Event-based education and innovation in Learning Factories – concept and evaluation from Hackathon to GameJam

Max Juraschek\textsuperscript{a,}\textsuperscript{*}, Lennart Bütha, Niels Martin\textsuperscript{a}, Stefanie Pulsta, Sebastian Thiedea, Christoph Herrmann\textsuperscript{a}

\textsuperscript{a}Chair of Sustainable Manufacturing and Life Cycle Engineering, Institute of Machine Tools and Production Technology (IWF), Technische Universität Braunschweig, Langer Kamp 19b, 38106 Braunschweig, Germany

Abstract

Innovations in manufacturing technology and ongoing digitalization require the constant acquisition of new skills and competencies. Especially in the case of emerging technologies, insecurities and reservations can cause challenges for implementation. Events for facilitating innovation, education and training, as for instance hackathons or code-camps, are popular in the ICT sector. Learning Factories offer a prime location and assets for conducting technology and education-based events. A concept for event-based education is developed. With an attributed collection of event types it allows the structured identification of suitable events. The feasibility of event-based education is demonstrated with the analysis of a hackathon and a game jam held at “Die Lernfabrik”. A self-evaluation of the participants indicates a positive reception and knowledge improvement.

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Peer-review under responsibility of the scientific committee of the 10th Conference on Learning Factories 2020.

* Corresponding author. Tel.: +49-531-391-8752; fax: +49-531-391-5842.
E-mail address: m.juraschek@tu-braunschweig.de
1. Introduction

Manufacturing technology and the required competencies for operation and development are constantly changing, for instance due to the increasing degree of digitalization. A constant acquisition of new skills is required while especially in the case of emerging technologies, insecurities and reservations can cause challenges for companies. Learning Factories provide an effective learning environment by offering physical infrastructure in combination with learning elements for research, education and training [1]. Study courses on a specific topic and single or multi-day trainings are established formats for conveying teaching content and build competencies in Learning Factories. Events as mean for education and innovation are increasingly popular formats, mostly in technology-related environments. For instance, the agency BeMyApp published figures for the year 2018 from the Hackathon.com listings, showing 5,636 Hackathon events globally recorded in this database alone (2016: 3,450) [2]. Learning and networking were stated as primary motivations in a study among participants of Hackathons on informal STEM (Science, Technology, Engineering and Mathematics) learning through such events [3]. Learning Factories with their physical infrastructure can provide a great environment for hosting such events and slowly first trials are emerging as for instance the hackathon “HoloHack” [4]. However, a structured framework and analysis of potential contributions of event-based education formats providing implementation and decision support is currently lacking. A concept for event-based education was developed at Die Lernfabrik of Technische Universität Braunschweig based on a classification scheme for Learning Factories. Together with an attributed collection of event types, it allows the structured identification of suitable events for a specific Learning Factory and target audiences.

2. Events for facilitating innovation, education and training

Effective innovation processes are in most cases collaborative efforts. This perception has led to the creation of new methods and processes for research and development [5]. Teaching and learning success can also benefit from collaborative and interactive elements, for instance through the integration of practical learning content in lectures with Learning Factories [6]. The benefit of conducting events for solving challenges and accomplish design tasks, create innovations and provide coaching as well as education and training has been increasingly recognized. A rising number of different event formats and organizers illustrates this. In the context of innovation, education and training, several recurring event types can be identified, of which a large share originates from a digital technology background or has been adapted in this field. An overview is provided in Table 1, summarizing the most important event types and their typical goals and duration retrieved by a literature search. In colloquial and web language many synonyms are frequently used. A short Hackathon can be for instance also referred to as “Hackfest” or “Hackday” [7]. In the table, the most commonly used terms for each event-type are stated.

The already mentioned Hackathon (compound of “hack” and marathon”) is an event type gathering participants to create solutions or innovative applications for specific technologies, challenges or techniques. A GameJam is organized in a similar way but focused on the development of digital or analog games, usually for a specific theme. An Installfest is an event for the communal and coordinated installation and initiation of specific software applications. Originating from Linux user groups these events were organized to lower entry barriers and enable the capacity for productive work. Another very application-specific event type is an Editathon, at which contributors to applications or databases physically meet to intensively work on editing and generating generally digital content. Sprint-driven development processes such as the scrum method are state of art in software development, design tasks [8] and increasingly utilized in production engineering [9]. The translation into intense working events has been around for several decades and thus evaluations on their effectiveness can be found for specific cases [10]. A Charrette is a specific form of Sprint originating from architecture [11]. With a Forum, discussions on specific topics can be facilitated towards forming opinions or creating concepts. Frequently used elements are panel discussions and expert workgroups [12]. A World Café provides a very strict structure for exchange among the participants and the collaborative development of concepts and frameworks [13]. Festivals and Camps are usually multi-day events that are organized by a central organization or a committee. These events can combine different types of activities and provide space for encountering like-minded people [14]. Startup Weekends facilitate the development of business models for innovative teams and entrepreneurs [15]. BarCamps and TeachMeets are thema-
specific “unconferences”. In unconferences, as opposed to centrally organized conferences, the agendas, the formats, topics and content is provided by the participants of the event in consensual methods [16].

Table 1. List of potential events for innovation and education in Learning Factories.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Description</th>
<th>Typical Goals</th>
<th>Typical Duration [d]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BarCamp</td>
<td>Conference style event with self-organizing agenda structured in sessions. Workshops and presentations are led by the participants. Focus on specific technologies, tech-related topics and applications.</td>
<td>Knowledge sharing, development of concepts, agendas and conventions</td>
<td>2-3</td>
</tr>
<tr>
<td>Camp</td>
<td>Communal event with participants gathering for several days at a specific location. Agenda set around one or more themes including long working sessions with elements of self-organization.</td>
<td>Knowledge sharing, crowdsourcing, innovation generation, community building</td>
<td>2-5</td>
</tr>
<tr>
<td>Charrette</td>
<td>Collaborative event for working on a specific task in one or several (sub-)groups. Focused on design or planning activities.</td>
<td>Solving a specific design task, creation of visions and concepts</td>
<td>2-7</td>
</tr>
<tr>
<td>Codefest</td>
<td>Collaborative event for working on a predetermined challenge related to programming, software development and data processing. Often organized as a competition in teams.</td>
<td>Software and application development, innovation generation</td>
<td>2-4</td>
</tr>
<tr>
<td>Editathon</td>
<td>Collaborative event for editing and generating content for digital applications and information repositories. Rarely exercised for analog content generation.</td>
<td>Content generation, knowledge sharing, crowd sourcing of information, community building</td>
<td>1-2</td>
</tr>
<tr>
<td>Festival</td>
<td>Open event with a predefined theme combining different activities and formats. Often organized by a program committee and debate. Can be limited to experts or opened to the public.</td>
<td>Knowledge sharing, concept development, community building</td>
<td>1-5</td>
</tr>
<tr>
<td>Forum</td>
<td>Open event for the formation of opinions and concept development. Focus on discussions and controversy.</td>
<td>Concept development, community building, opinion formation</td>
<td>1-2</td>
</tr>
<tr>
<td>GameJam</td>
<td>Collaborative event for developing games and game concepts commonly around a specific topic or message. Often organized as competition in self-organizing teams.</td>
<td>Development of games and game concepts, application of gamification techniques</td>
<td>1-3</td>
</tr>
<tr>
<td>Hackathon</td>
<td>Collaborative event for working on a predetermined challenge, often technology-related and organized as a competition in teams. Focus on specific topics and/or technologies.</td>
<td>Technology development, application development, innovation generation</td>
<td>1-3</td>
</tr>
<tr>
<td>Installfest</td>
<td>Collective installment of specific software (collections). Can be extended with tutorials and walkthroughs.</td>
<td>Assisted roll-out of specific software, best practice sharing, community building</td>
<td>0.5-1</td>
</tr>
<tr>
<td>Sprint</td>
<td>Intense working period for development of solutions, designs or concepts within a predefined challenge or application context.</td>
<td>Creation of concepts, designs, prototypes and products</td>
<td>1-5</td>
</tr>
<tr>
<td>Startup Weekend</td>
<td>Multi-day event for creation and elaboration of business models for start-ups. Involves coaching, presentations and working sessions.</td>
<td>Creation of concepts, designs, prototypes and business models, competence building, innovation generation</td>
<td>2-3</td>
</tr>
<tr>
<td>TeachMeet</td>
<td>Conference style event on teaching and education with self-organizing agenda structured in sessions. Workshops and presentations are led by the participants. Focus on exchange of experience and best-practice sharing.</td>
<td>Best practice sharing, development of concepts and agendas, community building</td>
<td>2-3</td>
</tr>
<tr>
<td>World Café</td>
<td>Discussion and exchange focused event with a pre-structured workflow. Communal discussions around a specific topic with alternating groups to facilitate cross-disciplinary exchange.</td>
<td>Concept development, knowledge sharing</td>
<td>0.5-1</td>
</tr>
</tbody>
</table>
Learning Factories with their physical environment can be a suitable venue for conducting such events. The availability and accessibility of technology, machines and equipment add the opportunity to prototype and test developed solutions. Some important success factors for events for education and innovation can be found repeatedly in experience from organizers [17] and were also experienced at Die Lernfabrik at TU Braunschweig:

- Communicate thoroughly with the participants before and during the event as this is crucial for the experience and decreases the no-show rate
- Allow sufficient time and provide a process for team building in collaborative events
- Provide inspiration and resources for the participants to improve the quality of the results
- Facilitate communication and exchange among participants and contributors
- Document the event for dissemination of the results

For the identification of suitable events innovation, education and training, assessable features have to be identified. A specific event can be characterized by type, audience, topic and elements employed. The event elements can include activities such as workshops, lightning talks, demos, storyboarding or walkthroughs. Collaborative events facilitate teamwork among the participants. Adapted from a study on the characteristics of successful teams at Google [18], the following criteria should be fulfilled in an event for collaborating teams:

- Psychological security – providing a risk free environment facilitating to test new ideas and concepts
- Reliability – ensure suitable team constellations and provide mediation for potential conflicts
- Structure and clarity – state goals of the events clearly and communicate the expected outcomes
- Identification – invoke the personal motivation of the participants towards the specific event topic
- Meaning – set a global context and highlight the potential positive impact of the results

3. Classification scheme for learning factories

A Learning Factory is a close to reality representation of real production environments for education, research and training purposes [1]. This allows the conduction of learning and teaching modules in controlled and safe environments while lowering abstraction barriers through the relation to actual application systems. Building on the challenges and approaches to competency development outlined by Adolph et al. [19], generalized goals of Learning Factories can be extracted. For education and training, these goals include technology dissemination, knowledge dissemination, competence building and providing spaces for encounter and developing social skills. Goals fostering research activities in Learning Factories are innovation generation and the development of solution elements, as for instance technological components or novel concepts. The event types in Table 1 were rated regarding their potential contribution to these generalized goals based on the input of an expert panel from Die Lernfabrik. The results are illustrated in Fig 1.

The analysis of the potential contribution of event types to the Learning Factory shows that for each goal contributing events can be identified. All analyzed events provide a very high contribution potential to at least one goal. The rating framework can support the selection of suitable events for Learning Factories.

![Fig. 1. Potential contribution of different event types to Learning Factory goals.](image-url)
4. Case studies for event-based education in Learning Factories

For testing the feasibility and assessing the actual benefit of event-based education and innovation, two different types of events were organized and hosted at a Learning Factory and are analyzed as case studies. The participants were enabled to intensively work on a challenge in teams while being provided with the necessary tools, data and equipment. The participants of both events were asked to complete a survey to rate the events and provide a self-assessment of their knowledge and competence gain. The results of these surveys are illustrated in Fig 2. The motivation for the HoloHack 2017 event was grounded in the observation that the dissemination and implementation of mixed reality (MR) and new devices is initially hampered by integration barriers. The potential of new technology has to be understood before it can be put into application [20]. A Hackathon was organized within the Learning Factory Die Lernfabrik to lower the entry barriers to new MR technologies by enabling learners to experience novel devices they usually do not have access to. In this three-day event, the participants were challenged to develop applications within the scope “manufacturing in cities” with mixed reality technology [4]. Within the frame of the German Science Year 2018 “Working Life of the Future” a two-day GameJam was hosted in Die Lernfabrik [21]. The implications of digitalization and new manufacturing technology on the character of work places and their required skills are complicated to communicate and can invoke fear and reservations. Games can be an effective mean to convey messages in an immersive way. The participants were challenged to develop concepts and prototypes of games to convey potentials, challenges or future required competencies in this context.

![Survey results HoloHack 2017 hosted at Die Lernfabrik](image)

**Corresponding goals of the Learning Factory**

<table>
<thead>
<tr>
<th>Knowledge &amp; Technology Dissemination</th>
<th>Space for Encounter and Engagement</th>
<th>Technology Dissemination</th>
<th>Competence Building</th>
<th>Knowledge Dissemination</th>
<th>Enablement through Physical Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Hackathon is a good format for getting to know a technology intensively</td>
<td>I can now assess the potential of mixed reality and the HoloLens</td>
<td>The HoloHack has benefited from the learning factory as the location</td>
<td>The HoloHack has reduced my barriers to mixed reality</td>
<td>Cumulative evaluation of the multiple workshops and events</td>
<td>My expectations of the HoloHack have been fulfilled</td>
</tr>
<tr>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
</tr>
<tr>
<td>High consent</td>
<td>High consent</td>
<td>High consent</td>
<td>High consent</td>
<td>High consent</td>
<td>High consent</td>
</tr>
<tr>
<td>Avg. result</td>
<td>4.5</td>
<td>4.4</td>
<td>4.7</td>
<td>3.9</td>
<td>4.1</td>
</tr>
</tbody>
</table>

![Survey results GameJam 2018 hosted at Die Lernfabrik](image)

<table>
<thead>
<tr>
<th>Knowledge &amp; Technology Dissemination</th>
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</tr>
</thead>
<tbody>
<tr>
<td>A GameJam is a good format for elaborating a specific topic intensively</td>
<td>I was able to engage with like-minded people and to build new contacts</td>
<td>Cumulative rating of the offered learning factory infrastructure</td>
<td>Cumulative self-assessment of relevant competencies after the GameJam*</td>
<td>Cumulative evaluation of the multiple workshops and events</td>
<td>Our team had access to all resources required</td>
</tr>
<tr>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
<td>Low consent</td>
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<tr>
<td>High consent</td>
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</tr>
<tr>
<td>Avg. result</td>
<td>4.4</td>
<td>4.6</td>
<td>3.9</td>
<td>3.5*</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Fig. 2. Results of two self-assessment surveys amongst participants of the Hackathon event “HoloHack 2017” and the GameJam event “Arbeit und Spiele 2018” hosted at Die Lernfabrik of TU Braunschweig. Short video documentations are available through the QR-codes.

The Hackathon as a format for getting to know a new technology intensively was rated as very helpful (4.5/5.0). Similarly, the GameJam was seen as good format for elaborating a specific topic (4.4/5.0). The specific goals of Learning Factories addressed by the event types were conveyed and received positively for both events. The Hackathon enabled the assessment of new technology and concepts (4.4/5.0) while the GameJam provided an opportunity to engage with like-minded people and build new contacts (4.6/5.0). In both events, the resources of the Learning Factory were made assessable to the participants including machines, sensors, database access, devices and physical infrastructure such as meeting areas and workplaces. This was received especially positive in the technology focused HoloHack (4.7/5.0) and received positively as well for the GameJam (3.9/5.0). The self-assessment of the addressed competencies showed an improvement for both events and was successful in reducing the barriers towards new technologies.
5. Conclusion and outlook

Learning Factories provide the means for education and innovation generation by facilitating research activities, study courses and training modules. At the same time, they provide the resources to host events for education and innovation. To outline the scope of event-based education and innovation in Learning Factories, fourteen potentially suitable general event types were identified and their contribution to the generalized goals of Learning Factories analyzed. The feasibility of event-based education in learning factories was demonstrated by the analysis of a Hackathon and a GameJam hosted at Die Lernfabrik. The conducted self-evaluations of the participants show a very positive reception and successful contributions towards the goals of Learning Factories. The organization of events for education and innovation demands undisputedly an intense effort by Learning Factory staff and its infrastructure. These efforts are outweighed by the benefits of event-based education in Learning Factories if suitable events are chosen according to the goals to be achieved. Due to the increasing popularity and the positive evaluation results of event-based education and innovation the number of such events in Learning Factories will most likely increase in the near future.

Acknowledgements

The authors are thankful to the German Federal Ministry of Education and Research for financially supporting the GameJam 2018 within Science Year 2018, to AKB Stiftung, Braunschweig Zukunft GmbH and Microsoft Student Partners for financially supporting the HoloHack 2017 and to all contributors, participants and presenters.

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