Gamified learning analytics: An initial outline of design concept synergies from two fields

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Abstract

Technology advancement has dynamically improved the ability to conduct research on large amounts of data and produce innovative ways to engage students. This work-in-progress paper presents tentative research proposals devised from two related and emerging fields: learning analytics and educational gamification. We highlight three shared concepts – processes and elements of development (design), institutional actors and practitioners (stakeholders), and perceptions about usability and adoption (acceptance). We explore the unique nature of each field pertaining to these concepts. Further, we explore how these fields intersect and present opportunities for implementing design that can be beneficial to researchers and practitioners currently working at the interaction between the fields. We also want to bring awareness to the potential synergies that the combination of these fields presents.

Keywords

Gamification, Learning Analytics, Synthesis, Conceptual, Narrative review, Design, Stakeholder, User, Acceptance, Adoption

1. Introduction

Learning Analytics (LA) and Educational Gamification (EG) are two fields that have previously been developed as two parallel constructs. Since the 2010s, EG and LA have rapidly evolved in education research [1], [2]. However, until recently, the fields have had separate expansion paths. Today, more attention has been directed towards their intersection, indicating a growing interest and value in finding synergies between the fields.

In the Nordics, there is an ongoing tendency of academic-industrial cooperation in researching[1,2] and productizing EG and Serious Games (SG)[3]. Correspondingly, there is a rising educational technology industry[4] and game industry[5] in the region. By outlining predominant conceptual denominators between

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[1]An ongoing co-founded PhD project Bergen Science Center VilVite, University of Bergen and Turbo Tape Games exploring effects from narratives in SG.

[2] Finnish LudoCraft, Danish Serious Games Interactive and Norwegian Kahoot*!* is all outcomes of research and PhD project at Scandinavian Universities.

[3] HolonIQ (2020) *HolonIQ Nordic-Baltic EdTech 50: HolonIQ's annual list of the most innovative EdTech startups across the Nordic-Baltic region*.

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EG and LA on the basis that the two fields are operating in the same context, this paper aims to benefit from the Nordics in particular and worldwide in general, practitioners and scholars of both fields respectably. Addressing these specific concepts, we intend to pave the way for upcoming collaborations, prevent loss of resources while enabling the development and innovation of learning technology towards a fusion of LA and EG, advancing both the academic and industry field.

LA is an emerging multidisciplinary research field [3]. The field has a strong community rooted in the Society for Learning Analytics Research (SoLAR), and its emergence can be traced back to the announcement of the First International Conference on Learning Analytics & Knowledge (LAK) in 2011 [4], [5]. Currently, one of the most cited papers defines LA as: "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" [5 p.31]. LAs educational approach collects, analyses, and visualises student data based on interactions and engagement with digital tools in a Learning Environment (LE) [5]. LA provides a dynamic understanding of the learning process by visualising student behaviours [6], [7].

The LA field's underpinning application provides dynamic insights and improves students' learning outcomes based on the collection and analysis of data from their interaction with digital tools in a LE. This premise has sparked a growing interest for LA in the educational sectors [8].

Initially, gamification was deployed as a marketing strategy but has emerged in various business [9] and research fields [10]. Gamification has also been adapted for educational purposes, where learning tools such as Duolingo, Khan Academy and Kahoot signal an emerging large gamified educational technology industry. Today, education is the largest research field for gamification [10].

EG aims to enhance student engagement and performance in a LE by adding game design elements such as collecting badges, setting goals, or collaborating in learning missions. The game design elements are based on active user participation, staged exploration and instant feedback rather than passive user determination and observation [11]. These traits are often conceptual qualities with potential in a LE as educational tools [12]. The widespread implementation of gamification in a LE has been explained in terms of its intuitive fit with education, as gamification shares similarities with formative assessment principles of step-by-step progression and obtaining feedback for each step [10].

EG and LA share many similarities regarding their opportunities in a LE. Both fields empower students and facilitate improved learning outcomes by providing multimodal feedback on digital behaviours [13]. Moreover, they both focus on enhancing various stakeholders' outcomes in a LE [2], [14], [15]. The similar aims of LA and EG indicate that integration would be beneficial, as displayed by recent intersectional work that used LA methods to personalise game elements facilitating higher student engagement [16] or successfully designing an entire learning management system (LMS) based on EG and LA elements [13].

However, the fields are stipulated with complications in both business and academia: EG deals with the novelty effect [17], [18], student exploitation and manipulation[19], and the current need for guiding theories that enable longitudinal investigation [20]. Also, EG has been questioned regarding the knowledge transfer [21] and the complexities surrounding digital game-based learning in a school LE [22].

For LA, complications relate to privacy issues, consent and transparency, and the broader issues of datafication of higher education [23], [24]; 'black-box' technology and algorithmic decision-making [25].

By combining techniques and procedures from LA and EG, there is a potential to unfold an additional application dimension in education practice and research. Merging LA and EG could also entail severe ethical concerns for the practitioner and/or the researcher that needs further scrutiny. Both fields are surrounded by overly optimistic broadcasting with ready-to-go-to-market products that may not be sufficiently thought-through [26]–[28]. An initial theoretical integration of the two fields that can support and guide further research on the application of LA and EG is needed. Therefore, this conceptual paper outlines opportunities for researchers and practitioners to improve learning outcomes by combining LA and EG.

2. Conceptual Foundation and Concept Development

The paper builds on a narrative review [29] rooted in a synthesis outlook that focuses on summarisation, differentiation and integration [30]. This approach provides a framework for identifying theoretical commonalities between LA and EG by translating concepts for each field towards a common understanding [31].

Theoretically developing these areas may be helpful for both researchers and practitioners. The concepts were identified by contrasting two omnibuses from each field. From the field of LA, the Society for Learning Analytics Research (SoLAR) Handbook of Learning Analytics [32] while for EG, a special section on Gamification: Gameful Design, Research, and Applications in Computers in Human Behaviour [27] were used as a frame of reference and primary foundation for the conceptualisation and theory synthesis.

The Handbook of Learning Analytics is devised to display the current LA research field blending rigour, quality, interest and appeal [33]. The publication consists of several peer-reviewed papers (chapters) thematically categorised under four prevalent LA research field: (1) Foundational concepts – focusing on high-level concepts of LA; (2) Techniques and approaches – discussing critical methodologies and their development in LA; (3) Applications – Reviewing the methodologies together with several fields occurring in LA; and (4) Institutional Strategies & Systems Perspectives – addressing practical challenges implementing LA.

Similarly, the three prevailing research fields in gamification as laid out in Gamification: Gameful Design, Research, and Applications are: (1) Theory-driven empirical studies – outlining the current knowledge structure of the field; (2) Design methods – focusing on challenges, tools, and processes when designing gamification; and (3) Application areas – considering activities and a LE which lend themselves to being gamified and activities in a LE that do not.

The two publications have a similar raison d'etre to capture the current state and themes of the field's prevalent research and were published the same year, 2017, which is attractive because the scientific investigation of EG and LA shares approximately the same duration. The primary justification for choosing these two particular omnibuses as the foundation was their concurrence of focal research phenomenons [32] concerning the concepts design, stakeholders and acceptance in EG and LA. These concepts require further elaboration concerning scope, practice, unit of analysis, techniques, and conclusion in the intersection of LA and EG.

The SALSA (Search, AppraisaL, Synthesis and Analysis) framework [34] was used to construct the synthesis with four inclusion criteria: had to address design, stakeholders and acceptance, present a defined empirical or theoretical case, undergone a review process and constitute a valid contribution to the conceptual synthesis. If a manuscript had three of these four criteria without considerable overlap between domains, it was included in the analysis.

A limitation of the study is inherently linked to the omnibuses. First, their credibility towards encapsulating conceptual aspects of entire fields may be questioned. Second, LA and EG are two relatively novel and fast emerging fields. Thus, they are both evolving through academic research, and further, their development accelerates, which are both evolving through academic research and are thrust forward by a continuously accelerating evolving tech industry development. Knowing this, synthesising theoretical commonalities on agreed-upon prevailing concepts from 2017 is a shortcoming that may fail to capture recent conceptual developments in both fields. Having an awareness of these circumstances, the authors of this paper agreed that a narrative review that encompassed knowledge leading up to and preceding 2017 was necessary to improve this paper's rigour.

The authors of this article have inductively identified different conceptualisations of the focal research phenomenons in the omnibuses and exceeding research. Building on this knowledge, we argue that the prominent aspect of interest in the focal research phenomenons is best addressed as summarised, differentiated and integrated concepts for further investigation for practitioners and researchers alike.

3. Conceptual Foundation and Concept Development

The two representations of the research fields of EG and LA were translated to the research concepts design, stakeholders and acceptance, which are the focus for the conducted narrative review aiming to

synthesize the research intersection of EG and LA. Below, we present each concept separately, along with opportunities for implementing design. The design concept describes the process, the elements, and the rationale of their usage for specific purposes in a LE. The stakeholder concept describes the various institutional actors and practitioners that affect or are affected by the implementation of LA or EG. Lastly, the concept acceptance describes both adoption and stakeholders' perceptions regarding the usability and usefulness of LA or EG.

3.1. Design Elements and Process

During the first half of the 2010s, LA practitioners were mainly from "hard" disciplines (e.g., computer science, mathematics) [23], which, to some extent, attuned the field towards design thinking of LA instruments in the fields early days. Since then, LA has put significant effort into exploring the opportunities of design: the purposeful shaping of the human processes required in delivering and applying analytic tools, data, and reports as part of an educational environment [35]. Design in LA relates to three main dimensions: interaction and visualisation design, learning design, and study design [4].

Recently, the design of interactive visualisations, visual dashboards, employed to increase teachers' awareness of student progress and workflow manipulation, have received considerable attention in LA research [36] [6]. These dashboards serve as an example of LA with the potential for practitioner and research opportunities [6], [37], [38]. To a greater extent, there are opinions that LA research should synthesise with learning theory, e.g., Self-Regulated Learning (SRL) [39]. While perhaps not yet to an optimal degree [40], LA tools increasingly use pedagogical approaches and learning theories in their design, e.g., SRL, inquiry-based learning, and constructivist approaches such as collaborative learning [40][41]. Learning theories are also used to evaluate LA tools' design, where the primary focus is "whether the dashboard brings any benefit to learners" [42 p.37].

Learning design, "the practice of devising effective learning experiences aimed at achieving defined educational objectives in a given context" [43 p.221], has been long discussed in relation to LA [34]. This is not surprising, as LA can offer powerful tools and provide actionable measurements that can inform practice in a LE [43].

With footing in several design-focused fields (e.g., game studies, human-computer interaction, information systems), gamification research emphasises the design- process, context and practice [44]. Agreed upon skills required for designing EG are comprehensive and interdisciplinary, including game design, behavioural science, human learning and, preferably, the topic studied, although a best practice is yet to be discovered [44]–[46].

A characteristic of the gamification field is the frequent collaboration between academia and industry, which has facilitated the field's rapid development, provided valuable insights, produced various artefacts, and contributed to a surplus of quantitative gamification effect studies.

In EG, various practitioners' and scholars' design frameworks occur, from generic to more specific, composed differently, yet most focus on the LE and the students. The prime purpose of the design frameworks is to foster motivation towards a particular goal by using game design elements. The game design elements are accompanied by distinctive amplifying components of various characteristics, significance, and positions in the design framework. The amplifying components mainly originate from a broad spectrum of non-game disciplines and business fields, frequently motivational and social psychology [47], likewise organisational behaviour or behavioural economics [48].

Even though the design is extensive in EG, the field is neither fully understood, defined, or interpreted. One challenge is reproducing, e.g., an EG design to increase a course completion rate could play out well the first time but fail in subsequent attempts [45], [46], [49]. To address these issues, recently, gamification researchers have started to examine the gamification design elements systematically and to chart the distinct stages in a gamification implementation: ideation, user, design, context, project planning, implementation and evaluation. Distinguishing the stages of an EG project has visualised knowledge gaps, showing that the stages ideation, user, design, and context had an overabundance but less on project planning, implementation, and evaluation.

The recent design research in gamification has transformed the research community interest from whether gamification works to how it works [27]. By changing the field's fundamental research

questions from whether?, what? and why?, to how?, when?, as well as how and when not? sets the stage for a more comprehensive, theory-driven, hypothesis-testing and multidisciplinary research interest and approach towards gamification design.

3.2. User and Stakeholders

Implementing EG or LA in a LE involves several stakeholders such as students, teachers, educational providers and management, which are beneficial for implementing projects.

LA categorised stakeholders as data clients and data subjects [50], with the former describing beneficiaries of LA with authority to act on its products, and the latter the data suppliers, commonly the students. While the LA community prioritizes students and teachers as the main beneficiaries of LA tools [50], those are commonly the data subjects, while institutions emerge as the most common data clients [51]. The benefits for institutions and the related data clients reported in LA literature include: improving student retention, supporting informed decision making, increasing cost-effectiveness, understanding students' learning behaviours, and lastly, providing personalized assistance for students [15], [52]. LA applied in a digital LE is oriented towards monitoring/analysis and prediction/intervention [53], to the extent that even when learning theories such as SRL are utilized, the focus might remain on measurement rather than students' support [54]. This might be further problematic as the introduction to LA can possibly lead to changes in the behaviour of both educators and students [8]. The field acknowledges these above issues with a panel of international experts advocating for enhancing learning as the goal of interventions and prioritising the student as an audience [37].

Student-centered LA [55] is an approach including students "as equal partners in the collection, analysis and use of their data" [56 p.618]. Centring students is considered as an ethical way forward, as it acts to decrease student vulnerability and increase their agency [57].

LA research has recently started to address design from a user perspective, engaging students [58], [59]and teachers [60], [61] in co-design processes. Still, in a recent systematic review, a "lack of involvement of stakeholders and adoption of participatory or co-design approaches" [62 p.15] was observed, indicating the potential of such approaches for the future of the LA field.

In EG, and gamification in general, there is an emphasis on a user-centric approach both in practitioner [63], [64] and researcher literature e.g., [44], [46], [49]. In previous work on gamification, end-users' needs and requirements in the design process have been acknowledged to be fundamental. In a meta-study on gamification design frameworks, the most critical requirement identified was to "understand the user needs, motivation and behaviour as well as the characteristics of the context." [46 p.7]. The meta-study concluded that designing gamification without considering its compliance with its users' needs and perceptions may hinder its implementation and cause adverse side effects, such as discouragement or demotivation, even threatening the well-being of end-users, depending on the gamified LE. However, in EG studies, stakeholders other than the end-user receive limited attention [65], [66]. Transforming players to customer/user and vice versa has been addressed and problematised regarding its effect on manners, actions, understandings and expectations [67]. LAs accepted and adopted stakeholder-definition could provide a more robust definition than those practised and display a comprehensive research scope.

3.3. Acceptance and Adoption

LA research has investigated barriers and drivers to adoption at multiple levels (e.g., institutional, classroom, individual) and for various stakeholders. Adoption is influenced by factors relating to the institutional context, the strategy of their deployment, the stakeholders, and challenges at the intersection of the above [68]. Institutions are fundamental for LA adoption by providing supporting structures, such as integrated and trustworthy infrastructures and incentives or support in the usage of LA, as highlighted by faculty and advisors [69]. From a broad perspective, social challenges emerge as the most significant for LA adoption [67] and the multifaceted nature of the adoption process can be viewed as not merely a technical or pedagogical issue, but also as a "human challenge — cognitive, social, organizational, political" [70 p.2.] Further, due to the multiplicity of stakeholders, research on

LA adoption has incorporated perceptions of institutional leaders and senior management [67], as well as teachers and students, allowing for the identification of differences in perspectives [70]. Due to those differences, multi-stakeholder communication has been advocated for improving LA acceptance and adoption [71], as well as the inclusion of teachers and students in design processes [55], [60].

More recently, the focus has turned to the primary stakeholders (students and teachers) and studies, especially on LA dashboards, have begun more specifically addressing the notion of acceptance. For example, the technology acceptance model (TAM) [72] has been utilized to explore teachers' perspectives, finding that, somewhat surprisingly, greater perceived usefulness might not be translated to greater usage or acceptance of tools [73]. Under the same model, perceived ease of use emerges as an important challenge [74][75]. This finding might relate to the importance of the institutional context, available infrastructure, and teacher training [74].

Acceptance for LA also relates to its potential to provide quality information and feedback, with different needs identified for managers, teachers, and students [76]. Perceptions on LA as promoting student success also differ between stakeholders. Students view dashboards as useful at a broader level, e.g., assisting with the transition to university and management skills that are not course-specific [77]. That being said, the ability of LA to facilitate learning is crucial [78]. Research on how LA can support students' SRL shows the benefits of tools promoting awareness and reflection [42]; however, those goals do not necessarily imply that learning outcomes are achieved [40]. Allowing for some interactivity and social comparison has positive effects on student motivation [2], although suggestions of cautious usage of such comparisons with peers have not been absent [40, 42].

In EG, one current field of interest is the acceptance and adoption of gamification in a LE. Several studies on acceptance and adoption have used theories, frameworks and lenses from information technology, e.g., TAM, Unified theory of acceptance and use of technology (UTAUT) [79] and social studies, e.g., diffusion of innovations [80] and models adjusted for the research design.

Previous findings regarding higher education students' acceptance and adoption of EG indicate a positive attitude [81]–[83]. Factors that influenced students' acceptance and adoption were performance expectancy and effort expectancy [82], knowledge improvement, engagement, and playfulness [83], Learnability, reward and level of e-skills [81].

Overall, studies show a mixed impression of teachers' views on gamified digital tools in a LE. The teachers' acceptance and adoption of EG show discrepancies ranging from optimistic [84]–[86] to neutral/negative depending on condition [66], [87], [88]. In the studies reporting an optimistic attitude towards EG, few teachers had used EG in their LE. In the more neutral/negative reports, factors affecting teachers' acceptance and adoption appear to be related to LE and student dependent [66], [88]. Also, gamification's compatibility with the instructional content facilitates teacher reception [66], [87], [88]. Also, gamification's compatibility with the instructional content facilitates teacher reception [66], [89].

4. Implications, Future research, and Limitations

Even though gamification design research pioneered early in education, the extensive body of knowledge encircles (1) single university campus courses as research circumstances and (2) higher education students and teachers as research participants. This predicament is comparable to LA research regarding participants and circumstances. Therefore, further research should extend LA and EG design research beyond higher education and systematically study the moderating effects of different learner demographics and LE. It is imperative to note that these fields need continual support from further research and practitioners in industry fields.

Regarding design research in LA and EG, there is also a distinction between the theoretical frameworks that underpin the fields. Whereas LA mainly focuses on the learning environment and on promoting self-regulated learning, EG focuses on student engagement and promoting motivation. The fields could benefit from each other by integrating motivational research from EG into LA as well as integrating learning research from LA into EG. Further research should explore the application of self-regulation in EG and the application of motivational theories in LA.

An important distinction when comparing the two fields is that whereas EG can be integrated into LA (e.g., by adding game elements to the students' or teachers' dashboard), meaningful application of EG will typically involve aspects of LA. Students' behaviour in gamified LE relies on collecting data, measuring progress and displaying the student progress, which is all central LA aspects. Due to the iterative nature of design processes in EG, student data should be used to improve students' LE by e.g. optimising individual game elements.

LA and EG stakeholders may have distinct design processes in terms of their focal points. In previous years, LA has to some extent suffered from a lack of user-centric design approaches, which bring attention to different stakeholders' needs. On the other hand, EG has prioritised end-users and thus addressing design primarily from a user perspective. The fields could benefit from each other's experiences by conducting research integrating student-centered design with user-centric approaches.

Despite having a more prevalent user-centric approach, EG has been challenged by a viewpoint that regards end-users as customers, which can be especially problematic when adopting EG applications in a LE. Stakeholder engagement in LA emphasises ethics, agency, and user empowerment (i.e., students and teachers), which can assist in combating limitations that are currently a challenge for EG in a LE.

In terms of acceptance, the two fields have developed along somewhat distinct paths: LA research has been concerned with investigating barriers and drivers to adoption at multiple levels (e.g., institutional, classroom, individual), whereas EG has focused on measuring acceptance at the end-user level (i.e., students and teachers). The integration of a variety of aspects (e.g., emotional, behavioural, physical, social and cultural) could ultimately be strongly beneficial towards designing a LE with inclusive goals. As outlined in LA research, this design could be properly adopted in a more vital educational infrastructure of personal and social relationships, organisational arrangements and architecture of material space of settings. Both fields can develop links between these collective levels.

Clear opportunities lie in the mutual consensus in LA and EG on methods and theories measuring acceptance, e.g., the technology acceptance model. Agreed upon frameworks are beneficial when synthesising and translating LA and EG concepts. Also, such frameworks are exceedingly adaptable to the context and perspective; researchers from each field may combine factors of interest as part of their investigations. E.g., one initial investigation could examine how factors from EG (i.e. playfulness) and LA (i.e. self-regulated learning) affect each other and contribute to acceptance and adoption.

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