2014 IEEE/ACM 7th International Conference on Utility and Cloud Computing

Tools for Gamification Analytics: A Survey

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***Abstract*—Application and gamification data contains valuable information about users and their behavior. This data can be used to measure the success of gamification projects, to analyze user behavior, and to continuously improve gamification designs. Existing software solutions promise support for analyzing game- and gamification-related data. However, research shows that most gamification projects do not monitor and analyze this data in an automated way, even though gamification experts are aware of its potential. In this survey paper we identify relevant software solutions and assesses them with regards to their fulfillment of user requirements in the gamification analytics domain. The survey results can be used by practitioners to make tool decisions. Furthermore, we identify gaps of current solutions that should be addressed by future work in the field of gamification analytics.**

***Keywords*—Gamification; Analytics; Data Analysis**

I. Introduction

Gamification is a novel topic which receives increasing attention from researchers and practitioners. Inspired by the user experience of computer games, gamification describes the idea of using game design elements in non-gaming contexts [1]. Recent studies show that gamification has the potential to considerably improve user experience and user engagement in a variety of software application domains [2], [3].

In literature [4], experts structure the methodology of gamification projects into four high-level phases: (1) *Business Modeling and Requirements*, where the application context is analyzed and business goals are documented; (2) *Design*, where the gamification design is developed and playtested; (3) *Implementation* and related activities, where the design is implemented as software artifacts and functionally tested; (4) *Monitoring and Adaptation*, where business goal achievement is measured and subsequent design adaptations are conducted.

To support the rapid implementation and integration of gamification designs in phase (3), researchers and industry have come up with generic gamification platforms such as [5], [6], [7]. However, as we showed in previous work, there is still an unsatisfied demand for tools that support phase (4), i.e., the monitoring and adaptation of gamification designs [8]. Experts request such gamification analytics tools to measure the success of gamification design changes, to better understand the user behavior, and to learn when a gamification design requires adjustment [9].

Our previous work identified and validated 22 functional user requirements for gamification analytics tools by interviewing 10 gamification experts [8]. Figure 1 shows an overview of the resulting requirements model which is organized into five categories:

Application KPI Monitoring helps gamification experts to define and monitor Key Performance Indicators (KPIs) which operationalize business goals in context of the gamified application. Unsatisfying application KPI values can be the starting point of deeper investigations. Furthermore, application KPIs can be used to measure business-related improvements and side-effects of gamification design changes.

Gamification Element Analytics supports gamification experts in monitoring the game state. Moreover, they can learn which game elements attract particular types of users and how interaction with game elements influences their behavior.

User Groups of Interest allows experts to discover and define groups of users which can be used as filters in aggregated overviews such as the application KPI visualizations.

Gamification Design Adaptation enables gamification experts to create and analyze experiments that test the impact of gamification design changes on user behavior which is reflected in application KPIs or game element statistics.

Simulation enables experts to simulate arbitrary gamification designs with historical user behavior data, thus allowing an early and rough validation of a gamification design idea.

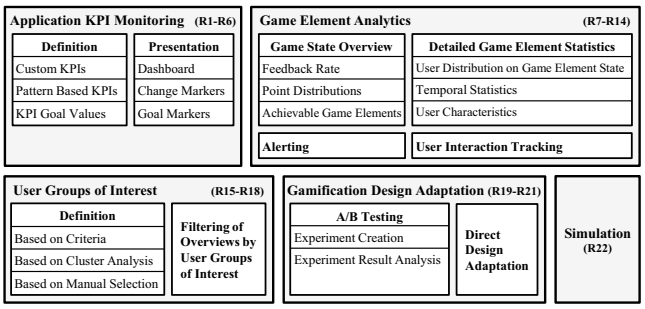

Fig. 1. Functional User Requirements for Gamification Analytics [8]

Our previous study showed that 7 out of 10 gamification experts already used self-built solutions to implement monitoring for critical aspects of their gamified applications. Although, specific solutions exist, none of the experts reported to use one of them. We believe that this can be for two reasons: Either suitable tools exist, but experts are not aware of them, or suitable solutions lack and thus need to be developed before the demand of gamification experts can be satisfied.

978-1-4799-7881-6/14 $31.00 © 2014 IEEE
DOI

II. Methodology

This section describes our methodology and the results of selecting relevant tools for our survey.

In a first step, we searched for solutions that directly advertise analytics support in the gamification domain. For this we queried internet search engines and the digital libraries of IEEE, ACM as well as Google Scholar with the terms *gamification analytics* and *gamification data analysis*. Our research resulted in the following three gamification analytics solutions: Badgeville Behavior Analytics [10], Bunchball Nitro Analytics [11], and Gigya Gamification Analytics [12].

In a second step, we also searched for solutions that advertise support for the similar domain of game analytics [13]. While the young field of gamification still lacks tool support for many aspects, game analytics is more matured and offers a bigger variety of tools. Early game analytics tools were often custom developments of game studios or publishers who tailored them to particular games, e.g., [14], [15], [16]. Accordingly, these tools were not available to the market in form of reusable standard products. However, the success of casual games and Free-to-Play (F2P) games as well as the rise of the Software-as-a-Service (SaaS) provisioning model led to the availability of more generic, SaaS-based solutions that can be used to track and analyze game related data without implementing a custom solution. Accordingly, we queried IEEE, ACM, and Google Scholar with the terms *game analytics* and *game data analysis*. Our research resulted in the following game analytics tools: DeltaDna [17], GameAnalytics [18], GameHud [19], HoneyTracks [20], NinjaMetrics [21], Pingflux [22], and Upsight [23].

Gamification projects typically do not have the necessary resources to build own solutions based on general purpose tools [8]. Therefore, we did not further investigate tools such as BI applications, statistics software, or spread sheet tools which could also be used to realize a part of the requirements. They lack the necessary specificness which is required to keep the adoption effort acceptable.

After filtering out solutions without accessible documentation the following seven tools remained for our assessment: Bunchball Nitro Analytics, Gigya Gamification Analytics, DeltaDna, GameAnalytics, GameHud, HoneyTracks, Upsight.

To rate the applicability of these solutions we assess them with regards to their fulfillment of the 22 gamification analytics requirements. Each requirement is rated according to the following four level scale:

- ↓ *Not fulfilled*: The assessed solution does not fulfill any aspect of the considered requirement.
- ↘ *Partially fulfilled*: The assessed solution fulfills only a minority of the requirement's aspects;
- ↗ *Mostly fulfilled*: The assessed solution fulfills a majority of the requirement's aspects.
- ↑ *Fulfilled*: The assessed solution fulfills the requirement in all of its aspects.

III. Tool Assessment

This section briefly presents the assessed solutions by first describing their focus and defining characteristics. Then it assesses the identified tools with regards to their fulfillment of user requirements for gamification analytics tools. A detailed description of the requirements which we use as criteria can be found in our previously conducted requirements study [8].

A. General Classification of Assessed Solutions

The Bunchball Nitro gamification platform comes with integrations for several enterprise applications such as Jive. The tool offers a set of pre-defined gamification-related reports and a user segmentation feature.

Gigya's gamification platform mainly targets gamification of online communities. The embedded analytics offer a set of predefined reports which accordingly focus on social metrics.

Bunchball Nitro Analytics as well as Gigya Gamification Analytics are part of gamification platforms of the corresponding vendors. On the one hand, this reduces the integration effort since gamification platform and analytics are provisioned as an integrated solution. On the other hand, the adoption of those solutions also enforces to use the corresponding gamification platform. For greenfield projects, this might be critical since the relevant gamification platform might not provide all required features. For brownfield projects, a change of the gamification platform might be too invasive and expensive just for the benefit of better analytics support.

The game analytics solutions DeltaDna, GameAnalytics, GameHud, HoneyTracks, and Upsight mainly target monetization in F2P games. Accordingly, they come with a predefined set of event types and dashboards which are specialized to relevant metrics of the F2P domain. All tools provide interfaces to populate them with custom events. DeltaDna and GameHud support arbitrary event structures. In GameAnalytics, HoneyTracks, and Upsight custom events have to comply with a pre-defined structure which means that they cannot be tailored to specific use cases.

All mentioned game analytics tools are SaaS-based standalone solutions. On the one hand, this means that they can be integrated into every system landscape where the use of the SaaS-model is acceptable. On the other hand, their adoption comes with integration effort and they create a new data-silo which is not under control of the gamification expert.

B. Application KPI Monitoring (R1–R6)

The target of gamification is to support the achievement of business goals. These goals can be operationalized via Key Performance Indicators (KPIs) which are calculated based on user behavior data that originates from the gamified application. Accordingly, a gamification analytics tool should be able to calculate application-related KPIs based on event data. In the following we present related requirements and discuss if and how each of the solutions addresses them.

R1: It should be possible to define application-specific KPIs based on custom events. For example, an application KPI that measures the average customer satisfaction for previously completed IT tickets.

DELTADNA, UPSIGHT, GAMEANALYTICS, HONEYTRACKS, and GAMEHUD support custom events. This mechanism can be used to signalize the events of IT ticket completion and customer satisfaction rating.

DELTADNA supports arbitrary event structures and stores all consumed events in a data warehouse. There they can be queried through an integrated BI tool which allows multidimensional analysis of recorded event data by executing queries in *Multidimensional Expressions* (MDX) language. The BI tool can be leveraged for defining custom KPIs such as calculating the average customer satisfaction rating for given time frames (↑R1).

UPSIGHT, HONEYTRACKS, and GAMEANALYTICS support custom events with a predefined structure. In consequence, it is not possible to track additional attributes such as the corresponding ticket-id or the customer name.

GAMEANALYTICS comes with an own query editor that can be used for the definition of custom KPIs. The query editor provides the functions *sum*, *mean*, *count* and *histogram*. GAMEANALYTICS is therefore capable of calculating the example KPI. However, more complex examples which require basic arithmetical operations or additional statistical functions such as *max* cannot be realized (↗R1).

In HONEYTRACKS and UPSIGHT custom KPIs are limited to counting event frequency. More complex KPIs cannot be realized (↘R1).

GAMEHUD does not provide any means to extend the set of pre-defined metrics by custom KPIs (↓R1).

Finally, the gamification analytics solutions of BUNCHBALL and GIGYA focus completely on gamification related reports. An integration of external data sources and the definition of custom KPIs is not possible (↓R1).

R2: It should be possible to define application KPIs which count the frequency of event patterns. For example, how often users opened a FAQ-site before creating a new IT ticket. Such an application KPI could be realized by counting the number of event patterns where users created the event *view_faq* maximum five minutes before the event *new_ticket*.

None of the assessed solutions allows the definition of pattern-based KPIs (↓R2).

R3: It should be possible to associate application KPIs with goal values. For example, that the average customer satisfaction should be >75%.

None of the assessed solutions allows to associate application KPIs with goal values (↓R3).

R4: The solution should visualize application KPIs in a dashboard which combines charts and descriptive statistics.

GAMEANALYTICS, UPSIGHT, and HONEYTRACKS provide customizable dashboards which can be populated with charts of custom KPIs. However, only GAMEANALYTICS also supports descriptive statistics (↑R4). UPSIGHT and HONEYTRACKS do not have support for descriptive statistics (↗R4).

Figure 2 shows a GAMEANALYTICS dashboard that visualizes customer satisfaction application KPIs.

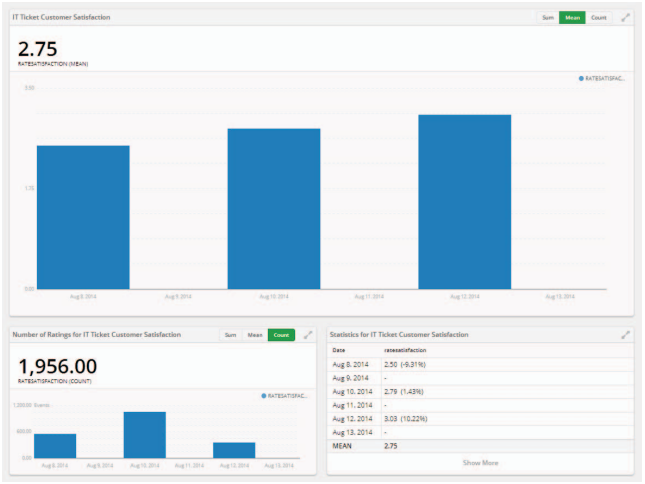

Fig. 2. A GAMEANALYTICS Dashboard Visualizing Application KPIs

R5: The solution should provide means to annotate application KPI curves with change markers on the time axis. For example, a marker representing the introduction of a new game mechanic.

HONEYTRACKS and UPSIGHT support for visual annotations on the time axis of KPI charts (↑R5). All remaining solutions do not offer similar functionality (↓R5).

R6: The solution should visualize application KPI goal values together with their actual value.

None of the assessed solutions allows to associate application KPIs with goal values. Accordingly, no solution is capable of visualizing KPI goal values (↓R6).

C. Game Element Analytics (R7–R14)

Gamification experts need an overview of the game state and its development over time. Exploring the relation between game element states and the users helps experts to detect design flaws or other needs for design adjustment.

R7: The tool should allow to inspect the gamification feedback rate that is measured as the amount gamification feedback events per time in which the users actively work with the gamified application. In addition, the tool should offer corresponding descriptive statistics and annotations which indicate past design changes that help experts to understand the effects of past design changes on the development of the feedback rate.

In DELTADNA the feedback rate can be calculated by a custom MDX-query in its BI tool. However, change markers are not supported (↗R7).

The solutions HONEYTRACKS, GAMEANALYTICS, GAMEHUD, and UPSIGHT allow to count events and can therefore be used for at least a partial realization of this requirement by counting the frequency of events of a explicitly introduced new event type which signalizes gamification feedback. However, no solution allows to normalize the event count by the session lengths of users (↘R7).

R8: The tool should provide insight into the distribution of points over users. For example, by a chart that has users on its abscissa and points on its ordinate.

DELTADNA's integrated BI tool can be used to implement a report which calculates and visualizes the distribution of points among users (↑R8).

BUNCHBALL provides a barely documented report with regards to the *Points Balance*. Since we did not find sufficient evidence, we consider this requirement as most probably fulfilled (↑*R8).

R9: The tool should provide insight into the overall statistics of badges, levels, missions, and other achievable game elements. For example, showing that 54% of the users received *badge x*. A drill-down should be available to allow a deeper investigation of the selected game element (see R10–R12).

GIGYA provides progression reports for levels and missions. However, the solution does not allow to investigate how many users own a particular badge (↘R9).

DELTADNA, HONEYTRACKS, GAMEANALYTICS, GAMEHUD, and UPSIGHT do not provide direct support for this requirement; however can be used for at least a partial realization.

DELTADNA's integrated BI tool can be used to implement MDX-queries which calculate reports for the progress of users. However, this requires high initial effort and further effort in consequence of any subsequent change to the set of used game elements (↗R9).

In HONEYTRACKS, GAMEANALYTICS, and UPSIGHT, sequential game elements can be monitored by using the mechanism of event funnels. Further game elements can be tracked by creating custom metrics which count events that signalize that a user achieved a particular game element. However, in all cases, the tracking of each game element has to be created manually. Moreover, it is not possible to show how many percent of the users achieved an element, because the number of achievers cannot be normalized by the total number of users (↘R9).

GAMEHUD also provides a funnel feature which can be used to track sequential game elements. Other game elements can only be tracked by manually issuing queries that return the count of achievement events for a particular game element. However, these queries cannot be saved, thus have to be re-entered every time the expert is interested in the corresponding numbers. Normalization by the total number of users is also not possible (↘R9).

R10: The tool should provide a detail view on the state and progress of users with regards to a particular game element. For example, that 10% of the users are assigned to *Mission M* and that 7% of out of these completed 2 of 3 goals in *Mission M*.

None of the assessed solutions provides suitable functionality to realize this requirement (↓R10).

R11: The tool should provide temporal statistics on the progression of users with regards to a particular game element. Relevant metrics are for example: the *time to assignment* to the game element, the *time to completion* of the game element, and the *time active* between assignment and completion.

None of the assessed solutions provides mechanisms to monitor temporal statistics (↓R11).

R12: The tool should allow an exploration of the correlation between user properties and user game state. Statistically significant correlations should be detected and indicated. For example, that a particular mission is significantly more often completed by users from Europe than from other geographical regions.

None of the assessed solutions provides means to conduct correlation analysis (↓R12).

R13: The tool should provide mechanisms to define goal values and goal ranges for game element metrics. Violations of these goals should be indicated to the gamification expert. For example, that users should not complete a particular mission in less than 7 days.

None of the assessed solutions provides suitable functionality to define and monitor goal values for game element statistics (↓R13).

R14: The tool should allow experts to track and investigate how much attention users draw to particular game elements and how this influences their behavior with regards to application KPIs. For example, that a leaderboard for customer satisfaction has been inspected by 151 support engineers and that engineers who check their position in the leaderboard generate significantly stronger satisfied customers.

None of the assessed solutions allows to analyze user interaction with game elements and their effect on application KPIs (↓R14).

D. Gamification Design Adaptation (R15–R17)

A/B testing allows to evaluate the effects of game design changes before activating them for the whole user base. Appropriate gamification analytics tools should support the creation of new experiments and the investigation of experiment results. Moreover, a direct adaptation of the design should also be possible.

R15: Experts should be able to create an experiment by defining its name, description, the size of the experimental group, target KPIs, desired KPI impact, and the design changes which are subject of the experiment. After starting the experiment, a user group with the selected experiment size should start interacting with the new design. From this point on the analytics tool should analyze the difference between the metrics of the experimental and control group. For example, experts could test a new version of the gamification design which rewards IT service engineers who generated three very satisfied customers in a row. The analytics tool should then detect whether service engineers who interact with this new game element create stronger customer satisfaction than the control group.

DELTADNA supports the process of A/B testing. However, because of its generic nature the actual variation logic has to reside in the client application. An adaptation of the gamification design from within the analytics solution is not realizable (↘R15).

R16: As an intermediate and final result of A/B tests, a gamification analytics tool should show a summary of impacts on application KPIs and game element metrics, also indicating whether these changes are statistically significant. Experts should then be able to decide whether they want to apply the changes to all users or whether they want to discard them. As a result of keeping a new design idea, a new annotation should be created in all relevant graphical charts, indicating that a design change was conducted (see R5, R7). Experiment results should be archived for durable access to the result data which led to a design decision. For example, experts could see, whether the customer satisfaction in the experimental group significantly increased. Based on these numbers they could then decide whether they want to apply the design for all users.

GAMEANALYTICS events have a *build* attribute that can be used to distinguish events originating from different versions of the gamified application. Metrics of each version can then be composed together in one chart to compare them with each other. However, significance testing with regards to application KPIs, applying changes, creating corresponding change annotations, and archiving the data which drove the design decision are not supported (↘R16).

DELTADNA allows experts to analyze A/B test results by comparing game metric values of user groups. An analysis of the impact on application KPIs is not possible. The tool allows experts to assess the significance of the frequency-difference of an initially defined event. Significance testing, applying changes, creating corresponding change annotations, and archiving the data which drove the design decision is not supported (↘R16).

HONEYTRACKS supports A/B testing by allowing gamification experts to manually assign users to groups. These groups can then be used for direct comparison in charts. All other aspects of this requirement are not supported (↘R16).

R17: The tools should allow direct changes to the gamification design resulting in the creation of change markers in charts which visualize time based data (see R5, R7). In some cases it can, for example, be necessary to directly adapt a gamification design because of time constraints that do not allow to conduct an A/B test.

None of the assessed solutions provides means to directly adapt a gamification design (↓R17).

E. User Groups of Interest (R18–R21)

Gamification analytics tools should allow experts to focus their analyses on user groups which are of special interest.

R18: The experts should be able to define groups based on criteria which are evaluated against user properties. For example, by selecting users with gender *male* and geographical region *Europe*.

DELTADNA, GAMEANALYTICS, HONEYTRACKS, UPSIGHT do not support the persistent definition of user groups of interest. However, similar functionality exists in some aspects. In all mentioned solutions, dashboard overviews can be filtered by properties of a predefined user model, e.g., age or gender. (↘R18).

R19: The experts should be able to conduct cluster analysis on selected properties of users to discover groups which are of interest for them. For example, by exploring processing time of IT-tickets in dependence of geographical region and age of support engineers.

DELTADNA allows to conduct interactive 3 dimensional cluster analyses on the set of predefined user properties and metrics. However, no cluster algorithm is available for automatic cluster detection (↘R19).

None of the other solutions provides cluster analysis mechanisms to discover user groups (↓R19)

R20: Experts should be able to manually compose a user group of interest. For example, by selecting users who caught their attention by something that is not explicitly tracked in the system.

None of the assessed solutions allows to manually compose user groups of interest (↓R20).

R21: The experts should be able to filter overviews by selecting a user group of interest. This should be possible at all places, where overviews are shown, i.e., the application KPI overview, game metric overviews and result views of A/B tests.

DELTADNA, GAMEANALYTICS, HONEYTRACKS, UPSIGHT provide filters which can be applied on predefined user properties such as age or gender to filter within dashboards (↘R21).

F. Simulation (R22)

R22: The tool should give experts the opportunity to simulate the rules of arbitrary gamification designs with historical user behavior data. The simulation results should be explorable in the same way as real data by viewing application KPIs, game element analytics, and the opportunity of defining user groups of interest. Experts should for example be able to simulate a new point-system with user events of the past year to identify whether it could be a reasonable design option.

None of the assessed solutions provides support for conducting simulations (↓R22).

G. Assessment Results

A summary of our assessment results is shown in Table I. It is shown that the integrated solutions of gamification vendors provide rather simplistic analytics support. Their provided functions only address a minority of user requirements. The requirement categories of application KPI monitoring, gamification design adaptation, user groups of interest, and simulation are completely unsupported by both assessed gamification platforms. Even the category of game element analytics is almost completely unsupported. We conclude that gamification platforms currently do not leverage their potential of offering well-integrated gamification analytics. Thus they are falling short in supporting the whole development cycle of gamification projects.

On side of the standalone game analytics solutions we see a diverse picture. Especially DELTADNA and UPSIGHT provide decent support with regards to the assessed requirements. However, direct support for concepts from the gamification

TABLE I. TOOL ASSESSMENT RESULTS

Requirement		Bunchball	Gigya	DeltaDna	GameAnalytics	GameHud	HoneyTracks	Upsight	Median
Application KPI Monitoring	R1	↓	↓	↑	↗	↓	↘	↘	↘
	R2	↓	↓	↓	↓	↓	↓	↓	↓
	R3	↓	↓	↓	↓	↓	↓	↓	↓
	R4	↓	↓	↓	↑	↓	↗	↗	↓
	R5	↓	↓	↓	↓	↓	↑	↑	↓
	R6	↓	↓	↓	↓	↓	↓	↓	↓
Game Element Analytics	R7	↓	↓	↗	↘	↘	↘	↘	↘
	R8	↑*	↓	↑	↓	↓	↓	↓	↓
	R9	↓	↘	↗	↘	↘	↘	↘	↘
	R10	↓	↓	↓	↓	↓	↓	↓	↓
	R11	↓	↓	↓	↓	↓	↓	↓	↓
	R12	↓	↓	↓	↓	↓	↓	↓	↓
	R13	↓	↓	↓	↓	↓	↓	↓	↓
	R14	↓	↓	↓	↓	↓	↓	↓	↓
Gamification Design Adaptation	R15	↓	↓	↘	↓	↓	↓	↓	↓
	R16	↓	↓	↘	↘	↓	↘	↓	↓
	R17	↓	↓	↓	↓	↓	↓	↓	↓
User Groups of Interest	R18	↓	↓	↘	↘	↓	↘	↘	↘
	R19	↓	↓	↘	↓	↓	↓	↓	↓
	R20	↓	↓	↓	↓	↓	↓	↓	↓
	R21	↓	↓	↘	↘	↓	↘	↘	↘
Simulation	R22	↓	↓	↓	↓	↓	↓	↓	↓
Median		↓	↓	↓	↓	↓	↓	↓	↓

↓ Not fulfilled ↘ Partially fulfilled
↗ Mostly fulfilled ↑ Fulfilled

domain and important functions such as A/B testing or simulation lack appropriate support. These game analytics tools can be leveraged to implement many aspects of the assessed requirements. However, we argue that the corresponding implementation effort, maintenance effort, and the resulting new data silo embody too many disadvantages compared with the amount of support they currently provide.

IV. SUMMARY AND OUTLOOK

In this paper we identified 10 software solutions for gamification analytics and assessed them with regards to their fulfillment of 22 user requirements which were identified and validated in earlier research.

The assessed tools comprise solutions from the domain of gamification analytics as well as solutions from the similar domain of game analytics. We conclude that all analyzed solutions lack appropriate support for a majority of the requirements. Even the best solution of our assessment did only provide partial or better support for 9 out of 22 requirements.

With these results we argue that our study clearly showed that neither current integrated solutions nor current standalone solutions offer considerable support for the monitoring and adaptation phase of gamification projects. In future research we will therefore focus on elaborating the concept and technical architecture for generic tool support of the monitoring adaptation phase in gamification projects.

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