Gregg et al. 2001). A young person may be financially literate having grown up in a well-informed household; however simultaneously, the study also accommodates for youth that may be considered financially illiterate. This applies towards a multitude of possibilities depending on factors such as household influence and personal characteristics. These conditions are relevant to ontological value of all the research objectives, nevertheless it is most important for objective 3 whereby the artefacts are designed and implemented. Given that the research aims to problem-solve around the idea of youth financial illiteracy, a design paradigm appears to be more ontologically appropriate as opposed to positivist or interpretivist paradigms. Our study is also conducive (Gregg et al. 2001) in describing the epistemological conditions for design. When we create game-related artefacts as problem solving vehicles for the financial illiteracy of youth, we are actively creating the context environment which is interactive and objectively constrained to the artefacts. The subjection of learning games onto youth is a known objective constraint, and the improvement of literacy and decision-making is constrained by factors such as the boundaries of play, the gaming environment, and the length of time during play. A 'knowing through making' approach is used, because artefacts are created and tested actively with the environment (Vaishnavi, Kuechler, et al. 2004). This idea works in parallel to the repetitive and addictive nature of

games. At one level this emphasizes the appropriateness of design science because repetitive gaming sessions can be used as separate subjects of interpretation. The research should eventually and progressively learn the educational effects of the game related artefacts the more frequently youth play or interact with them. Within the conditions of these objectives, the research nevertheless appears to be supported by design science philosophy.

The contribution of this study is that it aims to *evolve* and support the possibilities of lifelong learning. Designing for such a scenario seems to extend the boundaries of a design science philosophy. Design science research is explicitly described "as very similar to the action research methodology of the interpretive paradigm; however, the time frame of design science research construction is enormously foreshortened relative to the social group interactions typical of action research" (Vaishnavi, Kuechler, et al. 2004). Under this description, one may argue that our study, which focuses on artefacts that exhibit an appreciation for lifelong learning (and thus, lifelong interactions), does not limit or shorten the breadth of influence of its artefacts to a limited scope in time or interactions. Despite this, our study nevertheless stands on the philosophical pillars of design science. Therefore, we believe that there is a case to be made that design science should explicitly support the possibilities of continuous evolution through longer periods of time, and through countless numbers of interactions. An evolutionary concept needs to be made explicit within design science frameworks to encourage and inspire support for similar works that aim to design artefacts that are sustainable and practical for long term use.

Multi-methodological Approach

To support the persuasive, immersive, personalizable, and evolutionary critical design that the research requires, the following components emanating from traditionally accepted frameworks have been considered (Nunamaker et al. 1990; Sein et al. 2011; Stringer 2013).

Observation: Although it is not entirely specified in the framework (Nunamaker et al. 1990) where the method begins, observation is the most logical beginning in grasping the general outlook of the a design situation (Bai et al. 2013). Observation includes research methodologies like case studies, surveys, and field studies to gather information. Observation also further builds and refines initial hypothesis, and strengthens the researchers' 'lens' so that sufficient contextual and environmental conditions of their research can be reported to judge the limitation of the conclusions (Nunamaker et al. 1990).

Theory Building: Theory building can be defined as 'learning through the act of building' (Kuechler and Vaishnavi 2008). It encompasses the development of new ideas and concepts through conceptual frameworks, new methods, and/or models. Based on preliminary observations, theories can be generated from both qualitative and quantitative perspectives. Through repetitive iterations within the framework, the theory can be effectively reinforced.

Experimentation: Experiments are fundamentally guided by theory and are carried out considering system development. Experimentation may help validate preliminary theories and systems or provoke new findings that could lead to many reconsiderations within the research. In any way, experimentation can be instrumental for ironing out hypotheses in the research.

System Development: System development is paramount as the development serves as the 'proof-of-concept' for the research. Furthermore, the artefacts become the focus of the research for continuous development at which experimentation is done to build and refine current theories. Following the strengths of using multiple methodologies, the conducive design science research methodology is most appropriate to meet our research objectives while allowing for multiple paradigms.

Experiential Learning, Reflection, Generalization and Evolution: The unique interaction between an implemented, critically designed artefact and its prospective user, in a stretch of lifelong learning is best conceptualized by the founding principles of action research (Stringer 2013), as well as action design research (Sein et al. 2011). A focus on experiential learning is crucial in our study which can be correlated to action research's unique focus on the practitioner's actions rather than their statements (Avison et al. 1999). A dedicated case for reflection is also paramount, which is explicitly demonstrated in the action design framework (Sein et al. 2011). Lastly, the recursive and generalizable nature of learning and evolution can be closely aligned to the dynamic interaction of the action researcher and the environment at hand.

These components are significantly important to this research, however, current frameworks fall short in appropriately highlighting all these factors. Therefore, the following design methods have been constructed to explicitly support the requirements of the overall research.

Evolutionary Design Science Research

With inspiration from Nunamaker et al. (1990), an Evolutionary Design Science Research approach is proposed to support the requirements of the overall study (Figure 2).
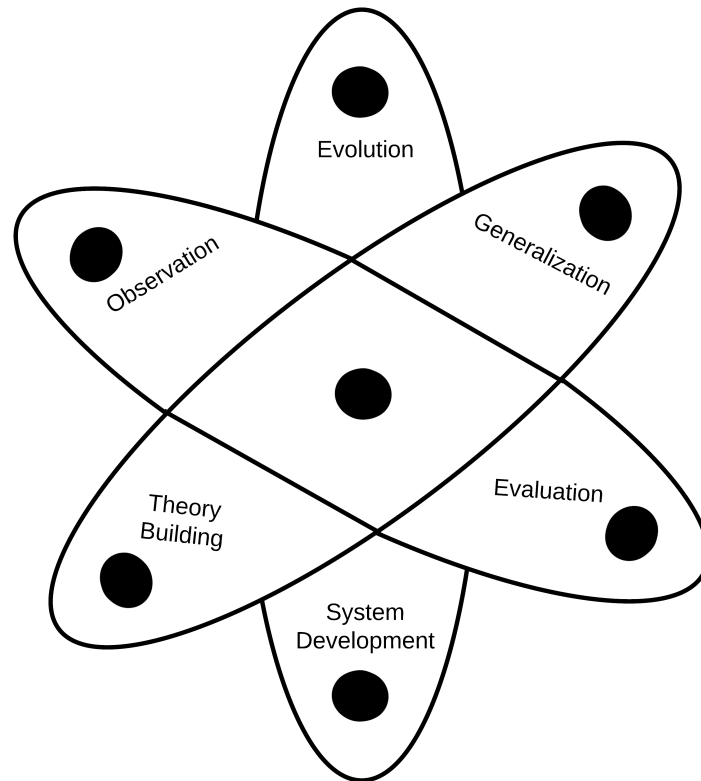

Figure 2. Evolutionary Design Science, Adapted from Nunamaker et al. (1990)

Observation: Observe literature and systems related to immersive, persuasive, and personalized financial literacy games among young decision-makers. A preliminary observation is mandatory for understanding the status quo with financial literacy interventionist programs. The first objective concerns the examination of contemporary solutions and the closest alternatives of immersive, persuasive, and personalized serious games within the context of financial literacy and decision-making. The research aims to discover the presence, and the extent to which, serious games are applied in dedication to educating the youth demographic.

Theory Building: Build and refine theory based on the observations of the literature and systems related to immersive, persuasive, and personalized financial literacy games among young decision-makers. The second objective builds upon the first, through the development of theories regarding the patterns and effects of immersive, persuasive, and personalized serious games among young decision-makers. While solutions may inexactly exist at different levels, the theories will be analyzed and built from the ground up through preliminary investigations. Through consistent and careful reiterations, the theories will be refined based on several experiments.

System Development: Design and implement systems artefacts in reflection of the theories and observations. As the design focus, system development will manifest to reflect the theories and observations considered during the study. The implemented system development will try to address the shortcomings of contemporary financial literacy programs. The system development will then measure its results based on immersiveness, persuasiveness, and personalization metrics.

Evaluation: Evaluate artefacts created for the purpose of the study. Several design evaluation tools from literature are used to benchmark the artefacts created in this study. Furthermore, the pillars of immersiveness, persuasiveness, and personalization will be used in deep consideration when evaluating the artefacts. Relevant stakeholders like students, teachers, game developers, and academics will be used to evaluate the artefacts' suitability to the purpose of the study.

Generalization: Generalize the concepts, models, processes, frameworks, architectures, and the systems to other novice financial decision-makers. Given that the lack of effective financial literacy and decision-making are universal problems, the study will be generalized to cover other novice financial decision-makers of different backgrounds and characteristics. For example, the study can be generalized to cover ethnic minorities such as the Māori people of New Zealand to convey the distinct immersive, persuasive, and personalized appeal.

Evolution: Evolve and allow the capacity for ongoing open source evolution, within the concepts, models, processes, frameworks, architectures, and the systems to cover the current study, and other generalized studies at a deeper level. The findings of the initial study will serve as the baseline from which it can be imitated for the betterment of the current, and other generalized studies. Other domains such as engineering, business studies, and medical science should be able to use the concepts, models, processes, frameworks, architectures, and the systems at an open source level so they can openly be evolved and facilitate concurrent evolution within the platform and the phenomena.

Evolutionary Action Design Science Research

Taking inspiration from the Action Design Science Framework (Sein et al. 2011), the Evolutionary Action Design Framework (Figure 3) takes a step forward through explicitly emphasizing the evolutionary capabilities of action design through multiple sequential growth frameworks.
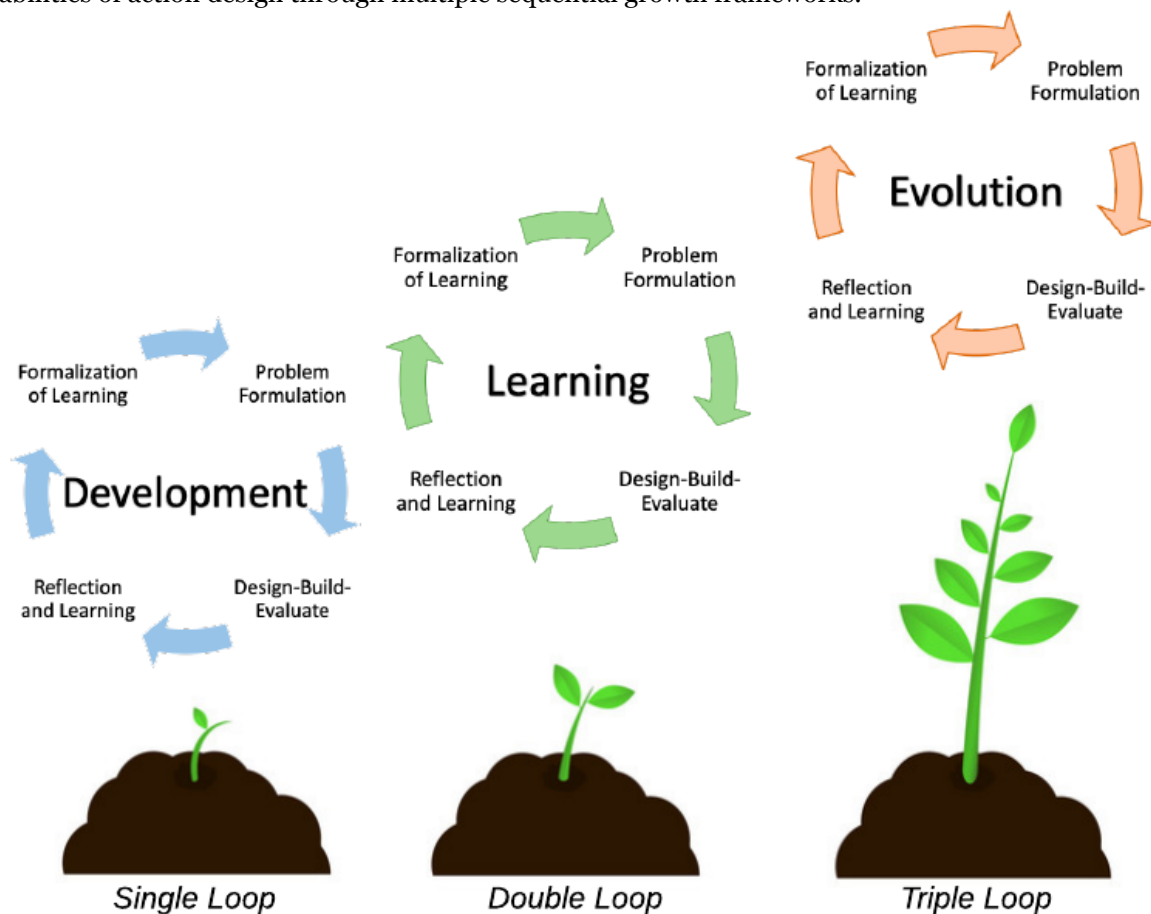

Figure 3. Evolutionary Action Design Science, Adapted from Sein et al. (2011)

A notable addition within this framework is the upward progression from a *development* cycle, to a *learning* cycle, and finally, to an *evolution* cycle. Each cycle is preempted by a loop of learning, with *development* focusing on a single loop; *learning* focusing on a double loop; and *evolution* with a triple loop. Inherent within each step is a reflective of learning tasks (Argyris and Schön 1978; Bloom 1956; Georges et al. 1999).

The framework begins with problem formulation. Subsequently, it is followed by designing, building and evaluation. Afterwards, reflection and learning are initiated. The last stage is the formalization of learning. This same elemental structure applies for each phase (Figure 4).
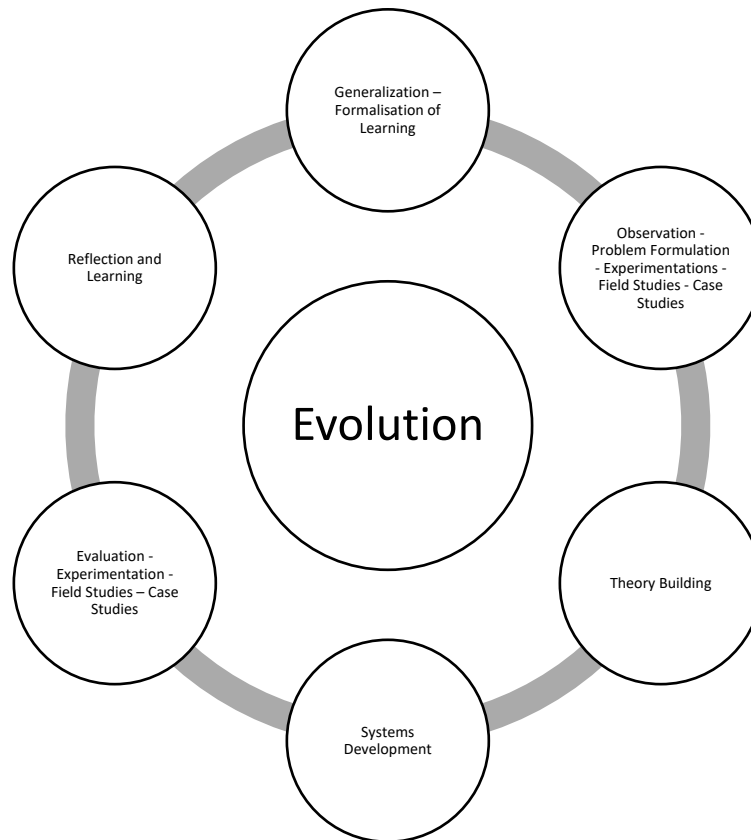

Figure 4. Elemental Iterative Cycle Embodied in Each Phase

Problem Formulation

The first step focuses on problem formulation. This involves investigating the financial status quo of youth and identifying the problems and issues that exist.

Principle 1 - Practice-Inspired Research: The first principle of problem formulation is that the research must be practice inspired. This research is essentially driven by contemporary educational practice that we observe in schools. Financial literacy is taught at a basic level with limited consideration over lifelong learning. We have limited confidence in the spending and saving habits of youth given that financial decision-making skills are primarily learnt at home. There is a huge variance among youth financial literacy depending on how informed, or financially concerned their households are. Learning institutions have a huge opportunity to embed gamified financial literacy modules during school, especially when they are primarily accommodating for the younger generation. Since the younger generation are closely associated with play mechanics, as with the rise of serious games, this opportunity to improve financial educational practice has never been more important.

Principle 2 - Theory-Ingrained approach: The second principle of problem formulation is that a theory-ingrained approach should be adopted. The research will leverage several theories from learning, decision-making, psychology, and gamification to support the overall design science process.

Design, Build and Evaluate

The second step focuses on designing, building, and evaluating research artefacts. Following the two principles of reciprocal shaping and mutually influential roles, the design-build-evaluate cycles will focus on a concurrent iterative progression within the steps while growing alongside its dynamic environment.

Principle 3 - Reciprocal shaping: It is important that this study focus on the two inseparable influences mutually exerted by the phenomena (financial reality of youth), and the growing artefacts. The interpretation of the status quo financial literacy environment shall help in designing the artefacts and alternatively, the artefacts will seek to serve in solving the problems of financial literacy for youth. Reciprocal shaping allows for increasing the understanding of the artefact and financial literacy through fluidly reflecting across both domains. For example, the study aims to work closely with student gamers to understand the implementation of financial literacy games within their schooling expectations. Consequently, the demands of the environment i.e. the requirements of the educators, students, and the developers (which will be discussed in the following principle) will also aid in shaping the research artefacts.

Principle 4 - Mutually influential roles: It is also important to consider the unique requirements of the roles, as well as their interconnectedness and collaborative dynamics. This is quite important in our approach towards financial literacy which contain students, teachers, and developers as the main stakeholders. From the perspective of the game developer, it is mandatory to understand how teachers and students prefer to use the system. Simultaneously, the teacher would have their own preference for the specific use of the systems, as with students. A mutually open environment within the gamification system is envisioned to allow for a concurrent designing and building of user interfaces. Reporting systems, feedback outputs, and timely reflection are examples of effective mechanisms to facilitate a holistic approach on the varying roles at play.

Principle 5 - Authentic and concurrent evaluation: Evaluation occurs throughout, and it is highly important that it is integral and concurrent to designing and building. There may be evaluation cycles during the alpha version and they would be formative in nature, however, subsequent beta cycles tend to be summative. As much as evaluation is about refinement, it is also about assessing value and the utility outcomes. Authenticity is key to make sure that the evaluation is fair, reasonable, and worthwhile. To ensure that this principle is acknowledged, authentic and concurrent evaluate will be undertaken with relevant evaluators.

Reflection and learning

Reflection and learning are most prominent in the framework as it involves the thorough consolidation of all work to produce, anticipate, and determine worthwhile subsequent reiterations.

Principle 6 - Guided emergence: While the preliminary design, carefully ingrained with theory, is important in the emergence of the artefact, so will the ongoing shaping of financial literacy's growth, stakeholders and other relevant perspectives be used to guide the emergence of the financial literacy artefact. The concurrent, authentic evaluation will keep the efforts honest and fully symbolic and relevant to the financial literacy domain.

Formalization of learning

To satisfy its purpose as research, which is to disseminate knowledge, it is paramount that the findings are formalized so others can benefit from the learning outcomes of this study. Journals and conference papers are the main formalized outputs of this research.

Principle 7 - Generalized outcomes: While financial literacy is an important domain in our research, the results can catered for other evolutionary outcomes to cover other educational modules and target other novice decision-makers. Ultimately, the generalization of the gamification of education can be transferrable across several domains.

Conclusion

In this paper we proposed an evolutionary design science research approach. The conceptualization was motivated by several methodological issues with realizing the study's research objectives through the application of a specific methodology. A multi-methodological, research philosophy was adopted that integrated multiple methods to avoid the paradigmatic problems in supporting our research in immersive, persuasive, personalized, and evolutionary financial games. To support this research several components such as experiential learning, reflection, and evolution needed to be explicit within the chosen research approach. Given traditional design science frameworks focused on research artefacts that solve a particular research problem at a point in time, new research frameworks are proposed in this paper. Evolutionary design science and action design science provide methodologies that allows individuals and groups within the study to dynamically interact with the prototype, evolve and facilitate different loops of learning as well as supporting the embedded learning objectives (Bloom 1956). This paper proposes methodologies that are philosophically oriented in design and compatible with lifelong learning.

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