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Flowful work design:

Perspectives on flow and team flow experiences in dynamic and challenging work contexts

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Abstract

Modern work contexts present new kinds of changes and flexibilization, digitalization, and new dynamics confront people with novel challenges. These changes also alter opportunities to experience positive states at work, such as flow and team flow. Flow is defined as the state of being completely absorbed in an activity that is perceived as optimally demanding, and it is associated with positive effects on well-being and performance. Similar assumptions apply to team flow, which is defined as a shared experience of flow within a team during optimal team dynamics.

Different work design models propose systematically considering the characteristics of a work task to further develop and redesign it towards specific goals. However, the overarching context is often overlooked. This dissertation aims to examine flow and team flow promoting forms of work design from a context-specific perspective. The goal is to identify factors that promote or hinder flow and team flow at work, and to investigate the effect of external contextual factors in challenging work environments. To this end, three examples of modern work contexts are examined: work in a start-up, industrial manufacturing work, and virtual teamwork.

Study I employs qualitative interviews to investigate how flow and team flow are experienced during the early start-up stage, which is often characterized by high levels of autonomy and meaningfulness, yet also by uncertainty and lack of support. Some of the influencing factors and consequences discussed are known from previous research, while others appear specifically relevant to the challenges start-ups face. Overall, the importance of promoting flow and team flow in the context of start-ups becomes apparent, and the results provide some recommendations for work design.

Study II focuses on manufacturing work, which can be considered a flow-aversive context due to monotony and boredom. The study examines how gamification, a strategy for designing work to promote flow, affects both flow and performance. The study suggests that gamification could be particularly effective at the beginning of work processes; however, flow can also arise in non-gamified manufacturing work via other mechanisms.

Study III examines the context of international virtual teams and investigates team flow experiences, exploring the possibility of identifying them through communication parameters. Depending on the task type, the examined communication parameters are insufficient for identifying team flow. Nevertheless, the study makes an important contribution to the ongoing

methodological debates in flow research concerning the development of interruption-free measurement approaches.

While each of the studies conducted in this cumulative dissertation addresses different research questions, they all contribute to a better understanding of flow and team flow in the workplace. Furthermore, they enable the development of recommendations for work designs that promote flow and team flow. The central results of the three studies are integrated into a work design model. This model is developed as an extension of an Input-Process-Output model and is based on the Job Characteristics Model. The model systematizes the various factors influencing flow and team flow at work, as well as the consequences of these states, with an emphasis on the influence of the context. The relevance of the key contextual factors examined in the dissertation, such as playful approaches and intercultural perspectives in work design, is also addressed. Furthermore, methodological reflections on the dynamics and the measurement of flow and team flow are presented. Based on the three contexts studied, concrete work design practices and recommendations are formulated. Future research should consider additional work contexts relevant to the evolving challenges faced in today's working world and evaluate the effectiveness of specific interventions. The methodological questions raised regarding the operationalization and measurement of flow and team flow should be examined more closely in light of the results. Overall, this dissertation demonstrates that promoting flow and team flow may be possible in challenging and dynamic modern work contexts. However, this is context-dependent and should be planned in a reflective, evidence-based manner.

Keywords

Flow experience; team flow experience; work design

Kurzfassung

Moderne Arbeitskontexte bringen neuartige Veränderungen mit sich und durch Flexibilisierung, Digitalisierung und neue Dynamiken sehen sich Menschen mit neuen Herausforderungen konfrontiert. Dadurch verändern sich auch die Möglichkeiten, positive Zustände wie Flow und Teamflow bei der Arbeit zu erleben. Flow bezeichnet den Zustand vollständiger Absorbiertheit während einer als optimal beanspruchend wahrgenommenen Tätigkeit und geht mit positiven Effekten auf Wohlbefinden und Leistung einher. Ähnliches wird für Teamflow angenommen, den Zustand eines geteilten Flow-Erlebens im Team während optimaler Teamdynamiken.

Verschiedene Modelle zur Arbeitsgestaltung schlagen eine systematische Betrachtung der Merkmale einer Arbeitsaufgabe vor, um diese basierend auf spezifischen Zielen weiterzuentwickeln und zu gestalten. Dabei wird jedoch häufig der übergeordnete Kontext vernachlässigt. In der vorliegenden Dissertation soll daher eine kontextspezifische Perspektive auf flow- und teamflow-förderliche Formen der Arbeitsgestaltung eingenommen werden. Ziel ist es, Faktoren zu identifizieren, die Flow und Teamflow bei der Arbeit begünstigen oder hindern, sowie zu untersuchen, wie externe Kontextfaktoren in herausfordernden Arbeitsumgebungen wirken. Zu diesem Zweck werden drei verschiedene moderne Arbeitskontexte beispielhaft untersucht: die Arbeit in einem Start-up, die industrielle Fertigung und die virtuelle Teamarbeit.

In Studie I wird mittels einer Interviewstudie der Frage nachgegangen, wie Flow und Teamflow in der häufig von großer Autonomie und Sinnhaftigkeit, jedoch auch von Unsicherheit und fehlender Unterstützung geprägten Arbeit in den frühen Phasen der Start-up-Gründung erlebt werden. Einige der diskutierten Einflussfaktoren und Konsequenzen sind bereits aus der bisherigen Forschung bekannt, während andere spezifisch im Kontext der Herausforderungen von Start-ups relevant zu sein scheinen. Insgesamt zeigt sich die Relevanz der Förderung von Flow und Teamflow im Start-up-Kontext, zu der einige Empfehlungen aus den Ergebnissen abgeleitet werden können.

In Studie II wird der Kontext der industriellen Fertigungsarbeit betrachtet, der aufgrund von Monotonie und Langeweile als flow-aversiv angesehen werden kann. Es wird untersucht, wie sich Gamification als Strategie einer flow-förderlichen Arbeitsgestaltung auf Flow und Performance auswirkt. Die Studie legt nahe, dass Gamification insbesondere zu Beginn von Arbeitsprozessen wirksam sein könnte und Flow darüber hinaus auch in nicht gamifizierter Fertigungsarbeit über andere Mechanismen entstehen kann.

Studie III betrachtet den Kontext internationaler virtueller Teams und untersucht das Erleben von Teamflow und die Möglichkeit, dieses über Kommunikationsparameter zu identifizieren. Die untersuchten Kommunikationsparameter zeigen sich je nach Art der Aufgabe als noch nicht ausreichend zur Identifikation von Teamflow. Die verwendete Methode leistet jedoch einen wichtigen Beitrag zu aktuellen methodischen Debatten der Flow-Forschung bezüglich der Entwicklung unterbrechungsfreier Messmethoden.

Die im Rahmen der kumulativen Dissertation durchgeführten Studien beschäftigen sich jeweils mit verschiedenen spezifischen Forschungsfragen, tragen jedoch alle zu einem besseren Verständnis von Flow und Teamflow bei der Arbeit bei. Darüber hinaus erlauben sie die Ableitung von Empfehlungen für eine Arbeitsgestaltung, die Flow und Teamflow begünstigt. Die zentralen Ergebnisse der drei Studien lassen sich zusammen in ein Work Design Modell einordnen, das eine Erweiterung eines Input-Process-Output Modells darstellt und an das Job Characteristics Model angelehnt ist. Die verschiedenen Einflussfaktoren auf Flow und Teamflow bei der Arbeit sowie die Konsequenzen dieser Zustände werden systematisiert und geordnet, wobei der Einfluss des Untersuchungskontexts betont wird. Die Relevanz der in der Dissertation untersuchten zentralen Kontextfaktoren, wie spielerische Ansätze und interkulturelle Perspektiven in der Arbeitsgestaltung, wird thematisiert. Darüber hinaus werden methodische Überlegungen zur Dynamik und Messung von Flow und Team-Flow vorgestellt. Einige konkrete Maßnahmen und Empfehlungen zur Arbeitsgestaltung werden am Beispiel der drei untersuchten Kontexte formuliert. Zukünftige Forschung sollte darüber hinaus weitere Arbeitskontexte und zentrale Herausforderungen der aktuellen Arbeitswelt betrachten sowie die Wirksamkeit von spezifischen Interventionen testen. Auch die auf methodischer Seite aufgeworfenen Fragen zur Operationalisierung und Messung von Flow und Teamflow sollten auf Basis der Ergebnisse genauer untersucht werden. Insgesamt zeigt die vorliegende Dissertation, dass die Förderung von Flow und Teamflow auch in herausfordernden und dynamischen modernen Arbeitskontexten möglich sein kann, jedoch kontextabhängig ist und daher reflektiert sowie evidenzbasiert geplant werden sollte.

Schlüsselwörter

Flow-Erleben; Teamflow-Erleben; Arbeitsgestaltung

List of publications

The present thesis includes three publications for peer-reviewed journals. Minor formatting changes have been made to achieve a consistent style throughout this thesis, including, for example, changes to the font, table layout, and citation style. The literature cited is listed together at the end of the thesis. Psychological research typically involves co-authors in publications, as is the case here. All of the co-authors and their contributions are listed below.

Study I: Flow and team flow in start-up work

Kloep, L., Roese, K., & Peifer, C. (2023). Founders' flow: A qualitative study on the role of flow experience in early start-up stages. *PloS one 18*(10), e0292580, https://doi.org/10.1371/journal.pone.0292580

Author contributions

Leonie Kloep: conceptualization, methodology, formal analysis, investigation, original draft preparation

Katharina Roese: conceptualization, methodology, resources, original draft preparation, supervision

Corinna Peifer: conceptualization, methodology, resources, original draft preparation, supervision, project administration

Study II: Flow and gamification in manufacturing work

Kloep, L., Hug, J., Ulmer, J., Wollert, J., & Peifer, C. (2025). Gamification in manufacturing work: Can it help to increase flow and performance? *International Journal of Human–Computer Interaction*. https://doi.org/10.1080/10447318.2025.2502968

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Leonie Kloep: Conceptualization, writing – original draft, writing – review and editing, formal analysis, investigation, methodology, visualization

Johannes Hug: Conceptualization, writing – review and editing, investigation, methodology, software, resources

Jessica Ulmer: Conceptualization, writing – review and editing, investigation, methodology, software, resources

Jörg Wollert: Conceptualization, project administration, writing – review and editing

Corinna Peifer: Conceptualization, project administration, supervision, writing – review and editing

Study III: Team flow and communication in virtual teamwork

Kloep, L., Miecznik, A.T., Klimowicz, P., Sieciński, S., Kowalczyk, B., Kożusznik, B., Pollak, A., Grzegorzek, M., Pyszka, A., Flak, O., & Peifer, C. (submitted). Flowing conversations: Exploring communication parameters as team flow indicators in virtual teamwork

Author contributions

Leonie Kloep: Writing - original draft, visualization, conceptualization, methodology, formal analysis, investigation

Anna Teresa Miecznik: Writing - original draft, visualization, conceptualization, investigation

Piotr Klimowicz: Conceptualization, investigation

Szymon Sieciński: Conceptualization, investigation

Barbara Kowalczyk: Conceptualization

Barbara Kożusznik: Funding acquisition, conceptualization, resources

Anita Pollak: Funding acquisition, conceptualization, resources

Marcin Grzegorzek: Funding acquisition, conceptualization, resources

Adrian Pyszka: Funding acquisition, conceptualization, resources

Olaf Flak: Funding acquisition, conceptualization, resources

Corinna Peifer: Writing - original draft, supervision, funding acquisition, conceptualization, methodology, resources

Contents

1. Introduction

Today's working world is subject to an increasing number of changes in working conditions and practices (Gagné et al., 2022; Schermuly et al., 2024). Research institutes are constantly identifying new trends, and digitalization, automation, and artificial intelligence have become integral to many modern workplaces (Tewes & Tewes, 2020). While some authors outline scenarios in which jobs are at risk of being replaced by technology (Frey & Osborne, 2017), others anticipate a new dynamic and a shift in focus across a wide variety of jobs (Arntz et al., 2016; Autor, 2015; World Economic Forum, 2018). This development is accompanied by changes not only on technological and organizational levels, but also on social and psychological levels (Santana & Cobo, 2020). Due to changes in the broader contexts of workplaces, some work tasks are being automated, while others are evolving in scope and requirements. At the same time, entirely new work contexts are emerging, for example, in the fields of artificial intelligence or big data (Holford, 2019; World Economic Forum, 2025). Although the adoption of flexibilization and new technologies is supposed to make work more dynamic, it may also increase the complexity people face at work. Recent research has shown that technological developments can result in new stressors, or techno-stress, and that the perception of a technology-related invasion of different life and work domains can be associated with adverse effects on individuals, such as decreased well-being (Q. Wang & Yao, 2025). This impacts how people work together and how they experience their work, which in turn initiates a wave of research concerning the future of work (Santana & Cobo, 2020). When investigating modern work contexts, researchers aim to explore the characteristics that shape them and how they can meet people's needs despite the presence of automation and complexity (Gagné et al., 2022). Then, positive states of experience can be understood, assessed, and promoted.

Key positive states at work include flow and team flow experiences, which are examined in detail in the present thesis, particularly in relation to the dynamics and complexity of modern work contexts. Flow experience can be defined as the phenomenon of being completely absorbed in an optimally demanding activity (Csikszentmihalyi, 1975). In this sense, team flow experience is described as a collective experience of flow within a group (van den Hout et al., 2018). In addition to being absorbed in a shared task, it is characterized by optimal team dynamics and is facilitated by open communication and mutual commitment (van den Hout et al., 2018; van den Hout & Davis, 2019). Flow and team flow can entail positive consequences, such as improving performance and well-being (Engeser & Rheinberg, 2008; Ilies et al., 2017; Liu et al., 2023; van den Hout et al., 2019) and are therefore considered desirable states at work. In this way, flow and team flow may act as a mechanism to mitigate the negative effects

of workplace challenges and changes, potentially helping reframe work demands as a more positive experience.

Yet, the conditions under which flow and team flow can emerge have changed in the context of modern work. Technical complexity, multitasking, remote collaboration, and constantly shifting demands call into question the premises of early flow research, which frequently centered on solitary, intrinsically motivated activities, such as playing chess, mountain climbing, and dancing (Csikszentmihalyi, 1975). In contrast, many activities in today's working world are perceived as fast-paced, demanding, and unpredictable (Pavlista et al., 2024).

In work environments where collaboration, adaptability, and critical thinking become important and work structures evolve dynamically in various directions, work design research plays an important role in structuring and understanding work-related experiences and outcomes (Morgeson & Humphrey, 2008). While earlier research argues that not only job characteristics but also individual employee behaviors should be considered when investigating flow experiences (Bakker & van Woerkom, 2017; Liu et al., 2023), the broader structural and contextual conditions under which work is organized have been less studied in flow research. This thesis takes a step back and aims to address overarching contextual factors and their impact on work settings. It is crucial to study not only the immediate antecedents of flow and team flow, located within the individual, the task, or social interactions within a team, but also to reflect on the work context, including, for example, organizational structures and technological infrastructure. It is questionable whether the same work design approaches are effective in different settings.

Taking this into account, the present thesis employs a work design approach, explicitly considering the broader context in which work is embedded. It understands flow and team flow as phenomena situated within specific organizational, technological, and social conditions, aiming to derive design recommendations for work settings that are able to promote flow and team flow despite challenging work conditions.

2. Theoretical background

The following section introduces the central topics and theoretical frameworks of this thesis: approaches to work design and the concepts of flow and team flow experience as part of positive psychology research. In addition, these are embedded into the background of modern work contexts, including the examples of start-up work, manufacturing, and virtual teamwork.

2.1. Work design

Since this thesis examines flow and team flow in work settings and aims to derive recommendations for flow-promoting workplaces, it is crucial to first review theoretical approaches to work design. The term work design refers to a structured approach for modeling the content and organization of all activities and relationships within a work environment, including the composition, structure, roles, tasks, and interactions (Morgeson & Humphrey, 2008; Van den Broeck & Parker, 2017). Thus, work design involves considerations of who performs work, what tasks and responsibilities are carried out, how these are organized and interrelated, and how work is embedded within broader contexts (Morgeson & Humphrey, 2008; Parker, 2014). In work and organizational psychology, various theoretical models of work design exist to explain the perceptions and effects of work (Knight & Parker, 2021). Prominent examples include the Job Characteristics Model (Hackman et al., 1975) and the Job Demands–Resources Model (Bakker & Demerouti, 2007), which have significantly shaped the field (Parker, Morgeson, et al., 2017).

While differing in approach, many work design models primarily focus on individuals in specific jobs and tasks. This perspective has yielded important insights, but it often neglects the contextual conditions under which work is performed (Parker et al., 2001). As work continues to evolve due to technological and societal changes, many established work design models that were developed under different conditions may reach their conceptual limits. Therefore, research has called for a more systemic and dynamic understanding of work design that incorporates organizational, social, and technological environments (Johns, 2006; Parker et al., 2001; Parker, Van Den Broeck, et al., 2017). For instance, Parker et al. (2001) emphasize the importance of considering contextual antecedents—factors neither located in the task nor in the individual—when studying work design. These may include, for example, overarching organizational strategies, complex technological developments, or cultural norms (Parker et al., 2001). Furthermore, it is suggested to view models as flexible frameworks that can be extended rather than static sets of predefined factors (Parker et al., 2001).

In line with this perspective, while acknowledging that established models still provide an important starting point for research, the present thesis assumes that flow and team flow-conducive work design must extend beyond task-level approaches. It requires a contextualized understanding of how individual, task-related, and social factors interact to enable or hinder optimal work experiences. At the same time, as workplace changes continue to evolve dynamically, work design models must become flexible and adaptable to meet the demands of new contexts. These considerations are particularly relevant for understanding flow and team flow, as these experiences may emerge from the dynamic interplay of individual, task-related, social, and contextual factors. Thus, attempts to design flow and team flow promoting work settings must adopt a systemic and context-sensitive perspective. In this regard, Johns (2006) defines contexts as all the situational surroundings that influence organizational behaviors and their effects, including opportunities and constraints. In research, context extends beyond observed or manipulated variables, affecting them on a broader scale and interacting with them (Johns, 2006).

This thesis explores flow and team flow in three distinct work contexts: start-up work, manufacturing, and different task settings in virtual teamwork. Although the three studies pursue specific research goals, which will be introduced below, they must be considered in light of the influence of contextual factors, as these may impact flow and team flow on a broader level.

2.2. Flow experience

Flow experience is the positive state of complete absorption during the execution of an activity that feels intrinsically rewarding. The demands of the activity match one's own skills, and attention is fully focused on the task at hand. In flow, one step seems to follow the next effortlessly, and the activity feels rewarding. There is a strong focus of attention on the task at hand, which is perceived as particularly enjoyable (Csikszentmihalyi, 1975).

Mihaly Csikszentmihalyi (1975) was the first to define and examine flow from a scientific perspective. He aimed to understand why some people are eager to pursue activities that involve a great deal of effort and sometimes high risk, while they are not followed by any extrinsic reward. Csikszentmihalyi (1975) described these activities as autotelic experiences, meaning activities whose goal and reward reside in the task itself, therefore being experienced as particularly enjoyable. During flow, neither boredom nor anxiety is perceived, and the activity in which one is completely involved makes full use of one's own highly skilled abilities (Csikszentmihalyi, 1975).

To empirically support his initial observations, Csikszentmihalyi (1975) conducted studies with people engaged in a variety of activities, including rock climbers, surgeons, and professional dancers. Despite the vast differences in their activities and the skills they required, their descriptions of peak experiences while being completely absorbed in their activities were similar. The results of these studies led to the definition of flow and its six components, which provided a basis for further research (Csikszentmihalyi, 1975): (1) merging of action and awareness, (2) focus of attention, (3) self-forgetfulness, (4) sense of control, (5) coherent demands and feedback, and the (6) autotelic nature of a task.

Researchers used these initial flow components to derive and further develop additional flow models with slightly different component definitions (Abuhamdeh, 2020). To provide an integrative and empirically applicable conceptualization, Peifer and Engeser (2021) proposed a model synthesizing prior definitions into three core dimensions. This model serves as the basis for operationalizing flow in the present thesis. The three components are as follows:

(1) *Absorption* is the state of being completely immersed in a task, during which external stimuli are blocked out and the focus is entirely on the task at hand. There is a merging of action and awareness, and the experience of time is distorted during flow.
(2) *Perceived demand-skill balance* includes a person's perceived matching to the demands of a task as well as feelings of control and experiences of coherent demands, clear goals, and feedback.
(3) *Enjoyment* represents the autotelic nature of the task, as well as the intrinsic motivation and joy in executing it.

The theoretical models, measurement approaches, and result interpretations in the present studies are based on these considerations. While Peifer and Engeser's (2021) core components provide an applicable framework for flow measurement, Csikszentmihalyi's (1975) initial definition and theoretical model remain the cornerstone of flow research.

2.3. Team flow experience

Although flow is typically associated with individual activities, it can also occur in social situations—still as an individual-level experience (Walker, 2021). For instance, Bakker et al. (2011) observed soccer players experiencing flow while playing a match. Aubé et al. (2014) also demonstrated in a work context study that employees can experience individual flow while working in a team. The authors discuss a potential collective phenomenon, assuming that an individual’s experience of flow positively influences the flow of their teammates (Aubé et al., 2014). The contagion effect of flow has also been observed in earlier studies (Bakker, 2005;

Bakker et al., 2011). In these examples, however, even when embedded in the context of social interactions, the focus was on the individual experience of flow, that is, an individual's complete absorption in the activity at hand, and not team flow itself.

In contrast, a phenomenon closely related to these experiences, but distinguishable from individual flow, is the group-level state of group flow or team flow experience (Lavoie et al., 2024; Pels & Kleinert, 2022; van den Hout et al., 2018; Walker, 2021). Although some of the attributes of the definitions of individual and team flow overlap, there are key characteristics that distinguish the two phenomena (Peifer et al., 2021). The experience of team flow differs from individual flow in teams as it is an emergent team-level state characterized not only by individual absorption but by a shared experience of optimal dynamics, mutual responsiveness, and group cohesion (van den Hout et al., 2018). This group-level state is characterized by interaction, coordination, and communication within the team, as well as interdependence and synchronization (Walker, 2021). The distinction between individual-level and team-level flow experiences is therefore crucial for both theoretical framing and empirical investigation.

These central characteristics of shared flow experiences can be found in various attempts to conceptualize the team-level state (for an overview see Pels et al., 2018; Pels & Kleinert, 2022): For example, Gaggioli et al. (2015) refer to *networked flow* as a collective state of mind within a team and an optimal experience that goes hand in hand with peak team performance emphasizing the connectedness of group members, which is crucial to this state (Gaggioli et al., 2015, 2020). Similarly, Sawyer (2003) describes *group flow* as a group's peak performance, where group members perceive themselves as a collective unit and act in synchrony. As with individual flow, one step naturally follows the next, and the joint activity is accomplished effortlessly (Sawyer, 2003).

A systematic approach to defining collective flow at work, therefore referred to here as *team flow*, is offered by van den Hout et al. (2018, 2019): Team flow is defined as a shared experience of being completely absorbed in an interdependent task during a perceived optimal team dynamic (van den Hout et al., 2018). In their definition, they differentiate between characteristics and prerequisites that can be operationalized for measurement, clearly distinguishing team flow from individual flow. According to this framework, team flow is characterized by the presence of four core characteristics (van den Hout et al., 2018):

(1) *Sense of unity* is understood as the sense of cohesion and identification with the group that the team members perceive.
(2) *Sense of joint progress* describes the collective awareness merging with the coordinated actions of the team and aligning towards a common goal, which translates into a feeling of accomplishment.

(3) *Mutual trust* is the confidence to show vulnerability and rely on each other without worrying about failure while an atmosphere of support and safety prevails.
(4) *Holistic focus* is defined as a shared focus that occurs when team members collaborate closely, forming a collective consciousness as they pursue a shared ambition and focus on achieving their shared goals.

This approach serves as the conceptual foundation for this thesis due to its explicit reference to the teamwork context and the adjacent operationalization for measurement. Therefore, it guides the measurement and interpretation of the data in Study I and Study III.

2.4. Flow and team flow at work

Early conceptualizations of flow described it as a rare state, primarily occurring during leisure activities such as sports or arts (Csikszentmihalyi, 1975). However, later empirical research has shown that flow is not limited to leisure activities but can also be experienced at work. Moreover, flow may even occur more frequently in the work context than in leisure time (Csikszentmihalyi & LeFevre, 1989; Engeser & Baumann, 2016). Studies in which participants were repeatedly asked about their experiences during their workday—an approach known as Experience Sampling Method (ESM) (Csikszentmihalyi, 1990)—show that conditions conducive to flow are frequently encountered in everyday working life. For example, employees at a U.S. university reported flow experiences in 28% of measurement occasions (Ilies et al., 2017). These results indicate that flow can be a central part of the everyday work experience.

Studying flow in the workplace is especially relevant because of its potential impact on both well-being and performance—two central outcomes in occupational psychology (Liu et al., 2023; Peifer & Wolters, 2021; van den Hout et al., 2019).

Research has shown that experiencing flow can promote positive affect (Fullagar & Kelloway, 2009; Ilies et al., 2017). Additionally, experiencing flow at work can positively influence job satisfaction and commitment (Ilies et al., 2017; Maeran & Cangiano, 2013; Plester & Hutchison, 2016). In a diary study investigating how flow at work influences daily experiences, it was found that employees who experience more flow at work tend to be more energetic and less exhausted in the evening (Demerouti et al., 2012). Moreover, experiencing flow may positively affect life satisfaction (Datu & Mateo, 2017) and is negatively related to burnout symptoms (Aust et al., 2022).

Regarding the effects of flow experiences on performance, theoretical models suggest different mechanisms. First, since flow is accompanied by a strong focus of attention and is achieved through the application of high skills, it can be assumed that flow is inherently associated with high performance. Second, the positive, rewarding experience of flow is assumed to be related to increased intrinsic motivation. Consequently, new challenges and similar tasks are actively approached in an attempt to experience flow again. Again, this would be associated with increased performance in the given activity (Engeser & Rheinberg, 2008). Empirical studies also demonstrate the positive effects of flow on performance, for example, in terms of the perceived quality of one's own work (Weintraub et al., 2021), innovative behavior (Slavec Gomezel & Aleksić, 2020; L. Wang et al., 2019), and creative performance (Min et al., 2015; Stollberger, 2019).

Similarly, team flow is also associated with positive outcomes at work. For instance, team flow has been found to be positively related to team positivity (van den Hout et al., 2019). Shared flow has also been shown to benefit team goal commitment and performance (Aubé et al., 2014; van den Hout et al., 2019). Moreover, positive correlations have been found between collective flow and collective efficacy beliefs in work groups (Salanova et al., 2014).

Various influencing factors can positively impact the emergence of flow and team flow, allowing them to entail the described consequences. For instance, job characteristics such as autonomy and task variety can positively influence flow (Kuo & Ho, 2010; Maeran & Cangiano, 2013). In addition, individual factors such as feelings of recovery (Debus et al., 2014) and self-efficacy (Peifer, Schönfeld, et al., 2020) can promote flow, as can the fulfillment of basic needs, which enables individuals to develop strategies that may facilitate flow experiences (Bakker & van Woerkom, 2017). At the social level, social support (Salanova et al., 2006) and a fun atmosphere within the work team (Plester & Hutchison, 2016) have been shown to benefit flow. Previous research has also identified approaches for promoting team flow. For example, teamwork resources such as team mindfulness (Feng et al., 2024), shared mental models, and good communication (Aust et al., 2023) have been shown to facilitate team flow experiences.

2.4.1. Flow and team flow in start-up work

The start-up context is marked by dynamics and challenges, including uncertainty and high stakes (Hameed & Irfan, 2019; Salamzadeh & Kawamorita Kesim, 2015). The daily work of founders is characterized by rapidly changing demands that make it difficult to establish a routine and recurring crises due to various unexpected stressors and problems (Kuckertz et al., 2020; Rauch et al., 2018). Resilience and social support are often lacking (Hameed & Irfan,

2019; Hartmann et al., 2022). The challenges of start-up work suggest that positive states, such as flow and team flow, are more difficult to achieve and may be hindered by these factors.

At the same time, founders experience a high degree of autonomy (van Gelderen, 2016). They have the freedom to determine their start-up's path and define their own work, adapting it flexibly to current needs. In this way, innovative working methods and task types can be identified that may promote flow through techniques such as design thinking (Yang & Hsu, 2020). It can also be assumed that, especially at the beginning of a start-up process, founders perceive their enterprise and efforts as particularly meaningful (Cardon et al., 2009). Following work design models like the Job Characteristics Model (Hackman et al., 1975), start-up contexts seem to fulfill many crucial job characteristics such as autonomy, task significance, and feedback from the job, which in other work contexts already have been shown to promote flow (Kuo & Ho, 2010; Maeran & Cangiano, 2013).

At the team level, intensive collaboration among a small team and the interdependent distribution and joint processing of work tasks may create a beneficial environment for team flow (van den Hout et al., 2018; Walker, 2021). Additionally, given the dynamics of cooperation in start-ups, it can be assumed that the start-up team shares high goal commitment and mutual ambitions—factors that are theorized to act as antecedents of team flow (van den Hout et al., 2018; Walker, 2021).

In early start-up stages, factors that may promote flow and team flow, as well as possible hindering factors and challenges, interact in a contextually specific and potentially unique manner. Their interplay with individual, team-level, and context-related influences may result in novel effects on flow and team flow. Understanding these enables the development of a holistic work design model that considers a wide range of input and output factors of flow and team flow in the start-up context. Furthermore, it allows for deriving implications that are applicable to the experiences of start-up founders and provides design recommendations for positive start-up environments. Therefore, Study I of the present thesis aims to explore the research question:

RQ1: *In the dynamic work context of start-up work, which factors promote or hinder the flow and team flow experiences of founders, and what are the consequences of these states?*

2.4.2. Flow in manufacturing work

Manufacturing work is often repetitive and perceived as boring or monotonous (Loukidou et al., 2009)—conditions that due to the lack of challenge or enjoyment initially do not appear to

be flow-promoting. However, new technological developments automate work steps, sometimes involving collaboration with autonomous systems or robots, while still human labor remains crucial in the context of manufacturing workplaces (B. Wang, 2018).

Due to technical possibilities and automation, gamification is an example of a work design approach that is easy to implement in manufacturing and is increasingly being integrated into daily work in industrial production (Ulmer et al., 2022; Warmelink et al., 2020). Gamification can be defined as the implementation of game elements into new contexts (Deterding et al., 2011). Based on theoretical assumptions about games that provide a variety of flow antecedents (Csikszentmihalyi, 1975), a flow-promoting effect is also assumed for gamification. Following flow theory (Csikszentmihalyi, 1975), gamification elements such as feedback systems, leaderboards, or progress bars provide characteristics that may facilitate flow experiences. Flow researchers recognized these potentials, which is why gamification is currently gaining attention in the field (Oliveira & Hamari, 2024).

Flow is often used mainly as a conceptual and theoretical basis for designing gamification strategies, ensuring that gamification elements are perceived as engaging and positive (Krath et al., 2021). However, applied research often does not focus on measuring the resulting flow experience when gamified systems are used (Koivisto & Hamari, 2019). This gap in empirical validation requires systematic research to determine how gamification elements can promote flow experiences during manufacturing work tasks. Possibly, gamification may not be inherently flow-inducing, and its effectiveness may depend on specific design elements and the context of the task. Furthermore, the idea that flow experiences result in improved performance has not yet been adequately tested in the context of gamified industrial tasks. A better understanding of this relationship could lead to rethinking work design approaches in manufacturing and to redesigning future workplaces to create more positive work experiences. Although theoretical models suggest positive effects, there is a lack of empirical evidence in this area. Clarifying the effects of gamification on flow in different work contexts is therefore crucial for deriving recommendations on the practical applicability of gamified work designs that aim to promote flow experiences at work, especially in the context of modern manufacturing.

Study II of the present thesis investigates the role of gamified work design in manufacturing work and its relationship with flow experiences and task performance. Recommendations for designing flow-promoting workplaces in manufacturing are derived considering opportunities from the field of gamification. The following research question is addressed in Study II:

RQ2: *In the context of manufacturing work, how does gamification affect flow experience, and how is it related to performance?*

2.4.3. Team flow in virtual teamwork

Another central context of modern work and therefore a key area of research is virtual teamwork (Santana & Cobo, 2020). Alongside flexibility and automation, digitization is a key development in today's workplaces. Digital structures enable virtual collaboration, allowing teams to work together across geographical distances via digital tools without meeting physically in the same place (Feitosa & Salas, 2021; Handke & Wesche, 2024).

Virtual teams rely on technology to cooperate and communicate, and face particular challenges. The perceived distance between team members and the often reduced informal communication in virtual teamwork can negatively affect team outcomes, such as trust among team members (Morrison-Smith & Ruiz, 2020; Purvanova & Kenda, 2022).

Despite the associated challenges, many employees prefer at least partially virtual working models (Barrero et al., 2021). This means that the temporary solutions initially implemented during the Covid-19 pandemic have become the norm for many teams (Barrero et al., 2021). Consequently, virtual workplaces should be carefully designed to minimize negative consequences and promote positive outcomes, such as experiencing team flow in a virtual setting. Handke and Wesche (2024) likewise argue that the question is no longer whether teams work virtually, but how virtual work is designed.

Not much is known about the antecedents of team flow in the virtual space and how they differ from those in face-to-face team interactions, but it can be assumed that there are different influencing factors in virtual than in face-to-face teamwork settings (Peifer et al., 2021), as collaboration and communication are altered due to technological changes (Morrison-Smith & Ruiz, 2020). Still, it can be supposed that, given the appropriate circumstances, team flow can also occur in virtual contexts (Peifer et al., 2021). A recent study revealed that virtual meetings can provide employees with suitable conditions for individual flow (Rivkin et al., 2024). A similar assumption can be made for team flow, in which the role of virtual communication may be particularly important (Peifer et al., 2021). Most communication among virtual teams takes place in virtual meetings, whereby this communication differs from face-to-face interaction (Standaert et al., 2022). Because communication is considered a key antecedent of team flow (van den Hout et al., 2019), investigating virtual team communication thoroughly is of central importance for understanding team dynamics. Identifying communication parameters that show an effect on team flow can contribute to work design theory by incorporating communication into virtual teamwork models in a differentiated way. On a methodological level, the study contributes to advancing the development of interruption-free measurement approaches for team flow. Furthermore, it provides a starting point for developing implications

and work design recommendations for virtual teamwork. Therefore, Study III of the present thesis aims to explore the research question:

RQ3: *In the context of virtual teamwork, which communication parameters accompany team flow experiences in different types of tasks?*

2.5. Aims and contributions

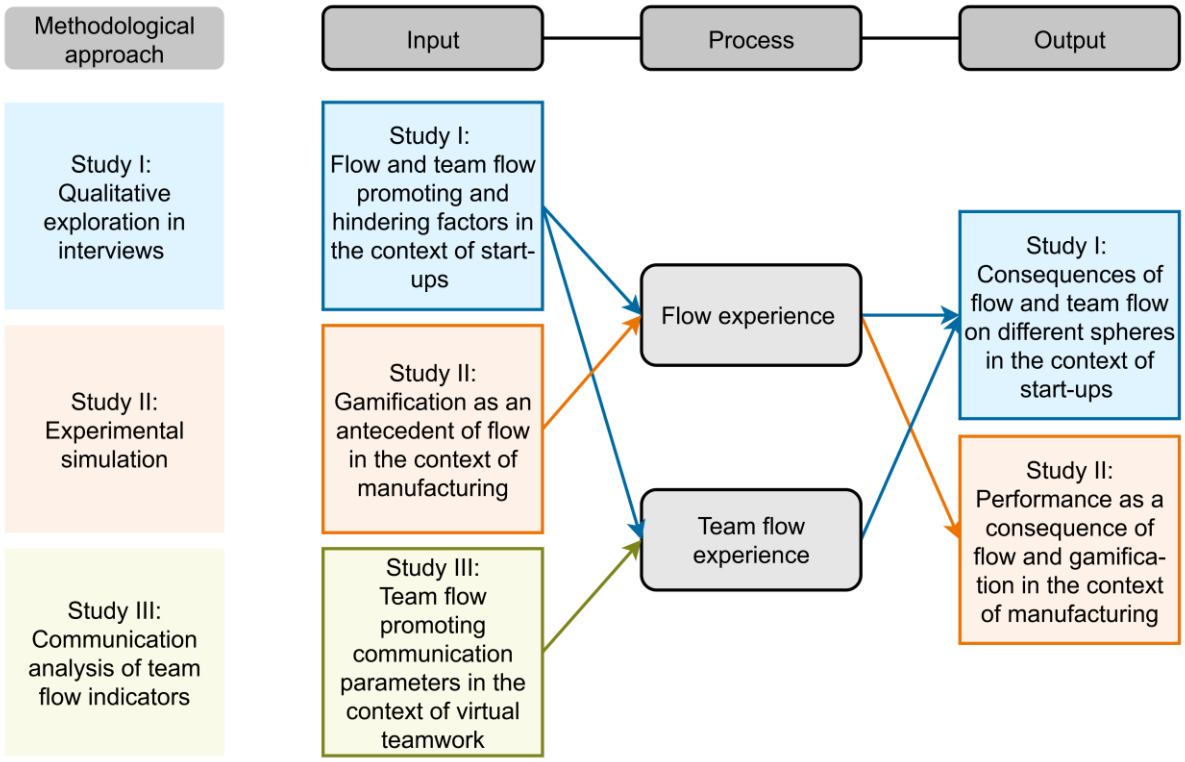
The present thesis aims at enhancing the understanding of flow and team flow, as well as the antecedents and consequences of these states in modern work contexts. It uncovers which factors promote or hinder flow and team flow at work, and how these are dependent on external context factors in challenging work settings.

To this end, three empirical studies are conducted as part of the thesis. Study I provides an overview of the individual, social, and task-related factors that promote and hinder flow and team flow in start-ups, as well as the consequences of both states for start-up founders. Study II manipulates flow by applying a gamified and non-gamified task design in manufacturing and investigates the effects of flow on performance in this context. Study III provides a closer examination of the team flow experience and its promoting factors in team communication, which could be seen as indicators of the experience in virtual teamwork. Overall, the studies contribute to expanding work design models to better understand flow and team flow as psychological processes influenced by individual, task-related, and social factors, as well as unique contextual features. Thus, the thesis aims to advance the development of an adaptive work design model for promoting flow and team flow in different work contexts.

Adopting a work design perspective, the three studies are classified within an overarching model that establishes connections between them. It serves as the groundwork for further development and derivation of work design recommendations. An Input-Process-Output (IPO) model provides a suitable basis for this approach, as it describes and organizes relationships within a system, and is well-established in work psychology (Ilgen et al., 2005). It is used to guide work design research and can be found, for example, in the Work Characteristics Model (Hackman et al., 1975; Ilgen et al., 2005). The IPO model illustrates how inputs of the work context affect central psychological processes, which can then lead to outputs for individuals or teams. At the same time, it can be flexibly adapted and extended to a wide variety of contexts (Marks et al., 2001).

In Figure 2.1, the three empirical studies are categorized using an IPO model in which flow and team flow represent the processes to be investigated.

Figure 2.1: Input-Process-Output Model of antecedents and consequences of flow and team flow in different contexts as a framework for the empirical studies of the present thesis



Study I explores the factors that promote or hinder flow and team flow at the input level in the context of start-up work. Both flow and team flow are included as processes within the model, and the consequences of both states are examined as outputs. Study II investigates the influence of gamification in manufacturing work at the input level of the IPO model. The state examined in this study is the individual experience of flow, and the output level focuses on its effect on performance in manufacturing. Study III is situated within the context of virtual teamwork, incorporating communication parameters as input factors into the model and examining their effect on team flow as the central process, while not further investigating the output level.

While considering different work contexts with unique characteristics and challenges, each of the three studies employs a distinct methodological approach: Study I takes a global perspective and considers all kinds of different tasks in a start-up, Study II examines a specific scenario in more detail, and Study III focuses on the experience process itself. Thus, the experiences of flow and team flow in modern work contexts are examined at various levels of abstraction. The findings may contribute to approaches for promoting flow and team flow in different work contexts while taking into account the specific challenges of modern work settings.

Based on the findings of the empirical studies, this thesis then aims to pursue a higher-level perspective. The IPO model mentioned before is used as the basis for developing a holistic work design approach that considers different types of challenging workplaces to consolidate factors that promote flow and team flow. To conclude, the overarching research objective of this thesis is to derive design recommendations for promoting flow and team flow in different work contexts.

2.6. Thesis outline and overview of empirical studies

This thesis examines different modern work contexts with regard to flow and team flow experiences, their antecedents, and outcomes. In particular, in work settings that initially appear unsupportive of such experiences, due to factors such as rapid changes, monotony, or virtual collaboration, the traditional antecedents of flow and team flow may not fully apply. However, these contexts may also offer novel opportunities for proactively designing positive moments at work. Therefore, questions arise about how already established and theoretically assumed but not yet widely tested antecedents of flow and team flow manifest, and how they can be modeled from a work design perspective. The three studies presented in this thesis aim to provide detailed insights into factors promoting flow and team flow while applying different research designs in three different work settings.

Similar to the antecedents of flow and team flow, the consequences of flow and team flow at work require further investigation. While earlier research emphasized positive effects on well-being and performance (Liu et al., 2023; Peifer et al., 2022), it does not automatically transfer to new contexts. The effects of flow and team flow in the face of new challenges at work are therefore examined in this thesis in different work contexts.

The first work context to be considered is the start-up context, specifically in the early stages. Study I focuses on the start-up context as a dynamic and flexible work context. It examines which factors in the early start-up stage can promote or hinder the experience of flow and team flow, as well as the consequences of these conditions. A qualitative approach in the form of an interview study is chosen to investigate the relationships, and the results are evaluated by applying a qualitative content analysis. Then, the outcomes regarding flow and team flow promoting or hindering work design factors are structured in a model that differentiates between individual, task-related, and social levels, and are discussed in the context of the challenges of start-ups and dynamic workplaces.

In contrast to the flexibility of start-up work, industrial manufacturing work contexts offer much more structure. Study II of the present thesis focuses on highly standardized work with a

manual workstation and investigates whether a gamified work design approach to manufacturing work tasks is able to lead to increased flow experiences and, consequently, better task performance. A controlled comparison of gamified and non-gamified user interfaces in industrial settings provides initial insights into these relationships.

The third work context investigated is the context of virtual teamwork. Study III examines how team communication parameters are able to predict team flow and thus may be seen as promoting factors or serve as indicators of team flow in the context of virtual team collaboration during different task types. In a study simulating a virtual team workshop, video data are recorded while participants engage in two different tasks. One of them is enriched with LEGO® bricks to create a co-creative, playful activity. The videos are analyzed using a communication analysis approach and are linked to questionnaire data regarding team flow. Identifying team flow-related communication parameters then guides recommendations for virtual team interactions.

This is followed by a joint discussion of the studies. When deriving theoretical and methodological implications, the focus is on developing an overarching work design model that combines and systematizes the key aspects of all the studies. Additionally, the theoretical and methodological aspects of the thesis are discussed in the context of work design, flow, and team flow research. The strengths and limitations of the thesis are reflected upon, and the implications for future research are explored. Lastly, recommendations for flow and team flow promoting work design in practical applications are derived before the final chapter draws general conclusions.

3. Study I: Flow and team flow in start-up work

Founders' flow:
A qualitative study on the role of flow experience in early start-up stages

Kloep, L., Roese, K., & Peifer, C. (2023). Founders' flow: A qualitative study on the role of flow experience in early start-up stages. *PloS one 18*(10), e0292580, https://doi.org/10.1371/journal.pone.0292580

3.1. Abstract

Flow experience is a state of complete absorption while performing an optimally challenging and enjoyable task. It is often experienced at work—both in the form of individual and team flow—and can have a positive effect on performance and well-being. However, start-up founders' work situation differs from that in established companies, facing not only great autonomy but also new challenges, uncertainty, and risks. It can be assumed that flow also provides benefits in start-ups, however, this has not yet been examined in depth and the factors that may operate differently in start-ups in comparison to other work contexts have not yet been explored in detail. Using a qualitative research approach, 21 founders from different industries were interviewed. Enhancing and inhibiting factors of flow and team flow as well as consequences for the founders and the start-up in general were examined and structured with the help of a qualitative content analysis. A variety of contexts was identified in which founders experienced flow and team flow. Various factors on the individual, task-related and organizational sphere were found to be perceived as promoting or hindering flow and team flow, e.g. well-being, autonomy or the environment. The findings regarding the consequences of flow and team flow show that these mainly are very desirable states for founders, e.g. leading to better results, progress or team processes. Only few negative consequences were identified, e.g. perfectionism. Thus, it is helpful to foster flow in the start-up context. Possible approaches derived from the participants' statements to this could be, for example, to design flow-promoting environments or participation in specific workshops.

3.2. Keywords

Flow experience; team flow experience; start-up founders

3.3. Introduction

A team of young students decides to found their own start-up after graduation. They invest a lot of time in their idea and team members work passionately for the common goal. While people around them mainly perceive the uncertainties in starting a business and wonder if it is worth it, the team members do not lose their motivation. They seem to be absorbed by their work; nothing can stop them when they are working on their idea.

Starting a business is a process fraught with risks, difficult decisions, and uncertainty (Rauch et al., 2018; Salamzadeh & Kawamorita Kesim, 2015). Many factors are unpredictable and the path to a functioning start-up is a series of challenging ups and downs (Salamzadeh & Kawamorita Kesim, 2015). Often start-ups have not yet developed sufficient resilience in the team to face challenges with confidence (Hartmann et al., 2022). Nevertheless, many founders seem to be absorbed in their task, do not lose their vision, and motivate themselves every day anew, although the work in many cases does not yet bring them any financial or other rewards.

One possible reason for founders' persistence could be flow and team flow experiences. It is already known from other work contexts that flow is conducive to work satisfaction (Maeran & Cangiano, 2013) and team performance (Aubé et al., 2014). In the field of start-ups, however, these relations are still largely unexplored. Therefore, flow as well as its antecedents and consequences are worth examining, especially in the early start-up phase, in order to benefit from its positive effects. Thus, the present paper aims to explore how founders get into flow and team flow and what impact this has on them and their work in the start-up process.

3.3.1. Start-up companies and entrepreneurial challenges

Working on a start-up is associated with new opportunities, but also with challenges (Hameed & Irfan, 2019; Salamzadeh & Kawamorita Kesim, 2015). For example, start-up founders may face a lack of support (Hameed & Irfan, 2019), and dealing with crises can also be highly demanding (Kuckertz et al., 2020). In addition, start-ups have often not yet developed routines to master their everyday business and meet challenges (Gorgievski & Stephan, 2016). Thus, entrepreneurs are particularly exposed to stressors such as uncertainty (Rauch et al., 2018; Stephan et al., 2023). Although working in a start-up can be highly satisfying and a current meta-analysis found entrepreneurs to perceive higher well-being than employees of other organizations (Stephan et al., 2023), the negative effects of entrepreneurial challenges, for example on an increase of the founders' negative emotions, cannot be neglected (Williamson et al., 2022).

As flow experience could be a possible outcome of a positive form of dealing with stressful events by interpreting them as manageable challenges (Peifer & Tan, 2021) this mechanism should also be looked at in the context of start-ups. Hereby, flow could be an approach to deal with challenges and create a more positive work environment. However, it is unclear how flow can arise in the conditions of start-ups and what factors have an impact there. Therefore, the present study aims to create a profound understanding of flow in start-ups and to identify possible approaches.

3.3.2. Flow and team flow experience

Flow experience is defined as a state of complete absorption and self-forgetting while performing a task that is perceived as optimally demanding (Csikszentmihalyi, 1975). During flow, one step seems to automatically follow the next, with no need to think about how the activity should be performed. At the same time, the individual's entire attention is focused on the task and their thoughts do not wander. Irrelevant distractions are suppressed and a sense of complete control of a fluid process with little effort is experienced while time seems to be accelerated (Csikszentmihalyi, 1975; Nakamura & Csikszentmihalyi, 2014). Csikszentmihalyi was the first to describe the experience of flow when he observed people pursuing a wide variety of activities—some of them involving high risks—even though they were not rewarded for doing so (Csikszentmihalyi, 1975). In his interviews, he concluded that people who perform different actions, such as dancing, rock climbing or playing chess, experience similar situations and describe their activities as absorbing and extrinsically rewarding. Various antecedents show positive effects in different contexts and can promote flow. Peifer and Wolters suggest a framework that assigns them to three spheres: the individual, the task- or job-related, and the organizational or social sphere (Peifer & Wolters, 2021).

The phenomenon of flow experience can also be observed on the team level. Team flow is defined as a shared flow of a group or team in a social situation (Walker, 2021). It typically results from optimal team dynamics during an interdependent task (van den Hout et al., 2018). Beyond that, a distinction can be made between co-active flow, with team members experiencing flow individually, and interactive flow, requiring direct interaction and communication (Walker, 2021).

3.3.3. Flow experience in innovative work contexts

Flow can be experienced in a variety of contexts at work and leisure. However, it is experienced more frequently at work (Csikszentmihalyi & LeFevre, 1989; Engeser & Baumann, 2016) and has several positive consequences, which can be beneficial in the start-up process. The consequences of flow can also be classified into the three spheres individual, task- or job-related, and organizational or social consequences (Peifer & Wolters, 2021). Flow at work is usually perceived as a positive state and is shown to have positive effects on a person's performance as well as on well-being and teamwork factors (for an overview see Peifer & Wolters, 2021). Moreover, it can have positive effects on creative behavior (Min et al., 2015; Stollberger, 2019). In a study with music students, for example, it was shown that the flow when composing a piece of music is related positively to the creativity of the resulting composition (MacDonald et al., 2006). Flow experience also has a beneficial effect on innovative behavior, as a study on consumer participation in product innovation showed (L. Wang et al., 2019).

Thus, it is likely that the flow experience also plays a role in the start-up process, which is characterized by a need for innovation (Sarri et al., 2010). Start-up founders are confronted with various challenges during the process of developing and implementing ideas (Hameed & Irfan, 2019). At the same time, working on one’s own start-up is an activity characterized by intrinsic motivation (Murnieks et al., 2020) in which potentially flow-promoting conditions can be found. For example, according to a study on team leaders from different companies, flow occurs particularly in tasks such as planning processes, problem solving, and evaluation (Nielsen & Cleal, 2010)—activities that could also be crucial in the start-up process. Furthermore, a study with students in a business simulation shows that flow has a positive effect on learning performance and this in turn on entrepreneurial self-efficacy (Yen & Lin, 2020). The autonomy perceived and chosen by the founders also plays a pivotal role in the start-up (van Gelderen, 2016). At the same time, it is part of the Job Characteristic Model by Hackman and Oldham (Hackman & Oldham, 1975) and, according to the model, affects the perceived responsibility for work results and, as a consequence, the positive perception of these. The relationship between perceived autonomy and flow has already been observed in other contexts and could be of particular importance in start-ups (Fullagar & Kelloway, 2009).

3.3.4. Research gap and aims of the study

Research to date shows controversial results regarding start-up founders’ experiences and well-being (Stephan et al., 2023). On the one hand, entrepreneurs are motivated by various

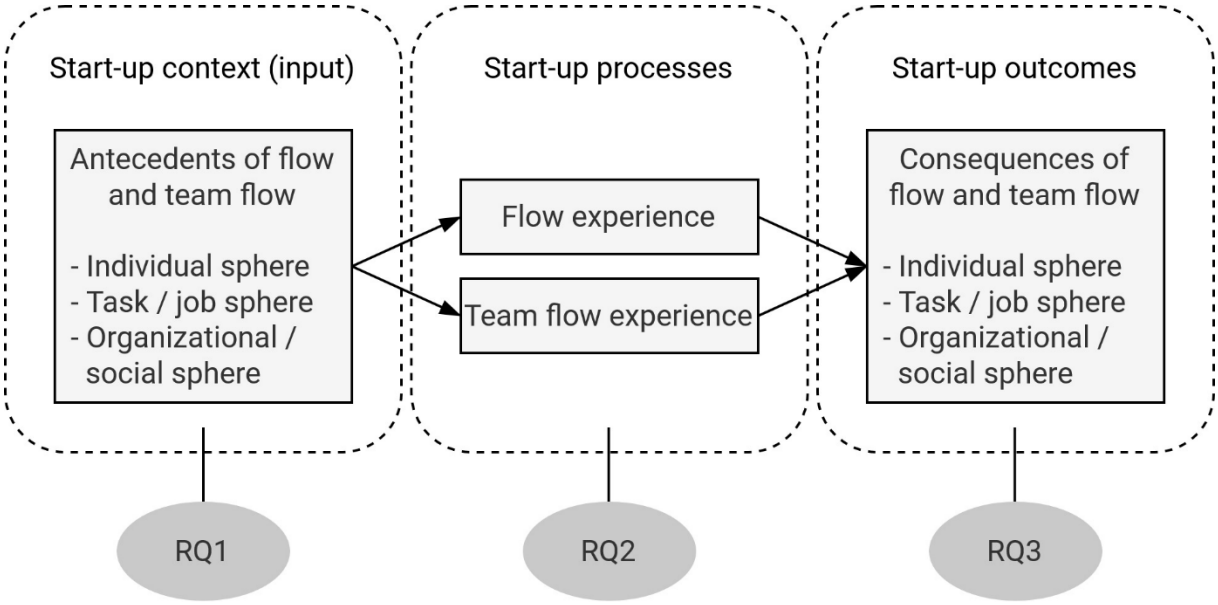
factors to pursue their start-up (Murnieks et al., 2020) and show high levels of well-being (Stephan et al., 2023). On the other hand, opposite results, such as negative affective states triggered by different factors (Williamson et al., 2022) and the confrontation with a variety of stressors in the start-up, are also evident (Rauch et al., 2018). Furthermore, a recent study showed that the stressors in the start-up context do not only have negative effects, but that the high demands are also associated with entrepreneurs' well-being (Wach et al., 2021). Here, the experience of flow could have played a central role. The challenges might have been just so difficult that the founders interpreted them as feasible and expressed exactly the right skills to overcome them. This could have led to a positive experience of flow as proposed by Peifer and Tan (Peifer & Tan, 2021), which in turn could have had a positive effect on well-being. However, it is not yet understood how founders experience flow and what effects the experience has in the context of start-ups. Since many different factors can have an effect on the experience of flow and flow in turn can lead to a variety of consequences (Peifer & Wolters, 2021), a thorough analysis should be carried out here.

Flow and its consequences have been studied mainly using quantitative methods, but have not yet been considered in detail with reference to the start-up process, which may differ considerably from other work contexts regarding the challenges, stressors and motivational factors that can be experienced (Hameed & Irfan, 2019; Murnieks et al., 2020). In order to understand start-up founders' experiences and support them in their work in the best possible way, it is necessary to identify which of the already known factors (Peifer & Wolters, 2021) and which additional factors are related to their flow and team flow. As Swann already stated, qualitative research approaches can provide detailed insight into how flow is experienced and can enhance the understanding of this state (Swann et al., 2019). To identify so far unexplored aspects and beneficial factors, the qualitative approach shows great potential.

The research questions (RQ) concerning start-up founders' flow to be investigated through the interviews as illustrated in Figure 3.1 in an input-process-outcome model of the start-up context were the following:

1. RQ1: Which factors do founders experience as enhancing or inhibiting their individual flow and team flow?
2. RQ2: How do founders perceive flow and team flow and in which situations in the start-up work do they experience them?
3. RQ3: What are the consequences of flow and team flow in the start-up context and what role do these states play when working on the start-up?

Figure 3.1: Derivation of the research questions from the relationship between start-up factors and flow and team flow in an input-process-outcome model.



3.4. Method

In order to better understand the founders' experiences, the qualitative method of a semi-structured interview-based study provides a suitable approach. It allows for an explorative analysis of the still rarely examined factors and effects of flow experience in the start-up process. Furthermore, the participants in their unique state during the founding process are given the opportunity to discuss their experiences in detail, which would be limited in a standardized questionnaire. Ethical approval for the study was obtained from the Ethics Committee of the University of Lübeck, Germany (21–465, 05/01/2022).

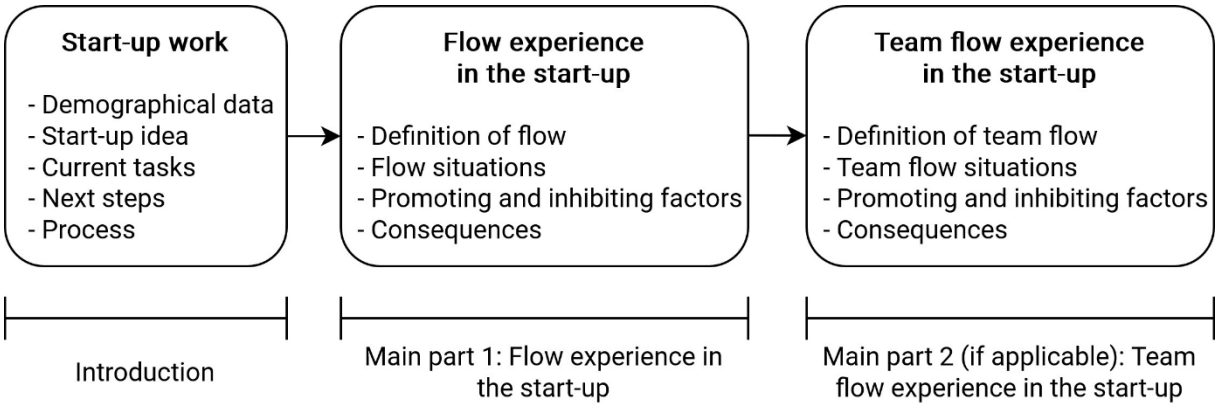
3.4.1. Participants and procedure

The participants in the interview study were 21 start-up founders or prospective start-up founders in Germany, Austria and Switzerland currently working on their own business ideas and about to formally establish a business or having done so within the past three years. The average age was 31; nine participants identified as female and 12 as male. They were recruited by convenience sampling via social media and were not rewarded for their participation. The interviews were semi-structured with an interview guideline, with questions adapted to the participants' experiences aiming to establish an interactive conversational setting (Potter &

Hepburn, 2005). First, a pilot interview was conducted to check the interview guideline, and was not included in the analysis. The main topics of the interview guideline as depicted in Figure 3.2 were the participants' individual flow and team flow experiences, focusing on typical situations of the experience, its antecedents, and consequences. Thus, the applicability of the already known characteristics of flow (Nakamura & Csikszentmihalyi, 2014; Peifer & Engeser, 2021) were to be examined for the start-up context. The factors associated with flow and team flow were to be identified in the individual, task-related, and organizational/social spheres, following the framework by Peifer and Wolters (Peifer & Wolters, 2021). The complete interview guideline can be found in Appendix A.

Prior to the start of the interview, all participants were given detailed information about the procedure and data protection and gave their written consent to the audio recording. The interviews, which lasted on average for 25 minutes, were conducted in German between January and April 2022 in digital form via video call using the video conferencing tool Webex. An audio file was recorded and subsequently transcribed verbatim.

Figure 3.2: The interview guideline



3.4.2. Qualitative content analysis

To structure and contextualize the participants' statements, a content-structuring qualitative content analysis according to Kuckartz (2012) was applied following the process steps in a computer-assisted form with the help of the tool MAXQDA. In the coding process, deductive and inductive codings were developed and applied to the transcripts. The deductive codings were based on the established characteristics of flow as described by Csikszentmihalyi (1975) and on a framework developed by Peifer and Wolters (2021), which assigns antecedents and

consequences of flow to three spheres: the individual sphere, the job and task related sphere, and the organizational and social sphere. The inductive codings originated from the participants' responses and complemented the coding frame that covered in detail the founders' experiences and ideas regarding flow and team flow. Within the scope of self-reflective subjectivity according to Steinke (1999), the interviews were coded by two members of the research team using the coding frame developed for the material. Subsequently, agreements and disagreements on codings were discussed in detail. The complete codebook can be found in Appendix A.

3.5. Results

The content analysis allowed for the central aspects of flow and team flow to be identified. They are presented in the following in order of the topics addressed in the interview.

3.5.1. Flow experience

First, participants were asked how they defined flow experience. Most participants were familiar with flow. As characteristics of flow they mentioned a strong focus of attention as well as fun while working on the task at hand.

P6: *When you have so much fun or focus on your work that you hardly even realize you're working […]*

Participants also named a demand-skill balance in which the activity is neither too challenging nor boring. Other characteristics of flow experience the participants identified were a sense of autonomy, clear goals, motivation, and the feeling of fulfillment, while at the same time the sense of time is distorted.

P7: *I believe that you are happy at that moment and that time simply passes without your noticing it*.

P5: *And maybe also when I know that it is a linear way of working*. *What I do is that I have a clear goal in mind and can then also totally focus on it and achieve it very ambitiously at work in this situation*.

In addition, they reported a feeling of progress and increased productivity as characteristics of flow, as well as physical changes, such as forgetting about feeling cold or hungry. A few participants were not familiar with the term flow experience. Nevertheless, after flow was defined by the interviewer, they recognized the state and reported having experienced it.

3.5.2. Flow situations

Next, participants were asked about typical flow situations in their everyday start-up activities. They named different types of tasks: strategic tasks such as business plan development, creative tasks such as designing, and tasks directly related to product development. They moreover mentioned systematic tasks such as accounting or technical as well as practical tasks.

P9: *Then I've definitely had that a couple of times now as well*, *in general when it comes to strategic planning*.

P4: *I think what definitely comes up a lot is when I have to think about things intensely and sort of let myself be creative […]*

Some could not describe a specific flow task and reported that for them there were rather different factors or characteristics of the task that can promote flow. For example, they described that they experienced flow primarily in tasks that coincided with their interests, related to learning experiences, or involved interaction in a team or with customers.

P8: *Well*, *I would say all the things which I have much fun with*. *That makes it easier to stay in the flow*.

In addition, flow was described as occurring more frequently in the early stages of the start-up. Some participants, however, reported having experienced flow more often in other areas of life than in start-up activities, explaining this with the turbulent and unpredictable work routine in start-ups.

3.5.3. Factors conducive to flow

Next, participants were asked about factors having a positive effect on their flow experience. In the individual sphere, participants defined personal well-being as crucial for the flow experience in the start-up process.

P3: *And I have that very often when I feel well mentally […]*

In the task sphere they named the variety of different tasks and skills demanded, as well as the demand-skill balance of a task described as conducive to flow.

P14: *And from the task itself*, *I see in any case a certain variety*. *In other words*, *phases where it becomes more difficult*. *Phases where you can just rest a little bit mentally and put something together or so*, *and have a certain variety in any case*.

Moreover, (positive) feedback from others or from the task itself and autonomy or perceived control when performing a task are mentioned. In addition, participants explained that flow occurred especially when the task was perceived to be meaningful for the start-up.

P3: *[…] when I realized*, *oh*, *that's something where I really pursue my mission in life*. *So*, *with this I fulfill a little bit of what I want to change in the world*.

The founders also described that clear goals and moderate stress could promote flow and that tasks offering a learning opportunity for the founder were more likely to be experienced in flow.

P2: *And the other thing is kind of a light pressure*, *I would say*. *So*, *not the deadline due in two hours and you're screwed if you don't make it by then*, *but so that it doesn't hurt yet*, *it's still okay just knowing you have to do it*.

On the organizational and social sphere, the work environment and the equipment of the workplace were mentioned as conducive to flow. Participants reported that a quiet workplace with no interruptions was also crucial to a flow experience. They explained that, depending on personal preference and the nature of the task, both individual work and interaction with the team could promote flow.

P11: *And environment*, *for me a room where I feel comfortable […] where I can create the atmosphere*.

P21: *And I think*, *in general*, *a healthy balance between communication and also being able to work alone and keep going*.

Also, as a factor at the interface between the social and the task sphere, several participants reported that personal interest in performing a task influenced their flow, resulting in more flow when the characteristics of a task matched a person's strengths.

3.5.4. Factors inhibiting flow

The participants were asked not only about factors that enhanced their flow, but also about those that inhibited it. Again, the factors named can be assigned to the spheres of the framework.

In the individual sphere, participants identified physical limitations, e.g., physical pain, preventing them from performing the flow activity. In the task sphere, they named being

overwhelmed by the task as a crucial factor. A disruption of the demand-skill balance led to a lack of flow. In this context, failures in present or previous tasks and a lack of personal interest in a task were named as inhibiting factors.

P5: *[…] when I'm overloaded*. *That is*, *when I'm stuck on something and don't know how to continue*.

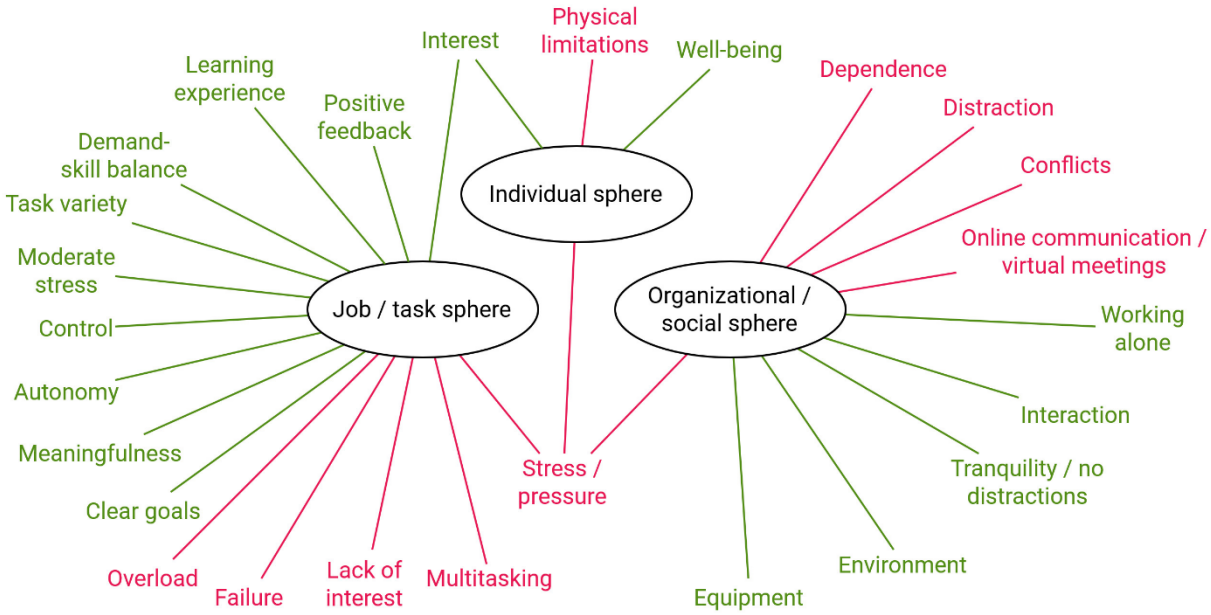
Multitasking or a heavy workload in other fields, for example due to a second job in parallel to the start-up, also inhibited flow in start-up related tasks and can also be assigned to the task-related sphere.

P2: *Yes*, *I think the typical thing is that you have something else to do that is more important or at least has a high priority*, *so that you can't fully focus on it*. *So*, *for quite a while I was still working in the hospital at the same time when founding the start-up*, *and it's obvious that when you're working there*, *you're not able to focus on your goal*, *"flowing" in your start-up*.

In the organizational and social sphere, many participants described distraction as an inhibiting factor of flow. In addition, they named dependence, for example on the results of others, and thus limited autonomy, as an obstacle to flow. Within the start-up, online communication and meetings were perceived as not beneficial, and conflicts—both within the start-up team and in the private sphere—had a negative influence on flow experience.

P19: *[…] disagreements in the team—you also have that sometimes—this disrupts the flow*.

Figure 3.3: Start-up factors enhancing flow (green) and inhibiting flow (red).



A factor related to all three spheres was stress in terms of a lack of time or high performance demands. The reasons for the stress or pressure the founders felt could be caused by themselves, such as high expectations regarding their own performance or due to external factors like challenging start-up stages with lots of new situations to be mastered.

P10: *So somehow pressure factors*, *so that I think I have to perform now*. *Or I have to finish this and that by the end of the day*.

Figure 3.3 shows all factors conducive to and inhibiting flow that were mentioned by the participants.

3.5.5. Consequences of flow

Next, we asked the participants about the consequences of their flow experience in the start-up concerning the individual, task- and job-related as well as organizational and social sphere. The participants recognized various consequences of flow in the personal sphere. They reported more fun at work and increased motivation. Moreover, they attributed the feeling of being full of energy and satisfied with their own work to their flow at work. Moreover, according to the participants, flow can have a positive effect on resilience and self-efficacy.

P20: *I somehow just get more accomplished*, *I'm more convinced of myself that I can do things*, *I just feel a lot of joy*.

In the task and job sphere, better progress at work as well as better results in work tasks were mentioned. In addition, participants reported that they worked more in flow and also mastered unpleasant tasks, stating that flow helped them to make progress during challenges or periods of stagnation. They also mentioned learning experiences and the development of new ideas due to flow.

P10: *Yes*, *it was just extremely productive*, *extremely good*. *So effective*, *efficient*. *Just in terms of the use of time*, *that I simply managed to get a lot done in a short period of time*, *I was incredibly productive*. *And that it was just a great result*.

Likewise, the effects of flow on teamwork were reported and could be assigned to the social and organizational sphere. For example, participants described being able to engage more with others in flow or to experience improved collaboration.

Apart from the positive effects of flow, a few participants also mentioned some negative effects, namely that in flow one sometimes tends towards perfectionism and might become obsessed with details, even if unnecessary. This can be assigned to the individual sphere. As a negative

consequence in the job sphere, it was also stated that flow in the start-up process might lead to other tasks and obligations being neglected.

P19: *[…] because you do a lot in a very short time*, *because you only think about the one thing and maybe neglect other things*. *But still*, *the experience is very positive*.

In the organizational and social sphere participants described a lack of team communication due to individual flow leading, for example, to decisions being made hastily.

P19: *Yes*, *also because in my opinion flow also leads to the fact that one rushes ahead a little bit and makes hasty decisions*, *because you are in flow and then you just call a few people or settle things that are perhaps not planned or discussed in detail yet*.

As a consequence, it was also mentioned that in flow the focus of attention was narrowed, which could be either positive or negative. Depending on the task, this might be helpful or could impede openness to new inspirations while the attention was overwhelmingly on details.

P4: *When you're in the flow*, *it's just relaxed and you're so extremely focused*. *And I think that sometimes it's also good to be torn out of this pure focus*, *because then it can of course also happen that you miss some things*.

By contrast, it was also pointed out that in some situations and tasks flow had little to no effect and was not necessary, for example because the outcome of a task is not variable and cannot improve in flow.

Figure 3.4: Reported positive (blue), negative (orange), and nondirectional (purple) consequences of flow.

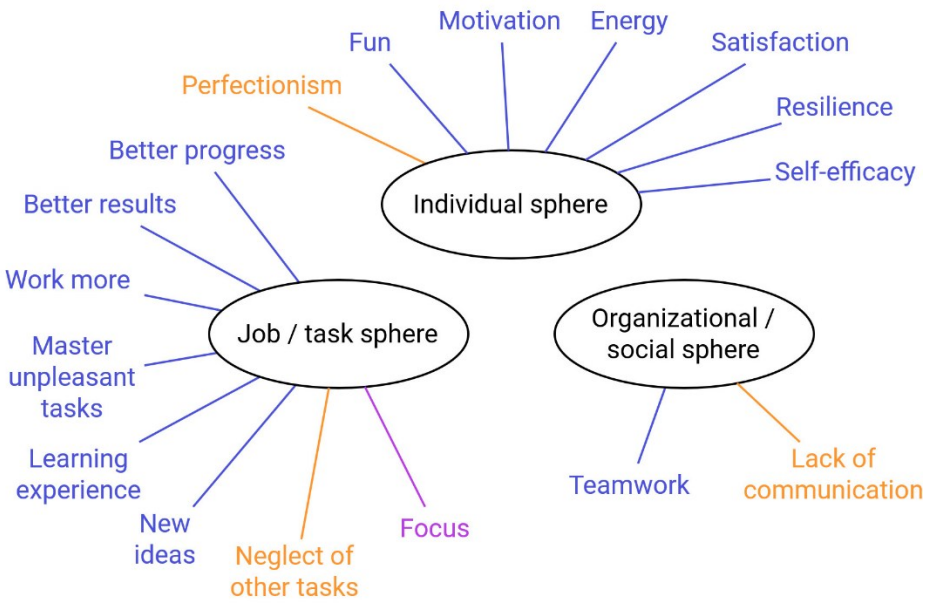


Figure 3.4 shows all consequences of flow in the start-up that were mentioned by the participants.

3.5.6. Team flow experience

In the second part of the interview, we discussed the phenomenon of team flow with participants collaborating with a team on the start-up. As with individual flow, we first asked them to define team flow. In general, it was confirmed that flow could be experienced in a team. As central characteristics, the participants mentioned that in team flow the team members must engage with each other and that, unlike in individual flow, interaction was common.

P6: *Yes*, *definitely just by interacting*. *So*, *the individual flow is really that you kind of sink into your figures and can block out everything around you*. *Of course*, *it's a different situation in the team because you have an incredible amount of interaction and it's a different way of working*, *a different feeling*.

Similar to individual flow, clear goals and focusing on the task at hand were mentioned as characteristics. The participants moreover reported that team flow could also occur as a combination of individual flow experiences and that individual flow could stimulate other team members' flow, thereby creating team flow.

P10: *So I had the feeling that in the team it's mainly about one idea sparking the other*.

3.5.7. Team flow situations

The typical situations in which team flow was experienced frequently coincided in many parts with those of individual flow. Thus, team flow was also reported to be experienced in creative, strategic, and product development tasks, and generally tasks that matched personal interests.

P6: *Product selection*, *definitely*. *So it's super exciting when you can really imagine what the product looks like and then finally have the product in your hand at some point*. *That's very cool and fun*, *because it's really about what you want to do in the end*.

However, participants most frequently mentioned generally experiencing team flow in collaborative tasks or in team interactions. New tasks were also described as suitable for team flow.

P19: *And that's how it was that we always communicated with each other throughout the day*. *Person A does this*, *person B does that*, *persons C and D do that together*. *That was a very fulfilling experience or a good feeling […]*

3.5.8. Factors conducive to team flow

Also regarding team flow, participants were asked about conducive factors. Again, it was found that many different antecedents in the individual, task-related, and organizational and social sphere influence team flow in the start-up. The individual sphere included factors conducive to team flow concerning the individuals in the team. As for individual flow, the participants named well-being as a crucial factor.

In the task sphere, similar to the results for individual flow, clear goals and moderate stress were named as being conducive to team flow.

P19: *Then this*, *I'll call it positive stress before the launch*, *as I said*, *is definitely something that has brought us forward*.

In addition, participants reported that the sense of autonomy, positive feedback, and perceived meaningfulness of the task could facilitate team flow.

In the organizational and social sphere, an additional factor regarding team flow was personal contact. The founders experienced team flow more frequently in face-to-face interaction than during virtual teamwork. Furthermore, they described their work environment and working without interruptions as crucial factors for team flow, as they had done for individual flow.

P10: *And then it was also the environment*. *I'm very sure that it's just because of it*. *[…] [In the co-working space] they have different rooms for co-working or for seminars or something like that*, *and the rooms are especially designed to stimulate creativity*, *and that really works*.

Furthermore, as a factor at the interface between the individual and the task sphere, the participants stated that team flow depended on the team members' interests and if these coincided with the characteristics of a task, explaining that tasks that are fun for the team members are more conducive to team flow.

P2: *[…] it just depends very much on how enjoyable the tasks are or not*.

As factors combining the individual and social sphere, they also stated that there must be a common basis in the team or team members have to be prepared individually for a certain task to experience team flow together, for example, referring to matching prior knowledge and skills.

P5: *Then*, *that the knowledge base is the same*. *In other words*, *you don't have to inform everyone about the current situation*, *everyone is on the same level*.

Similarly, they described the team members' commitment as beneficial, i.e., identification with common goals, and a general team spirit in the form of trust and mutual support.

P13: *So I think that the relationship between people also helps a lot and is important*. *I couldn't imagine working so much and so closely with someone I didn't somehow like*. *Even if the person has super-good skills*, *I mean*.

3.5.9. Factors inhibiting team flow

Similarly, the factors inhibiting team flow coincided in many aspects with those for flow. In the individual sphere, the participants mentioned physical factors such as physical pain as a hindrance to team flow, as in the case of individual flow. In the task sphere, they also named overload as an inhibiting factor. However, the daily routine was also described as an obstacle; a lack of challenges inhibited team flow. Participants similarly described failure in previous tasks or the lack of feedback in terms of a missing visibility of the results of a task as unfavorable for team flow.

P3: *Sometimes*, *when you're in the daily routine or you're not making good progress on something*, *on an existing issue*, *then I notice that it leads to fewer experiences like this*.

A further obstacle in the task sphere was multitasking, as start-up founders most times have parallel jobs with different demands to handle, especially in early start-up stages.

P6: *We also have the problem*, *of course*, *that not everyone always has time*. *Two of our co-founders also have full-time jobs*. *So it's difficult*, *let's say*, *to take the whole day*. *But when we do*, *it always has a positive effect on us*.

In the social and organizational sphere, dependence on external factors and interruptions were mentioned to negatively influence team flow. In addition, the participants explained that online communication was often not suitable for team flow and represented a further barrier. They also stated that any kind of conflict in the team or in the team members' private lives could negatively affect team flow.

P19: *Well*, *disagreements*, *as well*. *Half a year ago*, *there was a really critical situation*, *because we had disagreements in the team*. *That definitely killed the flow for a few weeks*.

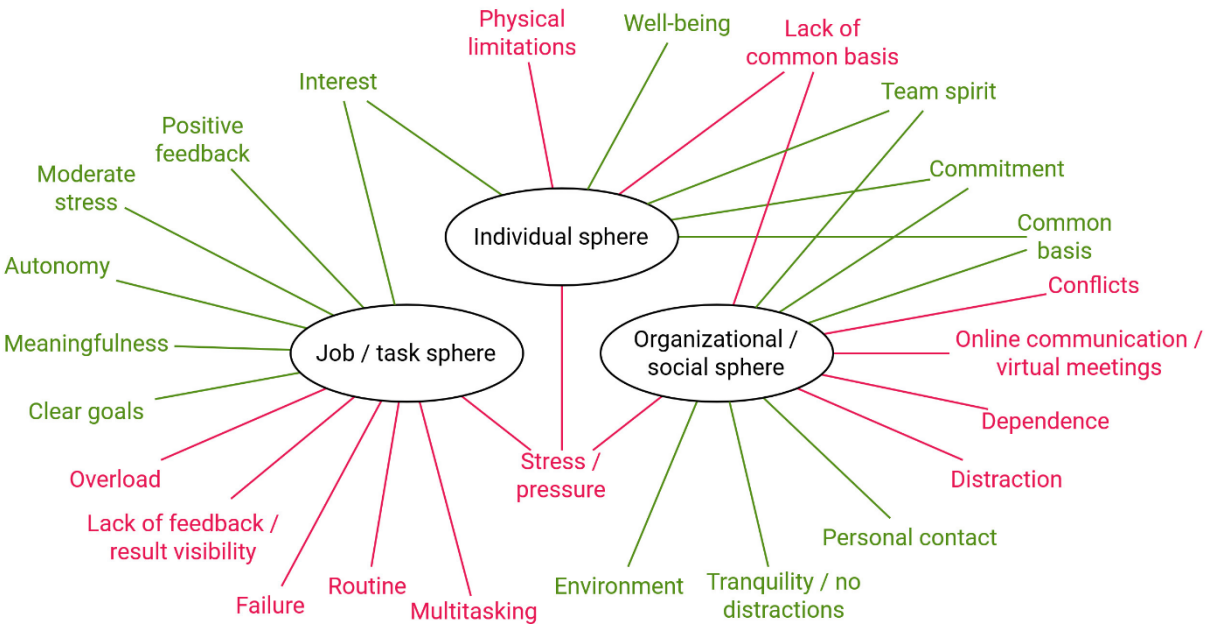
As a factor related to all spheres, the founders mentioned stress as inhibiting flow. Stressed team members, whether due to high demands in the start-up or external factors, did not

experience flow together. In addition, it was pointed out that a lack of a common basis could be a problem. This factor can be assigned to the individual and the social sphere. There was no shared flow if, for example, the team members had different levels of enthusiasm for the start-up idea.

P11: *When one is more convinced than the other. Let's say when the common mission is disrupted*.

All factors mentioned to be conducive to or inhibiting team flow are presented in Figure 3.5.

Figure 3.5: Start-up factors enhancing team flow (green) and inhibiting team flow (red)



3.5.10. Consequences of team flow

Concerning the individual sphere of team flow consequences, the participants described increased satisfaction and motivation, both when facing new challenges and while moving forward in stages of normal routine. In the task and job sphere, many participants emphasized making better progress and getting improved results in team flow, just as with individual flow.

P6: *Being focused and in the flow together*, *then you can achieve quite a lot*.

Beyond that, the main consequences of team flow described were those affecting the team itself and thus attributable to the organizational and social sphere. The participants reported

that experiencing team flow together had a positive effect on their team spirit, thus promoting trust among the team members, and allowing them to grow together as a unit. In this context, they also mentioned increased collective efficacy, similar to self-efficacy in individual flow.

P9: *Well*, *at that moment*, *it feels like we're getting closer again in the team*, *I'd say*, *or more closely connected*, *that's what I would call it now*, *from a team perspective*. *And that you just feel more like a unit*, *or this team spirit that we shape and are the company*.

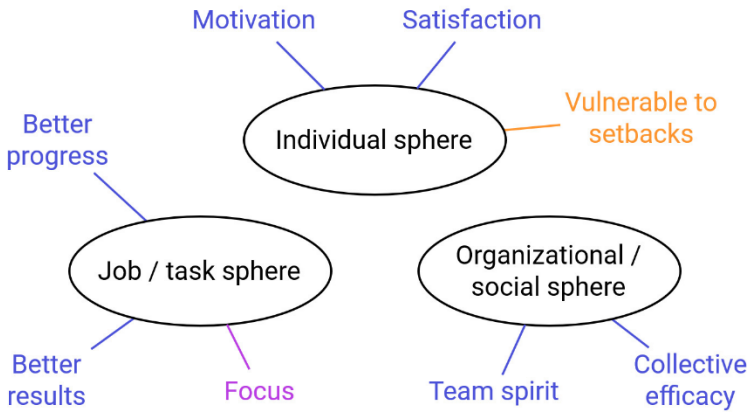
A negative consequence of team flow was also mentioned and could be assigned to the individual sphere. A participant noted that team flow caused the team to be more vulnerable to setbacks, meaning more difficulty dealing with periods of less progress after the positive experience of team flow had been shared as a team.

P17: *However*, *if you're always in this flow mode*, *things are going very well*, *you're making progress*, *then you can also become dissatisfied quite quickly if small things now set you back again*, *for example*.

As for individual flow, participants reported a strong focus during team flow that could both help or hinder, representing an undirected consequence of team flow that, depending on the task, can be seen as positive or negative.

The consequences of team flow that were mentioned by the participants are summarized in Figure 3.6.

Figure 3.6: Reported positive (blue), negative (orange) and nondirectional (purple) consequences of team flow



3.6. Discussion

The present study was intended to shed light on the role of flow and team flow experience in start-ups. In semi-structured interviews, founders explained their unique work situations when creating a new venture. They reported on typical flow situations an also on promoting and inhibiting factors. In addition, the consequences of flow and team flow for their work outcomes and the start-up teams were identified.

3.6.1. Flow and team flow experience

The majority of the participants were familiar with flow as a psychological state and were able to name specific situations and also promoting and inhibiting factors. This indicates that start-up founders are a very well-informed and self-reflective group, which explains the broad outcomes of the interviews.

The participants' descriptions of flow are consistent with the definitions in established models (Csikszentmihalyi, 1975; Peifer & Engeser, 2021). The reports suggest that the participants were familiar with working in flow and that a start-up offers great potential for flow situations. The start-up founders experienced flow, for example, in creative tasks, strategic tasks, and product development. This is in line with prior research showing that flow plays a role especially in creative and innovative work processes, in which various antecedents favoring flow can be found. For example, the method of design thinking can promote flow, as a study by Yang and Hsu showed (Yang & Hsu, 2020). In addition, it was confirmed that flow is experienced in activities like planning, problem solving, and evaluation tasks (Nielsen & Cleal, 2010).

Team flow was also familiar to most participants working on their start-ups in teams. Situations of shared flow seemed to occur repeatedly in the start-up context. On the one hand, similar contexts were mentioned as for individual flow, such as creative tasks and strategic tasks. On the other hand, the emphasis was clearly on the interaction in the team and collaborative tasks were described as team flow situations. This is in line with conceptions suggesting that interdependent tasks are a typical context for team flow to occur (Peifer et al., 2021; van den Hout et al., 2018; Walker, 2021).

3.6.2. Factors conducive to flow and team flow

Regarding flow and team flow promoting factors, many aspects were named that have already been described in the literature to have positive effects on flow. In the task sphere there are several flow promoting factors the founders experienced that are described by Csikszentmihalyi as being among the main elements present when experiencing flow, for example perceived control and the challenge-skill balance (Csikszentmihalyi, 1996). Also, tasks with clear goals (Barthelmäs & Keller, 2021) as well as learning situations (Schüler, 2007) as mentioned by the founders are described as typical flow contexts. In addition, the founders name factors such as autonomy, feedback, variety and meaningfulness as promoting factors that can be assigned to the task sphere. These factors can also be found in the Job Characteristics Model (Hackman & Oldham, 1975). Research has already confirmed the positive effect of these factors on flow (Kuo & Ho, 2010; Maeran & Cangiano, 2013).

The slight pressure that fosters flow and team flow as described by the founders is also consistent with the results of earlier research on individual flow. For example, Peifer et al. suggest that there is an inverted u-shaped relationship between flow and arousal, which indicates a positive relationship between mild stress and flow (Peifer et al., 2014).

In the organizational and social sphere, too, factors were identified that are already known from existing research. The general observation that both working alone and in teams can stimulate flow has been researched in other contexts (Magyaródi & Oláh, 2015; Walker, 2021) and was confirmed here by the founders. Also, their perception of personal contact as being more conducive to team flow than remote teamwork is in line with suggestions from Peifer et al. and provides empirical evidence for it (Peifer et al., 2021). The quiet setting without interruptions that the founders perceived retrospectively as conducive to flow and team flow could be explained by the strong focus of attention during flow that makes it possible to exclude external events (Salanova et al., 2014). A novel aspect of the present study is the extension of these findings to team situations and to the start-up context.

Other factors that seem to be particularly relevant in the start-up context are flow-promoting equipment and environment. For the latter, there is no specific flow-facilitating environment, but rather a person-environment fit: The founders reported that the workspace must meet their needs and the demands of the task in order to be conducive to flow. Thus, for creative tasks, a different environment could promote flow than that for strategic tasks. This is in line with findings from environmental psychology stating that different environments serve different needs (for an overview see Pan & Rief, 2019) and applying them to flow research.

Interest in a task is another flow-promoting factor named by the founders that can be assigned to the interface between the individual and the task-related sphere. This has been reported in

the literature not only as a predictor of flow, but also as a moderator of the positive relationship between the perceived challenge-skill balance and flow (Bricteux et al., 2017).

On the team level, the founders explained different team aspects that favor especially the shared flow experience, such as a general team spirit, a common basis and commitment, that can be assigned to the interface between the individual and social sphere. In a similar way, van den Hout et al. define collective ambition, high skill integration, and mutual commitment as prerequisites of team flow (van den Hout et al., 2018). The common basis, i.e., balanced competencies and expectations, is found in the theorized preconditions of social flow by Walker describing that every group member knows the competencies of every other and even goes beyond this assumption (Walker, 2021).

3.6.3. Factors inhibiting flow and team flow

Among the inhibiting factors for flow and team flow, factors known from earlier research as well as new factors in this context were mentioned. In the individual sphere, physical constraints were described as an example—an aspect that has received little attention in research to date. Moreover, in the task sphere, the mismatch between one's own needs and the characteristics of the task may inhibit flow, for example in the form of a lack of new challenges or excessive demands that cannot be fulfilled. An imbalance between the challenges of the task and individual skills inhibits flow and team flow (Csikszentmihalyi, 1975). This is also in line with our result that perceived pressure to perform or limited time to complete a task could lead to a perceived overload and thus inhibit flow and team flow.

The negative effect of multitasking on flow as described by our participants has also been shown in earlier research (Peifer & Zipp, 2019). Here, our study supports this finding using a qualitative approach. Also, it adds empirical evidence that the effect is not only valid for individual flow but also for team flow.

Start-up teams also seem to suffer from less successful work periods, as the participants described reduced flow and team flow due to failure in previous tasks or the lack of visibility of one's own results. The visibility of the results and thus feedback from the task is known from the job characteristics model (Hackman et al., 1975), which has already been shown to be related to flow (Kuo & Ho, 2010). Performance accomplishments are considered a source of self-efficacy (Bandura, 1977), which in turn is positively related to flow (Salanova et al., 2006). Failure in tasks within the start-up could reduce this self-efficacy and collective efficacy at team level and thus inhibit flow.

Regarding interdependent tasks as a factor in the organizational sphere, the founders described both positive and negative effects. On the one hand, team flow was experienced primarily in collaborative tasks. On the other hand, dependence on others was mentioned as a potential impeding factor for flow and team flow—particularly when the team members' expectations and motivation did not match. This is in line with the findings of Aust et al., which show that a lack of shared mental models, i.e., shared assumptions about expectations and procedures within the team, can have a negative impact on team flow (Aust et al., 2023). Similarly, participants reported that conflicts in the team may inhibit flow and team flow.

As an impeding factor at the interface between the individual and the task sphere, a lack of interest was mentioned. In order to achieve flow, a match between one's own interests and the task is beneficial, which at the same time should not be too demanding but match the individual's own skills (Bricteux et al., 2017).

3.6.4. Consequences of flow and team flow in the start-up

In the individual sphere, the positive effect of flow and team flow on work satisfaction described by the participants is already known for flow from earlier research (Maeran & Cangiano, 2013)—a novel aspect of the present study is the extension to the team flow experience. Moreover, participants reported increased motivation, energy, and fun as consequences. This concurs with findings suggesting a connection between flow and fun at work (Plester & Hutchison, 2016). Furthermore, flow is already known to result in a feeling of greater vigor or sense of energy (Demerouti et al., 2012). Also, the phenomenon of intrinsic motivation during the flow experience has already been described (Rheinberg & Engeser, 2018). The perceived higher self-efficacy—collective efficacy at the team level—described by the participants is in line with findings of Salanova et al. confirming the positive relationship between flow at work and self-efficacy which becomes apparent in the form of an upward spiral (Salanova et al., 2006). In addition, the resilience reported as a consequence of flow in the start-up has recently been suggested as an outcome of the flow experience that serves as a mechanism to deal with stressful events at work in a positive way (Kloep, Aust, et al., 2023). Furthermore, it has been examined in terms of positive correlations between flow and psychological capital, a concept including resilience as one of four positive psychological factors (Zubair & Kamal, 2015).

In the task sphere, the founders described both better results and better progress as consequences of flow and team flow. The positive effect of flow on performance measures has been described in earlier research (Demerouti, 2006), likewise the effect of team flow on performance (van den Hout et al., 2019). The new ideas resulting from flow as explained by

the participants have also already been reported in earlier research, for example, in terms of a positive relationship between daily flow and daily creative performance (Stollberger, 2019). Moreover, the reported improved mastery of unpleasant tasks in flow is in line with earlier findings showing less procrastination in a learning setting when experiencing flow (E. Lee, 2005). The founders' statement that they worked more as a result of flow can be explained by the already known association between engagement and flow (Medhurst & Albrecht, 2016). Regarding the learning experience participants report, Csikszentmihalyi describes growth and the development of new skills as a result of flow, which in subsequent flow activities leads to the search for new challenges—through which further learning takes place—in order to maintain a challenge-skill balance (Csikszentmihalyi, 1990).

Regarding the team, the participants mentioned positive effects of flow on team processes like commitment or an improved team spirit in general. This fits with findings by Aubé et al. showing a positive effect of flow on team goal commitment that consequently enhances team performance (Aubé et al., 2014). In line with this, van den Hout et al. (van den Hout et al., 2019) describes a positive effect of team flow on team positivity.

Besides the mainly positive consequences of flow and team flow, some participants also mentioned potentially negative consequences—among these perfectionism. A possible explanation for this may be the high intrinsic entrepreneurial motivation among founders (Murnieks et al., 2020), which then coincides with the strong focus in flow (Csikszentmihalyi, 1975) and the autonomy in the start-up context (van Gelderen, 2016) potentially resulting in founders losing themselves while working passionately. Another negative consequence described was being more vulnerable to setbacks. This could be explained by the improved performance resulting from flow (Demerouti, 2006), in which founders may develop even higher expectations regarding their own work. These then can no longer be met in phases without flow. In the task sphere a negative consequence that was mentioned is neglecting other tasks. Csikszentmihalyi already claimed that nothing else seems to matter during flow, as the focus is so intense that individuals forget about other things (Csikszentmihalyi, 1990).

Regarding the consequences reportedly positive and negative, the strong focus during flow is known as a typical characteristic of this state (Csikszentmihalyi, 1975). In the present study, it is emphasized that this aspect of flow may have a decisive influence on the results of a task done during flow. The strong focus of attention influences the perception and way of working during flow and team flow. The effect of flow on decision-making described by the participants could be explained by the increased self-efficacy associated with flow (Salanova et al., 2006). The founders could feel more confident to manage decisions on their own, which may be positive or negative, depending on the context.

Overall, however, flow and team flow seem to have mainly positive effects for individuals and teams in start-ups. Therefore, it is recommendable to support flow and team flow among founders.

3.6.5. Practical implications

Many participants describe being subjected to great pressure and also having high expectations of themselves and their start-up. At the same time, they describe mainly positive effects of flow and team flow in the start-up, for example, in terms of increased personal motivation, satisfaction, performance or better team processes. Therefore, it is recommended to systematically promote flow and team flow in the start-up context and to help founders benefit from the positive consequences of these states.

Based on our findings, we propose applying approaches to promote flow and team flow in the start-up in the individual sphere as well as in the task-related and organizational or social spheres. In the individual sphere, it is suggested to allocate tasks in the start-up according to interests, so that flow can be generated during tasks matching the individual preferences.

To create more flow-promoting work taking account of the factors identified in the task sphere, founders should try to avoid overload and multitasking. Even with the high workload in a start-up, it is not helpful to work on things in parallel as this may impede flow and team flow—states that influence progress and the results of the start-up work. In addition, in order to achieve a shared flow experience, care should be taken to ensure that team members formulate clear goals for their tasks and perceive meaningfulness in their work, which should preferably be in line with the goals of the start-up itself. Regular interaction and reflection within the team could be helpful in this regard.

In the organizational sphere a key factor many founders describe is the design of a flow-conducive environment. As our results show, personal preferences determine what such an environment can look like. For founders, it can be a first step to becoming aware of their own preferences and to select specific environments for certain tasks, thus, for example, alternating between home office, public spaces, and co-working rooms. For the providers of co-working rooms, it is also important to design a flexible and diversified environment offering different spaces for different needs.

A way to implement the approaches outlined could be to create workshops for start-ups. As flow and team flow are experienced differently between different individuals and teams, workshops should focus more on reflecting on one’s own flow situations and the factors that promote or inhibit flow, rather than providing general instructions on how to experience it. In a

workshop, following the three spheres of the model (Peifer & Wolters, 2021) the start-up team can explore how to create flow-promoting work, how to benefit from the flow in the team and at the same time how to be aware of the possible unfavorable consequences.

3.6.6. Strengths, limitations, and directions for future research

To the best of our knowledge, the present study is the first to focus on flow and team flow experience among founders and to assess this with the help of qualitative interviews. The present study was able to reproduce many already known promoting and inhibiting factors for flow and team flow and the corresponding consequences, confirming the structure of the three-sphere model as suggested by Peifer and Wolters (2021). Applying a qualitative approach, it was possible to show which factors have a particular effect in the context of start-ups and have been rarely considered in the research so far, among them team processes in newly created teams and factors in the working environment and equipment. In addition, we identified mostly positive and also some negative consequences of flow and team flow in start-up teams. For example, on the one hand positive effects on the motivation to pursue one's own goals in the start-up were mentioned as a consequence of particular interest in the start-up context. On the other hand, negative consequences such as perfectionism and a lack of team communication were uncovered, which had previously received little attention in flow research.

To ensure rigor and trustworthiness of the present study, the quality criteria of qualitative research according to Steinke (1999) were taken into account in the research process. Thus, self-reflective subjectivity was ensured by discussing the coding frame and its application during the process among the analyzing team. In sampling and conducting the interviews, the aim was to create a dependency-free setting in order to establish an open and unbiased atmosphere. Thus, no prior relationships existed between the researchers and the interviewees. In addition, effort was made to represent the perspectives and values of the participants as broadly as possible in order to meet the criterion of authenticity. However, an issue that was not considered in the present study is the concept of triangulation. By adding further data sources, future research should consider putting the statements into a broader context.

A qualitative approach offers the potential to uncover previously unknown issues. This can provide a starting point for future research questions regarding flow and team flow in start-ups. In this context, the results found in the present study should in future studies be quantified with larger samples. In addition, it could be interesting to match the experienced flow and team flow with the innovation outcomes of start-ups to find if the perceived better performance actually

results in better company results. Also, the selection of participants in the study through convenience sampling in a future iterative research process should be replaced by successive selection.

3.7. Conclusion

Working on one's own start-up is challenging, but at the same time rewarding and meaningful for many founders. Flow and team flow can make an essential contribution to start-ups, helping them to progress on the one hand and not to lose motivation even in times of doubt on the other. Therefore, founders of start-ups should try to recognize and cultivate their personal flow. This study identified many flow-promoting and inhibiting factors, which can help to increase the frequency of founders' future flow and team flow.

3.8. Acknowledgments

The authors would like to thank all the start-up founders that have participated in the study.

3.9. Data Availability

Unfortunately, a complete publication of the data is not possible for us due to restrictions resulting from the consent participants gave. The participants were assured in the informed consent form at the beginning of the study that their data would be fully protected and it was stated that the interview transcripts would not be published: "The interview transcript will not be published; if necessary, individual, fully anonymized quotations will be included in publications.“ This is why confidential data can only be requested in case of justified interest. As PLOS ONE does not allow authors to be the sole contact for data inquiries, data can not only be requested from the corresponding author but also from the institution administration where the data is stored: sekretariat.ipsy@uni-luebeck.de.

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3.11. Competing interests

The authors have declared that no competing interests exist.

3.12. Copyright

4. Study II: Flow and gamification in manufacturing work

Gamification in manufacturing work: Can it help to increase flow and performance?

Kloep, L., Hug, J., Ulmer, J., Wollert, J., & Peifer, C. (2025). Gamification in manufacturing work: Can it help to increase flow and performance? *International Journal of Human–Computer Interaction*. https://doi.org/10.1080/10447318.2025.2502968

4.1. Abstract

Gamification is a promising way to enhance performance and motivation at work. Flow experiences play a significant role in gamification design, while also being a possible gamification outcome and a predictor of performance. In a study with 89 participants, we compared gamified and non- gamified assembly tasks, examining flow and performance. While performance did not differ between groups, it improved over time. The gamified group reported more frequent flow experiences. Flow intensity increased over five assembly runs, but did not differ between groups. A positive repeated measures correlation was found between flow intensity and performance. The results suggest that gamified work can enhance flow, which in turn can be associated with improved performance. However, flow also occurs in non-gamified settings, indicating that other mechanisms may contribute. Possible explanations include playful work design and training effects in learning the assembly routine. Future research should consider personalization and adaptive tailoring of gamification.

4.2. Keywords

Gamification; flow experience; manufacturing

4.3. Introduction

For the most part, manufacturing work means standing at an assembly line or manual workstation and performing the same tasks over and over again to produce a standardized product (DGUV, 2015). This is a monotonous work setting offering little stimulation, resulting in a lack of challenges and action opportunities. It includes characteristics that are likely to cause boredom among workers (Loukidou et al., 2009). Feelings of monotony and boredom are especially widespread among manufacturing workers (Harju et al., 2014), and, as a study with manufacturing workers in the United States shows, these can have far-reaching consequences such as increased job dissatisfaction and absenteeism (Kass et al., 2001).

Trends such as Industry 4.0 and virtual assistance systems, which could potentially encourage engagement and reduce monotony, are evolving but are less prevalent in traditional manufacturing jobs than in other industries (Warmelink et al., 2018). A lot of manufacturing work is still done manually by individuals. Even if automation and the use of robots play an increasing role in this context, a trend towards collaboration between humans and robots is foreseeable (Tausch & Kluge, 2023; B. Wang, 2018). Hybrid and additive manufacturing systems are more likely than fully autonomous systems without human involvement, emphasizing that human labor will therefore continue to play a crucial role in manufacturing work in the future (B. Wang, 2018).

However, it can be assumed that there is potential to create more enjoyable and positive working environments. One possible approach to redesigning manufacturing work or applying engaging interventions in organizations is gamification. Gamification, the integration of game elements into non-game contexts (Deterding et al., 2011), is a growing trend that has already shown positive effects in various contexts (Hamari et al., 2014). In production work, gamification is a relatively new approach, but no less promising. Gamification is currently finding its way into industry, work, and education contexts (Vesa et al., 2017). In the manufacturing industry, however, this type of work design seems to be little used so far (Korn, 2023; Warmelink et al., 2018). This is in contrast to the many opportunities offered by interactive user interfaces in manufacturing for integrating gamified elements into production training and routines (Ulmer et al., 2022).

People have been playing games for thousands of years and play is generally perceived as a positive activity (Huizinga, 1956) as the design of games is usually intended to create enjoyment for the players (Sweetser & Wyeth, 2005). In playful contexts, flow can be experienced (Khan & Pearce, 2015; Kloep, Helten, et al., 2023; Perttula et al., 2017)—a positive state of complete self-forgetting during the execution of an optimally demanding task (Csikszentmihalyi, 1975). Flow is associated with a wide variety of positive outcomes in the

work context (Liu et al., 2023; Peifer & Wolters, 2021), such as increased in-role and extra-role performance (Demerouti, 2006) or job satisfaction (Maeran & Cangiano, 2013). Therefore, it is worth investigating how flow can be promoted through the application of gamification even in potentially monotonous manufacturing work contexts affording little autonomy.

While manufacturing work may appear monotonous and inflexible, the question is how the implementation of gamification elements is perceived and what impact it can have on flow experience and performance. With a better understanding of this, future manufacturing workplaces could be rethought and redesigned to create better work experiences.

The present study therefore focuses on the integration of game elements into the design of a manual workstation and explores how gamification affects user experiences in terms of flow and work performance. Following the agenda points for future gamification research as stated by Koivisto and Hamari (2019), we employ an experimental method to explore the effects of gamification in a controlled setting while at the same time taking into account the specific application context for a gamification strategy.

With this study, we aim to make the following contributions to science and practice: First, we want to apply approaches from the field of gamification to design a novel concept for manufacturing work. Second, we seek to understand how to foster flow experience and increase performance in this setting. By ascertaining how flow and performance are influenced by gamification, we plan in a third step to derive recommendations for the design of gamified workplaces.

4.3.1. Gamification

Games have a long history of being part of human social life (Huizinga, 1956) and are generally intended to be fun and challenging for people (Pivec, 2007). While games traditionally take place in a confined context in a fictitious reality outside actual life and entail no consequences beyond their own boundaries (Huizinga, 1956), gamification, on the other hand, is the integration of game elements into non-game contexts (Deterding et al., 2011)—for example, into the work context (Vesa et al., 2017). In this way, engaging situations should be created like those typically prevailing during play while enhancing motivation and performance (Vesa et al., 2017). This means that gamification is not only about entertainment and the positive experience itself, but goes beyond this, for example by aiming at value creation and behavioral changes at work (Huotari & Hamari, 2017; Warmelink et al., 2018).

Gamification in manufacturing work

Gamification is already being used in a wide variety of contexts, predominantly in the education sector and in the field of healthcare and crowdsourcing (Kasurinen & Knutas, 2018). However, its use in the context of manufacturing work has been rather rare and so far little researched (Warmelink et al., 2018). At the same time, the repetitive and highly structured work design as well as the technological possibilities typically found in production contexts might easily enable the implementation of gamification (Korn, 2023). Accordingly, more research on gamified manufacturing work is needed to derive implications for the design of future workplaces in this context.

An initial overview of the current research on gamified production and logistics is provided in a literature review by Warmelink et al. (2018). Overall, the authors concluded that gamification in production has potential for more motivation, fun, and performance at work, but is still an insufficiently researched area. In a recent experimental study conducted in a similar context to the present study, Ulmer et al. (2022) showed that gamification elements are suitable training tools in the context of manufacturing work. They compared a gamified virtual reality assembly training with a non-gamified training for a production procedure and found that the gamified group achieved better performance in terms of error rates when it came to the application of the procedure learned in the training. However, the mechanisms and motivational factors underlying the effects remain unclear (Ulmer et al., 2022). The effects of gamification on performance are already known from other settings, such as cognitive tasks (Groening & Binnewies, 2021) or task performance when dealing with the challenges of the COVID-19 pandemic (Hosseini et al., 2022). Participants in these studies showed higher levels of performance when using gamified applications. However, gamification does not always have a clearly positive effect. In some studies in industrial contexts, no statistically relevant improvements in performance could be identified with gamified applications compared to conventional systems (Dolly et al., 2024; Kampker et al., 2014). Instead, only trends in this direction could be found, and these need to be reviewed in follow-up studies. In the present study, therefore, we wanted to test the effects of gamification on performance and assumed, in light of existing research, that gamification has a positive effect on participants' performance in a manufacturing task:

Hypothesis 1: *During gamified assembly participants' performance is higher, meaning that less time is needed to successfully complete a task, than during non-gamified assembly.*

4.3.2. Flow experience

When focusing on the effects of gamification beyond performance measures, the experience of flow is a suitable indicator to capture how the gamified workplace design is perceived. Flow is a positive experience of being completely absorbed in an activity that is perceived as optimally demanding (Csikszentmihalyi, 1975). Neither boredom nor overload is perceived, and one step seems to follow the next almost by itself. In his theoretical model, Csikszentmihalyi (1975) reports that flow arises when a person perceives a match between his or her action capabilities with the action opportunities of a task, also referred to as challenge-skill balance. The perception of time typically is distorted during flow, while distractions are blocked out and a feeling of effortless attention with a strong focus on the activity at hand is perceived (Bruya, 2010; Csikszentmihalyi, 1975). Following the definition by Peifer and Engeser (2021), the experience of flow entails the presence of three core components: absorption as a feeling of high concentration and focus on the task at hand, a perceived balance between the challenge of the task and the own skills to overcome it, and enjoyment in terms of a positive and rewarding experience.

The state of flow is generally perceived as a positive experience and also entails various consequences that can be particularly beneficial in the work context. The positive consequences for different performance measures have already been demonstrated in various work contexts. For example, start-up founders describe that flow can lead to better work results as well as to better progress (Kloep, Roese, et al., 2023). Flow can also have a positive impact on students' exam performance when experienced during the learning process (Engeser & Rheinberg, 2008). Furthermore, positive effects on well-being have also been reported (Fullagar & Kelloway, 2009) as well as on job satisfaction (Maeran & Cangiano, 2013).

Flow in the context of gamification and manufacturing work

Flow theory, as described by Csikszentmihalyi (1975), can be used to derive several arguments for why a manufacturing task with gamification elements can be considered a flow activity. Various factors can influence the balance of action opportunities and action capabilities, thereby facilitating the emergence of flow. Then, the repeated practice of an activity and opportunity to constantly reassess one's own skills through feedback loops can lead to an expansion of action opportunities and so to the search for new challenges and flow opportunities. According to this theoretical model, the experience of flow in a task goes hand in hand with the development of personal skills.

The manufacturing task can be understood as a predefined and feasible task in which clear goals are set. The coherent demands of the task allow a focusing of awareness on a limited stimulus field. However, these characteristics are not yet sufficient to promote flow in the long term, as central engaging task characteristics to stimulate flow are lacking. Adding gamification elements can provide flow-promoting features; Csikszentmihalyi (1975) refers to play as a prototypical flow activity. According to early findings on flow experiences, playful behavior is a natural way to achieve flow. Csikszentmihalyi postulates that people engage in playful activities because they provide conditions conducive to flow, and thus offer positive experiences (Csikszentmihalyi, 1975). In addition, several of the gamification elements serve as feedback stimuli that can help participants to assess and enhance their own skills to master the assembly task. Therefore, it can be assumed that people try to either actively create playful moments in their work by themselves to get into a state of flow (Bakker & van Woerkom, 2017), or positively embrace playful opportunities such as gamified workplace designs that offer action opportunities enabling the experience of flow. By providing a gamified work scenario, we assume that we can direct the users of the manufacturing workplace towards engaging action opportunities. Many of the gamification elements can function as feedback loops derived from the task itself, which help users to locate their own skills or action capabilities and enter flow.

These assumptions also play a central role in empirical research. In gamification research in the production context, the concept of flow and its relevance are already well established. However, flow has often been used as a conceptual and theoretical basis for the design of gamification in general (Krath et al., 2021) and the development of gamified approaches in the production sector (Korn et al., 2012, 2017). There appears to be a lack of gamification studies in the work context, and especially in the production context, in which flow is assessed as an outcome of a gamification strategy. Even though studies on the relationship between gamification and flow represent a growing trend in recent research (Oliveira & Hamari, 2024), empirical results on the effect of gamification on flow in different contexts are still scarce. In a review analyzing 819 studies on gamification, only six could be identified that examined flow as an outcome in their research models (Koivisto & Hamari, 2019).

In the present study, we address this research gap by comparing gamified and non-gamified assembly routines. We assume that increased flow can be measured during the gamified assembly—both overall across the manufacturing process and in the separate assembly runs. For this purpose, the following hypothesis is formulated:

Hypothesis 2: *Increased flow is experienced during a gamified assembly task compared to a non-gamified assembly task.*

The positive effects of flow on performance as known from experimental settings (Christandl et al., 2018; Engeser & Rheinberg, 2008) suggest that these can also be observed in the

context of manufacturing. Studies have shown, for example, that flow can have a positive effect on in-role and extra-role performance at work (Demerouti, 2006) or on the academic performance of students (Sumaya & Darling, 2018). It is assumed that higher objectively measurable performance is achieved in the production task when participants experience flow. We suggest within-person relationships between flow and performance over the course of the repeated assembly runs:

Hypothesis 3: *A positive relationship exists between intensity of flow experience and performance in an assembly task over time in five assembly runs.*

Building on the theoretical framework and the hypotheses derived from it, we further aim to explore the role of flow experience in the relationship between gamification and performance:

Exploratory research question: *Does flow mediate the relationship between gamification and performance in an assembly task?*

4.4. Materials and methods

To obtain a detailed insight into the interplay between gamification and flow experience in manufacturing work, an experiment was conducted with two groups comparing gamified and non-gamified assembly routines. Ethical approval was obtained from the Ethics Committee of the University of Lübeck, Germany (2022-521).

4.4.1. Participants

A total of 89 participants took part in the study. The data collection took place from December 2022 to February 2023 and was carried out in the same way with an identical experimental set-up at the University of Applied Sciences FH Aachen and at the University of Lübeck. The participants were on average 24 years old (min: 18, max: 43) and mainly students of psychology (n¼50), mechatronics/mechanical engineering (n¼14), and industrial engineering (n¼12) with 31 of them identifying as male and 58 as female. Six participants reported having prior experience of manufacturing work with assistance systems, and 13 participants had already completed some kind of technical apprenticeship. In total, there were nine participants in the non-gamified group and seven in the gamified group who through apprenticeships and/or work experience in assembly had some kind of previous experience. However, these did not affect the distribution of performance data on the two groups.

4.4.2. Procedure

The participants were first informed about the procedure of the study and gave their written consent to participation and were guaranteed data protection. A first short questionnaire on self-efficacy was then completed and the use of the manual workstation used to create a realistic work environment in the present study was introduced with the help of a video. Thereafter, the practical part of the study started with the experimenter introducing the participants to the manual workstation followed by a training run in which the participants produced a handgrip with the help of the system and its support elements. Details of the workstation are presented in Section 4.4.3. During the training run, the goal was to ensure that the production of the handgrip was correctly learned. The participants performed the assembly step by step one time. They learned the original assembly routine, but without gamification elements, and were given time to become familiar with the assembly parts and the tool handling. The production was learned through various visual indications projected on the work area with the help of a beamer installed on top of the manual workstation explaining step by step how the handgrip was to be produced. The experimenter watched the assembly carefully and helped if there were any difficulties or questions. The aim was to keep the training run as consistent as possible for all participants, which is why the experimenter only responded to the participants' enquiries instead of intervening proactively. This way, the participants mainly familiarized themselves with the setup. According to their personal needs, previous experience, and technical skills, they were able to get to know the handling of the workstation at their own pace. After learning the production of the handgrip, the participants began the assembly runs without assistance, (i) with or (ii) without gamification, depending on the experimental condition. The experimental conditions and gamification elements are explained in more detail in Sections 4.4.3 and 4.4.4.

After each of the five assembly runs, the participants answered a question about their flow experience during the process. This was followed at the end by another questionnaire on various psychological variables as well as the evaluation of the system and demographic data. The scales assessed are described in more detail in Section 4.4.5. In total, the entire procedure took about 60–90 min. Participation was voluntary and student participants were rewarded with a course credit.

4.4.3. Manual workstation and gamified assembly

Central to the study was the production of an industrial handgrip at a realistic manual workstation. The manual workstation has already been piloted in prior research (Ulmer et al.,

2022) and enables tracking and evaluation of the participants' performance data. This means that the manual workstation records all participant activities automatically throughout the entire process with time stamps and information about the correct execution of each step. The exact execution time of an action is documented, which box is reached into to pick up an object, whether the tool is picked up, if errors occur in the sequence of steps, and if a piece is mounted in the right place. The setup of the manual workstation is shown in Figure 4.1. The handgrip is shown in Figure 4.2.

Figure 4.1: The manual workstation

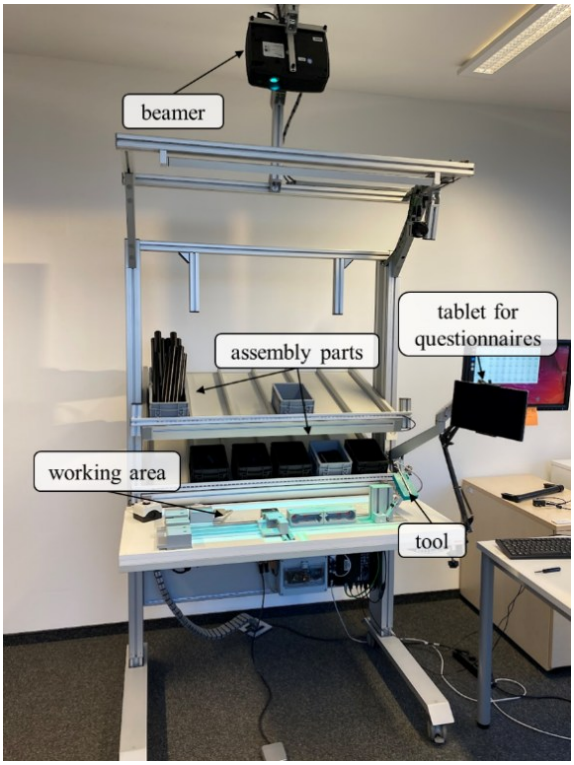
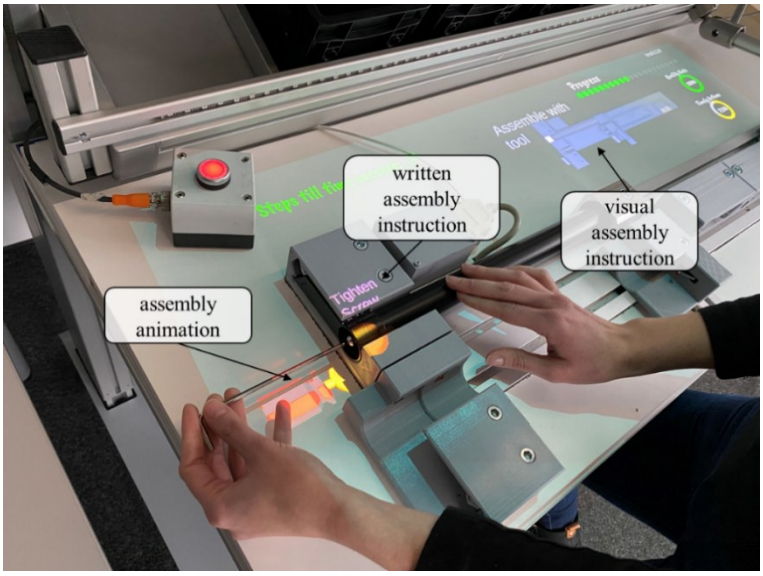


Figure 4.2: The handgrip

The manual workstation was precisely adapted for the production of the industrial handgrips of the company Industrietechnik GmbH and 3D printed parts were designed to facilitate assembly. Thus, a working area with a workpiece holder adapted to the handgrip production was mounted on the table, making it possible to align the parts precisely and assemble them accurately while the workpiece holder was intended to avoid unwanted errors (Poka-Yoke principle, Saurin et al., 2012). The assembly routine consisted of 20 steps that included, for example, the mounting and clipping of different parts. The required parts were sorted into boxes and a tool holder provided a screwdriver for assembly. The feasibility of the instructions to the assembly routine and handling of the manual workstation were validated in a pre-test to the present study.

There were two experimental conditions: (i) with imple- mentation of gamification elements in the assistance system of the manual workstation and (ii) without. An example of a projection of an assembly step can be seen in Figure 4.3.

Figure 4.3: Assembly instructions during the training



After the standardized training run, a distinction was made between the group working in a gamified production environment and the group working in a non-gamified environment with the conventional assistance elements. The assistance system, which functioned identically in both conditions, consisted of a pick-by-light system indicating which component should be picked and assembled next with a green light at the corresponding box. Errors—reaching into the wrong boxes, for example—were indicated by the system in the form of a red light signal and a warning sound.

4.4.4. Gamification strategy

The gamification condition of the experiment included game elements in addition to the pick-by-light system. As recommended by Korn (2023), the gamification thereby appeared in the place of action—projected exactly onto the area where the production task was to be performed. Following Groening and Binnewies (2021), we assumed that the gamification strategy would have a stronger effect on participants when combining multiple gamification elements. Since a large number of gamification elements has already been established in gamification research and industry (Koivisto & Hamari, 2019), and some of them have already been tested in manufacturing settings (Warmelink et al., 2018) we have made a selection of elements suitable for the present setting based on previous empirical results and theoretical assumptions about flow. The gamification elements implemented included a progress bar with animations and sounds, performance indicators, feedback pop-ups with animations and sounds, and animated finishing screens with sound effects. All elements are explained below.

One key element was the animated progress bar with sound effects. With the help of the progress bar, participants could evaluate their own progress (Sailer et al., 2013). This could help them to better visualize their goal of mastering the assembly. Following flow theory, clearly defined and accessible goals help to achieve a state of flow (Csikszentmihalyi, 1975). Progress bars are a widely established element in gamification research and have already shown an engaging effect (Mazarakis & Bräuer, 2023). We therefore assume that the progress bar with animations and stimulating sounds motivates participants and can have a flow-promoting effect.

Similar effects are expected from performance indicators with reward announcements that are constantly shown in the upper right corner of the user interface. The accuracy and speed of the action steps completed is displayed. Such indicators also allow participants to assess their own performance (Sailer et al., 2013), and, by helping participants to better assess their action capabilities, we expect them to have a positive impact on flow.

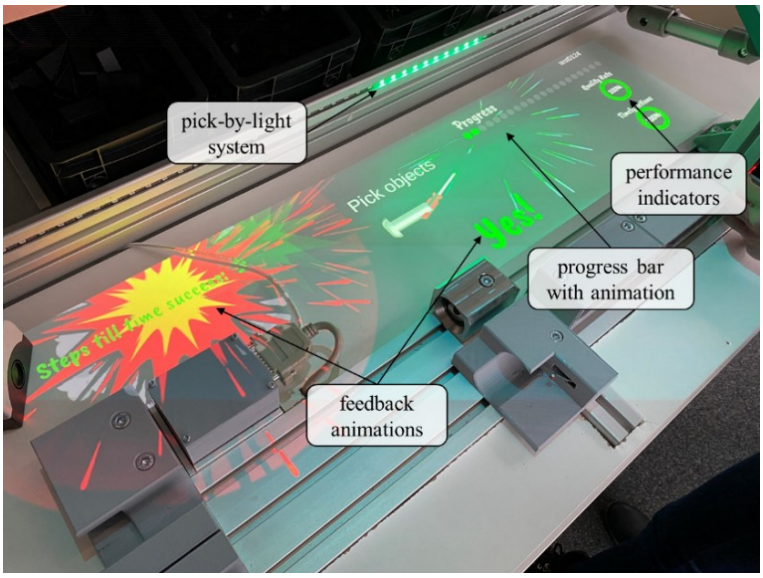
We also expected to see flow-promoting effects from feedback pop-ups with sounds and a finishing animation with sound effects at the end of each gamified assembly. Feedback from the task itself is central to the experience of flow (Csikszentmihalyi, 1975; Peifer & Engeser, 2021) and is playfully implemented through visual and acoustic stimuli and integrated into the process.

Other widely used gamification elements are, for example, badges and leaderboards (Groening & Binnewies, 2021; Koivisto & Hamari, 2019; Sailer et al., 2013, 2017; Warmelink et al., 2018). In the present study, however, we did not use these, as it is already known from

research on flow that competition only has a flow-promoting effect in a limited number of activities—generally in those involving direct competitors (Csikszentmihalyi, 1975). Since the assembly task is carried out alone, we expect the previously mentioned elements to be more effective.

Figure 4.4 depicts some of the gamification elements used in the present study: the progress bar animation and feedback pop-ups during a correctly performed assembly step.

Figure 4.4: Gamified feedback in the assembly task



4.4.5. Measures

Various variables were assessed, both by questionnaires and by recordings of the manual workstation. Some of the questionnaire scales used during the process were not relevant for the research questions in the present paper.[1] In the following we present the relevant variables and their measurements.

[1] Additional variables assessed in the study but not the focus of the analyses for the present paper were as follows: self-efficacy (Schwarzer & Jerusalem, 1999), workplace design characteristics (Stegmann et al., 2010), intrinsic motivation (Center for Self-Determination Theory, n.d.), system usability (Brooke, 1996), need for cognitive closure (Roets & Van Hiel, 2011), and big five personality traits (Körner et al., 2008).

Flow experience

Flow experience was assessed after the task with the Flow Frequency Scale (FFS) (Bartzik, Aust, et al., 2021) with an adapted instruction for the manufacturing work. The scale consisted of ten items—three for each of the subscales *enjoyment*, *absorption*, and *perceived challenge-skill balance*, and an overarching item on the frequency of the flow experience. All items were assessed on a six-point rating scale from "never" to "(almost) always". Sample items are "…you felt joy in what you were doing" (enjoyment), "…you were completely absorbed in an activity" (absorption) and "…you were challenged to just the right degree" (challenge-skill balance). Reliability resulted in $\alpha = .88$ for the complete scale, and $\alpha = .85$, $\alpha = .61$, and $\alpha = .81$ for the subscales enjoyment, absorption, and perceived challenge-skill balance respectively, that can usually be understood as good, or, in the case of absorption, as moderate internal consistencies (Taber, 2018).

In addition to the frequency of flow during the whole process measured at the end after completing all five assembly runs, we asked about flow intensity in each of the assembly runs with a single-item measure immediately after each run. The item text was as follows: "*To be in flow* is a pleasant experience during an activity. In flow, you are completely absorbed in the activity, you can concentrate effortlessly, you feel good and you are challenged in just the right way. Now imagine yourself again in the task you have just completed. Were you in *flow*?" We used a visual analogue scale from one = "not at all" to 100 = "totally" and on a tablet, the participants placed a slider on a bar labeled accordingly at either end.

Performance

The performance measure was defined as time in seconds needed to complete an assembly run and therefore was derived for each of the five assembly runs. The time was automatically recorded by the computer connected to the workstation and required no manual measurement or intervention.

4.4.6. Data analysis

The data were analyzed using IBM SPSS Statistics 29 and R. For this purpose, outliers differing by more than 2.5 standard deviations (SD) from the mean value (M) were first excluded variable-wise in both groups for the relevant variables. Descriptive and inferential statistical analyses were then performed, preceded by an examination of the relevant

assumptions for the chosen evaluation methods. T-tests, mixed ANOVA, robust mixed effects analysis, mediation analyses, and a repeated measures correlation (Bakdash & Marusich, 2017) were performed.

4.5. Results

Tables 4.1 and 4.2 show the means and standard deviations of the measured scales for the groups with and without gamification.

Table 4.1: Means and standard deviations of the variables assessed during (performance) and immediately after (flow) each of the assembly runs

	Gamification group			*Non-gamification group*		
	N	*M*	*SD*	*N*	*M*	*SD*
Flow intensity						
Assembly run 1	40	56.70	22.34	44	48.50	18.44
Assembly run 2	41	60.20	21.04	46	56.13	18.78
Assembly run 3	41	67.37	17.01	46	62.98	18.37
Assembly run 4	42	71.95	18.67	46	69.24	17.82
Assembly run 5	42	78.36	17.53	45	78.71	18.85
Performance						
Assembly run 1	40	261.45	64.98	43	269.90	85.41
Assembly run 2	39	222.63	54.57	43	223.77	45.48
Assembly run 3	39	200.87	44.83	44	212.50	43.64
Assembly run 4	38	184.82	45.55	43	189.96	31.58
Assembly run 5	39	182.25	50.40	43	177.61	30.68

Notes: Flow experience during assembly was assessed on a visual analogue scale from 1-100; performance was measured in the seconds that participants needed to complete the assembly.

Table 4.2: Means and standard deviations of flow frequency assessed after the assembly process when the five assembly runs were completed

	Gamification group			*Non-gamification group*		
	N	*M*	*SD*	*N*	*M*	*SD*
Flow frequency						
FFS: complete scale	43	3.98	0.83	45	3.55	0.81
FFS: enjoyment	43	4.16	0.91	46	3.66	1.07
FFS: absorption	43	4.17	0.89	45	3.83	0.87
FFS: challenge-skill balance	43	3.54	1.14	46	2.87	1.07

Note: Flow frequency was assessed on a six-point rating scale.

4.5.1. Hypothesis testing

Hypothesis 1 stated that the performance in the assembly task would be higher—meaning less time needed to complete an assembly—when participants experienced a gamified procedure instead of one without gamification. As the requirements of a mixed ANOVA were not met by the data characteristics, a robust mixed effects model was calculated. There was no difference between the groups, β = -1.67, SE =10.28, t = -0.16, and no interaction effect for group and time. The main effects for time show a significant decrease in time needed for the assembly, indicating an improvement in performance over the course of the five assembly runs while showing a difference between assembly run 1 and all the other assembly runs. The resulting values of the mixed effect model for the main effects for time can be found in Table 4.3.

Table 4.3: Main effects for time

	β	*SE*	*t*
run 1 compared to…			
2	-30.84	6.35	-4.86
3	-45.90	6.31	-7.28
4	-65.13	6.35	-10.25
5	-76.99	6.35	-12.12

To test Hypothesis 2 on the difference in flow between the gamified and the non-gamified assembly, a t-test was conducted to compare the two groups for their flow frequency. For this purpose, both the total scale and the subscales of the FFS were analyzed. The overall scale

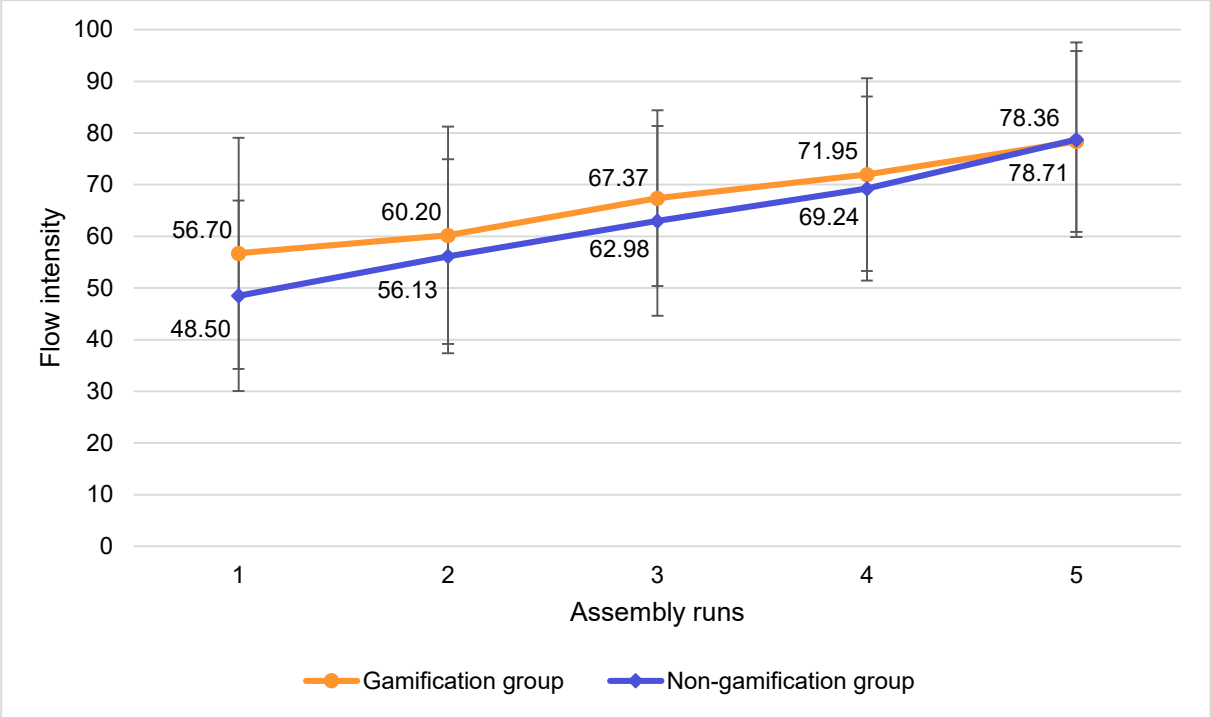
showed a significant difference between the groups, caused by more frequent flow experience in the gamification group during assembly. More frequent flow in the gamification group could also be observed on the subscales of the FFS, enjoyment, absorption, and challenge-skill balance. The results of the t-tests for the overall scale and all subscales are shown in Table 4.4. They support Hypothesis 2 and confirm that flow was experienced more frequently during gamified assembly than during non-gamified assembly.

Table 4.4: Group differences in flow frequency resulting from t-tests between the gamified and non-gamified assembly groups

	t	*DF*	*p (one-tailed)*	*d*
FFS: complete scale	-2.50	86	.007*	-0.532
FFS: enjoyment	-2.37	87	.010*	-0.502
FFS: absorption	-1.84	86	.035*	-0.392
FFS: challenge-skill balance	-2.88	87	.003*	-0.602
Note: Significant differences (p < .05) are marked with *.				

Further, we tested if flow was experienced more intensely during the gamified assembly runs than during the non-gamified assembly runs. We used a mixed ANOVA to compare the groups in their flow intensity throughout the five assembly runs. There was no statistically significant interaction for flow intensity between time (assembly runs) and group (gamified vs. non-gamified), $F(3.12, 249.26) = 1.342$, $p = .261$, meaning that the presence of gamification in the context of the five assembly runs had no significant influence on flow intensity during assembly. Besides that, the ANOVA showed a significant main effect for time (assembly runs), $F(2.90, 237.67) = 70.01$, $p < .001$, partial $\eta^2 = .47$, thereby confirming an increase in flow intensity over the course of the assembly runs. For the group variable, the differentiation between gamified assembly and non-gamified assembly, there was no significant main effect, meaning that the gamification and non-gamification group did not differ significantly with regard to their flow intensity in the overall assembly process, $F(1, 80) = 0.92$, $p = .339$. The intensity of flow experience, which was measured after each assembly run in both groups, is presented in Figure 4.5.

Figure 4.5: Flow intensity in the course of the assembly runs



In addition, we compared the flow intensity throughout the five assembly runs using t-tests. A significant difference resulted for assembly run 1, confirming that during the gamified assembly run flow was experienced more intensely than during the non-gamified run. No significant differences in flow intensity between the gamified and non-gamified assembly were found for the other assembly runs. The results are presented in Table 4.5.

Table 4.5: Group differences in flow intensity resulting from t-tests between the gamified and non-gamified assembly group

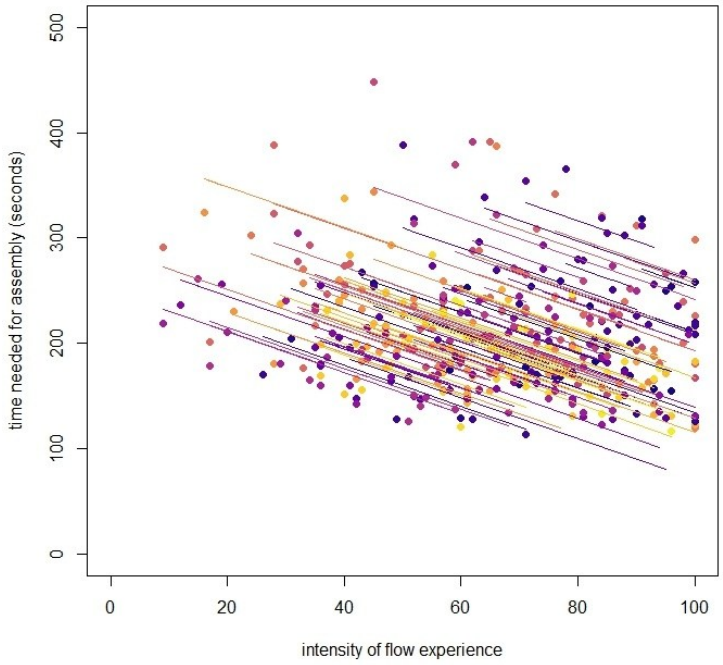
	t	*DF*	*p (one-tailed)*	*d*
Assembly run 1	-1.84	82	.035*	-0.402
Assembly run 2	-0.65	85	.172	-0.205
Assembly run 3	-1.15	85	.126	-0.247
Assembly run 4	-0.697	86	.244	-0.249
Assembly run 5	-0.09	85	.464	0.019

Note: Significant differences ($p < .05$) are marked with *.

To analyze the data regarding Hypothesis 3 that assumes a positive relationship between flow experience during the assembly task and performance during that task over the course of the assembly runs at the within-person level, a repeated measures correlation (rmcorr) analysis

was conducted. For this purpose, the repeated measures of flow intensity and performance in terms of time required for the assembly run were analyzed. A significant within-person relationship between flow intensity and time per assembly run was found, $r_{rm}(316) = -0.624$, 95% CI [−0.69, −0.55], $p < 0.001$. The relationship between the two variables in the five assembly runs is presented in Figure 4.6.

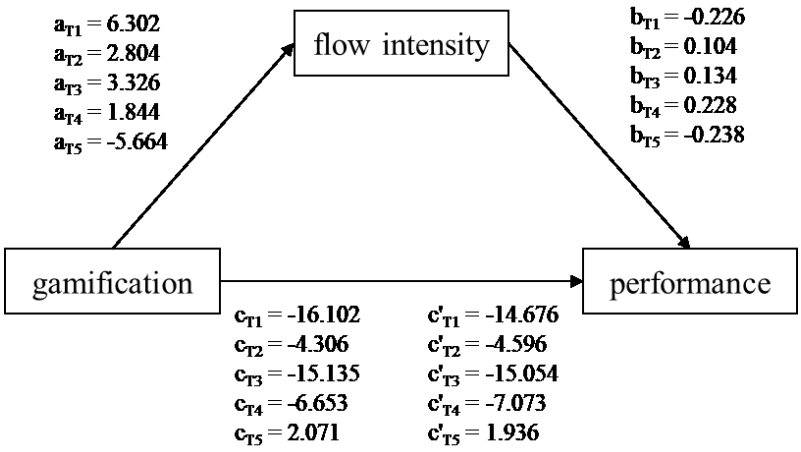
Figure 4.6: Repeated measures correlation of flow and performance in time in seconds.



Note: observations from the same participant are shown in the same color, with corresponding lines to depict the rmcorr fit for each participant for the variables flow intensity and performance (time in seconds) in the course of the five assembly runs. Depiction following the recommendations by Bakdash & Marusich (2017).

To analyze the exploratory research question regarding the role of flow as a mediator in the relationship between gamification and performance, five mediation analyses were conducted; for flow intensity and performance values for each assembly run. As before, lower values in performance represent a shorter time spent in the execution of the task and therefore better performance. The results are shown in Figure 4.7. It was found in the present study that none of the paths were significant and that flow did not mediate the relationship between gamification and performance, operationalized as time needed to complete the assembly task.

Figure 4.7: Mediation models for the five assembly runs



4.6. Discussion

In the experimental design of the present study comparing a gamified and a non-gamified assembly task, we investigated the relationships of gamification, performance, and flow experience in manufacturing work. While no differences in performance were found between the groups, we found higher flow frequencies in the gamified assembly than in the non-gamified assembly. For the first assembly run, a more intense flow experience was observed in the gamification group than in the group without gamification, although afterwards the differences were no longer statistically significant. Also, an increase in flow intensity and performance during the assembly as well as a positive relationship of both during the repeated assembly runs became evident. The results can be used to derive practical recommendations and design proposals for assembly work.

4.6.1. Effects of gamification on performance in the assembly task

In the present study, we were unable to show any differences in the participants' objectively measurable performance in a gamified assembly vs. a conventional assembly task. The two groups did not differ; only a performance increase between the measurement times of the five assembly runs was visible. This suggests a learning process that persisted over the course of the experiment, with participants becoming increasingly better at the assembly task being performed, meaning that they managed to perform the assembly task increasingly faster. However, the gamification of the task did not appear to have any influence on this. This study

adds to the body of existing research reporting inconsistent results on the effects of gamification on different objective and subjective performance measures. While in some scenarios data suggest that gamification is beneficial to performance (Groening & Binnewies, 2021; Hosseini et al., 2022; Ulmer et al., 2022; X. Wang et al., 2017), other applications show no clear effect (Dolly et al., 2024). When discussing this, it should be taken into account that performance was operationalized differently in the different research setups. While some studies take speed of task execution as a measure (Dolly et al., 2024; Ulmer et al., 2022)—the same measure we consider in the present study—others look at the number of correctly performed steps of a task (Groening & Binnewies, 2021; Hosseini et al., 2022), or the correctness of the task as a score of errors and improvement actions (Ulmer et al., 2022). Also, self-assessments of perceived performance or self-rated competence are used in some applications (Groening & Binnewies, 2021). Further detailed research with controlled applications of gamification and objective performance measures will be needed in the future to understand the exact effects and to be able to apply them in a positive way in contexts like manufacturing work.

4.6.2. Effects of gamification on flow in the assembly task

The analysis shows that flow was experienced more frequently during the gamified assembly process than during the assembly in the conventional production environment, thus confirming Hypothesis 2 for flow frequency within the sample of the present study. This corroborates the theoretical assumption that games, and likewise gamified contexts, offer the right action opportunities to be considered a flow activity (Csikszentmihalyi, 1975). The previous rather theoretical consideration of flow in the design of gamification elements (Krath et al., 2021) could be empirically tested in the present study emphasizing the role of flow experiences in gamified applications. Drawing on the results of this analysis, gamification could be interpreted as a flow-fostering element when designing assembly processes.

At the same time, comparing flow intensity between the two experimental groups throughout the process only revealed significant differences for the first assembly run. Comparing the whole course of the assembly runs, no significant differences could be found in the present study; indicating no support for Hypothesis 2 regarding flow intensity. The results indicate that there is still more research to be done regarding the experience of flow as an outcome in gamification research and can be explained by different mechanisms:

First, as reflected in a significant main effect for the assembly runs, it is noteworthy that also in the non-gamified assembly process, the flow intensity likewise increases with each assembly run. This contradicts the assumption that production work per se would be perceived

as monotonous or not engaging and therefore possibly less conducive to flow. The phenomenon of playful work design (Bakker et al., 2020; Scharp et al., 2023) could be an explanation for this observation. Following this approach, participants proactively design conditions that offer greater enjoyment and increased challenge during a work task without changing the work itself. In other words, playful work design is a reinterpretation and redefinition of the situation into a play opportunity for oneself by designing and solving surprises and complexities (Scharp et al., 2023). In this process, new action opportunities are created on a subjective level through reinterpretation, transforming the task into a potential flow activity. For example, participants may have set themselves challenges about how quickly or in what rhythm they could best assemble the handgrip, focusing on different steps and aspects in every assembly run, or they may have come up with further ideas to make the task more engaging for themselves. Following the assumptions of Bakker and van Woerkom (2017), the playful work design that might have been created during the non-gamified assembly could have led to the flow experience participants report in the present study.

Second, it may be that the assembly task was initially a completely new situation to the participants due to their lack of experience and that, despite the earlier training run before, the five assembly runs represented an ongoing learning process. Initially, we assumed that the learning process would primarily take place during the training run and that the repeated execution of a task five times in a row would already represent a routine. However, the data now also suggest other conclusions and could indicate a longer-lasting learning process. It is possible that both groups had a learning experience with increasing performance and flow intensity with each run. It is known from other contexts that flow is likely to be experienced during learning processes (Kloep, Roese, et al., 2023; Palomäki et al., 2021; Schüler, 2007) and theoretical assumptions about flow suggest that an increase in one's abilities, combined with a task offering more action opportunities, could enable more intense flow experiences (Csikszentmihalyi, 1975). Therefore, the present findings are of limited applicability to routine tasks, but support the potential of gamification in learning contexts. Regarding the context of manufacturing, Ulmer et al. (2022) also suggested that using gamification elements in training processes could be a suitable area in which to apply gamification to assembly work. A recent literature review on gamification in assembly work supports this assumption (Uletika et al., 2020). However, as only five assembly runs were completed in total and it was not possible to analyze the data controlling for former assembly experience in our study sample, we were unable in the present study to make a comparison between the effect of gamification in learning contexts and routine tasks.

Given the relatively short duration of the experiment, another question is how gamification affects flow in the long term and how flow affects the entire working day. Human energy follows

an inverted u-curve throughout the day and decreases after noon (Kosenkranius et al., 2023). A particularly positive and flow-promoting work environment, possibly with the help of gamification elements in the work, could mitigate this decreasing effect. It may be that the experience of flow in a gamified environment develops differently throughout the day compared to a non-gamified environment and could have a subjectively perceived energizing effect. Gamification could thus have a positive influence on the trajectory of flow throughout the day, thereby buffering against fatigue. If the findings from this study are taken as a starting point, gamification might lead to a more pronounced initial increase in the flow curve.

4.6.3. Flow and performance in the assembly task

Regarding the relationship between flow and performance, a significant repeated measures correlation between flow intensity in the assembly runs and performance, measured as time needed to complete the assembly, was found for the five consecutive assembly runs. Across the assembly runs, a positive relationship on an individual level between the participants' flow experience and their performance was shown, suggesting that an increased intensity of flow experience comes along with a faster assembly and therefore improved performance.

By contrast, the mediation analyses, which did not take into account the repeated measures structure of the data, could not confirm a significant path of flow predicting performance in the resulting models. Flow intensity had no effect on assembly performance, operationalized as the time required to complete an assembly. The other mediation paths were likewise not significant, indicating that flow was not a mediator in the relationship between gamification and performance, nor was this characterized by a significant path in the model.

Earlier research has shown inconsistent results on the relationship between flow and performance in gamified scenarios (Oliveira et al., 2021). In the context of games, Harris et al. (2023) in a systematic review found positive correlations between flow and performance in various studies. As games are the basis of gamification, similar effects for gamified work contexts could be expected. Oliveira et al. (2023), however, found a negative correlation between flow and performance operationalized as concentration during the use of a gamified system in a quasi-experimental study. They explained this by the fact that the gamification elements may have had a distracting rather than helpful effect. In the present study, it is also possible that the gamification elements were perceived differently by the participants. This may have undermined the effects. Besides the amount of game design elements (Groening & Binnewies, 2021), their combination (Mazarakis & Bräuer, 2023) may also have affected our findings. A recent study showed that the combination and interaction of different gamification elements plays a central role in motivating participants in gamified contexts. A combination of

feedback elements and progress bars was found to result in higher motivation than the combination of badges and feedback or only progress bars (Mazarakis & Bräuer, 2023). In the present study we used feedback animations and progress bars, but combined these with other elements like sounds and animations, which may have altered the effects compared to those of earlier studies.

It is possible that the gamification strategy used in this study was not the most beneficial in influencing both flow and performance beyond usual training effects. This would suggest that gamification should be designed more carefully and adapted to the individuals' needs as described in recent research to achieve a significantly more engaging work situation (Klock et al., 2020). For example, applications could classify users into player types and present them with different sets of game elements (Klock et al., 2020). When customizing gamification, personality traits and motivational states can serve as the basis for individualized applications. Furthermore, automated approaches could react flexibly to dynamic psychological states (Oliveira, Hamari, Shi, et al., 2023). Here, the use of machine learning algorithms and applications of artificial intelligence can be used to adaptively address the users' characteristics (Suresh Babu & Dhakshina Moorthy, 2024). The tailored gamification approach is also in line with the idea that flow can be dynamic and dependent on an individual's motives and on the opportunities of a situation or task. Schiepe-Tiska and Engeser (2021) argue that flow not only arises in achievement situations where there is a balance between perceived challenges and individual skills, but also when there is a motive-specific fit between the individual and the situation. This supports the assumption that gamified work situations should not only challenge a user, but also address their dynamic implicit and explicit motives in order to lead to a flow experience. In this way, gamification could help people get into flow, while also contributing to the conditions in which individuals can work well and therefore perform better.

4.6.4. Strengths and limitations

While earlier studies on gamification in a production context have often looked at small samples and in some cases assessed only a few variables besides objective performance data (Warmelink et al., 2018), in our study we followed an approach of standardized experimental procedures and data collection with a comparatively large sample size. On the one hand, this allows us to derive new insights based on a broader data set. On the other hand, our sample consisted mainly of students and not of manufacturing employees. Thus, in future studies, the findings of the present study should be extended, for example, in a field experiment with shop floor workers with different kinds of assembly routines and assistance systems at their

assembly workstations. Findings by Koivisto and Hamari (2014) suggest that when applying gamification, the demographic effects should not be neglected. Thus, the perceived ease of use in gamified applications was found to decrease with age. In addition, differences in the perception of gamification, especially with regard to social benefits, were identified (Koivisto & Hamari, 2014). Consequently, there may be a difference between the perception of gamification by the present sample and the effects of gamification on real production workers.

The sample of students in the present study had little to no experience of working on assembly. Only few participants reported having experience of manufacturing work with assistance systems. Thus, there was no opportunity to test the assumption of Palmas et al. (2019) that gamification has effects on performance especially with inexperienced users as there was no experienced group big enough to compare. The marked increase in performance over the course of the assembly runs indicates that there were training effects when performing the same assembly task several times during the experiment. It should also be noted that one training run may not have been sufficient to achieve a routine process for all participants and that a greater number of training runs may have prepared participants better. On the other hand, the difference in prior knowledge does not represent a systematic bias, but rather a natural variance that might also occur in the field and, according to other studies applying training (Peifer et al., 2014), does not necessarily need to be controlled for.

At this point, another limitation of the present study becomes apparent, which was not recognized to its full extent when planning and pre-testing the experiment. As mentioned in Section 4.6.2 and contrary to our expectations, five assembly runs may not have been sufficient for all participants to represent a routine task. Both flow and performance values varied and increased over the course of the five runs. It remains unclear how they relate to each other in the long term. Routine and even monotony are often part of daily work in assembly at real workstations or assembly lines. The results of the present study are therefore primarily indicative for training phases, for example, for new process steps or for new workers, but their applicability to the entire work routine in manufacturing work is limited. Future applications should therefore consider more assembly sessions within the experiments to simulate a more realistic routine work scenario or conduct field experiments with experienced workers.

Depending on the research question, a different methodological design might be a better choice to ensure the robustness of the results. For example, a multilevel mediation could be an alternative method to analyze the research question of whether flow has a mediating effect on the relationship between gamification and performance while also considering the repeated measure design of the study. However, the data structure and resulting power of the present

study did not meet the requirements for this method. Future studies with larger samples should take a more nuanced look at the interplay between gamification, flow, and performance.

Another aspect that may have had an influence on some participants' flow experience was occasional, unexpected malfunctions in the system. The user interface with the pick-by-light system sometimes reacted with a slight delay and did not recognize the correct action due to random errors or unusual movements by the participants. Although the participants knew how to deal with these possible malfunctions and they only caused a delay of a few seconds, in the participants' additional comments, a few people noted this. For example, one participant stated: "The technical problems that the system still has distracted me a lot, threw me off course and inhibited flow experience."

4.6.5. Practical implications

Overall, the results of the present study indicate that flow frequency can be enhanced in gamified work environments, thereby facilitating an engaging and positive work process. It remains to be investigated which particular gamification elements should be used to create the playful environment or whether a user-centered approach to playful work design is preferable.

It is not clear yet which gamification elements cause which effects and which combinations of gamification elements can be recommended for use in practice. Few studies have investigated the effects of specific gamification elements in a controlled manner (Groening & Binnewies, 2021), but which combination is particularly flow-promoting is still largely determined on conceptual considerations instead of empirically tested findings. In contrast to our approach in the present study of choosing a gamification strategy based on feedback animations, sounds, and progress bars, levels, badges, and leaderboards are among the most frequently used gamification elements in studies investigating flow (Oliveira et al., 2021). Studies show that a combination of several gamification elements can result in higher performance levels (Groening & Binnewies, 2021). Yet, recent findings also suggest that it is not only the quantity of gamification elements that matters, but also their combination (Mazarakis & Bräuer, 2023). The feasibility of the different gamification elements in work contexts is to be adapted individually to the circumstances of a particular work setting. Here, the duration of the application should also be taken into consideration. It is likely that different gamification strategies will be more successful for short-term applications or training scenarios than for long-term implementations (Mazarakis & Bräuer, 2023).

Perhaps, even when carefully choosing the game elements, there is no one-fits-all solution in gamification, but rather there should be a personalized approach to which and how many

gamification elements are used for different people when applied in practice (Klock et al., 2020). In addition, different gamification elements may have different effects and address specific needs (Sailer et al., 2017). Therefore, gamification should always be tailored not only focusing on the specific application context but also on its users (Korn, 2023). The demographic characteristics of the intended target group should be taken into account; these could be related to the perception and evaluation of the gamification elements (Koivisto & Hamari, 2014). Beyond that, applications should not only consider gamer types derived from demographic data, but also take into account the dynamic nature of psychological states and motives (Oliveira, Hamari, Shi, et al., 2023). In future applications, machine learning and artificial intelligence could play a central role in the dynamic and individual adaptation of gamification to create unique user experiences (Bennani et al., 2021). The effects of automated dynamic gamification should be compared with conventional approaches in future research and examined for the use in practical applications in industrial or other contexts.

Another aspect that is of central importance when implementing gamification in organizations, especially in industrial contexts, but which could not be considered in the present study due to the experimental setting, are the effects beyond the immediate task. The experiences gained while performing gamified work tasks may not only have short-term effects, but also longer-term effects on attitudes and behaviors. In the social context of an industrial site, this could lead to changes that affect social and organizational structures, either positively or negatively (Jacob et al., 2022). Gamification can thus become a trigger for changing dynamics in industrial work teams, which should be taken into account when designing gamification.

4.7. Conclusions

The present study shows that in a gamified manufacturing task flow can be experienced with higher frequency than in a conventional task, while in addition a positive relationship exists between flow intensity and performance, thereby confirming the beneficial effects of flow at work. Nevertheless, our results suggest that gamification may not be the sole solution to achieving more flow in the context of manufacturing work. They also highlight the limitations of gamification and the potential of work design approaches to influence user experiences in general. Even without externally applied gamification strategies, people can find ways to experience flow; perhaps especially while they are in a learning process and not yet experiencing the monotony of a standardized, repetitive task. However, this does not preclude the possibility that a carefully designed gamification strategy with tailored gamification elements selected to suit the employees' needs and motives when approaching a task can promote flow and positive experiences in manufacturing work.

4.8. Disclosure statement

No potential conflict of interest was reported by the author(s).

4.9. Data availability statement

The data that support the findings of this study are available from the corresponding author, LK, upon reasonable request.

4.10. Copyright

5. Study III: Team flow and communication in virtual teamwork

Flowing conversations: Exploring communication parameters as team flow indicators in virtual teamwork

Kloep, L., Miecznik, A.T., Klimowicz, P., Sieciński, S., Kowalczyk, B., Kożusznik, B., Pollak, A., Grzegorzek, M., Pyszka, A. Flak, O., & Peifer, C. (submitted). Flowing conversations: Exploring communication parameters as team flow indicators in virtual teamwork

5.1. Abstract

In the context of virtual teamwork, this study aims to explore the role of communication parameters as indicators of team flow—a shared experience of absorption and optimal team dynamics. In virtual team workshops with 94 participants (25 teams), communication parameters during two tasks were analyzed, including turn-taking, interruptions, questions, laughter, equal communication, and the duration of task-related communication. Results indicated positive effects of turn-takings and time spent asking open questions on perceptions of team flow, whereas closed questions had a negative effect. Depending on the task type, different indicators may be relevant, as distinct teamwork dynamics are present.

5.2. Keywords

Team flow experience, team communication, communication analysis

5.3. Introduction

Teamwork can be a complex, multifaceted process. However, when entering a state of intense engagement and positive team dynamics, team members may experience team flow—an experience characterized by a joint absorption in an optimally challenging interdependent task (van den Hout et al., 2018). To determine whether or not a team is experiencing team flow, it needs to be assessed with reliable instruments (Peifer et al., 2021; van den Hout et al., 2019). Researchers usually apply questionnaire tools. Nevertheless, these have a significant limitation: Emergent states in teams, such as team flow, are fragile and can easily be interrupted. Therefore, research aims to develop methods for interruption-free measurements of team flow through observable indicators (Peifer et al., 2021).

Research has identified open communication as a prerequisite of team flow (Coss et al., 2025; van den Hout & Davis, 2022), but little attention has been paid to the communication processes themselves. It is mostly unclear which specific communication parameters or speech actions contribute to open communication and are related to team flow in different contexts, raising the question of whether there are measurable indicators for team flow from team communication.

While a large part of modern work takes place in hybrid or virtual team settings, it is evident that team communication is also present in virtual contexts (Morrison-Smith & Ruiz, 2020; Raghuram et al., 2019). In the context of virtual teamwork, a substantial part of interaction between team members occurs through virtual communication, such as video calls, which poses additional challenges for teams (Handke et al., 2024; S. K. Johnson et al., 2009). Communication primarily manifests on a verbal level, as non-verbal cues are less easily expressed in virtually mediated communication (Eisenberg & Krishnan, 2018). This study looks at the context of a virtual team workshop via video call. As communication is considered a central precondition for team flow (van den Hout et al., 2019), studying virtual team communication is crucial for understanding team dynamics in virtual teams. The aim is to identify parameters of verbal virtual team communication that predict team flow, thereby contributing to the development of an interruption-free team flow measure for this specific context. In this way, the paper aims to contribute to the development of a comprehensive body of behavioral markers for team flow, thereby enhancing team flow measurement approaches.

Despite the challenges accompanying virtual work, studying virtual teams affords new opportunities, as the use of video calls as a popular means of communication enables an in-depth investigation of communication dynamics. Retrospective assessments with questionnaires could be supplemented by approaches for quantifying systematic behavioral patterns to better understand social interactions in teams (Lehmann-Willenbrock, 2024). The present paper, therefore, applies a quantifying communication analysis to identify indicators of

team flow from speech actions in team communication, thereby contributing to the further development of theoretical frameworks and measurement methods for team flow experiences. As team flow can emerge in a wide range of contexts (eg., Aust et al., 2023; Coss et al., 2025), it can be assumed that it is accompanied by distinct behavioral markers. To this end, we explore communication parameters in two different task types in a virtual team workshop setting. One task is enriched with LEGO®, which, when implemented in specific workshop concepts, is considered beneficial for stimulating team interactions (Wheeler et al., 2020) and has already been associated with team flow (Primus & Sonnenburg, 2018). The other task takes place using only a virtual collaboration tool. Next, team flow experience and relevant communication parameters are introduced, as they are key components of this paper.

5.3.1. Team flow experience

Flow experience can be defined as a positive and rewarding state of absorption during an optimally demanding task (Csikszentmihalyi, 1975). It may occur not only in individually performed tasks but also in social contexts and thus in teamwork (Aubé et al., 2014; Pels et al., 2018). The concept of team flow goes one step further and refers to the shared experience of flow within a group characterized by optimal team dynamics and mutual involvement (van den Hout et al., 2018). Thus, team flow is more than the sum of individual team members experiencing flow and differs from individual flow (Hackert et al., 2023; Pels & Kleinert, 2022). Team flow emerges in tasks in which team members work closely together in interdependent cooperation (Pels & Kleinert, 2022; van den Hout et al., 2018) and is shaped by the four key characteristics *holistic focus*, *sense of unity*, *sense of joint progress*, and *mutual trust within the team* (van den Hout et al., 2018). Like individual flow, team flow is considered a positive and desirable state for a team member and is associated with team members' well-being and team performance (Kloep, Roese, et al., 2023; van den Hout & Davis, 2019).

5.3.2. Communication parameters as team flow indicators

Optimal team dynamics constitute a central component of team flow (van den Hout et al., 2018). For these to develop, team members need to interact with each other, which takes place primarily at the level of communication (Marlow et al., 2018). In virtual teams, this is limited to computer-mediated verbal communication, which makes it more challenging for team members since many of the nonverbal cues that provide information, for example, about the

quality of the interaction, are missing (Eisenberg & Krishnan, 2018; Gressgård, 2011; Handke et al., 2020).

Research on emergent states in teams aims to understand antecedents and derive parameters that can serve as indicators to identify and operationalize those states (N. T. Carter et al., 2018). Team flow is a transient state that, by definition, ceases when it is interrupted for its assessment, as attention is then no longer focused solely on the task but also on completing the questionnaire. Therefore, the long-term research goal is to identify indicators that could predict team flow in an interruption-free way (Peifer et al., 2021).

Recent research provides initial evidence that open communication, described as a communication culture based on psychological safety and empowerment, can foster team flow in a clinical setting (Coss et al., 2025). Also, in firefighting missions, good communication among team members was identified as a resource that may facilitate team flow (Aust et al., 2023). In line with this, Peifer et al. (2021) suggest exploring the concept of collective communication, a group-oriented communication style in teams characterized by specific speech actions, as a predictor of team flow. However, the role of communication appears to depend on the type of task. For instance, a recent study demonstrated that continuous communication, as a team flow characteristic, was less pronounced in tasks involving LEGO® elements than in tasks without (Zenk et al., 2021). We examine a LEGO® task and a non-LEGO® task exploring if the suggested predictors apply to different task types.

Although team flow is a collective state, it is at first experienced on an individual level. Different team members may perceive the same interaction differently, potentially depending on their preferences and individual proneness to experience team flow. Some speech actions, which are all derived from the team flow-relevant communication parameters from collective communication by Peifer et al. (2021), such as speech frequency and time, questions, interruptions, or laughter, are initiated by individual team members. Therefore, they are linked to their individual perspectives and experiences, leading to hypotheses that will be analyzed on an individual level. Other characteristics of team communication and collaboration are inherently team-dependent, such as the equality of speaking shares and the time spent working together and communicating about a task. Therefore, these effects are assumed at the team level as aggregated team constructs.

Turn-taking and speaking time

Communication in teams includes changing speakers and responding to each other. Frequent turn-takings may indicate a highly dynamic collaboration with team members engaging actively

and an intense interaction flow during team conversation, which is described as an optimal and intensified dynamic of conversations (van Oortmerssen et al., 2015). Similarly, the experience of team flow is characterized by optimal team dynamics (van den Hout et al., 2018). In a study with student teams, it was shown that the individual perception of shared flow during teamwork is positively correlated with the number of verbal contributions (Raettig & Weger, 2018). This may apply not only to the frequency of individual turn-takings but also to the resulting speaking time, i.e., the amount of time that a team member spends speaking instead of being silent during a conversation. We therefore hypothesize:

1a: The frequency of individual turn-takings during a task-related conversation is positively related to the perceived team flow during this task.

1b: The total individual speaking time during a task is positively related to the perceived team flow during this task.

Interruptions

An interruption is a linguistic act in which one person intervenes in another person's speech. The original speaker is stopped, and the interrupter takes over (Sacks et al., 1974).

On the one hand, frequent interruptions from team members during a conversation may indicate insufficient synchronization among them (Lestary et al., 2018). Interrupting others may express disruptive behaviors by single team members aiming to gain more speaking turns and influence during a conversation (Ng et al., 1995; Raettig & Weger, 2018), representing an obstacle to team flow as it can disturb the desired balanced team dynamics (Raettig & Weger, 2018). Furthermore, rudeness in team interactions, as expressed through negative interruptions, can result in poor team effectiveness (Gale et al., 2024). For negative interruptions that redirect the conversation and cut off a team member's statement without addressing it, we assume a negative effect for both frequency and duration of a team member’s interruptions on their experience of team flow:

2a: The frequency of a team member’s negative interruptions during a task-related conversation is negatively related to the individually perceived team flow during this task.

2b: The time a team member spends with negative interruptions during a task is negatively related to the individually perceived team flow during this task.

On the other hand, interruptions involving supportive additions and the completion of each other’s statements may reflect an individual motivation to promote others and engage proactively in dynamic cooperation (Ng et al., 1995). In such cases, interruptions serve as

expressions of rapport and active listening reflecting a high degree of responsiveness and anticipation (Goldberg, 1990).

We therefore assume that a team member's positive interruptions positively affect their individual perception of team flow, both in terms of their frequency and duration:

2c: The frequency of a team member's positive interruptions during a task-related conversation is positively related to the individually perceived team flow during this task.

2d: The time a team member spends with positive interruptions during a task is positively related to the individually perceived team flow during this task.

Questions

Different types of questions can fulfill different functions in conversations (Schuman & Presser, 1979). Open questions—usually beginning with a question particle and also referred to as wh-interrogatives—request a particular type of response but do not provide specific response options. Closed questions or yes/no-interrogatives require a predefined answer and ask specifically for confirmation or denial of a certain statement (Schegloff, 2007; Schuman & Presser, 1979).

In general, questions indicate a team member's interest in the contributions of others. Thus, asking and discussing questions is crucial in collaborative decision-making processes (Halvorsen, 2018). With questions, a team member can actively elicit feedback. It can be assumed that feedback from the activity, in this case the team conversation itself, can have a flow-promoting effect (Nakamura & Csikszentmihalyi, 2014; Peifer & Engeser, 2021), which may be extrapolated to the perception of team flow.

Members having the opportunity to ask questions and thereby to indicate doubts or problems of understanding to each other may be a sign of their perception of an open communication atmosphere and mutual trust within the team. Team members respond to each other's needs, creating mutual understanding, which can help to experience team flow together (van den Hout et al., 2018).

We hypothesize the following for both the frequency and duration of open and closed questions asked by individual team members:

3a: The frequency of open questions asked by a team member during a task is positively related to the individually perceived team flow during this task.

3b: The time a team member spends with open questions during a task is positively related to the individually perceived team flow during this task.

3c: The frequency of closed questions asked by a team member during a task is positively related to the individually perceived team flow during this task.

3d: The time a team member spends with closed questions during a task is positively related to the individually perceived team flow during this task.

Laughter

Laughter in team communication can serve different functions and express various emotions, such as joy, but, for example, also nervousness or fear (Szameitat et al., 2009). However, positive types of laughter, expressing joy and fun, seem to predominate in conversations (Szameitat et al., 2022). Laughter is mainly perceived as pleasant in conversations (Pinheiro et al., 2017) and may be understood as a spontaneous expression of positive emotions (Hofmann et al., 2017). Since flow is described as a positive and rewarding state (Csikszentmihalyi, 1975), and enjoyment is defined as a key component of flow (Peifer & Engeser, 2021), laughter could be seen as a way to express this flow component. As individual flow can be considered a basis for team flow and both constructs share key components which are expanded in the team experience by additional aspects (Peifer et al., 2021; van den Hout et al., 2018), laughter among team members may also be an indicator of team flow.

Similarly, laughter can also be an expression of humor, which, in turn, is positively associated with flow (Bartzik, Bentrup, et al., 2021). Furthermore, a positive relationship was observed between the expression of humor and the use of positive emotion words and team performance in a complex problem-solving task in a computer simulation (Fischer et al., 2007). Laughter during teamwork can be used to establish an effective teamwork environment (Ponton et al., 2018).

For the frequency and duration of individual laughter, we derive the following hypotheses:

4a: The frequency a team member's of episodes of laughter during a task is positively related to the individually perceived team flow during this task.

4b: The time a team member spends with laughter during a task is positively related to the individually perceived team flow during this task.

Equal communication

Equal communication is defined as an even distribution of speech actions in a team, i.e., the duration of speech times and the number of turn-takings are shared equally among all team members (Peifer et al., 2021). Equal, collaborative communication involving the entire team could help to achieve these states of agreement and joint action as a team. In fact, collective ambitions and mutual commitment are known to be central prerequisites for team flow (van den Hout et al., 2018, 2019). In this process, no individual team member would dominate the conversation or find themselves being excluded.

Research has shown that conversation partners may tend to adjust their speech rate to each other over time (Freud et al., 2018; Schultz et al., 2016). Furthermore, there is initial evidence that conversation partners with higher speech rate convergence are more likely to come to a collaborative solution in a joint task (Manson et al., 2013) and that equal communication can be associated with team performance in terms of collective intelligence (Woolley et al., 2010). Similar processes may emerge in the context of the present study. In ongoing collaboration and communication, teams could find a style of equal communication that could be linked to a shared experience of team flow.

Accordingly, we hypothesize:

5a: Equal communication in terms of a balanced frequency of speech actions between team members is positively related to the aggregated team flow on team level during a task.

5b: Equal communication in terms of balanced durations of speech times between team members is positively related to the aggregated team flow on team level during a task.

Duration of task-related conversations

According to earlier research and theoretical assumptions, the relationship between the duration of a task and the experience of team flow during its completion is still unclear. Evidence on individual flow suggests that it cannot be achieved without effort (Gerpott et al., 2022). Hence, it can be assumed that a team needs a certain amount of time to progressively establish team flow, as a profound immersion in the activity is needed for flow states to develop (Csikszentmihalyi, 1975). During flow, the sense of time can then be lost and the task may seem to fly by, even if a certain amount of time has already passed (Csikszentmihalyi, 1975). Similar assumptions may be made for team flow.

Conversely, it can also be argued that during team flow, working on a task may take less time: Assuming that team flow is associated with performance (Kloep, Roese, et al., 2023), a task could be completed faster once the team has achieved team flow, as work becomes more goal-oriented and efficient.

We pose the following research question to explore the relationship between the duration of task processing and team flow:

6: What influence does the duration of a task have on the aggregated team flow on team level during the task?

5.4. Materials and methods

5.4.1. Participants

Data collection took place from February to July 2024. After excluding teams with missing data or non-analyzable video quality, the sample consisted of N = 94 participants (59 female; 32 male; 3 diverse) aged between 18 and 40 years (M = 23.94, SD = 4.02). Participants took part in the study either in Poland (n = 50) or Germany (n = 44) and formed a total of 25 international workshop teams (19 teams consisting of four participants; six teams consisting of three participants). The majority of the sample consisted of university students (n = 84). Recruitment was carried out via student mailing lists and social media. All adults were eligible to participate in the study. Exclusion criteria were non-correctable visual impairments, previous psychiatric and neurological illnesses, cardiovascular diseases, motor impairments, and insufficient knowledge of English to complete the tasks. Participation in the study was remunerated with a monetary allowance of 12 EUR in Germany or 50 PLN in Poland, per hour.

5.4.2. Procedure

The research questions and hypotheses described in the present paper were examined in the context of a larger study, for which a realistic teamwork situation was created. Four or three participants at a time, in Poland and Germany, formed a team and were connected via video call in a standardized laboratory setting (Figure 5.1) to work together in a workshop on sustainable start-up ideation. They wore a smart wristwatch (Empatica E4) to collect physiological data, including heart rate and electrodermal activity, completed questionnaires at various time points, and video data were recorded. For the present paper, however, we

focus only on the video data from two workshop tasks and the corresponding team flow measure. The present paper has been preregistered, https://osf.io/n7b6a/?view_only=7f378f6724d3458684a70425c9d8d4c7, and ethical approval has been obtained from the Ethics Committee of the University [removed for peer review] (2023-560).

Figure 5.1: Laboratory setting with workshop materials

5.4.3. Sustainable start-up workshop

The key element of the study was a realistic team workshop on start-up development. All 15 tasks were completed in English on an online whiteboard (Mural® visual collaboration platform), in which a template with task instructions was provided (Appendix B). The workshop was moderated primarily with standardized videos and was supported by a workshop facilitator. Each workshop task was followed by a short questionnaire and a short video explaining the next task. For some of the tasks, additional materials such as LEGO® bricks or a reader were provided. The workshop lasted approximately seven hours, while the duration varied depending on how quickly a team completed the tasks and questionnaires. Although all tasks had recommended time schedules with timers set accordingly, teams were free to decide how much time to devote to each task. There were two short breaks during the day and one longer lunch break, adopted from a realistic working day. From the 15 tasks, two were analyzed for the present paper: the *Mascot* task and the *Prototype* task. Both had the same scheduled timing: 20 minutes.

The tasks were chosen for analysis due to the following reasons. Both took place in the first half of the workshop, before the lunch break, but not at the very beginning, ensuring that participants already knew each other. At the same time, we aimed to mitigate possible signs of fatigue that could occur at the end of the workshop due to declining energy levels. Because of their temporal proximity and predefined completion time, the two tasks shared comparable framework conditions. However, they were different in terms of content, leading to different experiences and communication patterns. The *Mascot* task was a more creative task enriched with LEGO®, as its use is known to be particularly stimulating for positive team dynamics in workshops (Wheeler et al., 2020). The *Prototype* task was a more strategic task carried out in Mural®. Thus, different types of collaboration were required. Both are co-creative design and strategic decision-making tasks that may occur in the real work of start-up teams and can provide an opportunity to experience team flow (Kloep, Roese, et al., 2023).

Mascot task

The first task considered in this study was the joint creation of a mascot for the planned start-up using LEGO® bricks, which can help teams to visualize ideas and develop creative solutions together (Bab & Boniwell, 2016; Kristiansen & Rasmussen, 2014). As the sixth task in the overall workshop, the team already defined a goal for the start-up and collected ideas for actions to be taken. The aim of the *Mascot* task was to create something that represented this goal. In the end, all participants should have an identical mascot designed and built collectively, step by step. That means, the *Mascot* task was interactive and the team had to coordinate their creative collaboration precisely at all times. The instructions for the task shown in Mural® can be found in Figure 5.2.

Prototype task

The second task examined took place in Mural® itself. Building on the results of an earlier idea collection task, the teams designed a prototype of the central product of the start-up. The first step was to reflect together and decide on a product or service. Then, it was visualized using the resources in Mural®, such as icons, mind maps, and images. The *Prototype* task focused on decision-making and combined strategic and conceptual thinking with visual aspects. The instructions from the workshop's Mural® are shown in Figure 5.3.

Figure 5.2: Instructions for the *Mascot* task

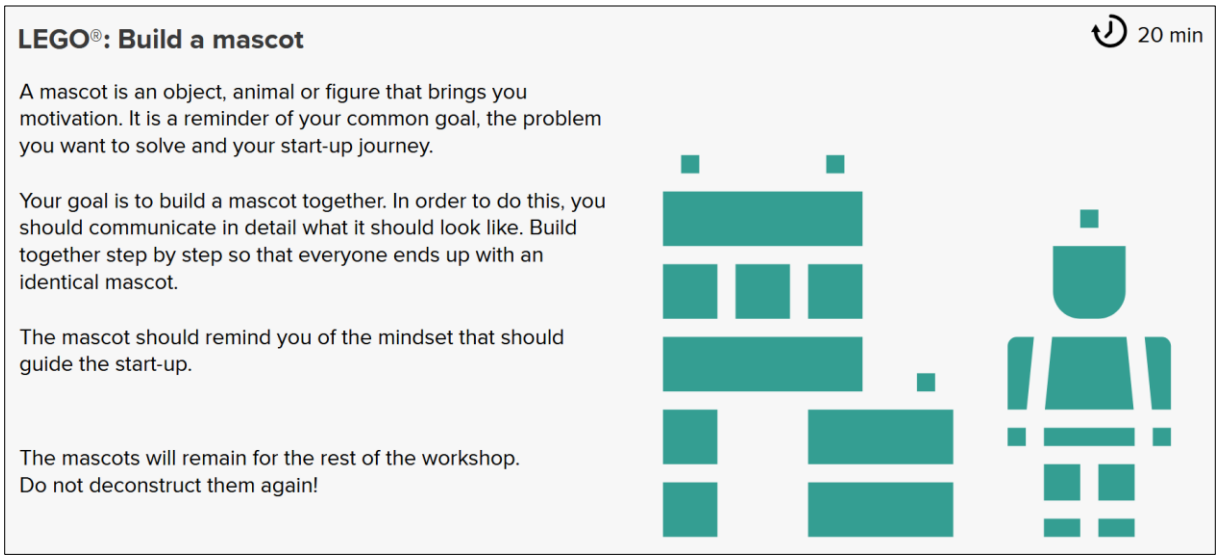
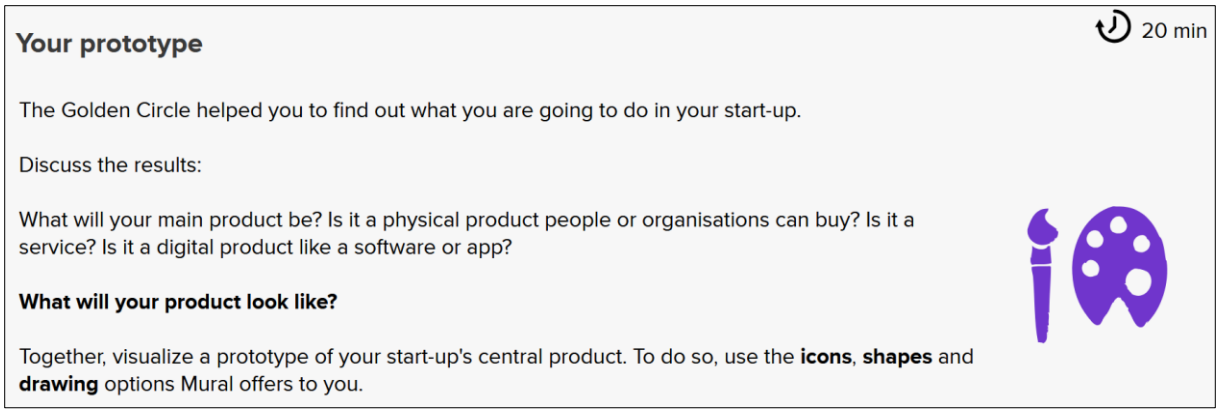


Figure 5.3: Instruction for the Prototype task



Note: Here, the *Golden Circle* relates to a previous task (for details see Appendix B).

5.4.4. Measures

For the questionnaires, participants selected their preferred language from English, German, and Polish. The study, as part of a larger project, included a series of questionnaires before, between, and after completing the tasks. In the following, however, we focus on the measures relevant to answering the present research questions.

Team flow experience

After each task, it was ensured that all participants shared the same understanding of the term *flow:* "*Flow* is a pleasant experience when doing something. In flow, you are completely absorbed in the activity, can concentrate effortlessly, feel good and are challenged just in the right amount." Then a short questionnaire was presented and individual flow was assessed with one item, followed by the assessment of the individually perceived team flow experience during the task that had just passed. Team flow was assessed with a self-developed item on a visual analog scale from 1 = "not at all" to 100 = "very much". The item was: "To what extent did you as a team experience a shared sense of flow and optimal team dynamics when carrying out an interdependent task?" Participants were instructed to refer to the task they had just completed. Each participant reported their assessment for each task individually, which served as the score for the individual analyses (Hypotheses 1-4). For the team-based analyses (Hypothesis 5, Research Question 6), mean values of all members of a team were aggregated for each task.

Speech actions

In order to measure the different speech actions, they were quantified in a video analysis with a predefined coding scheme (Table 5.1) that followed the theoretical assumptions about the emergence of team flow in virtual team communication (Peifer et al., 2021).

As a result of the coding process, the frequency and time of each participant's use of each parameter were recorded for both tasks. All resulting values were standardized by dividing by the duration of the respective task in minutes for every team.

Table 5.1: Coding of speech actions

Speech action	Characteristics
Turn-taking	Change of speaker
Positive interruption	Disruption while a participant had not yet finished their statement: Meant to support the current speaker; reinforce them; add one's own agreement or addition
Negative interruption	Disruption while a participant had not yet finished their statement: Counter the current speaker with a different aspect; direct the flow of conversation in a different direction
Closed question	Question with clear, limited response options; typically a yes/no-question
Open question	Question beginning with a question particle and allowing free answers
Laughter	Emotional expression with smile and sound; during or after one's own statement; in reaction to another person's statement after or parallel to it

5.4.5. Data analysis

The video recordings for each team were cut to the length of the two tasks to be studied and then analyzed with the help of the Communication Analysis Tool (CAT; Klonek et al., 2020). CAT allows for high-quality data even during live coding and enables interpretations by coding directly on video recordings using the prepared coding scheme, without prior transcription (Klonek et al., 2020). For the present paper, recorded video files were coded, and only codes with clear definitions and recognition features without interpretive margins were employed. Therefore, the coding was conducted by one trained researcher, following the tool recommendations and common practice in a recent research example applying CAT (Hagemann et al., 2025; Klonek et al., 2020). The resulting quantified data were then further processed for quantitative analyses with multiple linear regressions.

5.5. Results

5.5.1. Descriptive data analysis

A total of 16 hours, 45 minutes and 13.07 seconds of video was analyzed (*Mascot*: 9:07:04.04, *Prototype*: 7:38:09.03) and all speech actions were coded. Coding resulted in 8041 turn-takings in total. Participants used 1233 questions (401 open questions, 832 closed questions),

interrupted each other 856 times (764 positive interruptions, 92 negative interruptions) and laughed 726 times. At team level, this implied an average of 185.08 turn-takings in the *Mascot* task and 136.48 in the *Prototype* task, resulting from an average of 49.22 speech actions by individuals in the *Mascot* task and 36.30 in the *Prototype* task. All values for all coded speech actions on individual and team level are shown in Table 5.2.

Table 5.2: Mean values and standard deviations of speech action frequencies on individual and team level for both tasks

	Mascot				*Prototype*			
	Team level		Individual level		Team level		Individual level	
	M	SD	M	SD	M	SD	M	SD
Total turn-takings	185.08	79.80	49.22	28.88	136.48	69.69	36.30	24.74
Positive interruptions	13.72	8.73	3.65	3.14	16.80	12.32	4.47	4.78
Negative interruptions	1.84	1.46	0.49	0.68	1.84	1.70	0.49	0.79
Closed questions	21.88	11.37	5.82	4.87	11.40	6.99	3.03	2.98
Open questions	8.72	5.88	2.32	2.29	7.32	4.23	1.95	2.08
Laughter	16.56	10.15	4.40	4.62	12.48	8.37	3.32	3.65

Notes: team level: n = 25 teams; individual level: n = 94 participants

The teams spent an average of 21:52.96 minutes on the *Mascot* task and 18:19.56 minutes on the *Prototype* task. Within these, the teams spent an average of 14:03.19 minutes on speech actions in the *Mascot* task and 12:44.25 minutes in the *Prototype* task. The average durations of all speech actions per task at team and individual level can be found in Table 5.3.

Participants experienced team flow in both tasks, with average scores of M = 79.55 (SD = 24.89) for the *Mascot* task and M = 81.27 (SD = 23.49) for the *Prototype* task. A t-test revealed that there was no significant difference in team flow between the tasks, $t(85) = -0.76$, $p = .448$.

Table 5.3: Mean values and standard deviations of speech action times on individual and team level for both tasks

	Mascot				*Prototype*			
	Team level		Individual level		Team level		Individual level	
	M	SD	M	SD	M	SD	M	SD
Total turn-takings	843.19	332.44	224.25	141.53	764.25	372.87	203.26	154.03
Positive interruptions	31.28	22.56	08.32	08.24	42.09	36.00	11.19	12.48
Negative interruptions	07.62	07.49	02.03	03.39	09.11	14.93	02.42	05.98
Closed questions	96.06	45.74	25.55	21.40	60.94	38.45	16.21	18.11
Open questions	33.81	22.93	08.99	09.03	29.35	17.86	07.80	08.99
Laughter	27.72	16.40	07.37	08.26	21.44	15.55	05.70	06.91

Notes: all values in seconds; team level: n = 25 teams; individual level: n = 94 participants

5.5.2. Hypothesis testing

The hypotheses were tested using multiple regression models. Separate models were calculated for the frequencies and times of the different speech actions to analyze hypotheses 1, 2, 3, and 4 for the individual perception of team flow. A team-level model was calculated to analyze hypothesis 5 and research question 6 because of the team-level structure of the constructs.

Individual-based analyses

The multiple linear regression model examining the effect of the frequency of speech actions on team flow during the *Mascot* task was not significant, $R^2 = .06$, adjusted $R^2 = -.01$, $F(6, 79) = 0.87$, $p = .521$, $1-\beta = .35$. None of the predictors showed a significant relationship with perceived team flow, as shown in Table 5.4.

Table 5.4: Multiple linear regression model for frequencies of speech actions predicting team flow in the *Mascot* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	74.59	6.71		12.62	<.001 (<.001)
	[60.47, 87.36]				
Turn-takings	157.05	250.46	.135	0.69	.495 (.552)
	[-346.75, 635.61]				
Negative interruptions	-4984.45	3903.78	-.141	-1.19	.239 (.176)
	[-11542.29, 3814.22]				
Positive interruptions	1042.98	1273.35	.114	.76	.449 (.396)
	[-1343.60, 3838.56]				
Open questions	1917.18	2276.80	.148	.78	.437 (.370)
	[-2312.62, 6620.01]				
Closed questions	-704.02	934.29	-.106	-0.68	.499 (.456)
	[-2515.17, 1075.65]				
Laughter	-459.71	836.33	-.078	-.548	.586 (.578)
	[-2069.78, 1209.42]				

Notes: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

The overall model for the analysis of the times of the different speech actions in the *Mascot* task was marginally significant, $R^2 = .13$, adjusted $R^2 = .06$, $F(6, 79) = 1.92$, $p = .088$, $1-\beta = .72$. Within the model, more time spent on open questions was associated with higher team flow ($b = 1161.74$, $\beta = .33$, 95 % CI [180.08, 2213.32], $p = .030$), whereas more time spent on closed questions was associated with lower team flow ($b = -483.37$, $\beta = -.32$, 95 % CI -927.94, -113.74], $p = .023$). The resulting values are shown in Table 5.5.

Table 5.5: Multiple linear regression model for durations of speech actions predicting team flow in the *Mascot* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	78.91	5.65		14.63	<.001 (<.001)
	[66.92, 88.83]				
Turn-takings	14.63	37.62	.060	0.43	.667 (.690)
	[-59.72, 88.04]				
Negative interruptions	-859.65	763.18	-.127	-1.17	.248 (.186)
	[-2065.64, 929,15]				
Positive interruptions	536.04	405.12	.154	1.23	.223 (.162)
	[-245.154, 1401.45]				
Open questions	1161.74	496.37	.332	2.22	.030 (.020)
	[180.08, 2213.32]				
Closed questions	-483.37	208.82	-.324	-2.32	.023 (.018)
	[-927.94, -113.74]				
Laughter	-246.28	428.727	-.076	-0.63	.528 (.530)
	[-1055.15, 675.30]				

Notes: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

The overall model analyzing the effect of frequency of speech actions on team flow during the *Prototype* task was not significant, R^2 = .11, adjusted R^2 = .04, $F(6, 779) = 1.64$, p = .147, 1−β = .64. Within the model, two predictors were significant: More frequent turn-taking predicted higher team flow (b = 581.90, β = .586, 95 % CI [172.91, 1036.29], p = .023), while more frequent closed questions were associated with lower team flow (b = -2392.68, β = -.315, 95 % CI [-4484.27, -141.09], p = .045). All results can be found in Table 5.6.

Table 5.6: Multiple linear regression model for frequencies of speech actions predicting team flow in the *Prototype* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	75.73	4.70		18.03	<.001 (<.001)
	[66.81, 85.60]				
Turn-takings	581.90	212.37	.586	2.31	.023 (.009)
	[172.91, 1036.29]				
Negative interruptions	-2474.37	4651.09	-.080	-.71	.477 (.586)
	[-11834.62, 6115,687]				
Positive interruptions	-628.53	736.67	-.120	-.85	.398 (.397)
	[-2126.75, 826.46]				
Open questions	-800.30	1265.23	-.073	-.51	.614 (.495)
	[-3319.75, 1653.81]				
Closed questions	-2392.68	1073.40	-.315	-2.04	.045 (.032)
	[-4484.27, -141.09]				
Laughter	-169.17	652.27	-.030	-.20	.843 (.760)
	[-1744.45, 993.48]				

Notes: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

The multiple linear regression model for the effect of the duration of speech actions on team flow during the *Prototype* task was not significant, R^2 = .07, adjusted R^2 = .001, $F(6, 77) = 1.02$, p = .419, 1−β = .42, with none of the predictors showing an effect on team flow. The results are shown in Table 5.7.

Based on the analyses, none of the hypotheses 1, 2, 3, or 4 can be fully confirmed for the context of the analyzed virtual teamwork tasks due to non-significant overall models. However, there are indications of partial confirmation of hypotheses 1 and 4 regarding turn-taking frequencies in the *Prototype* task and durations of open questions in the *Mascot* task due to the effects of the individual coefficients.

Table 5.7: Multiple linear regression model for durations of speech actions predicting team flow in the *Prototype* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	77.45	4.61		18.53	<.001 (<.001)
	[68.25, 86.73]				
Turn-takings	26.23	25.18	.157	.93	.358 (.284)
	[-20.94, 78.10]				
Negative interruptions	251.10	497.39	.064	.53	.598 (.480)
	[-1189.94, 974.48]				
Positive interruptions	17.99	255.02	.010	.08	.939 (.943)
	[-538.32, 473.73]				
Open questions	65.48	321.78	.026	.18	.859 (.823)
	[-627.39, 643.39]				
Closed questions	-217.87	166.76	-.167	-1.27	.207 (.177)
	[-538.28, 125.16]				
Laughter	524.25	265.08	.181	1.49	.140 (.040)
	[-52.43, 1040.73]				

Notes: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

Team-based analyses

To analyze hypothesis 5 and research question 6, further regression models were calculated using aggregated team-level data due to the team-level structure of the constructs involved. The model for the effect of equal communication and the duration of task collaboration on team flow during the *Mascot* task was not significant, $R^2 = .05$, adjusted $R^2 = -.09$, $F(3, 21) = 0.35$, $p = .787$, $1-\beta = .12$. Results are shown in Table 5.8.

Also, the regression model for equal communication and task duration for the *Prototype* task was not significant, $R^2 = .14$, adjusted $R^2 = -.01$, $F(3, 20) = 1.09$, $p = .377$, $1-\beta = .29$. All results can be found in Table 5.9.

Hypothesis 5 is also rejected based on the results. Regarding the open research question 6, it can be concluded that task processing duration does not appear to influence team flow in the examined context.

Table 5.8: Multiple linear regression model for equal communication and task duration in the *Mascot* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	70.73	13.60		3.99	<.001
	[38.80, 91.06]				(<.001)
Equal communication	-75.32	132.24	-.156	-0.59	.559
(speech frequency SD)	[-356.14, 149.265]				(.544)
Equal communication	605.30	632.19	.266	0.99	.336
(speech time SD)	[-434.02, 2049.78]				(.324)
Task duration	0.01	0.01	.113	0.50	.620
	[-0.010, 0.027]				(.558)

*Note*s: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

Table 5.9: Multiple linear regression model for equal communication and task duration in the *Prototype* task

Predictor	*b [CI]*	SE_b	β	*t*	*p* (p_{boot})
(Constant)	97.55	8.44		11.86	<.001
	[82.78, 115.20]				
Equal communication	-39.81	50.28	-.220	-0.84	.410
(speech frequency SD)	[-150.03, 51.43]				
Equal communication	174.36	397.65	.131	0.50	.624
(speech time SD)	[-516.50, 1039.86]				
Task duration	-0.01	0.01	-.341	-1.62	.121
	[-0.024, 0.00]				

Notes: 95% confidence interval and standard error estimated with bootstrapping (1000 samples)

5.6. Discussion

The present study aimed to identify team flow indicators from team communication, examining two team tasks with regard to various communication parameters and their effect on team flow. The results will be contextualized in relation to existing theory and research in the following. It should be noted, however, that all analyses should be interpreted with caution due to insufficient statistical power and non-significant overall models.

For the *Prototype* task, we were able to identify a positive effect for the frequency of individual turn-takings during team conversation and the perception of team flow. Nevertheless, this effect should be interpreted with caution, as the overall model was not statistically significant. The finding may highlight the context-dependent nature of factors influencing team flow within team communication and suggests a potential team flow indicator for strategic team tasks. Talking to each other may have been essential to getting engaged and together achieving the goal of the *Prototype* task. Potentially, the team members' activity in the *Mascot* task may have been driven toward different outcomes by the LEGO® elements that were implemented. Building with LEGO® may not necessarily encourage communication, but it can still be associated with the experience of team flow while constructing a model together (Zenk et al., 2021). Thus, the perception of team flow could potentially arise from the interaction with the LEGO® rather than from conversation with the team. Future research should validate the effectiveness of the individual turn-taking count as an indicator of team flow in strategic virtual team tasks.

Regarding interruptions, neither positive nor negative interruptions were able to predict team flow and, according to the results, they may therefore not be regarded as indicators of team flow. Future studies may need to differentiate more precisely if an interruption has a supportive effect on a team's progress and reflects an atmosphere of trust and psychological safety, or whether it has a detrimental effect on an interpersonal level and may weaken the team as a whole. In addition to the message of the interrupter and the success in gaining a speaking turn, a detailed analysis could also consider the loudness and speed of the speech of both the interrupter and the interruptee (Ng et al., 1995).

For questions, instead, a positive effect was found for the time spent with open questions on the perception of team flow in the *Mascot* task. In this task, open questions seemed to be essential, as the other team members' results were not visible on the shared screen. Each participant worked individually with the LEGO® bricks, and information exchange only took place in the video conference. Thus, the co-creative and engaging nature of the task, along with the marked need for coordination, may have contributed to open questions becoming a prevalent way of experiencing team flow. Asking questions and obtaining feedback from one another could have led to increased team flow. We also know from earlier research that question episodes with open questions in team communication can be related to an improvement in individual performance (Menekse et al., 2019), which could simultaneously be a result of team flow experiences (Kloep, Roese, et al., 2023). In the *Prototype* task, instead, the task itself seemed to be designed in such a way that the individual perception of team flow was not determined by a team member's use of open questions.

However, a different pattern emerged regarding the use of closed questions. The time spent asking closed questions negatively affected the perception of team flow in the *Mascot* task, as did the number of closed questions in the *Prototype* task. Hence, a high proportion of closed questions in team communication may indicate reduced team flow in virtual teamwork. Unlike open questions, closed questions may not facilitate discussion or profound elaboration, but rather prevent the joint exploration of a topic due to their limited answer options, which are usually yes or no (Koshik, 2002). Therefore, closed questions may lead to more fragmented conversational dynamics and less spontaneous conversation in virtual teamwork. Since the overall models were not significant, the effects should be interpreted with caution in the context of these tasks. Further research is needed before these findings can be transferred to other tasks or work contexts.

Contrary to our expectations, laughter as an emotional expression was not associated with team flow. Future applications should consider not only laughter, but also the different ways of expressing humor and the use of positive emotion words, which may be associated with successful teamwork (Fischer et al., 2007). Similarly, an analysis of team meetings showed that humor, but not laughter alone, was positively related to team performance (Lehmann-Willenbrock & Allen, 2014). In the present study, however, the use of humor may have been limited by the fact that participants were communicating in a foreign language, as humor requires advanced language skills and the understanding of specific metaphors and cultural aspects (Ayçiçeği-Dinn et al., 2018; Schoos & Suñer, 2020). Furthermore, it should be noted that laughter, although generally considered positive, can also be an expression of negative emotions (Szameitat et al., 2022).

The present study was unable to confirm a relationship between equal communication and team flow within a team. Contrary to previous assumptions about speech rate convergence during teamwork (Freud et al., 2018) and in line with the present results, the current research on team dynamics is inconsistent. Instead of having equal voice distributions, teams may centralize their voice around the most competent members seeking to perform better (Wu et al., 2024). In this case, non-equal distributions of speech actions may even help to achieve team flow depending on the task type and context.

Furthermore, there were no significant effects when looking at the duration of the task. Here, it should be noted that the average completion time of the *Mascot* task was longer than that of the *Prototype* task, even though both tasks were designed to last approximately 20 minutes. It is possible that the participants found it more challenging to complete the *Mascot* task in 20 minutes and therefore felt moderately stressed. Earlier research suggests that, under time pressure, communication quantity and efficiency may increase (Pfaff, 2012). From research on individual flow, it is known that the experience of flow is related to moderate activation

(Peifer et al., 2014), and similar relationships could be assumed for team flow. By varying the task duration, teams could therefore indirectly influence the creation of a challenge-skill balance (van den Hout & Davis, 2019).

5.6.1. Theoretical and methodological implications

Regarding the understanding of team flow experiences in different contexts, the results indicate that different predictors are present depending on different task characteristics, affecting team flow to different extents. Influenced by task characteristics, there could be an individual fit between unique communication patterns and the perception of team flow, which we were not able to explore in detail in the present study.

Overall, the communication parameters assessed do not suffice to indicate team flow. Similar to other emergent team states, operationalizing the experience from behavioral patterns remains challenging (Lehmann-Willenbrock, 2024). Besides the question of how differences between individual perceptions should be approached when defining team flow, which we could not address in the present paper, other indicators may be relevant. Following Peifer et al. (2021), there could be more indicators from collective communication that can be considered as team flow indicators, such as facilitating listening, using “I” or “we”, vocal expression, and intonation patterns.

Furthermore, the quality of communication may be more important than frequency and time of certain parameters. According to Marlow et al. (2017), communication quality could be identified through timeliness and closed-loop communication—a communication style characterized by ensuring that messages are received and interpreted correctly by using questions and answering them consistently. However, due to the live interaction in the video call, timeliness was maintained at all times, and by analyzing questions and interruptions, we were able to approach markers for closed-loop communication. Since our findings are partly ambiguous, we conclude that, depending on the type of task, the content of the conversation could be more decisive than quantifiable communication features. For example, the proportion of task-critical information exchange could be related not only to a team's performance (Fischer et al., 2007), but also to team flow. However, the present analysis permits no conclusions about the speech content and the complex individual dynamics of each team.

The study reveals that quantified communication analyses can provide a starting point for the interruption-free measurement of team flow; however, depending on the task characteristics, other parameters may play a more decisive role. In-depth content analyses of team communication could enable more reliable conclusions regarding team dynamics and team

functioning (Fischer et al., 2007). In this regard, the combination of individually performed task components and interdependence within the team when coming to a solution does not contradict the assumption that team flow can be identified via communication parameters, but could complicate the identification of indicators. Team flow may also be present in moments dominated by silence, assuming that a concentrated work atmosphere characterized by absorption prevailed. However, in order to measure this, further indicators beyond verbal communication should be considered in future studies.

Physiological measurements and the application of machine learning may offer potential approaches. Initial evidence for the identification of individual flow from physiological data, including EEG and ECG, for example, has already been found, albeit in the context of a highly standardized laboratory setting (Irshad et al., 2023). The question arises as to whether this is transferable to a team context, more specifically a virtual team context, on the one hand due to the lack of standardization and, on the other hand, due to the assumption that, on a physiological level, team flow could be a fundamentally different experience than individual flow. The synchronization of physiological patterns in teams could provide insights in the same way it can indicate other team states, such as the emergence of cohesion (Mønster et al., 2016). Following the concept of shared attention, synchronized physiological activation patterns may be present during a shared experience of flow (Snijdewint & Scheepers, 2023). Future applications may combine physiological and communication parameters to gain a more comprehensive insight into the characteristics and dynamics of team flow experiences. Machine learning approaches may help to identify more complex patterns in previously unexplored team flow indicators. However, the practical application of these approaches may be limited compared to observation-based behavioral measures.

Furthermore, the individual and team- level measurement of the perception of team flow should be discussed. When looking at individual perceptions in a team context, it may occur that some team members may perceive team flow during a task, while the other team members do not recognize this for themselves. Although interpreted like this in the present study, the issue arises as to whether one should speak of team flow or if other forms of flow experiences in social contexts are present (Hackert et al., 2023). This leads to the question if individual-level speech parameters, for example, asking questions, should be regarded as team flow indicators. One way to address this could be to examine dyadic teams to systematically scrutinize the congruence between two individuals before gradually extending to larger teams. Thereby future research should seek an agreement on a coherent understanding of team flow and its measurement (Pels & Kleinert, 2023). For example, when aggregating team scores, researchers could consider the discrepancies between team members or discuss cut-off

values that all team members should achieve in order to be able to speak of a shared experience.

5.6.2. Strengths and limitations

A strength of the present study is the realistic implementation of a full-day workshop in a standardized setting. The workshop teams spent a working day on a realistic start-up ideation process and got to know each other through close interdependent collaboration.

The setting, as an online workshop with an international team, also corresponds to modern working realities. Work takes place across borders and teams often only communicate virtually (Handke & Wesche, 2024). There is preliminary evidence that time spent in virtual meetings may be positively associated with daily individual flow experiences; however, the role of cognitive depletion in virtual work should be further investigated (Rivkin et al., 2024), and the possibility of generalizing to team flow experiences remains to be further explored.

Conducting the workshop in English, which could be seen as an obstacle with regard to ease of communication, can also be interpreted as a strength of the study when considering the realistic nature of the setting. In many globalized work contexts, English is the workplace language and diversity among team members is commonplace (Varhelahti & Turnquist, 2021).

A limitation to the transferability of the findings to real-world settings is the lack of prior familiarity between the team members before the workshop. Although there was an initial introductory and warm-up time, real trust and mutual understanding, which can be crucial to the development of a joint team flow (van den Hout & Davis, 2022), possibly did not evolve. In addition, participants knew that their performance in the workshop would have no consequences; unlike teams that work on long-term projects, our workshop included no follow-up and no performance evaluation.

What should also be considered when interpreting the results is the impact of the virtual meeting itself. On the one hand, for many teams it represents a realistic context; on the other hand, it is associated with unique challenges (Marlow et al., 2017). Spending time in virtual meetings can be exhausting and may result in a lower level of activity than in face-to-face meetings (Nesher Shoshan & Wehrt, 2022). As discussed earlier, attention should be paid to the importance of communication quality rather than an exclusively quantitative approach (Marlow et al., 2017).

On a methodological level, it should be discussed that although the data were collected from individuals within teams, the objective was to model individual-level effects regarding individual team flow perceptions and the speech actions of turn-taking in general, interruptions,

questions, and laughter, rather than at the team level. This approach was chosen since these are speech actions performed by individuals that may primarily affect their own perceptions of team flow. In addition, the intraclass correlation (ICC) for the *Mascot* task was small (.10), and for the *Prototype* task moderate (.27). Due to the small number of teams (n = 25) and small team sizes (three to four team members), fully specified multilevel models may have been underpowered. For the hypotheses regarding equal communication and task duration, an analysis aggregated on team level was chosen because the dependent constructs to be investigated were defined and measured for teams as a whole.

Potential crossover effects of team flow across team members remain a limitation that we were not able to control for. Regarding individual flow, research has shown that one person's flow can have a contagious effect, facilitating flow in others with whom they interact (Bakker, 2005). In line with this, it can be assumed that team members may be dependent on one another in terms of their behaviors (Adams & Anantatmula, 2010), in particular during interdependent tasks, which can be typical team flow settings (van den Hout et al., 2018). Future studies should investigate team-level effects with sufficiently large sample sizes in controlled conditions and tasks (LeDoux et al., 2012).

5.6.3. Practical implications

As the results are limited in significance, only initial assumptions for practical implications can be derived. The theoretical basis of these implications warrants further exploration in future research. Communication in teams appears to be a central factor for the emergence of team flow. However, what exactly constitutes good or open communication, as described in earlier research (Aust et al., 2023; Coss et al., 2025), remains unclear. Nevertheless, carefully designed communication workshops for teams may already be considered an approach to promote team flow in virtual teams.

However, team flow does not only imply constant communication and interaction; it may also include phases of deep absorption and individual elaboration of tasks in silent work. In teamwork dynamics, team members continuously adapt to changing interaction situations. Accordingly, team flow may be characterized by a dynamic equilibrium of regulatory processes (Pels & Kleinert, 2022). This means that team flow promoting communication parameters may vary. In practice, teams should be given the opportunity to adopt different working modes, and teamwork phases with less communication should not be viewed as negative.

5.7. Conclusions

The present study contributed to the expansion of team flow theory with regard to a closer examination of team communication parameters as predictors for team flow and, in consequence, their use as team flow indicators when developing interruption-free measurement approaches. Depending on the task type in virtual teamwork, we found that individual turn-takings and questions asked in team communication may have an effect on the perception of team flow. Contrary to our assumptions, however, interruptions, laughter, equal communication, or the duration of task-related teamwork were not identified as predictors of team flow. The results indicate that analyzing team communication by quantifying speech parameters does not yet allow conclusions to be drawn about team flow in the context of virtual teamwork. Instead, the relationships appear to be more complex, and an analysis of the content of the speech actions or physiological activation patterns could contribute to understanding the dynamics leading to team flow experiences.

5.8. Ethical considerations

Ethical approval has been obtained from the Ethics Committee of the University of Lübeck (2023-560).

5.9. Consent to participate

Written informed consent to participate was obtained from the participants prior to data collection.

5.10. Consent for publication

Written informed consent to data publication was obtained from the participants prior to data collection. Video data of individual participants are excluded from publication.

5.11. Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

5.12. Funding statement

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5.13. Data availability

Quantitative data is available in a data repository: https://osf.io/g98ny/?view_only=6072bfd966524d29a26a4819e984e65f

6. Discussion

Following the three empirical studies, they will be contextualized and discussed below. After summarizing the results to answer the research questions, theoretical implications are derived considering a work design perspective. Furthermore, the strengths and limitations of the studies are discussed, and the implications for future research and practice will be presented.

6.1. Findings of the empirical studies

The three studies in this thesis focus on flow and team flow experiences in different modern work contexts. Taking different perspectives, they explored specific research questions with the help of three methodological approaches.

6.1.1. Findings on flow and team flow in start-up work

RQ1: *In the dynamic work context of start-up work, which factors promote or hinder the flow and team flow experiences of founders, and what are the consequences of these states?*

Study I of the present thesis took a global perspective to shed light on work processes in start-ups, aiming to better understand the role of flow and team flow in the start-up context. Assuming that flow and team flow can arise in the work of early-stage start-ups and may provide benefits to founders and their teams, the dynamics of these experiences were explored through semi-structured qualitative interviews with 21 founders from various industries. Based on deductive and inductive codings, a comprehensive picture of flow and team flow in start-ups was created. The concepts of flow and team flow were commonly known to start-up founders and experienced mainly in creative, strategic, and product development tasks. The promoting and hindering factors for flow and team flow identified in the interviews were classified in a model that differentiated between individual, job/task-related, and organizational/social factors. The consequences were also classified in the model, distinguishing between subjectively positive, negative, and non-directional consequences.

Overall, many factors known from other work contexts were shown to promote flow in start-ups, such as clear goals and meaningfulness (Maeran & Cangiano, 2013; Salanova et al., 2006). Furthermore, factors that may be considered given in other work contexts became central in the context of start-ups because they still represented a particular challenge for work design, such as having engaging environments and suitable equipment. Regarding hindering

factors, the findings also confirmed assumptions from earlier research, for example, with regard to multitasking (Peifer & Zipp, 2019). However, factors specific to start-ups, such as uncertainty and excessive demands, were particularly emphasized by the interviewees.

The consequences of flow in start-ups were described as predominantly positive. For example, founders reported increased satisfaction and performance indicators, such as better progress and new ideas, as consequences of flow. These findings are consistent with earlier research (for an overview, see Liu et al., 2023; Peifer & Wolters, 2021). Less-researched consequences, such as resilience, were also discussed as a result of flow experiences, aligning with assumptions from earlier research (Kloep, Aust, et al., 2023). In addition, the interviewees mentioned a few negative effects of flow that may negatively impact work behaviors in the start-up, such as increased perfectionism, which has been associated with negative impacts on work relationships (Ocampo et al., 2020).

Similarly, for team flow in start-ups, several conducive factors were identified, which are already suggested by both theory and empirical research, such as positive team spirit and commitment (van den Hout et al., 2019; van den Hout & Davis, 2022). Additionally, factors that are understood to hinder team flow were mentioned, for example, distractions and misunderstandings in online communication, going in line with the assumption that open communication and holistic focus are central to the emergence of team flow (van den Hout et al., 2018). There were also factors highlighted that may play a specific role in the context of challenging and dynamic start-up work, such as a general lack of visibility of results or conflicts within the team.

The consequences of team flow in start-ups largely aligned with theoretical models and earlier research findings. For instance, founders described increased satisfaction and collective efficacy as consequences of team flow (Raettig & Weger, 2018; Salanova et al., 2014). However, a result that has not yet been considered in research was the perceived increased vulnerability to setbacks, for example, that may result from the positive feelings experienced during team flow.

In total, many of the factors discussed for team flow overlapped with those for individual flow, as the two states may be perceived as similar by founders who often organize start-up work in team structures. Overall, the identified factors can be used to derive recommendations for flow and team flow promoting work design approaches for start-ups. Some recommendations are given in Section 6.5; partly validating existing models, partly opening up new research fields for future exploration.

Moreover, Study I can serve as a reference for interpreting Study II and Study III, as aspects mentioned in Study I can also be found in the contexts examined in these studies. For instance,

there are analogies regarding the autonomy and meaningfulness of work, which are important for start-ups but assumed to be low in manufacturing. Parallels can also be drawn for virtual teamwork, since online communication and misunderstandings were discussed as obstacles to team flow.

6.1.2. Findings on flow and gamification in manufacturing

RQ2: *In the context of manufacturing work, how does gamification affect flow experience, and how is it related to performance?*

Study II of this thesis investigated flow in the context of manufacturing work, with a particular focus on the effects of gamification. The goal was to explore how gamification could contribute to flow in work environments that initially seem less conducive to flow due to characteristics such as monotony and a lack of challenge.

It was assumed that gamification in manufacturing could have a positive influence on both performance and flow. It was also hypothesized that flow would be positively related to performance over the course of a production process and would mediate the relationship between gamification and performance.

In an experiment with two conditions—gamified and non-gamified manufacturing—participants produced a handgrip at a realistic manual workstation in five assembly runs. The gamification group had various gamification elements integrated into the user interface of the workstation, including progress bars, acoustic and visual feedback, and performance indicators.

The findings of the study revealed no difference in performance between the two conditions, which was measured by the time required to complete the assembly task. Performance in a manufacturing task was not significantly improved in a gamified work environment compared to a non-gamified one. Depending on the measurement approach, different results were found for flow experience. For the overall measurement of flow frequency across all assembly runs, a difference was observed between the two groups, with higher values in the gamified condition. However, for flow intensity, which was measured after each assembly run, the difference only existed in the first run. After that, there was no difference in flow intensity between the gamified and non-gamified assemblies. Although the relationship between flow and performance could be observed throughout the assembly runs, flow did not act as a mediator in the relationship between gamification and performance.

Overall, the study provides evidence that gamification may promote flow in manufacturing work. However, it also acknowledges that flow can emerge without the use of gamification. Based on these findings, recommendations for designing manufacturing work can be derived,

and the potential applications of gamified approaches can be discussed, which follows in Section 6.5.

6.1.3. Findings on team flow and communication parameters for its measurement in virtual teamwork

RQ3: *In the context of virtual teamwork, which communication parameters accompany team flow experiences in different types of tasks?*

Study III of the present thesis focused on virtual teamwork contexts and team flow experiences in different virtual team tasks. The study aimed to determine which parameters of virtual communication promote team flow and can, in consequence, serve as indicators for its identification. To this end, videos of two tasks from full-day team workshops on sustainable start-up development conducted with 25 international teams were analyzed regarding communication. One task was co-creative, involving the construction of a team mascot with LEGO®; the other was a strategic task, involving the compilation of a prototype on an online whiteboard. Based on theoretical assumptions about virtual team dynamics and team flow characteristics in general, the communication analysis focused on turn-taking, the use of closed and open questions, interruptions, the role of laughter, equal communication, and the duration of conversation. The videos were analyzed to quantify how often and how long each participant engaged in the different behaviors. Then, multiple linear regression analyses were conducted with the individual perception of team flow and, depending on the hypothesis focus, the aggregated team score.

It was found that team flow and its indicators appeared to differ depending on the type of task, suggesting context-dependent relationships. In the strategic prototype task, a significant positive effect was found for the individual turn-taking count and the perception of team flow. The more a team member talked, the more likely the team member was to experience team flow. For the analysis of questions asked during team communication in relation to team flow, a positive effect resulted for the time spent asking open questions in the mascot task. Open questions appeared to be markers of proactive engagement in team communication in the co-creative task and possible indicators of team flow under these specific task conditions. However, for closed questions, which may have led to a more fragmented conversational dynamic and less profound explorations of the topics asked about, negative effects on the perception of team flow were found in both tasks. There were no effects for positive and negative interruptions, laughter, or equal communication, that is, the balance of speaking

shares during conversation. These parameters did not appear to function as indicators of team flow, or at least not in the types of tasks investigated.

Overall, the study examined the communication parameters that affect the experience of team flow in different types of tasks. Thereby, the possibility of interruption-free measurements of team flow from communication was explored, yet only a few valid indicators were identified. It can be concluded that the quantity of speech acts alone is insufficient to determine team flow; other aspects, such as the content of speech, should be considered in future applications. The study thoroughly discussed team flow theory and its operationalization, and the communication factors identified may be seen as team flow promoting factors when classified in an overarching model. Therefore, it also provides a starting point for deriving practical implications related to communication for virtual teamwork that may promote team flow, as follows in Section 6.5.

6.2. Theoretical and methodological implications

This section presents a comprehensive discussion of the results from the three studies with focus on theoretical and methodological contributions to flow and team flow research. First, the findings of the thesis are integrated into an adapted work design model. Central components of the model, such as playful approaches and cultural influences, are addressed from a theoretical perspective, and the application of flow and team flow promoting work designs is critically reviewed. Lastly, the methodological contributions of the thesis regarding the operationalization and measurement of dynamic emergent states are discussed.

6.2.1. Developing a work design model of flow and team flow

This thesis examined flow and team flow in three work contexts, addressing them as process variables affected by various inputs and resulting in different outputs. Building on the theoretical assumptions outlined in Section 2, a holistic work design perspective on flow and team flow is adopted, integrating these states into a work design model.

Existing work design models provide a starting point for research, but they may seem static and overlook the context-dependent effects and dynamics of psychological states (Grant & Parker, 2009; Parker et al., 2001; Van den Broeck & Parker, 2017). Furthermore, some models focus predominantly on task-level features, while processes at work may also be affected by individual and social influences, as well as their interaction (Humphrey et al., 2007; Van den Broeck & Parker, 2017). Further developments and reconceptualizations of existing models, as well as new suggestions for flow promoting work design approaches, are required.

Following the recommendations from earlier research (Parker et al., 2001; Parker, Morgeson, et al., 2017), this thesis contributes to the field by taking a systemic, process-oriented approach to work design, adapting a model to meet the needs of flow and team flow research. Based on the Job Characteristics Model (Hackman et al., 1975) and the Input-Process-Output Model, which served as the structural basis of this thesis (see Section 2.6), an adapted work design model is proposed. This framework synthesizes the empirical findings of all three studies, emphasizing that flow and team flow emerge within a system of dynamic conditions influenced by contextual factors.

The Job Characteristics Model (Hackman et al., 1975) is an established model in work design research that is adaptable to various contexts (Van den Broeck & Parker, 2017). The model resembles an input-process-output model, which aligns with the perspectives on flow and team flow applied in the present thesis.

At the input level, this model encompasses task-related job dimensions, such as task significance, identity, variety, autonomy, and feedback (Hackman et al., 1975)—all of which can be found in the research design and results of the present thesis. For example, these characteristics are reflected in the interviewees' responses in Study I and in the considerations for designing a gamification strategy in Study II. Based on the findings of this thesis regarding flow and team flow promoting factors, it is recommended to consider factors from not only the task- and job-oriented spheres, but also the individual, social, and organizational spheres. This assumption aligns with earlier researchers' suggestions to extend and adapt the established work design model to specific contexts with additional job characteristics or other influencing factors, thus adopting an integrative perspective (Morgeson & Humphrey, 2006; Van den Broeck & Parker, 2017). In this way, individual and team-level factors in the social sphere, such as the communication patterns examined in Study III of the present thesis, which are conducive or hindering to team flow, can also be integrated.

The psychological states at the center of the original model—knowledge of results, responsibility, and meaningfulness (Hackman et al., 1975)—may also be understood as individual-level flow and team flow predictors, according to the results of the thesis, for example, in Study I. While the different factors may interact with each other, they can also have a direct effect on the processes of flow and team flow. All factors that influence flow or team flow are therefore classified as inputs within the adapted model. Thus, flow and team flow are placed at the center of the model as central psychological processes at work. These processes can impact personal and work-related outcome dimensions, which were also examined in the thesis.

Regarding the output section, the original model suggests internal work motivation, performance, and satisfaction, for example. Similar results were obtained in the studies of the present thesis, particularly in Study I and Study II, where consequences of flow and team flow were analyzed in detail. The adapted work design model categorizes and summarizes these outputs into performance and well-being aspects for individuals and teams.

Furthermore, a central extension of the model is the integration of context. Earlier research has emphasized the importance of contextual influences in work design and their effect on work-related outputs (Humphrey et al., 2007; Morgeson et al., 2010). Therefore, contextual factors are integrated as moderators that may interact with the effects of input factors on flow and team flow, as well as the effects of these processes on the outputs. Consequently, context is not merely an inactive backdrop (Morgeson et al., 2010); instead, it actively influences in a unique way how work design elements translate into flow experiences.

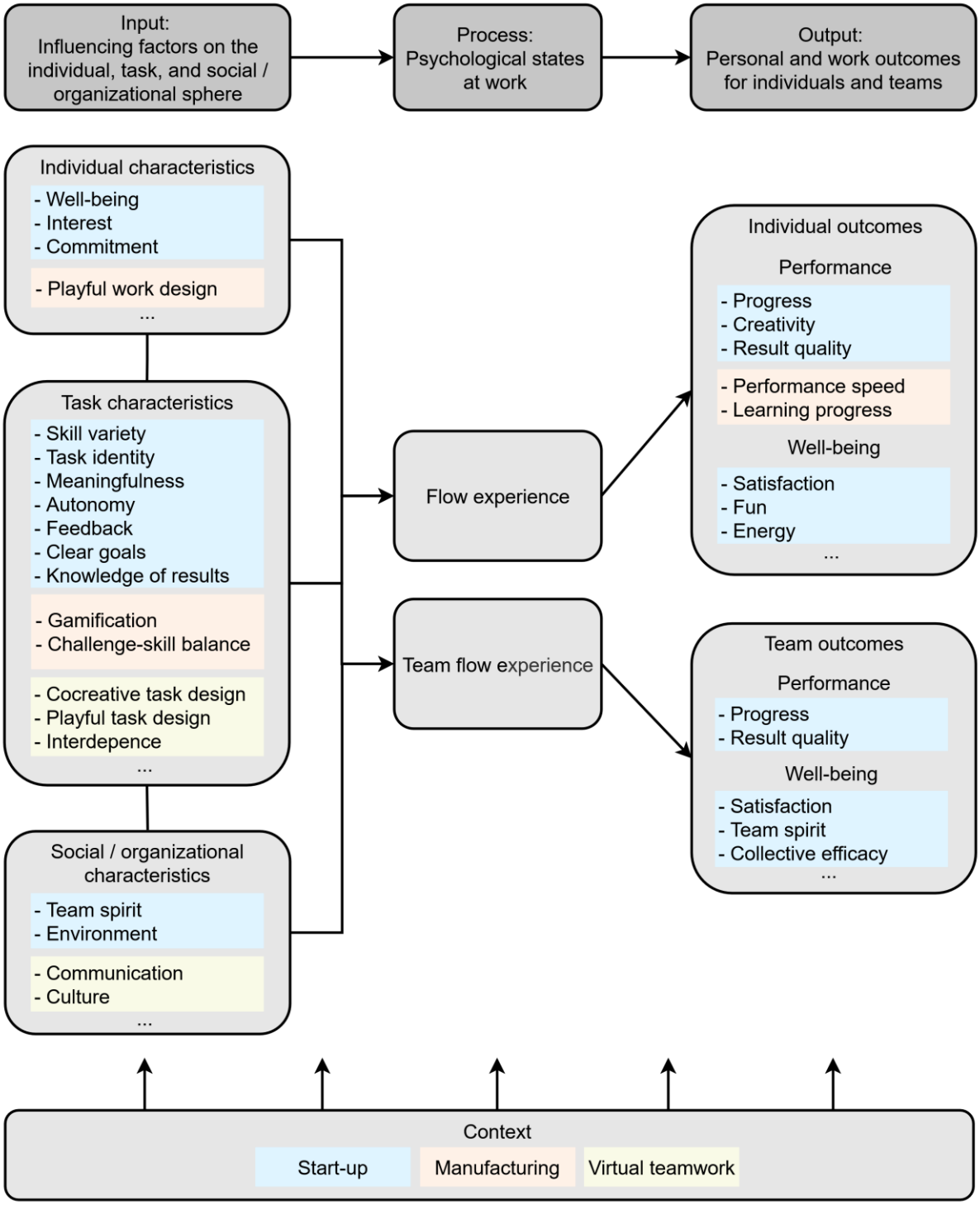
As a central contribution of this thesis, a novel work design model is presented, based on the Job Characteristics Model and the structure of IPO models in work design. In the form of an adaptable IPO model, it takes flow and team flow into focus. The model is adjustable to various contextual settings and allows for a better understanding of the relationships regarding flow and team flow in different work contexts. Therefore, it provides a guideline for developing practical applications and may be expanded in future research.

Figure 6.1 illustrates the proposed adapted work design model that incorporates both flow and team flow.

It provides an exemplary classification of the examined inputs and outputs from the studies in this thesis, focusing on the contexts of start-up work, manufacturing, and different task types in virtual teamwork. It is assumed that a dynamic interaction of individual, task-related, and social factors influences the emergence of flow and team flow depending on the context. This, in turn, leads to context-dependent effects of flow and team flow for individuals and teams. The three studies that comprise the model each have different facets and levels of detail, demonstrating that the model is dynamic and adaptable for various applications. Consequently, the proposed model is not exhaustive, but rather an adjustable framework that can be tailored to specific research goals and settings. Future research is needed to further develop and expand the model.

The following discussion will explore key aspects of the model, drawing on the studies in this thesis, in more detail. These include playful approaches and cultural influences, for example. Additionally, the use of flow and team flow promoting work designs will be critically evaluated.

Figure 6.1: Adapted work design model integrating flow and team flow



6.2.2. Playful approaches to work design

The effects of different types of playful approaches on flow and team flow were examined in different contexts across this thesis and, therefore, subsequently integrated into the adapted

work design model as input factors for flow and team flow promoting work. In this section, gamification, playful work design, and the integration of playful methods, such as LEGO®, are discussed in reference to work design and flow and team flow research.

While having a long history of being part of human social interactions (Huizinga, 1956), games are increasingly being integrated into work environments in various ways. This development is relevant in the context of flow research because games and playful contexts often have characteristics that function as antecedents of flow and team flow, and flow theory explicitly categorizes games as flow activities (Csikszentmihalyi, 1975). Csikszentmihalyi even states that "play is the flow experience par excellence" (Csikszentmihalyi, 1975, p. 37). While game-based team interventions have been shown to promote team flow at work (Kloep, Helten, et al., 2023), it may also be assumed that incorporating playful elements into the work itself could produce similar results.

Flow is an established concept in gamification research—the science of integrating game elements into non-game contexts (Deterding et al., 2011)—and one of the most frequently used theoretical models for developing gamification elements, which has made this an increasingly popular field of study in recent years (Krath et al., 2021; Oliveira et al., 2021; Oliveira & Hamari, 2024). However, it should be discussed whether a theoretically sound flow-based design of gamification can effectively promote flow at work, or if other mechanisms may explain possible effects, for example, on performance indicators. In the context of modern manufacturing work, a field in which flow-based gamification approaches are emerging, the benefits of these approaches should be critically reviewed (Korn et al., 2017). Study II of the present thesis found that the effect of gamification on flow was only evident at the beginning of the work process. This suggests that gamification may facilitate learning processes, which in turn can have characteristics that may promote flow. Earlier research has already observed the effect of gamification on learning new procedures in manufacturing (Ulmer et al., 2022).

When developing gamification strategies for future applications based on findings about gamification at work, it is also crucial to consider which types of gamification elements are suitable for promoting flow in specific contexts (Groening & Binnewies, 2021). A recent study emphasizes the importance of carefully selecting appropriate gamification elements and highlights the effect that narrative gamification strategies can have on promoting flow, rather than conventional gamification elements (Capponi et al., 2025). With this in mind, the methodology of Study II may need to be revisited, with a future iteration incorporating current knowledge about gamification and modifying some of its elements. Future studies and practical applications may integrate insights from storytelling and narrative strategies into their gamification framework. Thereby, it can be assumed that the effects of different gamification strategies depend on the application context (Hamari et al., 2014; Koivisto & Hamari, 2019;

Seaborn & Fels, 2015). Additionally, individual preferences should be considered, as gamification elements may affect individuals differently (Klock et al., 2020; Oliveira, Hamari, Shi, et al., 2023; Tondello et al., 2016).

However, independent of the design of the gamification strategy, Study II also demonstrates that flow can emerge in non-gamified manufacturing work when comparing both user interfaces—with and without gamification elements—of the manual workstation. These results suggest that, in addition to gamification as a work design strategy, an interplay of different parameters contributes to flow in this setting. Which factors actively promoted flow in the non-gamified manufacturing setting is unclear and could not be captured in the study design.

One possible explanation for the emergence of flow in the non-gamified manufacturing condition in Study II may be playful work design. Although the name of the construct might suggest otherwise, it is not an externally applied change at the task level. Instead, it can be understood as an individual strategy for reinterpreting given work contexts (Bakker et al., 2020; Scharp et al., 2019). Playful work design reinterprets existing work settings as opportunities for play, distinguishing between two facets: designing fun and designing competition (Scharp et al., 2023). Due to its inherent task characteristics, manufacturing may offer opportunities to apply playful work design tendencies that are already present at the individual level. Thus, playful employees may create opportunities for themselves to engage in play-like situations and achieve flow. Previous research on playful work design has already demonstrated that it can promote flow at work in general (Liu et al., 2022) and that playful design approaches during studying can promote flow experiences during university students' learning processes (Liu et al., 2025). Thus, playful work design may explain the high flow values observed in the non-gamified assembly process and provide implications for designing future assembly workplaces.

In contrast to the intrinsically induced playful work design, in Study III, LEGO® was used as a work design element directly incorporated into the task. Integrating LEGO® into workshop concepts is already an established practice, referred to as LEGO® Serious Play® (LSP). LSP is an interactive method in which workshop participants are instructed to build models with LEGO® to solve problems playfully. It enables teams to visualize ideas and develop creative solutions together (Bab & Boniwell, 2016; Kristiansen & Rasmussen, 2014). It has already been shown that LSP can promote the experience of flow in workshop settings. A positive relationship resulted between applying a LSP warm-up task before an actual task and flow and team flow measured afterwards (Primus & Sonnenburg, 2018). Also, regarding the team level, Zenk et al. (2021) argue that using LSP in creative task settings that require a combination of solitary creation and interdependent cooperation can facilitate team flow. These findings, along with initial insights into team dynamics in virtual settings (Bonneau & Bourdeau, 2019), were

considered in Study III. Although exploratory analyses revealed no difference in experienced team flow when comparing the two tasks examined, it was evident throughout the course of the workshop that, on average, participants showed significantly higher team flow levels during the LEGO® tasks (Appendix C). Overall, integrating LEGO® as a means of designing work in specific contexts may be beneficial to promote flow and team flow, particularly for creating task variety and stimulation.

6.2.3. Integrating culture into work design

As Study III demonstrated using the example of cooperation in German-Polish teams, workplaces are becoming increasingly globalized and intercultural. When it comes to work design and drawing up practical recommendations for flow and team flow to emerge, culture should be considered an overarching influencing factor, alongside the unique contextual factors of different workplaces (Peifer et al., 2022). Therefore, culture has been integrated into the adapted work design model as a social-level input factor. In the context of global virtual teams, cross-cultural collaboration is becoming increasingly common and can involve dynamics that present new challenges for team members (Kozlowski & Bell, 2003; M. R. Lee, 2014; Zakaria et al., 2004). In this sense, culture can be understood as the collective assumptions that distinguish one group from another, for example, relating to religious beliefs, ethnicity, worldviews, values, norms, and communication patterns (Hofstede, 1980; M. R. Lee, 2014).

Bringing together people from different cultural backgrounds for teamwork can lead to challenges, including difficulty in forming a sense of group identity, misunderstandings, and mistrust (Au & Marks, 2012; Zakaria et al., 2004). In Study III, participants from Germany and Poland collaborated in teams: Cultures that share some similarities, but also crucial differences that may arise depending on the context (Bouncken et al., 2009). These factors may have potentially influenced how the team communicated. For example, participants in Poland demonstrated longer average total speaking durations in the Mascot task (Appendix C). This difference may be attributed to general cultural variations in communication. Nevertheless, the sample of this study revealed no differences in the experience of team flow during the examined tasks.

Regarding the derivation of work design recommendations, research indicates that differences in cultural contexts can significantly influence the effects of work design (Cagliano et al., 2011; K. M. Carter et al., 2024). Work design approaches are perceived differently in different cultural contexts. For example, autonomy-oriented work design can have a more positive impact on the perception of work in individualistic cultural contexts than in collectivist ones. This is just

one example of the many ways in which work design can have culture-dependent effects (K. M. Carter et al., 2024). Also, the propensity to experience flow and its components in different activities appears to vary across cultures (Mesurado et al., 2016; Montijo & Mouton, 2016), a factor that should be considered when designing flow promoting work. At the same time, work designs for intercultural team constellations may be able to provide the infrastructure for a shared meaning system to develop by actively focusing on shared values and norms (Erez, 2010).

On the one hand, creating intercultural understanding should be the basis of work design that promotes flow, and especially team flow, in intercultural contexts. On the other hand, work design could be tailored to the individual needs and circumstances of employees from different cultures, enabling the best possible work experience in a way that is considerate of cultural differences.

6.2.4. Risks and possible misuse of flow and team flow promoting work designs

In light of the technology-driven changes in many workplaces, some researchers are warning about potential side effects, such as the over-exploitation of workers (Cetrulo & Nuvolari, 2019). In this context, it is important to review how flow and team flow may potentially be used to manipulate and exploit people and to discuss the potential ethical ambivalence and risks associated with flow-promoting work design. Although this was not explicitly mentioned in the three studies in the thesis, it should always be considered when presenting adaptable models for research and practice or deriving implications, especially in work contexts with limited autonomy and strong dependencies—conditions that may prevail, for example, in manufacturing contexts, as presented in Study II.

In a highly challenging work context, reframing the negative aspects of work tasks by designing work in a certain way may be a critical issue for employers. For example, flow promoting strategies, such as gamification, could be used to make employees subjectively perceive stressful and exhausting work as positive and engaging without questioning the meaningfulness of their work tasks (Butler & Spoelstra, 2024). In doing so, employers may avoid substantially improving the working conditions themselves or providing adequate compensation for their employees' efforts. Rather, not all jobs may be transformed into positive, meaningful work through playful methods if the organizational structure and type of tasks do not permit it. Instead of treating flow as a commercial commodity to be induced and

utilized for selfish purposes, alternative approaches should be explored to redesign work and minimize stressors while providing appropriate compensation for unavoidable strains.

Similar points of criticism should be considered when developing practical implications for promoting flow and team flow at the individual level, despite their potential benefits to these states. In organizations, flow and team flow can be supported actively at the individual level, and employees do not need to be seen as just passive recipients of top-down induced intervention concepts (Bartholomeyczik et al., 2023), but they should not be held responsible for the overall work design. In manufacturing companies and those that organize their work virtually, for example, employers should take the initiative to take responsibility for creating a positive and sustainable work environment, rather than assuming that individual interventions are a sufficient solution. While being communicated transparently, approaches in the task-related and organizational spheres could instead contribute further to designing positive work environments.

6.2.5. Dynamics of flow and team flow

During flow, it can be assumed that the experience is not static, but rather an interplay of different degrees of experience that comprise flow as a whole. Consequently, flow is associated with nonlinear behavior and unstable dynamic patterns (Ceja & Navarro, 2011). In this dynamic process, moments of mastery and challenge constantly alternate. Challenges or opportunities for action must be recognized, and skills are used and practiced until mastery of the task is achieved. This is followed by excitement and the development of new skills to take on the next challenge (Csikszentmihalyi, 1990). Thus, the experience of flow involves periods that are more relaxing and periods that require more effort (Ceja & Navarro, 2012; Csikszentmihalyi, 1990). Therefore, it may be assumed that flow is perceived differently when measured by questionnaires that interrupt an activity or take a retrospective approach, depending on which facet of the dynamic process is dominant in the moment of assessment.

This is illustrated by studies examining the challenge-skill balance as a central component of flow, whose results are partly contradictory. On the one hand, it has been found that flow can emerge when skills are slightly below perceived challenges, that is, when there is slight overload, which may have a motivating effect (Larche & Dixon, 2020). On the other hand, other studies show that flow is particularly observed when the skills slightly exceed the perceived challenges (Engeser & Rheinberg, 2008; Wojtasiński et al., 2025). It may be assumed that the subjective perception of the level of challenge of a task fluctuates over time, so the experience of flow may also change in intensity.

Similarly, team flow is a dynamic state that changes over time and varies in its intensity (Peifer et al., 2021; Pels & Kleinert, 2022; van den Hout et al., 2024). It can be assumed that team flow never remains at a constant level, and team members continuously adapt to changing interaction situations. Thus, team flow is characterized by a dynamic equilibrium of regulatory processes (Pels & Kleinert, 2022). As teams collaborate dynamically, periods of team flow may alternate with periods without. For example, Snijdewint and Scheepers (2023) argue that a team may pass through different flow levels during a task: Initially, a team may not experience a strong flow because they first have to establish dynamics and align their expectations. Then, when the necessary conditions are met, a period of increased flow may occur. Later, the task may become so easily mastered by the team that it is no longer challenging enough to provoke a flow state (Snijdewint & Scheepers, 2023). Therefore, measuring a single team flow value over the course of a task or work situation may be insufficient. A qualitative analysis, similar to that used in Study I, may be applied here to gain retrospective insight into the dynamics. In the long term, interruption-free measures, as discussed in detail in Study III, may provide a solution and offer a differentiated picture. The methodological implications for measuring flow and team flow are elaborated on further in the following section.

6.2.6. Flow and team flow measurement

The present thesis employs various measurement approaches to capture flow and team flow, including qualitative interviews (Study I), different questionnaire scales (Study II), and communication analyses (Study III). While Study III specifically addresses the challenges of interruption-free team flow measures, this section provides a detailed discussion of the measurement approaches used and relates them to current methodological debates in flow research.

Measuring flow and team flow is a key challenge in research. Although questionnaires are a well-established method for assessing flow and team flow states (Rosas et al., 2023; Wonders et al., 2025), they have limitations that depend on the context of a study or application. Flow is a volatile state that occurs unconsciously and, by definition, completely immerses one's awareness (Csikszentmihalyi, 1975). The internal and transient nature of the state poses a challenge to its measurement (Wonders et al., 2025). By their very nature, questionnaires interrupt the activity or team dynamic and with it the actual state of flow or team flow. Therefore, they only allow a retrospective view (Bartholomeyczik, Knierim, Weinhardt, Oettingen, et al., 2024; Peifer et al., 2021).

Objective and interruption-free approaches to measure flow in real-time without retrospective biases are therefore a focus of present research (Irshad et al., 2023; Peifer et al., 2021; Peifer, Kluge, et al., 2020). These approaches could help to better understand, anticipate, and actively create flow and team flow situations in the future. Initial attempts to measure flow without interruption used algorithms based on a combination of behavioral and physiological data, for example, including data from electrocardiography (ECG) or electroencephalography (EEG) measures (Irshad et al., 2023; Knierim et al., 2021). They showed potential, but were mostly not yet specific enough for widespread application (Irshad et al., 2023). For example, the machine learning based approach presented by Irshad et al. (2023), which utilized physiological sensor data, achieved up to 75% accuracy in detecting individual flow. These results were generated in a highly standardized and controlled laboratory setting. It can be assumed that human behavior in real work settings and social interactions differs from this context, highlighting a key challenge in developing interruption-free measures. To develop and validate these measures using questionnaire data, studies must be conducted in a controlled laboratory setting, where participants are assigned specific tasks to stimulate flow. However, this does not correspond to the dynamics and sometimes flow-aversive conditions of real work contexts. Furthermore, given that in the laboratory physiological data can be measured using complex equipment such as EEG, the question arises as to how these approaches may contribute to measuring flow or team flow in practical fieldwork. Many sensor-based approaches may be limited in their applicability to real work settings because not all types of data can be measured using wearable devices that are easily handled by participants.

A different approach to interruption-free measurement could be based on observational measures that document and systematically classify behavior (Klonek et al., 2020; Lehmann-Willenbrock, 2024). In particular, team interactions offer an opportunity to identify dynamics related to team-level constructs (Klonek et al., 2016), as team flow experience. Study III of the present thesis aimed to derive team flow indicators for interruption-free measurement by observing and quantifying communication, as communication is fundamental to the emergence of team flow (van den Hout et al., 2019). The results suggest that communication parameters also appear to be context- and task-dependent. While the study provides a starting point for communication-based team flow measurement, including turn-taking, questions, interruptions, and laughter, it mainly highlights the importance of other parameters and content-related characteristics of communication for team flow detection. Future studies may explore reciprocal feedback exchange or informal communication to build trust during team conversations.

In addition, developing interruption-free measurement approaches also relies on questionnaires to validate the observation outcomes. This poses an additional challenge that should be discussed in the context of the present research. Many questionnaires used to

measure flow in research are not validated (Wonders et al., 2025). Furthermore, the different questionnaire tools are based on various theoretical models and definitions of flow characteristics (Abuhamdeh, 2020). For instance, this thesis employs a model with the three core components absorption, perceived challenge-skill balance, and enjoyment, following Peifer and Engeser (2021), as well as a questionnaire that is currently being validated on this basis (Bartzik & Peifer, in preparation). Structuring the flow characteristics differently and assessing them with different questionnaire scales may lead to different results (Bartholomeyczik, Knierim, Weinhardt, Oettingen, et al., 2024). Also, regarding team flow experience, it is necessary to determine which components should be included in the measurement approach (Pels et al., 2018). The team flow measurement in Study III was based on a self-developed item that combined flow measures (Peifer & Bartzik, in preparation) with team flow characteristics. However, the scale developed by van den Hout et al. (2019) to measure team flow assesses not only the characteristics of the state but also its prerequisites. Study III focused on the communication parameters that accompany team flow and argued that these parameters may serve as indicators of the experience itself. However, they can also be considered factors that promote team flow and may therefore be prerequisites for the state. A comprehensive measurement that distinguishes between the antecedents and components of team flow and translates them into interruption-free measurable parameters may provide more information about the experience of team flow in future applications.

In general, the use of single-item measures to assess flow and team flow necessitates critical reflection (Allen et al., 2022). For reasons of efficiency in the study design, repeatedly asking about the experience with one individual item after explaining and defining the constructs throughout an experiment may be useful, as it avoids interrupting the realistic work process for longer than necessary. Thus, in Study II, long breaks between individual assembly runs were avoided, as they are also not expected in manufacturing practice. Also in Study III, participants were only briefly interrupted from the video call and completed a short questionnaire page after each task to minimize both the switching costs and the influence on the team's natural workflow. However, using a single item for measurement may likely result in a loss of information. Due to the possible lack of variance in the data, the results and their interpretability may be limited.

In this regard, Wonders et al. (2025) emphasize the importance of qualitative methods. These approaches enable study participants to better understand and contextualize the concepts of flow and team flow. In Study I of this thesis, for example, participants were asked at the beginning of the interview to describe their understanding of flow and team flow in their work. Then, the definition of the state was discussed, and participants were asked whether and how flow and team flow played a role in their work. This allowed for the retrospective exploration of

flow and team flow situations. Thus, qualitative approaches may help researchers gain deeper insights into actual flow and team flow situations.

However, another difficulty in measuring flow arises from the definition of flow. Csikszentmihalyi (1975) describes flow as a rare, exceptional state. If flow and team flow occur rarely in everyday life, then researchers face the challenge of being present at the precise moments to collect the relevant data (Abuhamdeh, 2020). This raises the question of whether real flow or team flow may be experienced in an experimental setting, or if only a state similar to this optimal experience may be present. In the context of this thesis, it may be discussed whether genuine flow occurred in the manufacturing task in Study II at all. The laboratory setting and unfamiliarity with the task may suggest that a state similar to flow was measured, but not complete immersion in the activity. Csikszentmihalyi (1990) also refers to micro flow in this context. Nevertheless, it could be assumed that similar positive experiences and consequences accompany this partial flow state.

6.2.7. Team flow scores at the team level

Besides the measurements, interpreting the measured values also poses challenges for researchers when looking at the group-level construct of team flow. Perceptions of the team may differ among team members. What one person perceives as optimal team dynamics and peak experience may not necessarily be the same for the other team members, as team flow is a subjective experience. Also, van den Hout et al. (2019) argue that, on a theoretical level, team flow is an inherently shared experience, rather than the sum of individual experiences. Yet, operationalizing the shared construct in empirical research remains an ongoing debate.

A variety of approaches have been established for measuring and comparing team-related constructs. Despite ongoing debates in the research field, to analyze some of its hypotheses, Study III of this thesis considered the team mean value as the key metric for evaluating a team's shared experience—a notion that requires further discussion. The team mean is a score that allows for comparability and aggregates all measured values at the team level (N. T. Carter et al., 2018). However, the frequently used mean value may not be the most suitable measure to represent a shared score corresponding to the definition of a construct (Woehr et al., 2015). Particularly in the case of shared experiences, it is not only individual perceptions in the team that play a role, but also their similarities or deviations from one another. The mean score may not be sufficient because two teams with extremely different variances may have the same aggregated mean value, which would be used in further analyses. Woehr et al. (2015) use the example of having one foot in the freezer and the other foot in the oven to illustrate this complication. Even if the average body temperature is in a moderate range, one can hardly

speak of well-being and functionality. What may sound trivial from a mathematical point of view reflects highly complex relations in a social context. Therefore, in team research, the mean as the only comparative value may not be sufficiently nuanced. It can be assumed that deviations between team members indicate that the team flow is lower than high-scoring team members individually perceive it to be, since it is defined as a shared perception. This problem is rarely considered in the practical application of questionnaire scores at the team level, but it may be taken into account to contribute to a more careful interpretation of team values.

An underlying question in this context is whether a questionnaire should be used to diagnose teams in development processes or to assess team flow as an outcome variable in research. While van den Hout et al. (2019) primarily use the *Team Flow Monitor* for team development, this and other questionnaire instruments are widely applied in research. To reflect the sharedness in team constructs when using team questionnaires in research studies, for example, Johnson et al. (2007) suggest compiling a score that includes not only the mean value, but also the standard deviation to represent how closely aligned team members are. This approach is not yet common in team flow research; however, it may be considered for future studies and the development of measurement approaches in general.

6.3. Strengths and limitations

The following section will elaborate on the theoretical and methodological strengths and limitations of this thesis, providing a critical evaluation of the results and interpretations.

6.3.1. Strengths

First, one strength of this dissertation is its variety of methods applied. The three studies employed different approaches: qualitative interviews, an experimental setting with manipulation of two groups, and an observational study with a realistic workshop setting. This variety of research methods enables a comprehensive understanding of flow and team flow in work contexts. The different study designs employed various measurement methods for flow and team flow, further developing them in Study III. Study I measured flow and team flow qualitatively using semi-structured interviews, which were evaluated with qualitative content analysis. Study II measured flow using questionnaire scales, and Study III explored new measurement methods for team flow based on communication parameters from a quantifying video analysis. Bringing these different perspectives together in the present thesis allows for a broader reflection on them.

In this context, the stepwise focus narrowing of the studies' perspectives should also be considered. Study I adopted a global perspective, discussing flow and team flow in general within the context of start-up work and its different tasks. Study II investigated a specific manufacturing scenario in a controlled manner to better understand the relationships of flow in this context. Study III examined team flow in two different tasks within a virtual teamwork setting, focusing on the experience of team flow itself, its promoting factors in team communication, and how different communication parameters may serve as indicators of it. Thus, opportunities were created to discuss flow and team flow at different levels of abstraction and to gain a deeper understanding of them. The integration of global and localized perspectives is critical because increased changes to work environments and fast-paced work dynamics require the development of robust models of flow and team flow.

Another strength of the present thesis and the empirical studies included is the practical relevance and contextual anchoring. The studies examined modern work contexts, highlighting developments that shape today's working world and exemplifying various trends in modern work design. Thus, the studies examined start-ups, characterized by flexibilization and a high degree of autonomy; manufacturing work, currently undergoing substantial changes due to digitization and automation; and teamwork, facing new challenges due to virtualization and internationalization. While these trends and contexts cannot be considered a complete representation of all major trends in today's working world (for an overview, see Schermuly et al., 2024; Tewes & Tewes, 2020), they are representative of ongoing changes that characterize present work environments, and the results may be transferred to new, similarly challenging contexts. The studies conducted thus provide an opportunity to reflect on flow and team flow in new contexts, expanding previous knowledge about the antecedents and conditions of these states. Thanks to their practical relevance and consideration of different work stressors, the results of this thesis provide not only initial recommendations and ideas for work design applications in various fields, but also allow for critical reflection on them within the scope of current challenges in flow and team flow theory and research.

6.3.2. Limitations

In addition to its strengths, this thesis has limitations that should be critically reflected upon. In the following, the aim is to go beyond the limitations mentioned in Studies I, II, and III, taking a broader perspective.

A critical theoretical assumption of this thesis is that the impact of work design approaches is deeply context-dependent (Parker, Van Den Broeck, et al., 2017). For this reason, the results of the three studies were discussed primarily within their contexts of application, and design

recommendations for promoting flow in the workplace were developed based on the contexts investigated—start-up work, manufacturing, and virtual teamwork. While this allows for precise implications, the findings remain to be empirically validated in contexts outside of the three assessed here, as work design approaches are context-dependent. Due to current transformations and technological developments, many other new and altered work contexts are emerging, characterized by unique conditions and challenges. Examples include the increasing integration of artificial intelligence into different work settings and collaboration with robots (Cramarenco et al., 2023; Kauffeld et al., 2022; Tausch & Kluge, 2023). These contexts, along with others, would also need to be examined more closely to draw general conclusions and derive implications for work design. Nevertheless, the broad fields assessed in this thesis can provide initial indications for a global perspective.

Although the research settings strive for objectivity, it is important to discuss the possibility of implicit assumptions about the constructs measured. It should be noted that the studies in this thesis treated flow and team flow as inherently positive states, arguing that both flow and team flow are beneficial and therefore worth promoting in the workplace. The research models underlying the studies are based on the positive characteristics of flow and team flow, as well as the premise that these states are associated with positive outcomes. Only Study I revealed a small number of negative consequences of flow and team flow in start-ups. These consequences included perfectionism and neglecting other tasks as a result of individual flow, as well as a tendency to become accustomed to high performance during team flow, which resulted in higher expectations and increased vulnerability in the event of setbacks. However, regarding the other studies and flow and team flow research in general, it should be noted that, depending on the context and characteristics, flow and team flow may not necessarily have to be positive. Although research indicates that flow and team flow are predominantly positive experiences characterized by feelings of reward, intrinsic motivation, and increased well-being (Engeser et al., 2021), it is also worth noting that there are downsides. For instance, central components of the flow experience, such as loss of self-reflection and narrow focus, are occasionally viewed negatively in research (Zimanyi & Schüler, 2021). They may be associated with neglecting long-term goals, excluding relevant information, and engaging in high-risk behavior (Zimanyi & Schüler, 2021). Csikszentmihalyi (1990) argues that flow is neither inherently positive nor negative, but rather depends on the activity in which it is experienced. Thus, people can also experience flow in situations that are considered morally negative (Csikszentmihalyi, 1990; Harari, 2008). Similar arguments may apply to team flow experiences and their possibly adverse effects (van den Hout & Davis, 2019).

Not only should the implicit assumptions about the different constructs be reflected upon, but also whether these were clearly distinguishable from each other by the participants.

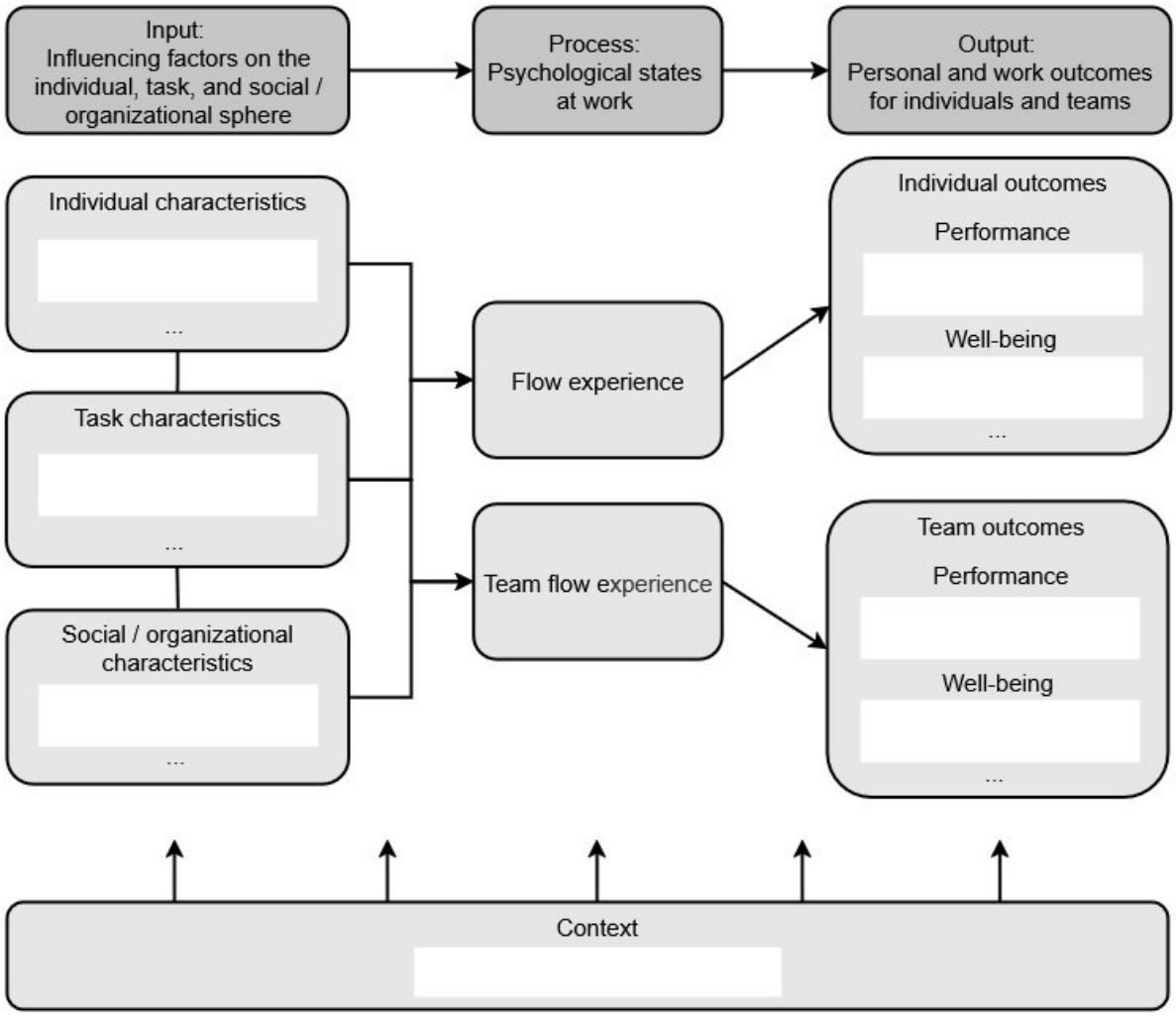
Participants may have found it difficult to distinguish between flow and team flow, or they may have interpreted team flow as the mere accumulation of their individual flow experiences due to ambiguous instructions or unclear operationalization. However, it can be assumed that team flow constitutes a higher-level construct with unique characteristics, meaning it is more than the sum of its parts (van den Hout et al., 2018). Similarly, it may be argued that, in general, individual experiences cannot be automatically extrapolated to a team level, and therefore relationships or effects at the team level cannot be assumed if they were measured at the individual level (Devine & Philips, 2001). In the context of this thesis, it is therefore necessary to discuss whether interpretation difficulties regarding flow and team flow may have occurred, particularly in Studies I and III, where both constructs were assessed consecutively, and whether results may have been affected by a misunderstanding of the measurements.

To conclude, some methodological limitations inherent to the studies, already discussed in detail in the corresponding chapters, are recalled here. For instance, Study II and Study III only presented relatively short tasks, even though they involved repetition and took place in a realistic environment, or were part of a longer workshop in a laboratory setting. Despite thorough design considerations, this may have limited the transferability to real-world work processes. In addition, the occupation of the participants of the studies may be relevant in this context. While in Study I the sample consisted of start-up founders, the samples in Studies II and III were dominated by students. The study samples may not have been representative. The method of convenience sampling was used to recruit participants, which may have limited the ability to select a truly random sample from the target population (Andrade, 2021). Furthermore, the analyses of the three studies did not include some control variables, such as the individual dispositional flow proneness or personality variables, which could explain or reveal further effects.

6.4. Implications for future research

The work design model for flow and team flow, developed in Section 6.2.1, contributes to the classification of the results of this thesis and can be seen as a framework for future research. Figure 6.2 illustrates how research questions from future studies can be incorporated into the model.

Figure 6.2: Adaptable work design model for future research on flow and team flow with placeholders for future applications



Future research should identify additional factors to obtain a more comprehensive understanding of flow and team flow as central processes among individuals and teams at work. Studies with different degrees of abstraction and focus are required. This means that future studies will not exclusively require an examination of the entire work situation to identify inputs and outputs. Similar to this thesis, future studies should also take different perspectives, ranging from a global view of a specific context down to controlled questions within a context or detailed considerations of the processes of flow and team flow themselves. This means, future research demands a broad approach, embedding the research questions in specific contexts.

A long-term goal may be to develop a holistic model that enables the derivation of contextually adaptable guidelines for work designs conducive to both individual and team flow. In addition to the moderating role of unique contextual factors, the inherently individual and subjective

nature of flow and team flow experiences should also be considered. Therefore, each model is never conclusive, but rather an approximation and a possible way to systematize flow and team flow at work.

An exemplary question that future research may address is how cultural differences in the perception of flow and team flow also play a role. Given the increasing globalization and popularity of remote work, future research should further explore the cultural dimensions of flow and team flow. It is possible that the factors that promote flow and team flow differ depending on the cultural context and may therefore only be suitable for work design approaches to a limited extent and may not be generalizable. Future research may explore this topic to derive implications, particularly for culturally diverse teams, and adapt work design strategies to meet the needs of the various team members.

In general, future research should examine the empirically measurable effects of the practical implications for flow and team flow-promoting work designs proposed in the present thesis in different contexts. The thesis derived concrete design recommendations for start-ups, manufacturing, and virtual team contexts. However, it remains to be tested whether these translate into measurable, long-term effects. Therefore, systematic intervention studies on flow and team flow interventions should be planned, for example, following the recommendations for flow intervention studies formulated by Bartholomeyczik et al. (2023).

Intervention studies and other approaches to research should always be considered in the context of their practical application. While some existing literature may take a generalized, context-free approach, this dissertation emphasizes that flow and team flow may be shaped or limited by the organizational and situational context. Researchers need to recognize that some contexts pose more challenges to flow or team flow than others due to the presence of different hindering factors. Thus, adopting a holistic and reflective approach may be essential. Previous research using experience sampling approaches has shown that, depending on the context, the expected frequencies of flow experiences may differ considerably (Ilies et al., 2017). By discussing challenging and dynamic work contexts, this thesis emphasizes the importance of flow and team flow even in aversive conditions, which should be a central focus of future research. Rather than looking for contexts in which flow is easily achieved and therefore more accessible to measurement, future studies should specifically examine challenging work contexts and explore how to achieve flow and team flow despite the unfavorable conditions.

Also at the methodological level, the thesis posed questions that warrant further investigation. This thesis employed various methods to capture individual and team flow experiences, such as qualitative interviews, standardized questionnaires, and communication analysis. While each method offered context-specific advantages, it also revealed methodological limitations in its ability to reliably capture the volatile states of flow and team flow, as well as its

susceptibility to retrospective bias. A limited number of measurement points were chosen in favor of economic study designs: one retrospective measurement in the start-up context (Study I), a short measurement after each assembly run in the manufacturing task (Study II), and one short measurement after each task in the virtual team workshop (Study III). Future studies may benefit from longitudinal designs with multiple measurement points across task or project phases. These designs may have the potential to more accurately identify the antecedents and consequences of flow and team flow.

In this line, the dynamics of flow and team flow should be further addressed. A single measurement does not provide a comprehensive picture of the actual state experienced because it may fluctuate in intensity. Flow is characterized by the presence of nonlinear processes and dynamic patterns (Ceja & Navarro, 2011); a similar dynamic, rather than a constant state, can be assumed for team flow (Pels & Kleinert, 2022; Snijdewint & Scheepers, 2023). Future research employing interruption-free, synchronous measurement approaches could address this issue. The methods used in Studies I and II of the present thesis—qualitative interviews and questionnaire scales—could only capture dynamics retrospectively and potentially in a biased way.

Regarding the understanding of team flow, a more nuanced communication analysis may provide more insight in future studies. For instance, breaking down a work situation into brief, comparable time periods could enable a more precise observation of team flow dynamics. First, indicators should be defined precisely. This would require an initial investigation in which teams would have to be repeatedly interrupted to examine the validity of the indicators during short periods of interaction with the help of established questionnaires. Thus, this process may pose new challenges and, in turn, interrupt and influence the team flow to such an extent that no natural collaboration situation can emerge. To better understand the dynamics without interruption and prevent the potentially biased measurement of a questionnaire at a single point in time, qualitative measures may also be considered. In a detailed interview about a recently completed task, participants might be given the opportunity to discuss the progression of the task in relation to different states of experience.

In this context, new interruption-free measurement approaches may be developed in future studies. In addition to approaches involving communication parameters, which are evaluated using interaction analyses, there may be more feasible approaches. In fact, there are initial efforts to identify individual flow through physiological patterns (Irshad et al., 2023; Knierim et al., 2021; Tian et al., 2017). Knowledge of the physiological correlates of flow—for example, regarding cardiovascular measures (de Manzano et al., 2010), or neurophysiological patterns (Lu et al., 2024)—may be incorporated into future studies on the development of flow and team

flow measures. Machine learning approaches could help systematize interactions between different data sources and identify related patterns (Peifer et al., 2021).

Furthermore, the empirical differentiation between flow and team flow experiences remains underdeveloped in some areas. Although the results of this thesis indicate that they may sometimes be described as nearly interchangeable, especially in collaborative environments, such as start-up teams, the two states differ in their core characteristics (Pels et al., 2018). Future research should explore whether individual and team flow are genuinely distinct phenomena or if they are overlapping perceptions at different levels of analysis. Multimethod designs and multilevel statistical models in future research may help to distinguish between individual and team flow and evaluate what makes team flow more than the mere sum of individual flow experiences.

6.5. Implications for practice: Design recommendations for workplaces to promote flow and team flow

The overall aim of this thesis was to derive design recommendations from the three studies for promoting flow and team flow in practical applications in different contexts. As discussed previously, work design should always be context-sensitive (Parker et al., 2001). Therefore, this section presents practical applications and intervention scenarios derived separately within the three examined contexts, followed by a holistic discussion.

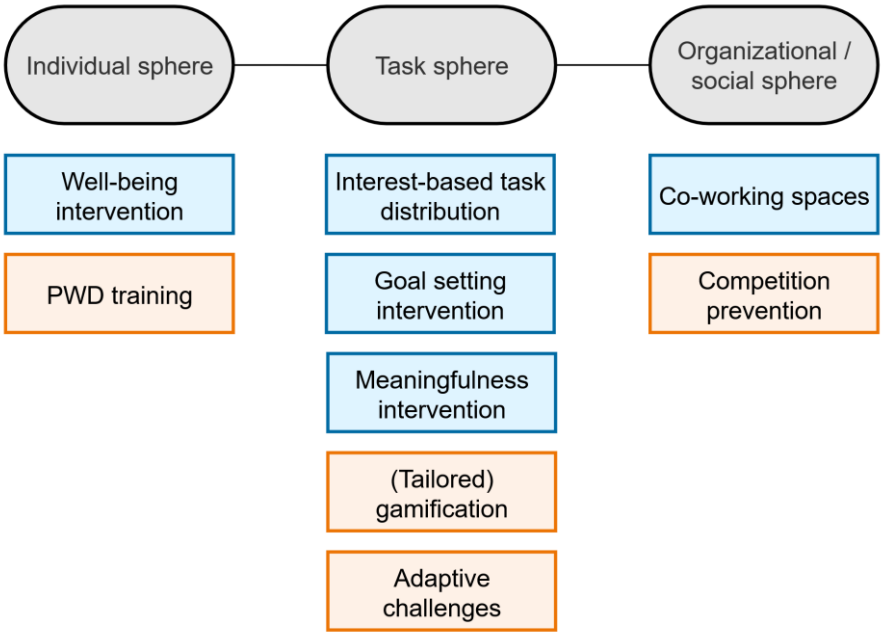
When designing practical applications in the form of flow interventions, it is also necessary to specify the goal of an intervention. Bartholomeyczik et al. (2023) suggest distinguishing between flow-entering, flow-boosting, and flow-maintaining interventions: approaches that create flow, strengthen existing flow, or prolong it. The present thesis considers work contexts that are assumed to pose particular challenges to flow due to their current trends and complexity. Thus, a crucial first step is helping individuals in these work contexts to establish flow by focusing on flow-entering interventions. However, some of the approaches discussed below also help individuals utilize existing flow and team flow moments in the most suitable way.

6.5.1. Designing flow at work

When considering flow at work, it is possible to distinguish between influencing factors in the individual, task-related, and organizational/social spheres. Following the distinction proposed by Peifer and Wolters (2021), the implications will be classified. Figure 6.3 provides an

overview of the derived work design recommendations for the contexts of start-up work and manufacturing, which are next explained step by step.

Figure 6.3: Design recommendations for flow promoting work



Note: Blue work design recommendations are derived from Study I, orange work design recommendations are derived from Study II.

Well-being intervention: On an individual level, start-up founders reported in Study I that well-being may not only be a consequence of flow, but also an antecedent. To experience flow, an individual must first adopt a positive mood. Promoting flow as a consequence could be approached through interventions for well-being at work and healthy practices in the daily work routine of a dynamic and demanding start-up environment. Research on an intervention designed to train the experience of flow among students showed connections between flow and well-being, both of which increased through the intervention. The direction of the relationship between well-being and flow remained unclear (Norsworthy et al., 2023). However, it can be concluded that both constructs should be considered together when designing workplace interventions.

Playful work design training: Study II assumed that playful work design approaches could enable individuals to experience flow, even in monotonous and less challenging work. Through an individual-level intervention, employees could learn about the concept of playful work design and strategies for recognizing playful opportunities in their daily work lives. Current

research on playful work design already makes similar suggestions and draws parallels with the experience of flow (Bakker et al., 2020, 2023). Playful work design training could be an approach to creating a more positive work environment, especially in cases of workplace boredom (Dishon-Berkovits et al., 2024), which can play a central role in manufacturing (Harju et al., 2014; Loukidou et al., 2009).

Interest-based task distribution: At the task-related level, the studies in this thesis revealed different approaches to deriving design recommendations that promote flow in start-up and manufacturing work contexts. For instance, in Study I, start-up founders explicitly mentioned interest and the presence of the challenge-skill balance as factors that promote flow, which aligns with previous research (Bricteux et al., 2017; Engeser & Rheinberg, 2008). This can be applied in practice by distributing tasks in a way that corresponds to the interests and skill levels of team members, if possible. However, it is worth noting that these can change and evolve over time, indicating that task distribution is a continuous and dynamic process (Mathieu et al., 2008).

Goal setting intervention: Another aspect mentioned in Study I is the importance of setting clear goals, from which work design recommendations can be derived. Weintraub et al. (2021) demonstrated the effectiveness of a goal-setting intervention for enhancing work-related flow. A similar approach may be applied to start-up work, where difficulties with goal setting play a role alongside other challenges. Previous research has shown that start-up founders often set unattainable goals that they are unable to achieve (Baron et al., 2016). Through training on SMART goals (Rubin, 2002), for example, founders may learn to structure achievable goals and design tasks accordingly, which could promote their flow in the long term (Weintraub et al., 2021). Another example of a goal-setting technique that may provide a theoretical basis for a goal-setting intervention is mental contrasting (Oettingen et al., 2010). In mental contrasting, a goal is imagined, and the best possible outcome is envisioned and contrasted with the greatest obstacle to achieving it (Oettingen et al., 2010). Earlier research has shown that mental contrasting interventions can have a positive effect on flow (Bartholomeyczik, Knierim, Weinhardt, & Oettingen, 2024).

Meaningfulness intervention: Meaningfulness is also described as a central flow promoting factor in start-ups in Study I and is known to influence job satisfaction in start-ups (Kruse et al., 2023). Additionally, the perceived meaningfulness of a task may positively influence the experience of flow (Maeran & Cangiano, 2013). Dirik and Özdoğan (2024) propose a tripartite model of entrepreneurial meaningfulness in the context of start-up work. The model distinguishes between professional meaningfulness, which affects task significance and autonomy; psychological meaningfulness, which affects identity, resilience, and work-life balance; and social meaningfulness, which affects recognition and support. This model could

serve as the basis for developing a workshop for early-stage start-up founders and co-founders to strengthen meaningfulness as a resource and, consequently, promote flow. However, such a workshop should also include critical reflection on one's perception of meaningfulness within the start-up (Williamson et al., 2021). Research suggests that the positive effect of meaningfulness on well-being may take the form of a reverse u-shaped curve, indicating that excessive meaningfulness could increase the risk of overtime work and, consequently, burnout (Stephan, 2018). Nevertheless, creating flow-promoting tasks and contexts may buffer this effect, allowing flow at work to be interpreted as a resource that reduces the risk of burnout symptoms (Aust et al., 2022). Considering these mechanisms, designing meaningful work could be an effective tool for increasing flow in start-up work.

(Tailored) gamification: Study II focused on gamification as a central approach to work design. Gamification provides numerous opportunities to make work more positive and engaging. The results of Study II and earlier research suggest that manufacturing work may benefit from gamification, especially in learning processes (Ulmer et al., 2022). At the beginning of a task or when training new production routines, incorporating gamification elements may facilitate flow and positive experiences in the new task. However, gamification should be used carefully and in moderation. Transparency in its implementation and personalizable options, if possible, may be decisive factors in order to avoid manipulation and increase acceptance, as discussed in Section 6.2.4. Tailored gamification approaches (Cónego et al., 2024; Klock et al., 2020) in the design and selection of gamification elements may address employees' individual interests and preferences, creating suitable opportunities for flow.

Adaptive challenges: Similarly, adaptive work design approaches could be used in the future to prevent boredom. As argued in Study II, boredom can be prevalent in manufacturing (Harju et al., 2014) and, following flow theory, inhibit flow experiences (Csikszentmihalyi, 1975). A task structure with learning opportunities and successively increasing demands can help maintain the balance between challenge and skill level, thereby avoiding boredom. Future machine learning approaches could develop systems that identify each individual’s optimal level of difficulty for achieving flow and adapt continuously as their skills increase over time. In the field of gamification research, approaches to designing adaptive challenges have already been employed, for example, in educational contexts (Klock et al., 2020; Oliveira, Hamari, Shi, et al., 2023). Systems that adapt challenges to the individual users’ skills may be particularly beneficial during learning phases.

Co-working spaces: Furthermore, this thesis also revealed approaches to designing organizational and social framework conditions, from which concrete design recommendations can be derived. For instance, in Study I, start-up founders explicitly emphasized the importance of environments that promote flow. It can be concluded that it is not only important

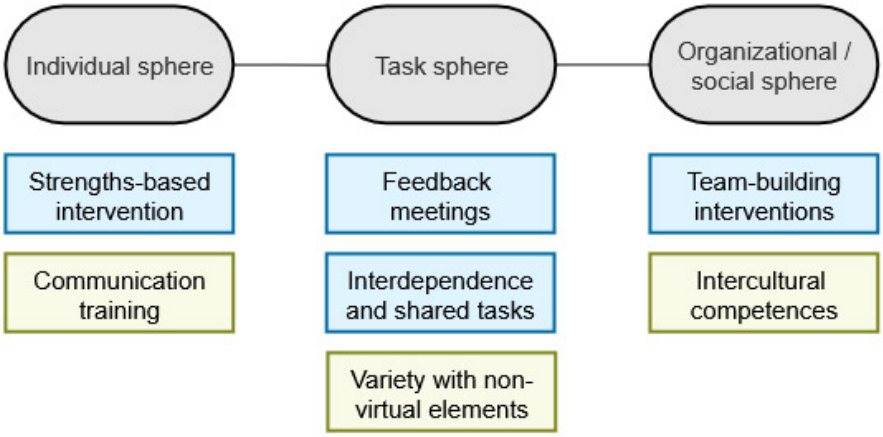
to design the tasks themselves, but also to create a space that facilitates positive working conditions. Even in the early stages of a start-up, when many start-up-related activities occur alongside the primary job, founders should find an opportunity for themselves and their team to work in a neutral place equipped with the necessary resources, such as appropriate hardware and software, to enable a comfortable work process. Start-up accelerator programs that support start-ups in the early stages may also take the initiative to offer co-working spaces specifically designed for these ventures. Start-up members generally perceive co-working spaces as having a positive influence on their personal and private lives (Banka et al., 2023). Using specific spaces for start-up work could prevent disruptions and multitasking tendencies, providing an environment conducive to concentration and flow.

Competition prevention: In the context of manufacturing, another factor that should be discussed in the social and organizational sphere is social comparison. In Study II, a controlled simulated setting of manufacturing work was presented to individuals; however, it may be assumed that in a workplace shared with other manufacturing workers, social comparisons would likely be present. When designing manufacturing work, elements of competition, such as those often found in gamification approaches through badges and leaderboards (Oliveira et al., 2021), may need to be used with caution or avoided completely. Flow occurs when an individual can focus entirely on the task at hand, provided that the task has an autotelic nature. This means the task is intrinsically motivating, not defined by external incentives (Csikszentmihalyi, 1975). Adding extrinsically motivating competition could draw attention away from the task itself, reducing the likelihood of flow unless it aligns with an employee's own innate competitive motivation (Peifer & Wolters, 2021; Schiepe-Tiska & Engeser, 2021). Additionally, social comparison can lead to negative consequences, especially at the emotional level (Greenberg et al., 2007).

6.5.2. Designing team flow at work

The studies in the present thesis, particularly Study I and Study III, which assessed team flow, provide implications and practical recommendations for promoting team flow in the workplace in the context of start-up work and virtual teamwork. Again, the work design recommendations are assigned to the three spheres—individual, task, and organizational/social—and are related to specific contexts. An overview can be found in Figure 6.4 and each one is explained next in detail.

Figure 6.4: Design recommendations for team flow promoting work



Note: Blue work design recommendations are derived from Study I, green work design recommendations are derived from Study III.

Strengths-based intervention: Start-up founders in Study I described interest in an activity as a factor conducive to team flow. To identify personal interests, it may be helpful first to develop an understanding of one's own strengths. The concept of character strengths, as studied in positive psychology research, provides a structured classification of strengths assumed to be present in every person, although they manifest to varying extents (Peterson & Seligman, 2004). Specifically, knowing one's signature strengths, which are defined as the strengths that are most pronounced for an individual, can be a starting point for positive work organization at the individual level. In turn, this may help experience team flow. For instance, the application of signature character strengths has been linked to increased positive experiences at work (Harzer & Ruch, 2013). These findings may guide the development of interventions and may also extend to the team. For example, a team intervention in the form of a board game that aimed to familiarize employees with their own strengths and those of their team colleagues was shown to be able to lead to an increase in team flow experience post-intervention compared to before (Kloep, Helten, et al., 2023). This aligns with the assumption that knowing each other's strengths and interests contributes to a high level of skill integration, which is described as a prerequisite for team flow experiences (van den Hout et al., 2018). Therefore, strengths-based interventions that initially focus on individual strengths and, in a next step, on team strengths may be recommended to create suitable conditions for team flow to emerge.

Communication training: A central assumption when discussing Study III was that communication in virtual teams differs from face-to-face interactions in several ways, one of which is the overall decrease in communication (Purvanova, 2014). Moreover, communication

is understood as a central factor in the emergence of team flow (van den Hout et al., 2018). To encourage more natural communication and reduce barriers in virtual teams, providing communication training to virtual team members may be helpful. This training may involve developing general communication skills and practicing specific techniques, such as formulating open questions during team discussions. Following the recommendations on team flow-promoting work design from earlier research (Coss et al., 2025), and assuming that improved communication could facilitate team flow, this approach may be a viable option for designing team flow-promoting work.

Feedback meetings: Also at the task-related level, approaches to promote team flow were identified. In Study I, start-up founders emphasized the importance of feedback. According to flow theory (Csikszentmihalyi, 1975), feedback that promotes individual flow primarily resides in the task itself. For instance, this occurs when one's performance and progress in an activity are immediately visible. Although not all start-up tasks fulfill this criterion, feedback from external sources may also promote individual flow, mediated by specific self-efficacy (Peifer, Schönfeld, et al., 2020). One way to elevate this factor to the team level and use it to promote team flow may be to plan joint feedback meetings, where team members can reflect together on their performance in a trusting atmosphere. Scheduling feedback meetings may create a climate of shared learning and collective efficacy. Similar to self-efficacy on the individual level, collective efficacy can predict shared flow experiences over time (Salanova et al., 2014). Therefore, establishing a feedback culture within the team may positively influence team flow.

Interdependence and shared tasks: According to the analysis of the start-up founders' statements in Study I, another aspect that might be particularly beneficial in the task-related sphere is interdependence when working on tasks. Team flow theory also emphasizes this as a central component of the experience (van den Hout et al., 2018). However, it could possibly be applied even more in the start-up environment. Rather than dividing tasks as efficiently as possible among team members, it may also be beneficial to complete smaller tasks in pairs or small groups. This may foster interdependence, which is known to function as a moderator in the relationship between collective efficacy and team performance (Gully et al., 2002). Interdependent work may provide a sense of safety and establish opportunities for feedback among team members. Although this type of work organization may require more organizational effort, it could offer beneficial factors that promote team flow and help achieve positive results. Therefore, distributing tasks to small groups, thereby reducing individual responsibility, could foster team flow in a start-up.

Variety with non-virtual elements: For virtual teams, it could be assumed that creating a variety of tasks and varying the skills to solve them is often overlooked, as many tasks take place in a virtual space and are characterized by the same framework conditions, even if they have

different content. To increase variety—a work design component of the job characteristics model (Hackman et al., 1975) that has been associated with individual flow in earlier research (Fullagar & Kelloway, 2009)—physical elements could be incorporated into the largely virtual workday. For instance, Study III incorporated LEGO® tasks based on the concept of LSP to provide engaging stimuli and integrate haptic skills alongside on-screen activities. The goal was to develop a diverse task portfolio and enhance co-creative performance. LSP may be used to visualize ideas (Kristiansen & Rasmussen, 2014) and has already been associated with team flow (Zenk et al., 2021). Integrating diverse materials into virtual teams could thus promote task variety and facilitate team flow. In addition to the LEGO® approach, other methods or materials that operate outside the virtual sphere, such as arts-based approaches for virtual teams (An et al., 2022), may also be employed to create engaging and diverse task formats to foster team flow in virtual collaboration.

Team-building interventions: At the team level, start-up teams may organize their work in a way that enhances team spirit, which was identified as a central factor that promotes team flow in Study I. For instance, shared rituals may foster identification with one's team and strengthen relationships (Ozenc & Hagan, 2018). Additionally, joint reflections and discussions may increase social cohesion, and research has demonstrated that team reflexivity may contribute to improved team performance (Leblanc et al., 2024). Overall, team-building activities and team training may provide opportunities for team members to get to know each other better and build a sense of unity and commitment to the start-up. This may help establish a collective ambition and mutual commitment, which are two central prerequisites for team flow, enabling team members to find meaning in their work and strengthen their motivation (van den Hout & Davis, 2022). Also, sharing concrete knowledge about team flow and its potential benefits may help teams recognize this state more easily and identify factors that contribute to it. In this context, van den Hout et al. (2024) suggest organizing so-called team flow inspiration sessions.

Intercultural competences: Virtual teams may face the additional challenge of team members potentially originating from different countries or cultures (Kozlowski & Bell, 2003), as was the case in Study III with participants from Poland and Germany. This may affect the team members' perception of team identification (Au & Marks, 2012). Furthermore, team communication may be impacted by diversity and the interaction of different cultures (Varhelahti & Turnquist, 2021). To improve mutual understanding, workshops and education on intercultural understanding and communication could be beneficial for teams, as cross-cultural competences are assumed to be a cornerstone of positive cooperation (Yousef, 2024). Raising awareness of cultural differences may help virtual team members understand each other better and develop a shared identity. Team leaders in particular play a key role here, as

they need to develop a culturally sensitive leadership style (Do, 2025). In conclusion, it can be assumed that cultural competence training may constitute a key tool for designing work in virtual, globalized teams, as it may foster the creation of conditions allowing for the emergence of team flow.

6.5.3. General integration and transferability of implications

As work design is recommended to be context-specific (Parker, Van Den Broeck, et al., 2017), the practical implications and work design recommendations described primarily apply to the contexts from which they were derived. Nevertheless, they could be understood as guidelines and examples that reflect general psychological principles and that could work similarly in other contexts if adapted carefully to fit the structural, social, and cultural features of the new conditions. In addition to the general context, it may also be necessary to consider individual, task-related, and organizational circumstances. Thus, the potential implementation of flow and team flow promoting work design approaches may be influenced by the degree of familiarity and openness to these concepts within the organizational culture. Furthermore, some individuals may be more receptive to flow and team flow interventions than others because they are more likely to perceive opportunities to experience flow; thus, they exhibit aspects of what Csikszentmihalyi (1990) describes as an autotelic personality (Baumann, 2021). Rather than applying standardized solutions, a participatory approach involving interested individuals or teams may lead to better acceptance and a better fit.

Targeted work design strategies that promote flow and team flow may be effective, but without broader societal awareness valuing such experiential states, these efforts may remain isolated and insufficient. Flow and team flow are not just individual experiences that need to be optimized locally. Rather, they raise fundamental questions about the quality and meaningfulness of work in modern workplaces, which are constantly changing due to contextual factors and novel challenges. Broader public and institutional discourse about positive psychological states and the future of work is needed to realize this potential. Therefore, recognizing flow and team flow as phenomena with societal relevance could increase their practical value beyond isolated interventions. However, this does not mean idealizing these states or ignoring critical perspectives on their implication, but rather incorporating flow-informed thinking into the design of work across organizations.

7. Conclusions

Current developments in the working world may compromise job satisfaction and well-being. Understanding how work can be shaped in a positive way to promote positive experiences despite new challenges is a key research question. This thesis contributes to understanding how flow and team flow function as positive states at work, even in challenging and dynamic work contexts, by employing a work design perspective and deriving specific design recommendations for work settings.

It has been demonstrated that flow and team flow, when specifically promoted, may also be beneficial in dynamic and challenging work settings. A comprehensive view of the work situation plays a crucial role here. Context influences how the fragile states of flow and team flow manifest, how they are promoted by different factors, and the effects they entail. In this case, context is not just a static backdrop, but a fundamental condition for flow and team flow promoting factors to take effect. Examining three different work contexts—start-ups, manufacturing, and virtual teams—provides a basis for further systematic research and reveals initial theoretical and practical implications. Thereby, the thesis broadens the scope of models that conceptualize flow as a mostly intrinsic phenomenon to include a context-dependent perspective that considers external influences, such as work design approaches, that can impact flow and team flow.

Overall, it becomes clear that, even 50 years after its first mention in the literature, the experience of flow remains relevant in the ever-evolving world of work and continues to be a focus of research. The concept of team flow is also becoming increasingly recognized, and its dynamics and effects should be examined in more detail in the future to better understand how teams can benefit from optimal cooperation. Flow and team flow-promoting work designs may help reframe certain types of work-related challenges as opportunities for positive experiences, potentially enabling a more positive view of the working world despite challenges and changes.

“Of all the virtues we can learn no trait is more useful, more essential for survival, and more likely to improve the quality of life than the ability to transform adversity into an enjoyable challenge.”

Mihaly Csikszentmihalyi

8. References

Abuhamdeh, S. (2020). Investigating the “flow” experience: Key conceptual and operational issues. *Frontiers in Psychology*, *11*, 1–13. https://doi.org/10.3389/fpsyg.2020.00158

Adams, S. L., & Anantatmula, V. (2010). Social and behavioral influences on team process. *Project Management Journal*, *41*(4), 89–98. https://doi.org/10.1002/pmj.20192

Allen, M. S., Iliescu, D., & Greiff, S. (2022). Single item measures in psychological science. *European Journal of Psychological Assessment*, *38*(1), 1–5. https://doi.org/10.1027/1015-5759/a000699

An, H., Sung, W., & Yoon, S. Y. (2022). Hands-on, minds-on, hearts-on, social-on: A collaborative maker project integrating arts in a synchronous online environment for teachers. *TechTrends*, *66*, 590–606. https://doi.org/10.1007/s11528-022-00740-x

Andrade, C. (2021). The inconvenient truth about convenience and purposive samples. *Indian Journal of Psychological Medicine*, *43*(1), 86–88. https://doi.org/10.1177/0253717620977000

Arntz, M., Gregory, T., & Zierahn, U. (2016). *The risk of automation for jobs in OECD countries: A comparative analysis* (OECD Social, Employment, and Migration Working Papers, Issue 189).

Au, Y., & Marks, A. (2012). “Virtual teams are literally and metaphorically invisible”: Forging identity in culturally diverse virtual teams. *Employee Relations*, *34*(3), 271–287. https://doi.org/10.1108/01425451211217707

Aubé, C., Brunelle, E., & Rousseau, V. (2014). Flow experience and team performance: The role of team goal commitment and information exchange. *Motivation and Emotion*, *38*(1), 120–130. https://doi.org/10.1007/s11031-013-9365-2

Aust, F., Beneke, T., Peifer, C., & Wekenborg, M. (2022). The relationship between flow experience and burnout symptoms: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(7). https://doi.org/10.3390/ijerph19073865

Aust, F., Heinemann, L., Holtz, M., Hagemann, V., & Peifer, C. (2023). Team flow among firefighters: Associations with collective orientation, teamwork-related stressors, and resources. *International Journal of Applied Positive Psychology*. https://doi.org/10.1007/s41042-023-00093-7

Autor, D. H. (2015). Why are there still so many jobs? The history and future of workplace

automation. *Journal of Economic Perspectives*, *29*(3), 3–30. https://doi.org/10.1257/jep.29.3.3

Ayçiçeği-Dinn, A., Şişman-Bal, S., & Caldwell-Harris, C. L. (2018). Are jokes funnier in one's native language? *HUMOR*, *31*(1), 5–37. https://doi.org/10.1515/humor-2017-0112

Bab, M., & Boniwell, I. (2016). *Exploring positive psychology with LEGO ® SERIOUS PLAY ®: A hands on thinking (TM) guide*. Gnist Aarhus ApS.

Bakdash, J. Z., & Marusich, L. R. (2017). Repeated measures correlation. *Frontiers in Psychology*, *8*, 1–13. https://doi.org/10.3389/fpsyg.2017.00456

Bakker, A. B. (2005). Flow among music teachers and their students: The crossover of peak experiences. *Journal of Vocational Behavior*, *66*(1), 26–44. https://doi.org/10.1016/j.jvb.2003.11.001

Bakker, A. B., Breevaart, K., Scharp, Y. S., & de Vries, J. D. (2023). Daily self-leadership and playful work design: Proactive approaches of work in times of crisis. *Journal of Applied Behavioral Science*. https://doi.org/10.1177/00218863211060453

Bakker, A. B., & Demerouti, E. (2007). The Job Demands-Resources model: State of the art. *Journal of Managerial Psychology*, *22*(3), 309–328. https://doi.org/10.1108/02683940710733115

Bakker, A. B., Oerlemans, W., Demerouti, E., Slot, B. B., & Ali, D. K. (2011). Flow and performance: A study among talented Dutch soccer players. *Psychology of Sport and Exercise*, *12*(4), 442–450. https://doi.org/10.1016/j.psychsport.2011.02.003

Bakker, A. B., Scharp, Y. S., Breevaart, K., & de Vries, J. D. (2020). Playful work design: Introduction of a new concept. *The Spanish Journal of Psychology*, *23*, e19. https://doi.org/10.1017/SJP.2020.20

Bakker, A. B., & van Woerkom, M. (2017). Flow at work: A self-determination perspective. *Occupational Health Science*, *1*(1–2), 47–65. https://doi.org/10.1007/s41542-017-0003-3

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1016/0146-6402(78)90002-4

Banka, M., Suplewska, I., Trzaskowska-Dmoch, A., & Boulange, P. (2023). Coworking space vs. support for start-ups under accelerator programmes. *Procedia Computer Science*, *225*, 3736–3744. https://doi.org/10.1016/j.procs.2023.10.369

Baron, R. A., Mueller, B. A., & Wolfe, M. T. (2016). Self-efficacy and entrepreneurs' adoption of unattainable goals: The restraining effects of self-control. *Journal of Business*

Venturing, *31*(1), 55–71. https://doi.org/10.1016/j.jbusvent.2015.08.002

Barrero, J. M., Bloom, N., & Davis, S. J. (2021). Why working from home will stick. In *NBER Working Paper Series* (No. 28731). https://doi.org/10.2139/ssrn.3741644

Barthelmäs, M., & Keller, J. (2021). Antecedents, boundary conditions and consequences of flow. In C. Peifer & S. Engeser (Eds.), *Advances in Flow Research* (pp. 71–107). Springer. https://doi.org/10.1007/978-3-030-53468-4_3

Bartholomeyczik, K., Knierim, M. T., & Weinhardt, C. (2023). Fostering flow experiences at work: A framework and research agenda for developing flow interventions. *Frontiers in Psychology*, *14*, 1–13. https://doi.org/10.3389/fpsyg.2023.1143654

Bartholomeyczik, K., Knierim, M. T., Weinhardt, C., & Oettingen, G. (2024). Using mental contrasting to promote flow experiences at work: A just-in-time adaptive intervention. *Computers in Human Behavior Reports*, *16*, 100488. https://doi.org/10.1016/j.chbr.2024.100488

Bartholomeyczik, K., Knierim, M. T., Weinhardt, C., Oettingen, G., & Ebner-Priemer, U. (2024). Capturing flow experiences in everyday life: A comparison of recall and momentary measurement. *Journal of Happiness Studies*, *25*(6), 1–26. https://doi.org/10.1007/s10902-024-00776-1

Bartzik, M., Aust, F., & Peifer, C. (2021). Negative effects of the COVID-19 pandemic on nurses can be buffered by a sense of humor and appreciation. *BMC Nursing*, *20*(1), 1–12. https://doi.org/10.1186/s12912-021-00770-5

Bartzik, M., Bentrup, A., Hill, S., Bley, M., von Hirschhausen, E., Krause, G., Ahaus, P., Dahl-Dichmann, A., & Peifer, C. (2021). Care for joy: Evaluation of a humor intervention and its effects on stress, flow experience, work enjoyment and meaningfulness of work. *Frontiers in Public Health*, *9*, 1–18. https://doi.org/10.3389/fpubh.2021.667821

Baumann, N. (2021). Autotelic personality. In C. Peifer & S. Engeser (Eds.), *Advances in Flow Research* (pp. 231–261). Springer International Publishing. https://doi.org/10.1007/978-3-030-53468-4_9

Bennani, S., Maalel, A., & Ben Ghezala, H. (2021). Adaptive gamification in e-learning: A literature review and future challenges. *Computer Applications in Engineering Education*, *30*(2), 628–642. https://doi.org/10.1002/cae.22477

Bonneau, C., & Bourdeau, S. (2019). Computer-supported collaboration: Simulation-based training using LEGO®. *Educational Technology Research and Development*, *67*(6), 1507–1527. https://doi.org/10.1007/s11423-019-09689-w

Bouncken, R. B., Zagvozdina, J., Golze, A., & Mrozewska, A. (2009). A comparative study of cultural influences on intentions to found a new venture in Germany and Poland. *International Journal of Business and Globalisation*, *3*(1), 47–65. https://doi.org/10.1504/IJBG.2009.021631

Bricteux, C., Navarro, J., Ceja, L., & Fuerst, G. (2017). Interest as a moderator in the relationship between challenge/skills balance and flow at work: An analysis at within-individual level. *Journal of Happiness Studies*, *18*(3), 861–880. https://doi.org/10.1007/s10902-016-9755-8

Brooke, J. (1996). SUS: A “quick and dirty” usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & I. L. McClelland (Eds.), *Usability Evaluation In Industry* (pp. 207–212). CRC Press. https://doi.org/10.1201/9781498710411-35

Bruya, B. (2010). Introduction: Toward a theory of attention that includes effortless attention. In B. Bruya (Ed.), *Effortless attention: A new perspective in the cognitive science of attention and action* (pp. 1–28). MIT Press.

Butler, N., & Spoelstra, S. (2024). Redemption through play? Exploring the ethics of workplace gamification. *Journal of Business Ethics*, *193*(2), 259–270. https://doi.org/10.1007/s10551-023-05584-w

Cagliano, R., Caniato, F., Golini, R., & Longoni, A. (2011). The impact of country culture on the adoption of new forms of work organization. *International Journal of Operations and Production Management*, *31*(3), 297–323. https://doi.org/10.1108/01443571111111937

Capponi, M., Gervasi, R., Mastrogiacomo, L., & Franceschini, F. (2025). Gamification in manufacturing: Some insights in human–robot collaboration assembly and preliminary results. *International Journal of Advanced Manufacturing Technology*, *137*(11), 6043–6071. https://doi.org/10.1007/s00170-025-15499-7

Cardon, M. S., Wincent, J., Singh, J., & Drnovsek, M. (2009). The nature and experience of entrepreneurial passion. *Academy of Management Review*, *34*(3), 511–532. https://doi.org/10.5465/AMR.2009.40633190

Carter, K. M., Hetrick, A. L., Chen, M., Humphrey, S. E., Morgeson, F. P., & Hoffman, B. J. (2024). How culture shapes the influence of work design characteristics: A narrative and meta-analytic review. *Journal of Management*, *50*(1), 122–157. https://doi.org/10.1177/01492063231179405

Carter, N. T., Carter, D. R., & DeChurch, L. A. (2018). Implications of observability for the theory and measurement of emergent team phenomena. *Journal of Management*, *44*(4),

1398–1425. https://doi.org/10.1177/0149206315609402

Ceja, L., & Navarro, J. (2011). Dynamic patterns of flow in the workplace: Characterizing within-individual variability using a complexity science approach. *Journal of Organizational Behavior*, *32*, 627–651. https://doi.org/10.1002/job

Ceja, L., & Navarro, J. (2012). "Suddenly I get into the zone": Examining discontinuities and nonlinear changes in flow experiences at work. *Human Relations*, *65*(9), 1101–1127. https://doi.org/10.1177/0018726712447116

Center for Self-Determination Theory. (n.d.). *Intrinsic motivation inventory (IMI)*. https://selfdeterminationtheory.org/intrinsic-motivation-inventory/

Cetrulo, A., & Nuvolari, A. (2019). Industry 4.0: revolution or hype? Reassessing recent technological trends and their impact on labour. *Journal of Industrial and Business Economics*, *46*(3), 391–402. https://doi.org/10.1007/s40812-019-00132-y

Christandl, F., Mierke, K., & Peifer, C. (2018). Time flows: Manipulations of subjective time progression affect recalled flow and performance in a subsequent task. *Journal of Experimental Social Psychology*, *74*, 246–256. https://doi.org/10.1016/j.jesp.2017.09.015

Cónego, L., Pinto, R., & Gonçalves, G. (2024). Digital transformation in manufacturing: The synergy of chatbots and tailored gamification strategies. *Procedia Computer Science*, *237*(2021), 171–178. https://doi.org/10.1016/j.procs.2024.05.093

Coss, N. A., Sinskey, J. L., van den Hout, J., Chang, J. M., Legrand, M., & Schwartz, R. (2025). Clinical team flow in the perioperative environment: a qualitative single-centre study. *British Journal of Anaesthesia*, *134*(3), 882–884. https://doi.org/10.1016/j.bja.2024.12.019

Cramarenco, R. E., Burcă-Voicu, M. I., & Dabija, D. C. (2023). The impact of artificial intelligence (AI) on employees' skills and well-being in global labor markets: A systematic review. *Oeconomia Copernicana*, *14*(3), 731–767. https://doi.org/10.24136/oc.2023.022

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. Jossey-Bass Publishers.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.

Csikszentmihalyi, M. (1996). The flow of creativity. In *Creativity: Flow and the psychology of discovery and invention* (pp. 107–126). Harper Collins.

Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology*, *56*(5), 815–822. https://doi.org/10.1037/0022-3514.56.5.815

Datu, J. A. D., & Mateo, N. J. (2017). Work-related flow dimensions differentially predict anxiety, life satisfaction, and work longevity among Filipino counselors. *Current Psychology*, *36*(2), 203–208. https://doi.org/10.1007/s12144-015-9401-3

de Manzano, Ö., Theorell, T., Harmat, L., & Ullén, F. (2010). The psychophysiology of flow during piano playing. *Emotion*, *10*(3), 301–311. https://doi.org/10.1037/a0018432

Debus, M. E., Sonnentag, S., Deutsch, W., & Nussbeck, F. W. (2014). Making flow happen: The effects of being recovered on work-related flow between and within days. *Journal of Applied Psychology*, *99*(4), 713–722. https://doi.org/10.1037/a0035881

Demerouti, E. (2006). Job characteristics, flow, and performance: The moderating role of conscientiousness. *Journal of Occupational Health Psychology*, *11*(3), 266–280. https://doi.org/10.1037/1076-8998.11.3.266

Demerouti, E., Bakker, A. B., Sonnentag, S., & Fullagar, C. J. (2012). Work-related flow and energy at work and at home: A study on the role of daily recovery. *Journal of Organizational Behavior*, *33*(2), 276-295.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining “gamification.” *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011*, 9–15. https://doi.org/10.1145/2181037.2181040

Devine, D. J., & Philips, J. L. (2001). Do smarter teams do better: A meta-analysis of cognitive ability and team performance. *Small Group Research*, *32*(5), 507–532. https://doi.org/10.1177/104649640103200501

DGUV. (2015). *DGUV-Information Fließbandarbeit: Gefährdungsbeurteilung und Maßnahmen bei physischen und psychischen Belastungen*. Fachbereich Holz und Metall der DGUV.

Dirik, D., & Özdoğan, B. (2024). To start or not to start? An exploratory study of work meaningfulness among start-up co-founders. *Frontiers in Psychology*, *15*(January), 1–18. https://doi.org/10.3389/fpsyg.2024.1500036

Dishon-Berkovits, M., Bakker, A. B., & Peters, P. (2024). Playful work design, engagement and performance: The moderating roles of boredom and conscientiousness. *International Journal of Human Resource Management*, *35*(2), 256–283. https://doi.org/10.1080/09585192.2023.2227920

Do, H. T. K. (2025). Identification in global and virtual teams: A systematic literature review. *Review of Managerial Science*. https://doi.org/10.1007/s11846-025-00890-1

Dolly, M., Nimbarte, A., & Wuest, T. (2024). The effects of gamification for manufacturing (GfM) on workers and production in industrial assembly. *Robotics and Computer-Integrated Manufacturing*, *88*. https://doi.org/10.1016/j.rcim.2024.102722

Eisenberg, J., & Krishnan, A. (2018). Addressing virtual work challenges: Learning from the field. *Organization Management Journal*, *15*(2), 78–94. https://doi.org/10.1080/15416518.2018.1471976

Engeser, S., & Baumann, N. (2016). Fluctuation of flow and affect in everyday life: A second look at the paradox of work. *Journal of Happiness Studies*, *17*(1), 105–124. https://doi.org/10.1007/s10902-014-9586-4

Engeser, S., & Rheinberg, F. (2008). Flow, performance and moderators of challenge-skill balance. *Motivation and Emotion*, *32*(3), 158–172. https://doi.org/10.1007/s11031-008-9102-4

Engeser, S., Schiepe-Tiska, A., & Peifer, C. (2021). Historical lines and an overview of current research on flow. In S. Engeser & C. Peifer (Eds.), *Advances in Flow Research* (pp. 1–30). Springer.

Erez, M. (2010). Culture and job design. *Journal of Organizational Behavior*, *31*(2–3), 389–400. https://doi.org/10.1002/job.651

Feitosa, J., & Salas, E. (2021). Today's virtual teams: Adapting lessons learned to the pandemic context. *Organizational Dynamics*, *50*(1), 100777. https://doi.org/10.1016/j.orgdyn.2020.100777

Feng, X., Han, P., & Long, T. (2024). Teams' stressors and flow experience: An energy-based perspective and the role of team mindfulness. *Journal of Business Research*, *183*(July), 114860. https://doi.org/10.1016/j.jbusres.2024.114860

Fischer, U., McDonnell, L., & Orasanu, J. (2007). Linguistic correlates of team performance: Toward a tool for monitoring team functioning during space missions. *Aviation Space and Environmental Medicine*, *78*(5), B86–B95.

Freud, D., Ezrati-Vinacour, R., & Amir, O. (2018). Speech rate adjustment of adults during conversation. *Journal of Fluency Disorders*, *57*, 1–10. https://doi.org/10.1016/j.jfludis.2018.06.002

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Fullagar, C. J., & Kelloway, E. K. (2009). Flow at work: An experience sampling approach.

Journal of Occupational and Organizational Psychology, *82*, 595–615. https://doi.org/10.1348/096317908X357903

Gaggioli, A., Mazzoni, E., Benvenuti, M., Galimberti, C., Bova, A., Brivio, E., Cipresso, P., Riva, G., & Chirico, A. (2020). Networked flow in creative collaboration: A mixed method study. *Creativity Research Journal*, *32*(1), 41–54. https://doi.org/10.1080/10400419.2020.1712160

Gaggioli, A., Mazzoni, E., Milani, L., & Riva, G. (2015). The creative link: Investigating the relationship between social network indices, creative performance and flow in blended teams. *Computers in Human Behavior*, *42*, 157–166. https://doi.org/10.1016/j.chb.2013.12.003

Gagné, M., Parker, S. K., Griffin, M. A., Dunlop, P. D., Knight, C., Klonek, F. E., & Parent-Rocheleau, X. (2022). Understanding and shaping the future of work with self-determination theory. *Nature Reviews Psychology*, *1*(7), 378–392. https://doi.org/10.1038/s44159-022-00056-w

Gale, J., Erez, A., Bamberger, P., Foulk, T., Cooper, B., Riskin, A., Schilpzand, P., & Vashdi, D. (2024). Rudeness and team performance: Adverse effects via member social value orientation and coordinative team processes. *Journal of Applied Psychology*, *109*(12), 1948–1971. https://doi.org/10.1037/apl0001213

Gerpott, F. H., Rivkin, W., & Unger, D. (2022). Stop and go, where is my flow? How and when daily aversive morning commutes are negatively related to employees' motivational states and behavior at work. *Journal of Applied Psychology*, *107*(2), 169–192. https://doi.org/10.1037/apl0000899

Goldberg, J. A. (1990). Interrupting the discourse on interruptions. An analysis in terms of relationally neutral, power- and rapport-oriented acts. *Journal of Pragmatics*, *14*(6), 883–903. https://doi.org/10.1016/0378-2166(90)90045-F

Gorgievski, M. J., & Stephan, U. (2016). Advancing the psychology of entrepreneurship: A review of the psychological literature and an introduction. *Applied Psychology*, *65*(3), 437–468. https://doi.org/10.1111/apps.12073

Grant, A. M., & Parker, S. K. (2009). Redesigning work design theories: The rise of relational and proactive perspectives. *Academy of Management Annals*, *3*(1), 317–375. https://doi.org/10.5465/19416520903047327

Greenberg, J., Ashton-James, C. E., & Ashkanasy, N. M. (2007). Social comparison processes in organizations. *Organizational Behavior and Human Decision Processes*, *102*(1), 22–

41. https://doi.org/10.1016/j.obhdp.2006.09.006

Gressgård, L. J. (2011). Virtual team collaboration and innovation in organizations. *Team Performance Management*, *17*(1), 102–119. https://doi.org/10.1108/13527591111114738

Groening, C., & Binnewies, C. (2021). The more, the merrier? - How adding and removing game design elements impact motivation and performance in a gamification environment. *International Journal of Human-Computer Interaction*, *37*(12), 1130–1150. https://doi.org/10.1080/10447318.2020.1870828

Gully, S. M., Incalcaterra, K. A., Joshi, A., & Beaubien, J. M. (2002). A meta-analysis of team-efficacy, potency, and performance: Interdependence and level of analysis as moderators of observed relationships. *Journal of Applied Psychology*, *87*(5), 819–832. https://doi.org/10.1037/0021-9010.87.5.819

Hackert, B., Lumma, A. L., Raettig, T., Berger, B., & Weger, U. (2023). Towards a re-conceptualization of flow in social contexts. *Journal for the Theory of Social Behaviour*, *53*(1), 100–125. https://doi.org/10.1111/jtsb.12362

Hackman, J. R., Oldham, G., Janson, R., & Purdy, K. (1975). A new strategy for job enrichment. *California Management Review*, *17*(4), 57–71. https://doi.org/10.2307/41164610

Hackman, J. R., & Oldham, G. R. (1975). Development of the job diagnostic survey. *Journal of Applied Psychology*, *60*(2), 159–170. https://doi.org/10.1037/h0076546

Hagemann, V., Watermann, L., Klonek, F., & Heinicke, C. (2025). The relevance of team processes for different task characteristics during performance episodes and over time in astronaut crews and their support teams. *Journal of Human Performance in Extreme Environments*, *20*(1). https://doi.org/10.7771/2327-2937.1167

Halvorsen, K. (2018). Questions as interactional resource in team decision making. *International Journal of Business Communication*, *55*(1), 69–93. https://doi.org/10.1177/2329488415589102

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - A literature review of empirical studies on gamification. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3025–3034. https://doi.org/10.1109/HICSS.2014.377

Hameed, I., & Irfan, Z. (2019). Entrepreneurship education: A review of challenges, characteristics and opportunities. *Entrepreneurship Education*, *2*(3–4), 135–148. https://doi.org/10.1007/s41959-019-00018-z

Handke, L., Costa, P., & O'Neill, T. A. (2024). Virtual teams: Taking stock and moving forward. *Small Group Research*, *55*(5), 671–679. https://doi.org/10.1177/10464964241274129

Handke, L., Klonek, F. E., Parker, S. K., & Kauffeld, S. (2020). Interactive effects of team virtuality and work design on team functioning. *Small Group Research*, *51*(1), 3–47. https://doi.org/10.1177/1046496419863490

Handke, L., & Wesche, J. S. (2024). Virtuelle Teamarbeit: Was sie kennzeichnet, wie sie wirkt und wie man sie gestaltet. *Psychologische Rundschau*. https://doi.org/10.1026/0033-3042/a000661

Harari, Y. N. (2008). Combat flow: Military, political, and ethical dimensions of subjective well-being in war. *Review of General Psychology*, *12*(3), 253–264. https://doi.org/10.1037/1089-2680.12.3.253

Harju, L., Hakanen, J. J., & Schaufeli, W. B. (2014). Job boredom and its correlates in 87 finnish organizations. *Journal of Occupational and Environmental Medicine*, *56*(9), 911–918. https://doi.org/10.1097/JOM.0000000000000248

Harris, D. J., Allen, K. L., Vine, S. J., & Wilson, M. R. (2023). A systematic review and meta-analysis of the relationship between flow states and performance. *International Review of Sport and Exercise Psychology*, *16*(1), 693–721. https://doi.org/10.1080/1750984X.2021.1929402

Hartmann, S., Backmann, J., Newman, A., Brykman, K. M., & Pidduck, R. J. (2022). Psychological resilience of entrepreneurs: A review and agenda for future research. *Journal of Small Business Management*, *60*(5), 1041–1079. https://doi.org/10.1080/00472778.2021.2024216

Harzer, C., & Ruch, W. (2013). The application of signature character strengths and positive experiences at work. *Journal of Happiness Studies*, *14*, 965–983. https://doi.org/10.1007/s10902-012-9364-0

Hofmann, J., Platt, T., & Ruch, W. (2017). Laughter and smiling in 16 positive emotions. *IEEE Transactions on Affective Computing*, *8*(4), 495–507. https://doi.org/10.1109/TAFFC.2017.2737000

Hofstede, G. (1980). Motivation, leadership, and organization: Do American theories apply abroad? *Organizational Dynamics*, *9*(1), 42–63. https://doi.org/10.1016/0090-2616(80)90013-3

Holford, W. D. (2019). The future of human creative knowledge work within the digital economy. *Futures*, *105*, 143–154. https://doi.org/10.1016/j.futures.2018.10.002

Hosseini, C., Humlung, O., Fagerstrøm, A., & Haddara, M. (2022). An experimental study on the effects of gamification on task performance. *Procedia Computer Science*, *196*, 999–1006. https://doi.org/10.1016/j.procs.2021.12.102

Huizinga, J. (1956). *Homo ludens: vom Ursprung der Kultur im Spiel*. Rowohlt.

Humphrey, S. E., Nahrgang, J. D., & Morgeson, F. P. (2007). Integrating motivational, social, and contextual work design features: A meta-analytic summary and theoretical extension of the work design literature. *Journal of Applied Psychology*, *92*(5), 1332–1356. https://doi.org/10.1037/0021-9010.92.5.1332

Huotari, K., & Hamari, J. (2017). A definition for gamification: Anchoring gamification in the service marketing literature. *Electronic Markets*, *27*(1), 21–31. https://doi.org/10.1007/s12525-015-0212-z

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual Review of Psychology*, *56*, 517–543. https://doi.org/10.1146/annurev.psych.56.091103.070250

Ilies, R., Wagner, D., Wilson, K., Ceja, L., Johnson, M., DeRue, S., & Ilgen, D. (2017). Flow at work and basic psychological needs: Effects on well-being. *Applied Psychology*, *66*(1), 3–24. https://doi.org/10.1111/apps.12075

Irshad, M. T., Li, F., Nisar, M. A., Huang, X., Buss, M., Kloep, L., Peifer, C., Kozusznik, B., Pollak, A., Pyszka, A., Flak, O., & Grzegorzek, M. (2023). Wearable-based human flow experience recognition enhanced by transfer learning methods using emotion data. *Computers in Biology and Medicine*, *166*, 107489. https://doi.org/10.1016/j.compbiomed.2023.107489

Jacob, A., Faatz, A., Knüppe, L., & Teuteberg, F. (2022). The impact of gamification on macro- and micro-level social structures—The case of an industrial organization. *International Journal of Human-Computer Interaction*, *38*(7), 614–630. https://doi.org/10.1080/10447318.2021.1952804

Johns, G. (2006). The essential impact of context on organizational behavior. *Academy of Management Review*, *31*(2), 386–408. https://doi.org/10.5465/amr.2006.20208687

Johnson, S. K., Bettenhausen, K., & Gibbons, E. (2009). Realities of working in virtual teams: Affective and attitudinal outcomes of using computer-mediated communication. *Small Group Research*, *40*(6), 623–649. https://doi.org/10.1177/1046496409346448

Johnson, T. E., Lee, Y., Lee, M., O'Connor, D. L., Khalil, M. K., & Huang, X. (2007). Measuring sharedness of team-related knowledge: Design and validation of a shared mental model

instrument. *Human Resource Development International*, *10*(4), 437–454. https://doi.org/10.1080/13678860701723802

Kampker, A., Deutskens, C., Deutschmann, K., Maue, A., & Haunreiter, A. (2014). Increasing ramp-up performance by implementing the gamification approach. *Procedia CIRP*, *20*, 74–80. https://doi.org/10.1016/j.procir.2014.05.034

Kass, S. J., Vodanovich, S. J., & Callender, A. (2001). State-trait boredom: Relationship to absenteeism, tenure, and job satisfaction. *Journal of Business and Psychology*, *16*(2), 317–327. https://doi.org/10.1023/A:1011121503118

Kasurinen, J., & Knutas, A. (2018). Publication trends in gamification: A systematic mapping study. *Computer Science Review*, *27*, 33–44. https://doi.org/10.1016/j.cosrev.2017.10.003

Kauffeld, S., Tartler, D., Gräfe, H., Windmann, A. K., & Sauer, N. C. (2022). What will mobile and virtual work look like in the future?—Results of a Delphi-based study. *Gruppe. Interaktion. Organisation. Zeitschrift Fur Angewandte Organisationspsychologie*, *53*(2), 189–214. https://doi.org/10.1007/s11612-022-00627-8

Khan, A., & Pearce, G. (2015). A study into the effects of a board game on flow in undergraduate business students. *International Journal of Management Education*, *13*(3), 193–201. https://doi.org/10.1016/j.ijme.2015.05.002

Klock, A. C. T., Gasparini, I., Pimenta, M. S., & Hamari, J. (2020). Tailored gamification: A review of literature. *International Journal of Human Computer Studies*, *144*. https://doi.org/10.1016/j.ijhcs.2020.102495

Kloep, L., Aust, F., & Peifer, C. (2023). Das Flow-Konzept im Arbeitskontext zur Förderung der Resilienz. In M. Moser & K. Häring (Eds.), *Gesund bleiben in kranken Unternehmen* (pp. 317–336). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-39903-0_17

Kloep, L., Helten, A. L., & Peifer, C. (2023). A playful way to promote team flow: Evaluation of a positive psychological board game for team building. *International Journal of Applied Positive Psychology*, *8*, 405–427. https://doi.org/10.1007/s41042-023-00096-4

Kloep, L., Hug, J., Ulmer, J., Wollert, J., & Peifer, C. (2025). Gamification in manufacturing work: Can it help to increase flow and performance? *International Journal of Human–Computer Interaction*. https://doi.org/10.1080/10447318.2025.2502968

Kloep, L., Roese, K., & Peifer, C. (2023). Founders' flow: A qualitative study on the role of flow experience in early start-up stages. *PLOS ONE*, *18*(10), e0292580.

https://doi.org/10.1371/journal.pone.0292580

Klonek, F. E., Meinecke, A. L., Hay, G., & Parker, S. K. (2020). Capturing team dynamics in the wild: The communication analysis tool. *Small Group Research*, *51*(3), 303–341. https://doi.org/10.1177/1046496420904126

Klonek, F. E., Quera, V., Burba, M., & Kauffeld, S. (2016). Group interactions and time: Using sequential analysis to study group dynamics in project meetings. *Group Dynamics*, *20*(3), 209–222. https://doi.org/10.1037/gdn0000052

Knierim, M. T., Pieper, V., Schemmer, M., Loewe, N., & Reali, P. (2021). Predicting in-field flow experiences over two weeks from ECG data: A case study. In F. D. Davis, R. Riedl, J. vom Brocke, P.-M. Léger, A. Randolph, & G. Müller-Putz (Eds.), *Information Systems and Neuroscience. NeuroIS 2021. Lecture Notes in Information Systems and Organisation* (2nd ed., pp. 47–55). https://doi.org/10.1007/978-3-030-88900-5_11

Knight, C., & Parker, S. K. (2021). How work redesign interventions affect performance: An evidence-based model from a systematic review. *Human Relations*, *74*(1), 69–104. https://doi.org/10.1177/0018726719865604

Koivisto, J., & Hamari, J. (2014). Demographic differences in perceived benefits from gamification. *Computers in Human Behavior*, *35*, 179–188. https://doi.org/10.1016/j.chb.2014.03.007

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, *45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Korn, O. (2023). Gamification in industrial production: An overview, best practices, and design recommendations. In C. Röcker & S. Büttner (Eds.), *Human-Technology Interaction* (pp. 251–270). Springer International Publishing. https://doi.org/10.1007/978-3-030-99235-4_10

Korn, O., Muschick, P., & Schmidt, A. (2017). Gamification of production? A study on the acceptance of gamified work processes in the automotive industry. In W. Chung & C. Shin (Eds.), *Advances in Affective and Pleasurable Design. Advances in Intelligent Systems and Computing* (Vol. 483, pp. 433–445). Springer. https://doi.org/10.1007/978-3-319-41661-8_42

Korn, O., Schmidt, A., & Hörz, T. (2012). Assistive systems in production environments: Exploring motion recognition and gamification. *PETRA '12: Proceedings of the 5th International Conference on PErvasive Technologies Related to Assistive Environment*, *9*, 1–5. https://doi.org/10.1145/2413097.2413109

Körner, A., Geyer, M., Roth, M., Drapeau, M., Schmutzer, G., Albani, C., Schumann, S., & Brähler, E. (2008). Persönlichkeitsdiagnostik mit dem NEO-Fünf-Faktoren-Inventar: Die 30-Item-Kurzversion (NEO-FFI-30). *Psychotherapie Psychosomatik Medizinische Psychologie*, *58*, 238–245. https://doi.org/10.1055/s-2007-986199

Kosenkranius, M., Rink, F., Weigelt, O., & de Bloom, J. (2023). Crafting and human energy: Needs-based crafting efforts across life domains shape employees' daily energy trajectories. *Journal of Occupational Health Psychology*, *28*(3), 192–204. https://doi.org/10.1037/ocp0000347

Koshik, I. (2002). A conversation analytic study of yes/no questions which convey reversed polarity assertions. *Journal of Pragmatics*, *34*(12), 1851–1877. https://doi.org/10.1016/S0378-2166(02)00057-7

Kozlowski, S. W. J., & Bell, B. S. (2003). Work groups and teams in organizations. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.), *Handbook of psychology (Vol. 12): Industrial and Organizational Psycology* (pp. 333–375). Wiley. https://doi.org/10.1002/0471264385.wei1214

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior*, *125*. https://doi.org/10.1016/j.chb.2021.106963

Kristiansen, P., & Rasmussen, R. (2014). *Building a better business using the Lego serious play method*. Wiley.

Kruse, P., Chipeta, E. M., & Ueberschär, I. (2023). What keeps social entrepreneurs happy? Exploring personality, work design, external support, and social impact as resources of social entrepreneurs' mental well-being. *Sustainability (Switzerland)*, *15*(5). https://doi.org/10.3390/su15054109

Kuckartz, U. (2012). *Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung*. Beltz Juventa.

Kuckertz, A., Brändle, L., Gaudig, A., Hinderer, S., Morales Reyes, C. A., Prochotta, A., Steinbrink, K. M., & Berger, E. S. C. (2020). Startups in times of crisis – A rapid response to the COVID-19 pandemic. *Journal of Business Venturing Insights*, *13*. https://doi.org/10.1016/j.jbvi.2020.e00169

Kuo, T. H., & Ho, L. A. (2010). Individual difference and job performance: The relationships among personal factors, job characteristics, flow experience, and service quality. *Social*

Behavior and Personality, *38*(4), 531–552. https://doi.org/10.2224/sbp.2010.38.4.531

Larche, C. J., & Dixon, M. J. (2020). The relationship between the skill-challenge balance, game expertise, flow and the urge to keep playing complex mobile games. *Journal of Behavioral Addictions*, *9*(3), 606–616. https://doi.org/10.1556/2006.2020.00070

Lavoie, R., Baer, M., & Rouse, E. D. (2024). Group flow: A theory of group member interactions in the moment and over time. *Academy of Management Review*, *00*(00), 1–26. https://doi.org/10.5465/amr.2021.0458

Leblanc, P. M., Harvey, J. F., & Rousseau, V. (2024). A meta-analysis of team reflexivity: Antecedents, outcomes, and boundary conditions. *Human Resource Management Review*, *34*(4), 101042. https://doi.org/10.1016/j.hrmr.2024.101042

LeDoux, J. A., Gorman, C. A., & Woehr, D. J. (2012). The impact of interpersonal perceptions on team processes: A social relations analysis. *Small Group Research*, *43*(3), 356–382. https://doi.org/10.1177/1046496411425190

Lee, E. (2005). The relationship of motivation and flow experience to academic procrastination in university students. *The Journal of Genetic Psychology*, *166*(1), 5–14. https://doi.org/10.3200/GNTP.166.1.5-15

Lee, M. R. (2014). *Leading virtual project teams: Adapting leadership theories and communications techniques to 21st century organizations* (G. Levin (ed.)). CRC Press.

Lehmann-Willenbrock, N. (2024). Dynamic interpersonal processes at work: Taking social interactions seriously. *Annual Review of Organizational Psychology and Organizational Behavior*, 1–26. https://doi.org/10.1146/annurev-orgpsych-110622-035421

Lehmann-Willenbrock, N., & Allen, J. A. (2014). How fun are your meetings? Investigating the relationship between humor patterns in team interactions and team performance. *Journal of Applied Psychology*, *99*(6), 1278–1287. https://doi.org/10.1037/a0038083

Lestary, A., Krismanti, N., & Hermaniar, Y. (2018). Interruptions and silences in conversations: A turn-taking analysis. *PAROLE: Journal of Linguistics and Education*, *7*(2), 64. https://doi.org/10.14710/parole.v7i2.64

Liu, W., Bakker, A. B., Tse, B. T., Linden, D. Van Der, & Tse, B. T. (2022). Does playful work design “lead to” more creativity ? A diary study on the role of flow. *European Journal of Work and Organizational Psychology*, *00*(00), 1–11. https://doi.org/10.1080/1359432X.2022.2104716

Liu, W., Lu, H., Li, P., van der Linden, D., & Bakker, A. B. (2023). Antecedents and outcomes of work-related flow: A meta-analysis. *Journal of Vocational Behavior*, *144*.

https://doi.org/10.1016/j.jvb.2023.103891

Liu, W., van der Linden, D., & Bakker, A. B. (2025). Enhancing student well-being and focus: The role of playful study design and strengths use. *Applied Psychology: Health and Well-Being*, *17*(4), 1–21. https://doi.org/10.1111/aphw.70058

Loukidou, L., Loan-Clarke, J., & Daniels, K. (2009). Boredom in the workplace: More than monotonous tasks. *International Journal of Management Reviews*, *11*(4), 381–405. https://doi.org/10.1111/j.1468-2370.2009.00267.x

Lu, H., van der Linden, D., & Bakker, A. B. (2024). The neuroscientific basis of flow: Learning progress guides task engagement and cognitive control. *NeuroImage*, *308*, 121076. https://doi.org/10.1016/j.neuroimage.2025.121076

MacDonald, R., Byrne, C., & Carlton, L. (2006). Creativity and flow in musical composition: an empirical investigation. *Psychology of Music*, *34*(3), 292–306. https://doi.org/10.1177/0305735606064838

Maeran, R., & Cangiano, F. (2013). Flow experience and job characteristics: Analyzing the role of flow in job satisfaction. *Testing, Psychometrics, Methodology in Applied Psychology*, *20*(1), 13–26. https://doi.org/10.4473/TPM20.1.2

Magyaródi, T., & Oláh, A. (2015). A cross-sectional survey study about the most common solitary and social flow activities to extend the concept of optimal experience. *Europe's Journal of Psychology*, *11*(4), 632–650. https://doi.org/10.5964/ejop.v11i4.866

Manson, J. H., Bryant, G. A., Gervais, M. M., & Kline, M. A. (2013). Convergence of speech rate in conversation predicts cooperation. *Evolution and Human Behavior*, *34*(6), 419–426. https://doi.org/10.1016/j.evolhumbehav.2013.08.001

Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, *26*(3), 356–376. https://doi.org/10.5465/AMR.2001.4845785

Marlow, S. L., Lacerenza, C. N., Paoletti, J., Burke, C. S., & Salas, E. (2018). Does team communication represent a one-size-fits-all approach?: A meta-analysis of team communication and performance. *Organizational Behavior and Human Decision Processes*, *144*, 145–170. https://doi.org/10.1016/j.obhdp.2017.08.001

Marlow, S. L., Lacerenza, C. N., & Salas, E. (2017). Communication in virtual teams: a conceptual framework and research agenda. *Human Resource Management Review*, *27*(4), 575–589. https://doi.org/10.1016/j.hrmr.2016.12.005

Mathieu, J., Maynard, M. T., Rapp, T., & Gilson, L. (2008). Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future. *Journal of Management*, *34*(3), 410–476. https://doi.org/10.1177/0149206308316061

Mazarakis, A., & Bräuer, P. (2023). Gamification is working, but which one exactly? Results from an experiment with four game design elements. *International Journal of Human-Computer Interaction*, *39*(3), 612–627. https://doi.org/10.1080/10447318.2022.2041909

Medhurst, A. R., & Albrecht, S. L. (2016). Salesperson work engagement and flow: A qualitative exploration of their antecedents and relationship. *Qualitative Research in Organizations and Management: An International Journal*, *11*(1), 22–45. https://doi.org/10.1108/QROM-04-2015-1281

Menekse, M., Purzer, S., & Heo, D. (2019). An investigation of verbal episodes that relate to individual and team performance in engineering student teams. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-019-0160-9

Mesurado, B., Cristina Richaud, M., & José Mateo, N. (2016). Engagement, flow, self-efficacy, and eustress of university students: A cross-national comparison between the Philippines and Argentina. *Journal of Psychology: Interdisciplinary and Applied*, *150*(3), 281–299. https://doi.org/10.1080/00223980.2015.1024595

Min, S., Delong, M., & LaBat, K. (2015). Exploring flow in the apparel design process. *International Journal of Fashion Design, Technology and Education*, *8*(3), 260–267. https://doi.org/10.1080/17543266.2015.1093179

Mønster, D., Håkonsson, D. D., Eskildsen, J. K., & Wallot, S. (2016). Physiological evidence of interpersonal dynamics in a cooperative production task. *Physiology and Behavior*, *156*, 24–34. https://doi.org/10.1016/j.physbeh.2016.01.004

Montijo, M. N., & Mouton, A. R. (2016). Love for frequent and low flow activities in the United States and India. *Creativity. Theories – Research - Applications*, *3*(2), 379–407. https://doi.org/10.1515/ctra-2016-0023

Morgeson, F. P., Dierdorff, E. C., & Hmurovic, J. L. (2010). Work design in situ: Understanding the role of occupational and organizational context. *Journal of Organizational Behavior*, *31*, 351–360. https://doi.org/10.1002/job.642

Morgeson, F. P., & Humphrey, S. E. (2006). The Work Design Questionnaire (WDQ): Developing and validating a comprehensive measure for assessing job design and the nature of work. *Journal of Applied Psychology*, *91*(6), 1321–1339. https://doi.org/10.1037/0021-9010.91.6.1321

Morgeson, F. P., & Humphrey, S. E. (2008). Job and team design: Toward a more integrative conceptualization of work design. In J. J. Martocchio (Ed.), *Research in Personnel and Human Resources Management* (pp. 39–91). Emerald Group Publishing Limited. https://doi.org/10.1016/S0742-7301(08)27002-7

Morrison-Smith, S., & Ruiz, J. (2020). Challenges and barriers in virtual teams: A literature review. *SN Applied Sciences*, *2*, 1096. https://doi.org/10.1007/s42452-020-2801-5

Murnieks, C. Y., Klotz, A. C., & Shepherd, D. A. (2020). Entrepreneurial motivation: A review of the literature and an agenda for future research. *Journal of Organizational Behavior*, *41*, 115–143. https://doi.org/10.1002/job.2374

Nakamura, J., & Csikszentmihalyi, M. (2014). The concept of flow. In *Flow and the foundations of positive psychology: The collected works of Mihaly Csikszentmihalyi* (pp. 239–263). Springer. https://doi.org/10.1007/978-94-017-9088-8_16

Nesher Shoshan, H., & Wehrt, W. (2022). Understanding “Zoom fatigue”: A mixed-method approach. *Applied Psychology*, *71*(3), 827–852. https://doi.org/10.1111/apps.12360

Ng, S. H., Brooke, M., & Dunne, M. (1995). Interruption and influence in discussion groups. *Journal of Language and Social Psychology*, *14*(4), 369–381. https://doi.org/10.1177/0261927X950144003

Nielsen, K., & Cleal, B. (2010). Predicting flow at work: Investigating the activities and job characteristics that predict flow states at work. *Journal of Occupational Health Psychology*, *15*(2), 180–190. https://doi.org/10.1037/a0018893

Norsworthy, C., Dimmock, J. A., Nicholas, J., Krause, A., & Jackson, B. (2023). Psychological flow training: Feasibility and preliminary efficacy of an educational intervention on flow. *International Journal of Applied Positive Psychology*, *8*(3), 531–554. https://doi.org/10.1007/s41042-023-00098-2

Ocampo, A. C. G., Wang, L., Kiazad, K., Restubog, S. L. D., & Ashkanasy, N. M. (2020). The relentless pursuit of perfectionism: A review of perfectionism in the workplace and an agenda for future research. *Journal of Organizational Behavior*, *41*(2), 144–168. https://doi.org/10.1002/job.2400

Oettingen, G., Mayer, D., & Brinkmann, B. (2010). Mental contrasting of future and reality: Managing the demands of everyday life in health care Professionals. *Journal of Personnel Psychology*, *9*(3), 138–144. https://doi.org/10.1027/1866-5888/a000018

Oliveira, W., & Hamari, J. (2024). Global trends in flow theory research within gameful environments: A scoping review, bibliometric analysis and agenda for future studies.

Proceedings of the 57th Hawaii International Conference on System Sciences, 1318–1327. https://doi.org/10.1007/978-3-030-53468-4_8 191

Oliveira, W., Hamari, J., & Isotani, S. (2023). The relationship between users' behavior and their flow experience in gamified systems. *Proceedings of the ACM on Human-Computer Interaction*, *7*. https://doi.org/10.1145/3611032

Oliveira, W., Hamari, J., Shi, L., Toda, A. M., Rodrigues, L., Palomino, P. T., & Isotani, S. (2023). Tailored gamification in education: A literature review and future agenda. *Education and Information Technologies*, *28*, 373–406. https://doi.org/10.1007/s10639-022-11122-4

Oliveira, W., Pastushenko, O., Rodrigues, L., Toda, A. M., Palomino, P. T., Hamari, J., & Isotani, S. (2021). Does gamification affect flow experience ? A systematic literature review. *5th International GamiFINConference 2021*.

Ozenc, F. K., & Hagan, M. (2018). Ritual design: Crafting team rituals for meaningful organizational change. *Advances in Intelligent Systems and Computing*, *585*, 146–157. https://doi.org/10.1007/978-3-319-60495-4_16

Palmas, F., Labode, D., Plecher, D. A., & Klinker, G. (2019). Comparison of a gamified and non-gamified virtual reality training assembly task. *11th International Conference on Virtual Worlds and Games for Serious Applications (VS-Games)*, 1–8. https://doi.org/10.1109/VS-Games.2019.8864583

Palomäki, J., Tammi, T., Lehtonen, N., Seittenranta, N., Laakasuo, M., Abuhamdeh, S., Lappi, O., & Cowley, B. U. (2021). The link between flow and performance is moderated by task experience. *Computers in Human Behavior*, *124*. https://doi.org/10.1016/j.chb.2021.106891

Pan, Y., & Rief, S. (2019). *Raumpsychologie für eine neue Arbeitswelt. Environmental Psychology for a new World of Work* (W. Bauer & Fraunhofer IAO (eds.)). Fraunhofer Verlag.

Parker, S. K. (2014). Beyond motivation: Job and work design for development, health, ambidexterity, and more. *Annual Review of Psychology*, *65*, 661–691. https://doi.org/10.1146/annurev-psych-010213-115208

Parker, S. K., Morgeson, F. P., & Johns, G. (2017). One hundred years of work design research: Looking back and looking forward. *Journal of Applied Psychology*, *102*(3), 403–420. https://doi.org/10.1037/apl0000106

Parker, S. K., Van Den Broeck, A., & Holman, D. (2017). Work design influences: A synthesis

of multilevel factors that affect the design of jobs. *Academy of Management Annals*, *11*(1), 267–308. https://doi.org/10.5465/annals.2014.0054

Parker, S. K., Wall, T. D., & Cordery, J. L. (2001). Future work design research and practice: Towards an elaborated model of work design. *Journal of Occupational and Organizational Psychology*, *74*(4), 413–440. https://doi.org/10.1348/096317901167460

Pavlista, V., Angerer, P., & Diebig, M. (2024). Challenges of modern work environments and means of overcoming them in the context of psychosocial risk assessments. *BMC Public Health*, *24*(1). https://doi.org/10.1186/s12889-024-20818-w

Peifer, C., & Engeser, S. (2021). Theoretical integration and future lines of flow research. In S. Engeser & C. Peifer (Eds.), *Advances in Flow Research* (pp. 417–439). Springer International Publishing. https://doi.org/10.1007/978-3-030-53468-4_16

Peifer, C., Kluge, A., Rummel, N., & Kolossa, D. (2020). Fostering flow experience in HCI to enhance and allocate human energy. In D. Harris & W. C. Li (Eds.), *Engineering Psychology and Cognitive Ergonomics. Mental Workload, Human Physiology, and Human Energy. HCII 2020. Lecture Notes in Computer Science* (Vol. 12186, pp. 204–220). Springer International Publishing. https://doi.org/10.1007/978-3-030-49044-7_18

Peifer, C., Pollak, A., Flak, O., Pyszka, A., Nisar, M. A., Irshad, M. T., Grzegorzek, M., Kordyaka, B., & Kozusznik, B. (2021). The symphony of team flow in virtual teams. Using artificial intelligence for its recognition and promotion. *Frontiers in Psychology*, *12*, 1–14. https://doi.org/10.3389/fpsyg.2021.697093

Peifer, C., Schönfeld, P., Wolters, G., Aust, F., & Margraf, J. (2020). Well done! Effects of positive feedback on perceived self-efficacy, flow and performance in a mental arithmetic task. *Frontiers in Psychology*, *11*(June). https://doi.org/10.3389/fpsyg.2020.01008

Peifer, C., Schulz, A., Schächinger, H., Baumann, N., & Antoni, C. H. (2014). The relation of flow-experience and physiological arousal under stress - Can u shape it? *Journal of Experimental Social Psychology*, *53*, 62–69. https://doi.org/10.1016/j.jesp.2014.01.009

Peifer, C., & Tan, J. (2021). The psychophysiology of flow experience. In S. Engeser & C. Peifer (Eds.), *Advances in Flow Research* (pp. 191–230). Springer. https://doi.org/10.1007/978-3-030-53468-4_8

Peifer, C., & Wolters, G. (2021). Flow in the context of work. In C. Peifer & S. Engeser (Eds.), *Advances in Flow Research* (pp. 287–321). Springer International Publishing. https://doi.org/10.1007/978-3-030-53468-4_11

Peifer, C., Wolters, G., Harmat, L., Heutte, J., Tan, J., Freire, T., Tavares, D., Fonte, C.,

Andersen, F. O., van den Hout, J., Šimleša, M., Pola, L., Ceja, L., & Triberti, S. (2022). A scoping review of flow research. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.815665

Peifer, C., & Zipp, G. (2019). All at once? The effects of multitasking behavior on flow and subjective performance. *European Journal of Work and Organizational Psychology*, *28*(5), 682–690. https://doi.org/10.1080/1359432X.2019.1647168

Pels, F., & Kleinert, J. (2022). Perspectives on group flow: Existing theoretical approaches and the development of the integrative group flow theory. *Group Dynamics*. https://doi.org/10.1037/gdn0000194

Pels, F., & Kleinert, J. (2023). "There is nothing as practical as a good theory" – A position paper on the development of group flow research. *European Journal of Applied Positive Psychology*, *7*, 1–5.

Pels, F., Kleinert, J., & Mennigen, F. (2018). Group flow: A scoping review of definitions, theoretical approaches, measures and findings. *PLoS ONE*, *13*(12), 1–28. https://doi.org/10.1371/journal.pone.0210117

Perttula, A., Kiili, K., Lindstedt, A., & Tuomi, P. (2017). Flow experience in game based learning – A systematic literature review. *International Journal of Serious Games*, *4*(1), 57–72. https://doi.org/10.17083/ijsg.v4i1.151

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification*. Oxford University Press. https://doi.org/10.1176/appi.ajp.162.4.820-a

Pfaff, M. S. (2012). Negative affect reduces team awareness: The effects of mood and stress on computer-mediated team communication. *Human Factors*, *54*(4), 560–571. https://doi.org/10.1177/0018720811432307

Pinheiro, A. P., Barros, C., Dias, M., & Kotz, S. A. (2017). Laughter catches attention! *Biological Psychology*, *130*, 11–21. https://doi.org/10.1016/j.biopsycho.2017.09.012

Pivec, M. (2007). Editorial: Play and learn: Potentials of game-based learning. *British Journal of Educational Technology*, *38*(3), 387–393. https://doi.org/10.1111/j.1467-8535.2007.00722.x

Plester, B., & Hutchison, A. (2016). Fun times: The relationship between fun and workplace engagement. *Employee Relations*, *38*(3), 332–350. https://doi.org/10.1108/ER-03-2014-0027

Ponton, H., Osbourne, A., Greenwood, D., & Thompson, N. (2018). Understanding the dynamics of construction design team meetings through joint laughter. *Proceedings of the*

34th Annual ARCOM Conference, 88–97. https://research.utwente.nl/files/216887939/ARCOM_2018.pdf

Potter, J., & Hepburn, A. (2005). Qualitative interviews in psychology: Problems and possibilities. *Qualitative Research in Psychology*, *2*, 1–27.

Primus, D. J., & Sonnenburg, S. (2018). Flow experience in Design Thinking and practical synergies with Lego Serious Play. *Creativity Research Journal*, *30*(1), 104–112. https://doi.org/10.1080/10400419.2018.1411574

Purvanova, R. K. (2014). Face-to-face versus virtual teams: What have we really learned? *Psychologist-Manager Journal*, *17*(1), 2–29. https://doi.org/10.1037/mgr0000009

Purvanova, R. K., & Kenda, R. (2022). The impact of virtuality on team effectiveness in organizational and non-organizational teams: A meta-analysis. *Applied Psychology*, *71*(3), 1082–1131. https://doi.org/10.1111/apps.12348

Raettig, T., & Weger, U. (2018). Learning as a shared peak experience: Interactive flow in higher education. *International Journal of Applied Positive Psychology*, *2*(1–3), 39–60. https://doi.org/10.1007/s41042-018-0011-9

Raghuram, S., Hill, N. S., Gibbs, J. L., Maruping, L. M., & Robinson, J. M. (2019). Virtual work: Bridging research clusters. *The Academy of Management Annals*, *13*(1). https://doi.org/10.5465/annals.2017.0020

Rauch, A., Fink, M., & Hatak, I. (2018). Stress processes: An essential ingredient in the entrepreneurial process. *Academy of Management Perspectives*, *17*(3), 340–357. https://doi.org/10.5465/amp.2016.0184

Rheinberg, F., & Engeser, S. (2018). Intrinsic motivation and flow. In J. Heckhausen & H. Heckhausen (Eds.), *Motivation and Action* (pp. 579–622). Springer. https://doi.org/10.1007/978-3-319-65094-4_14

Rivkin, W., Moser, K. S., Diestel, S., & Alshaikh, I. (2024). Getting into flow during virtual meetings: How virtual meetings can benefit employee functioning in the work- and home domain. *Journal of Vocational Behavior*, *150*, 103984. https://doi.org/10.1016/j.jvb.2024.103984

Roets, A., & Van Hiel, A. (2011). Item selection and validation of a brief, 15-item version of the need for closure scale. *Personality and Individual Differences*, *50*(1), 90–94. https://doi.org/10.1016/j.paid.2010.09.004

Rosas, D. A., Padilla-Zea, N., & Burgos, D. (2023). Validated questionnaires in flow theory: A

systematic review. *Electronics (Switzerland)*, *12*(13), 1–29. https://doi.org/10.3390/electronics12132769

Rubin, R. (2002). Will the real SMART goals please stand up? *The Industrial-Organizational Psychologist*, *39*(4), 26–27.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A simplest systematics for the organization of turn-taking for conversation. *Language*, *50*(4), 696–735. https://doi.org/10.1016/B978-0-12-623550-0.50008-2

Sailer, M., Hense, J., Mandl, H., & Klevers, M. (2013). Psychological perspectives on motivation through gamification. *Interaction Design and Architecture(S)*, *19*, 28–37. https://doi.org/10.55612/s-5002-019-002

Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior*, *69*, 371–380. https://doi.org/10.1016/j.chb.2016.12.033

Salamzadeh, A., & Kawamorita Kesim, H. (2015). Startup companies: Life cycle and challenges. *Proceedings of the 4th International Conference on Employment, Education and Entrepreneurship (EEE)*. https://doi.org/10.37200/IJPR/V23I6/PR190836

Salanova, M., Bakker, A. B., & Llorens, S. (2006). Flow at work: Evidence for an upward spiral of personal and organizational resources. *Journal of Happiness Studies*, *7*(1), 1–22. https://doi.org/10.1007/s10902-005-8854-8

Salanova, M., Rodríguez-Sánchez, A. M., Schaufeli, W. B., & Cifre, E. (2014). Flowing together: A longitudinal study of collective efficacy and collective flow among workgroups. *The Journal of Psychology*, *148*(4), 435–455. https://doi.org/10.1080/00223980.2013.806290

Santana, M., & Cobo, M. J. (2020). What is the future of work? A science mapping analysis. *European Management Journal*, *38*(6), 846–862. https://doi.org/10.1016/j.emj.2020.04.010

Sarri, K. K., Bakouros, I. L., & Petridou, E. (2010). Entrepreneur training for creativity and innovation. *Journal of European Industrial Training*, *34*(3), 270–288. https://doi.org/10.1108/03090591011031755

Saurin, T. A., Ribeiro, J. L. D., & Vidor, G. (2012). A framework for assessing poka-yoke devices. *Journal of Manufacturing Systems*, *31*(3), 358–366. https://doi.org/10.1016/j.jmsy.2012.04.001

Sawyer, R. K. (2003). *Group creativity: Music, theater, collaboration*. Lawrence Erlbaum Associates.

Scharp, Y. S., Bakker, A. B., Breevaart, K., Kruup, K., & Uusberg, A. (2023). Playful work design: Conceptualization, measurement, and validity. *Human Relations*, *76*(4), 509–550. https://doi.org/10.1177/00187267211070996

Scharp, Y. S., Breevaart, K., Bakker, A. B., & van der Linden, D. (2019). Daily playful work design: A trait activation perspective. *Journal of Research in Personality*, *82*. https://doi.org/10.1016/j.jrp.2019.103850

Schegloff, E. A. (2007). Sequence organization in interaction. In *Sequence Organization in Interaction: A Primer in Conversation Analysis I*. Cambridge University Press. https://doi.org/10.1017/CBO9780511791208

Schermuly, C. C., Rinne, C., Wilsker, F., & Meifert, M. (2024). *Bericht zum New Work Barometer*.

Schiepe-Tiska, A., & Engeser, S. (2021). Flow in nonachievement situations. In C. Peifer & S. Engeser (Eds.), *Advances in Flow Research* (pp. 109–136). Springer International Publishing. https://doi.org/10.1007/978-3-030-53468-4_4

Schoos, M., & Suñer, F. (2020). Understanding humorous metaphors in the foreign language: a state-of-the-art review. *Zeitschrift Für Interkulturellen Fremdsprachenunterricht*, *25*(1), 1431–1446.

Schüler, J. (2007). Arousal of flow experience in a learning setting and its effects on exam performance and affect. *Zeitschrift Für Pädagogische Psychologie*, *21*(3/4), 217–227. https://doi.org/10.1024/1010-0652.21.3.217

Schultz, B. G., O'Brien, I., Phillips, N., McFarland, D. H., Titone, D., & Palmer, C. (2016). Speech rates converge in scripted turn-taking conversations. *Applied Psycholinguistics*, *37*(5), 1201–1220. https://doi.org/10.1017/S0142716415000545

Schuman, H., & Presser, S. (1979). The open and closed question. *American Sociological Review*, *44*(5), 692–712. https://doi.org/10.2307/2094521

Schwarzer, R., & Jerusalem, M. (1999). SWE. Skala zur Allgemeinen Selbstwirksamkeitserwartung [Verfahrensdokumentation, Autorenbeschreibung und Fragebogen]. In Leibniz-Institut für Psychologie (ZPID) (Ed.), *Open Test Archive*. ZPID. https://doi.org/10.23668/psycharchives.4515

Seaborn, K., & Fels, D. I. (2015). Gamification in theory and action: A survey. *International*

Journal of Human Computer Studies, *74*, 14–31. https://doi.org/10.1016/j.ijhcs.2014.09.006

Slavec Gomezel, A., & Aleksić, D. (2020). The relationships between technological turbulence, flow experience, innovation performance and small firm growth. *Journal of Business Economics and Management*, *21*(3), 760–782. https://doi.org/10.3846/jbem.2020.12280

Snijdewint, J. A., & Scheepers, D. (2023). Group-based flow: The influence of cardiovascular synchronization and identifiability. *Psychophysiology*, *60*(5), 1–18. https://doi.org/10.1111/psyp.14227

Standaert, W., Muylle, S., & Basu, A. (2022). Business meetings in a postpandemic world: When and how to meet virtually. *Business Horizons*, *65*(3), 267–275. https://doi.org/10.1016/j.bushor.2021.02.047

Steinke, I. (1999). Fazit und Checkliste zu den Kernkriterien. In *Kriterien qualitativer Forschung. Ansätze zur Bewertung qualitativ-empirischer Sozialforschung.* (pp. 249–254). Juventa.

Stephan, U. (2018). Entrepreneurs' mental health and well-being: A review and research Agenda. *Academy of Management Learning and Education*, *17*(3), 290–322. https://doi.org/10.5465/amp.2017.0001

Stephan, U., Rauch, A., & Hatak, I. (2023). Happy entrepreneurs? Everywhere? A meta-analysis of entrepreneurship and wellbeing. *Entrepreneurship: Theory and Practice*, *47*(2), 553–593. https://doi.org/10.1177/10422587211072799

Stollberger, J. (2019). Go with the flow, but keep it stable ? The role of flow variability in the context of daily flow experiences and daily creative performance. *Work and Stress*, *34*(4), 342–358. https://doi.org/10.1080/02678373.2019.1695293

Sumaya, I. C., & Darling, E. (2018). Procrastination, flow, and academic performance in real time using the experience sampling method. *Journal of Genetic Psychology*, *179*(3), 123–131. https://doi.org/10.1080/00221325.2018.1449097

Suresh Babu, S., & Dhakshina Moorthy, A. (2024). Application of artificial intelligence in adaptation of gamification in education: A literature review. *Computer Applications in Engineering Education*, *32*(1), 1–16. https://doi.org/10.1002/cae.22683

Swann, C., Jackman, P. C., Schweickle, M. J., & Vella, S. A. (2019). Optimal experiences in exercise: A qualitative investigation of flow and clutch states. *Psychology of Sport and Exercise*, *40*, 87–98. https://doi.org/10.1016/j.psychsport.2018.09.007

Sweetser, P., & Wyeth, P. (2005). GameFlow: A model for evaluating player enjoyment in

games. *Computers in Entertainment*, *3*(3). https://doi.org/10.1145/1077246.1077253

Szameitat, D. P., Alter, K., Szameitat, A. J., Darwin, C. J., Wildgruber, D., Dietrich, S., & Sterr, A. (2009). Differentiation of emotions in laughter at the behavioral level. *Emotion*, *9*(3), 397–405. https://doi.org/10.1037/a0015692

Szameitat, D. P., Szameitat, A. J., & Wildgruber, D. (2022). Vocal expression of affective states in spontaneous laughter reveals the bright and the dark side of laughter. *Scientific Reports*, *12*, 5613. https://doi.org/10.1038/s41598-022-09416-1

Taber, K. S. (2018). The use of Cronbach's Alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tausch, A., & Kluge, A. (2023). Teaming mit Robotern – Prinzipien nachhaltig menschengerechter Arbeitsgestaltung. *Zeitschrift Für Arbeitswissenschaft*, *77*(4), 478–489. https://doi.org/10.1007/s41449-023-00389-z

Tewes, C., & Tewes, S. (2020). Megatrends und digitaler Einfluss. In *Geschäftsmodelle in die Zukunft denken* (pp. 21–31). https://doi.org/10.1007/978-3-658-27214-2_3

Tian, Y., Bian, Y., Han, P., Wang, P., Gao, F., & Chen, Y. (2017). Physiological signal analysis for evaluating flow during playing of computer games of varying difficulty. *Frontiers in Psychology*, *8*, 1–10. https://doi.org/10.3389/fpsyg.2017.01121

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., & Nacke, L. E. (2016). The gamification user types Hexad scale. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 229–243. https://doi.org/10.1145/2967934.2968082

Uletika, N. S., Hartono, B., & Wijayanto, T. (2020). Gamification in assembly training: A systematic review. *2020 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, 1073–1077. https://doi.org/10.1109/IEEM45057.2020.9309791

Ulmer, J., Braun, S., Cheng, C. T., Dowey, S., & Wollert, J. (2022). Gamification of virtual reality assembly training: Effects of a combined point and level system on motivation and training results. *International Journal of Human Computer Studies*, *165*. https://doi.org/10.1016/j.ijhcs.2022.102854

Van den Broeck, A., & Parker, S. K. (2017). Job and work design. In *Oxford Research Encyclopedia of Psychology* (pp. 1–25). Oxford University Press. https://doi.org/10.1093/acrefore/9780190236557.013.15

van den Hout, J. J. J., & Davis, O. C. (2019). *Team Flow: The psychology of optimal collaboration*. Springer International Publishing. https://doi.org/10.1007/978-3-030-27871-7

van den Hout, J. J. J., & Davis, O. C. (2022). Promoting the emergence of team flow in organizations. *International Journal of Applied Positive Psychology*, *7*(2), 143–189. https://doi.org/10.1007/s41042-021-00059-7

van den Hout, J. J. J., Davis, O. C., & Buseyne, S. (2024). How to spark team flow over time. *Human Factors and Ergonomics in Manufacturing and Service Industries*, *August*. https://doi.org/10.1002/hfm.21048

van den Hout, J. J. J., Davis, O. C., & Weggeman, M. C. D. P. (2018). The conceptualization of team flow. *Journal of Psychology: Interdisciplinary and Applied*, *152*(6), 388–423. https://doi.org/10.1080/00223980.2018.1449729

van den Hout, J. J. J., Gevers, J. M. P., Davis, O. C., & Weggeman, M. C. D. P. (2019). Developing and testing the team flow monitor (TFM). *Cogent Psychology*, *6*(1). https://doi.org/10.1080/23311908.2019.1643962

van Gelderen, M. (2016). Entrepreneurial autonomy and its dynamics. *Journal of Applied Psychology*, *65*(3), 541–567. https://doi.org/10.1111/apps.12066

van Oortmerssen, L. A., van Woerkum, C. M. J., & Aarts, N. (2015). When interaction flows: An exploration of collective creative processes on a collaborative governance board. *Group and Organization Management*, *40*(4), 500–528. https://doi.org/10.1177/1059601114560586

Varhelahti, M., & Turnquist, T. (2021). Diversity and communication in virtual project teams. *IEEE Transactions on Professional Communication*, *64*(2), 201–214. https://doi.org/10.1109/TPC.2021.3064404

Vesa, M., Hamari, J., Harviainen, J. T., & Warmelink, H. (2017). Computer games and organization studies. *Organization Studies*, *38*(2), 273–284. https://doi.org/10.1177/0170840616663242

Wach, D., Stephan, U., Weinberger, E., & Wegge, J. (2021). Entrepreneurs' stressors and well-being: A recovery perspective and diary study. *Journal of Business Venturing*, *36*(5). https://doi.org/10.1016/j.jbusvent.2020.106016

Walker, C. J. (2021). Social flow. In C. Peifer & S. Engeser (Eds.), *Advances in Flow Research* (pp. 263–286). Springer. https://doi.org/10.1007/978-3-030-53468-4_10

Wang, B. (2018). The future of manufacturing: A new perspective. *Engineering*, *4*, 722–728.

https://doi.org/10.1016/j.eng.2018.07.020

Wang, L., Yang, Y., & Li, Y. (2019). Extending lead-user theory to a virtual brand community: the roles of flow experience and trust. *Asian Business and Management*, *0123456789*. https://doi.org/10.1057/s41291-019-00097-9

Wang, Q., & Yao, N. (2025). Understanding the impact of technology usage at work on academics' psychological well-being: a perspective of technostress. *BMC Psychology*, *13*(1), 130. https://doi.org/10.1186/s40359-025-02461-1

Wang, X., Goh, D. H.-L., Lim, E.-P., Vu, A. W. L., & Chua, A. Y. K. (2017). Examining the effectiveness of gamification in human computation. *International Journal of Human-Computer Interaction*, *33*(10), 813–821. https://doi.org/10.1080/10447318.2017.1287458

Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2018). Gamification of the work floor: A literature review of gamifying production and logistics operations. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 1108–1117. https://doi.org/10.24251/hicss.2018.139

Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2020). Gamification of production and logistics operations: Status quo and future directions. *Journal of Business Research*, *106*, 331–340. https://doi.org/10.1016/j.jbusres.2018.09.011

Weintraub, J., Cassell, D., & DePatie, T. P. (2021). Nudging flow through 'SMART' goal setting to decrease stress, increase engagement, and increase performance at work. *Journal of Occupational and Organizational Psychology*, *94*(2), 230–258. https://doi.org/10.1111/joop.12347

Wheeler, S., Passmore, J., & Gold, R. (2020). All to play for: LEGO® SERIOUS PLAY® and its impact on team cohesion, collaboration and psychological safety in organisational settings using a coaching approach. *Journal of Work-Applied Management*, *12*(2), 141–157. https://doi.org/10.1108/JWAM-03-2020-0011

Williamson, A. J., Drencheva, A., & Wolfe, M. T. (2022). When do negative emotions arise in entrepreneurship? A contextualized review of negative affective antecedents. *Journal of Small Business Management*, 1–62. https://doi.org/10.1080/00472778.2022.2026952

Williamson, A. J., Gish, J. J., & Stephan, U. (2021). Let's focus on solutions to entrepreneurial ill-being! Recovery interventions to enhance entrepreneurial well-being. *SSRN Electronic Journal*, *45*(6), 1307–1338. https://doi.org/10.2139/ssrn.3844146

Woehr, D. J., Loignon, A. C., Schmidt, P. B., Loughry, M. L., & Ohland, M. W. (2015). Justifying aggregation with consensus-based constructs: A review and examination of cutoff values

for common aggregation indices. *Organizational Research Methods*, *18*(4), 704–737. https://doi.org/10.1177/1094428115582090

Wojtasiński, M., Tużnik, P., Jankowski, T., & Cudo, A. (2025). Analyzing skill-challenge interaction and flow state: Insights from response surface analysis among board gamers. *Journal of Happiness Studies*, *26*(3), 1–26. https://doi.org/10.1007/s10902-024-00846-4

Wonders, M., Hodgson, D., & Whitton, N. (2025). Measuring flow: Refining research protocols that integrate physiological and psychological approaches. *Human Behavior and Emerging Technologies*, *1*. https://doi.org/10.1155/hbe2/6464984

Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups. *Science*, *330*(6004), 686–688. https://doi.org/10.1126/science.1193147

World Economic Forum. (2018). *Towards a reskilling revolution: a future of jobs for all*. https://www.weforum.org/reports/towards-a-reskilling-revolution

World Economic Forum. (2025). *Future of jobs report*. https://www.weforum.org/reports/the-future-of- jobs-report-2025/

Wu, J., Tangirala, S., van Knippenberg, D., & Shu, R. (2024). Only time will tell: How teams centralize their voice around competent members over time to perform better. *Journal of Organizational Behavior*, *October 2024*, 401–420. https://doi.org/10.1002/job.2842

Yang, C. M., & Hsu, T. F. (2020). Integrating design thinking into a packaging design course to improve students' creative self-efficacy and flow experience. *Sustainability*, *12*(15). https://doi.org/10.3390/SU12155929

Yen, W.-C., & Lin, H.-H. (2020). Investigating the effect of flow experience on learning performance and entrepreneurial self-efficacy in a business simulation systems context. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2020.1734624

Yousef, K. (2024). Intercultural communicative competence in virtual and face-to-face teamwork: A quantitative analysis of culturally diverse teams. *Organizacija*, *57*(2), 139–150. https://doi.org/10.2478/orga-2024-0010

Zakaria, N., Amelinckx, A., & Wilemon, D. (2004). Working together apart? Building a knowledge-sharing culture for global virtual teams. *Creativity and Innovation Management*, *13*(1), 15–29. https://doi.org/10.1111/j.1467-8691.2004.00290.x

Zenk, L., Primus, D. J., & Sonnenburg, S. (2021). Alone but together: flow experience and its impact on creative output in LEGO® SERIOUS PLAY®. *European Journal of Innovation Management*, *25*(6), 340–364. https://doi.org/10.1108/EJIM-09-2020-0362

Zimanyi, Z., & Schüler, J. (2021). The dark side of the moon. In *Advances in Flow Research* (pp. 171–190). Springer International Publishing. https://doi.org/10.1007/978-3-030-53468-4_7

Zubair, A., & Kamal, A. (2015). Work Related Flow, Psychological Capital, and Creativity Among Employees of Software Houses. *Psychological Studies*, *60*(3), 321–331. https://doi.org/10.1007/s12646-015-0330-x

9. Appendix

9.1. Appendix A: Study I

9.1.1. Interview guideline

The interview guideline serves as an orientation for the course of the interview. It is not rigidly followed and read out, but flexibly adapted to the course of the dialogue and the natural dynamics of the conversation. This means that blocks of topics do not have to be asked in the prescribed order if the interviewees have already mentioned other aspects that suggest a transition to a particular block of questions. The exact wording of the questions does not have to correspond exactly to the wording used in the interview, but serves as a guideline and orientation.

Introduction

Thank you for your participation in this interview. As part of my PhD project, I am investigating the flow experience of aspiring founders. In doing so, I would like to talk about the stages and activities of the start-up process in which flow is experienced, which factors promote flow, and which effects flow can cause. First, however, a few questions about yourself:

- Please tell me your age, gender and career background.
- In the last few months, you have been working on your own start-up idea (and have already founded a company). Please briefly describe your project and your start-up idea. Which industry does your start-up belong to?
- Have you ever started a business before?
- What are you currently working on?
- At what point in the start-up process are you right now? What have you already done and what are your next steps?
- How would you describe the startup process overall?

Flow experience

- Does the term flow experience mean anything to you? How would you define it for yourself?
- We define flow experience as the experience of being completely absorbed in an optimally demanding activity. During flow, the entire attention is focused on the task and the thoughts do not wander. The impression of merging with the activity is experienced.
- Have you ever had this experience at work? (If no: How would you imagine such a situation?)
- Can you remember a situation in which you experienced flow? Try to imagine yourself in that situation again. How did it feel?

Factors promoting or inhibiting flow

- In which stages of the process of working on your idea have you experienced flow so far?
- Can you give examples of activities in which you experience flow?
- What characterizes these phases / activities?
- Are there factors that particularly support you experiencing flow in these phases / activities?
- What factors prevent or interrupt your flow?

Consequences of flow

- What effects does the flow experience have on your work process?
- How does the work in flow influence the progress in the start-up?
- What changes can you observe compared to other work phases?
- When is flow helpful for working on the start-up idea?
- Are there also phases when flow is not helpful for the start-up process?

Team flow experience

(Questions to ask if the start-up is a group project)

- Do you experience flow only alone or also in a team?
- How would you describe the shared flow experience?

Factors promoting or inhibiting team flow

- In which work phases have you experienced flow together so far?
- Can you give examples of activities in which you experience flow in the team?
- What characterizes these phases / activities?
- Are there factors that particularly support you experiencing flow as a team during these phases / activities?
- What factors prevent or interrupt team flow?

Consequences of team flow

- What effects does the team flow experience have on working together as a team?
- How does team flow influence progress in start-up?
- When is team flow helpful for working on the start-up idea?
- Are there also phases when team flow is not helpful for the start-up process?

9.1.2. Codebook

Table 9.1: Codebook

Code	Definition	Example
Flow experience		
Focus of attention	No distractions, being focused, blocking out surroundings	For me personally, it's simply that I'm so completely absorbed in a work task that I can do it for quite a long time without getting very tired and completely blocking out all the other things that are going on around me […]
Fun	Enjoyment while performing a task	And with it, for me, also comes that it is fun.
Demand-skill-balance	A task is challenging, demanding, but not	[…] that it's such a perfect mix between effort in the tasks, but at the same time

	overwhelming; match between challenge and own skills	you can work on them well, they're not too exhausting that you can't master them at all and despair of them, and also not so boring that you completely disconnect, but rather such a relaxed work phase.
Autonomy	Sense of control, freedom to make decisions	That is, the flow, as I would describe it now, when snowboarding or surfing or kitesurfing, whatever, I have the bar in my hand, sort of, or board under your feet and I just ride and can decide.
Clear goals	Having clear objectives, defined goals in a task	What I do is that I have a clear goal in mind and can then totally focus on it and achieve it with great determination in my work in this situation.
Motivation	Feeling motivated, having energy for a task	Probably by flow you mean motivation and such a motivational drive that you maintain or so, that's how I would define it.
Feeling of fulfillment	Feeling of accomplishment and absorption when performing an activity	I am completely caught up in it.
Sense of time distorted	No feeling for time passing, time seems to pass faster in flow	Somehow I forget about time, or at least I don't look at the clock, because I think, I don't need that right now.
Feeling of progress	Feeling of being productive, making progress	It's work that goes easily right away. So it's just flow. It's flowing. It's moving forward, constructively.
Physical changes	Physical processes during flow, e.g. (not) feeling hungry, cold, etc.	[…] I can sit at my desk and for me it's really like, I forget to eat, I forget to go to the bathroom, my heating system doesn't work physically anymore.
Flow not known	Participant never heard of “flow”, can’t define it	[…] so honestly, this term doesn't really mean anything to me now, but I can imagine what you mean by it.
Flow situations		

Strategic tasks	Strategy of the start-up, planning, business plan development	Then I've definitely had that a couple of times now as well, in general when it comes to strategic planning.
Creative tasks	Design, social media post creation, prototype design, free writing	If I can also be a little creative in the process, or if I make a video and I can cut it and so on […]
Product development	Working on the product itself	Mostly when immersing in the product.
Systematic tasks	Searching for information, systematic processes, research work; accounting, finances	Personally, I really enjoy researching information and I'm totally absorbed in it when I'm able to gather information.
Technical tasks	Tasks with technological aspects	Yes, maybe a technological factor.
Practical tasks	Get to work, do things by oneself, produce something	So just sitting in a quiet room and designing or drawing or something like that and then maybe going to a machine and building the first prototype and stuff like that. That is a very nice experience.
No specific flow task	Flow in different tasks, type of tasks doesn’t influence flow directly	In the end, I don't think it's the task that matters, it's the feeling of creating something, and achieving it constantly in a positive sense.
Interest	Tasks that fit one's interests and abilities; that are meaningful and fun to do	Well, I would say all the things which I have much fun with. That makes it easier to stay in the flow.
Learning experience	Discovering new things, learning, new challenges, unknown tasks	So these are things like suddenly discovering something, seeing something, and also just being able to understand. I think for me flow is very often associated with "I understand something that I didn't understand before”.
Interaction	Teamwork, interacting with colleagues, clients, other people	Most of the time, it's actually in a team. Not alone.

Early stage of the start-up	Idea of the start-up still new, in development	Um, especially in the beginning. So the first, I can't put an exact number on it, but I would say about six months it was actually a continuous flow experience, because then everything really took off and because it was really exciting and I was completely immersed in it […]
Few flow in start-up context	Less flow situations in start-up compared to other domains	In the workplace [before], I think I've actually experienced that almost more than I have in the start-up business.
Factors conducive to flow		
Well-being	Being in a good mood, well-rested	And I have that very often when I feel well mentally […]
Task variety	Diversified tasks, different high requirements alternate	And from the task itself, I see in any case a certain variety. In other words, phases where it becomes more difficult. Phases where you can just rest a little bit mentally and put something together or so, and have a certain variety in any case.
Demand-skill balance	Balance between requirements and skills; not being bored, not overwhelmed	So I really think this point, as you said, with the excessive and insufficient demands, that's kind of incredibly important, that it's just neither of them.
Positive feedback	Affirmations, recognition from others, positive feedback from the task itself, first achievements	If you always have such small feelings of success coming from the outside, that you were mentioned somewhere, for example, or that someone approached you and even asked you about your idea.
Autonomy	Sense of control, freedom to make decisions	freedom to make decisions, no time limit, no constraints
Control	Knowing how things work, having control over the task	But from 100% control, I gain more control with every step I take. I know which direction I'm going. The.... The nebulosity is clearing and I'm getting an

		idea of where I'm coming out. I think that's an important aspect.
Meaningfulness	Belief in own idea and potential of the start-up; task is perceived as significant, meaningful	[…] when I realized, oh, that's something, where I really pursue my mission in life. So, with this I fulfill a little bit of what I want to change in the world.
Clear goals	Clear objectives within of a task, structure, knowing what to do	Maybe having a clear goal of what you want. Otherwise it's hard to get into it.
Moderate stress	A moderate pressure or mild stress, being excited, stage fright	And the other thing is kind of a light pressure, I would say. So, not the deadline due in two hours and you're screwed if you don't make it by then, but so that it doesn't hurt yet, it' s still okay just knowing you have to do it.
Learning experience	Discovering new things, learning, new challenges, unknown tasks	So first of all they [= the flow situations] are a possibility to learn. I just love to become smarter.
Environment	Influences from the environment, weather, workplace design, external factors	And environment, for me a room where I feel comfortable […] where I can create the atmosphere.
Equipment	Required resources, tools, programs available	Maybe that's all it takes, easy access to tools. So that whatever it is, whether it's a machine where you can make something out or whether it's a well-filled bank account where you simply order something to try it out.
Tranquility / no distractions	Quiet environment	Definitely being in a quiet area.
Work alone	Individual work, no interactions	So I work, for example, I already did before, even before the pandemic,… I have moments where I have to be all to myself. That's definitely an important factor, or simply my privacy. I also do not want to see anyone around me.

Interaction	Teamwork, interacting with colleagues, clients, other people	Teamwork in general, good teamwork, can contribute a lot to this.
Interest	Tasks matching own interests and preferences	Well, I think it's all a kind of related to my interests and strengths, if you take it that way.
Factors inhibiting flow		
Physical limitations	Physical constraints, limitations, lack of physical resources	Well, I guess like I said earlier: back pain.
Overload	High demands, when one does not know what to expect, unknown task, high difficulty, challenge	[…] when I'm overloaded. That is, when I'm stuck on something and don't know how to continue.
Failure	Things don't work out as planned, unexpected incidents; negative feedback	One has a certain schedule or structure in the day and when for me something starts to not work properly.
Lack of interest	Tasks for which enthusiasm or interest is lacking, when a task is not enjoyable	Or if it's tasks that I'm not at all comfortable with, that I don't enjoy at all, and then I kind of end up stuck in front of it.
Multitasking	Other tasks, e.g. regular job, academic studies, private life, multiple tasks at a time	Yes, I think the typical thing is that you have something else to do that is more important or at least has a high priority, so that you can't fully focus on it. So, I was still working in the hospital in parallel for quite a while when founding the start-up, and it's obvious that when you're working there, you're not able to focus on your goal, “flowing” in your start-up.
Distraction	Distraction in terms of noise, other people, environmental factors	So when I notice that something triggers me from the outside, then I either have to turn off the trigger or I surrender to the trigger, but then I'm no longer in the flow and do other things in parallel.

Dependence	Waiting for feedback, dependency on input from others; dependency on the functioning of technical equipment	So if I have to rely on others to do the work and it's not there or it's not right, then that puts me off.
Online communication / virtual meetings	Lack of personal contact, lack of goal-oriented direct communication	And as I said, I don't really like these video conferences in the team, especially when you have to discuss important topics.
Conflicts	Disagreements with co-founders, conflicts in the private sphere that affect	[…] disagreements in the team – you also have that sometimes – this breaks the flow.
Stress / pressure	Stressful work phases, lack of time	So time pressure is also not at all... so it's very counterproductive for that.
Consequences of flow		
Fun	Eenjoyment with the work, happiness, euphoria	Like hey that was actually really super fun to do and super interesting.
Motivation	Be encouraged, more motivated to continue working, less doubts, more willing to take risks	Well, that's great, of course, when you're more motivated then.
Energy	Energetic feeling, being very awake, urge to move, physical effects	Um, yeah, I'm just totally full of energy.
Satisfaction	Being satisfied with what one has achieved, seeing what one has accomplished; fulfillment	In the end, I think it just felt good to get satisfying results out of it. You're just very, very satisfied with what you've come up with and you feel good about implementing it.
Resilience	Be less likely to be thrown off track by failures, overcoming setbacks positively	And if I then have someone who calls me and is not so polite or so, then I am much, much more resilient against it. Then I think to myself, much more "well", whereas maybe in other situations, when I had no flow at all on that day, it hits me more.

Self-efficacy	Be more confident, trust in your own abilities	I somehow just get more accomplished, I'm more convinced of myself that I can do things […]
Better progress	Work more productively, work more efficiently, faster	Yes, it was just extremely productive, extremely good. So effective, efficient. Just in terms of the use of time, that I simply managed to get a lot done in a short period of time, I was incredibly productive.
Better results	Results get better (not only achieved faster, but also in terms of quality)	A much clearer mind, better ideas […]
Work more	No time limit, ongoing work for hours, no need for breaks	Overtime so/ yes. What does overtime mean? Forgetting the time. Well, you have to. To be honest, you don't think about it at all.
Master unpleasant tasks	Less procrastination, more motivation to work on unattractive tasks	[…] I still think that you avoid some things and when you're in the flow, that doesn't happen.
Learning experience	Continue to learn, develop further	I have learned a lot.
New ideas	Creativity, working on new ideas, innovative behavior	I get good ideas then. So I suddenly find solutions for things that, if I had sat down in a different way and tried to solve them... I probably wouldn't have come up with so much.
Teamwork	Engage with others in one's own flow, interaction, collaboration	And because there are two of us and we don't always have a flow at the same time, we of course have an effect on each other.
Perfectionism	Get lost in a task, try to make it perfect	Rarely, I would have said, perhaps it leads to the fact that one is too perfectionist in something like that, but that may also be personally driven, so that one says "okay, I want to do it this way or that way now" and then somehow one has gotten stuck into it.

Neglect of other tasks	Forget about / don't care about needs, demands, problems other tasks	[…] because you do a lot in a very short time, because you only think about the one thing and maybe neglect other things. But still, the experience is very positive.
Lack of communication	Rushing ahead, taking decisions to fast, don't communicate with team members during flow	Yes, also because in my opinion flow also leads to the fact that one rushes ahead a little bit and makes premature decisions, because you are in flow and then you just call a few people or settle things that are perhaps not planned or discussed in detail yet.
Focus	Strong focus of attention, suppress external factors	When you're in the flow, it's just relaxed and you're so extremely focused. And I think that sometimes it's also good to be torn out of this pure focus, because then it can of course also happen that you miss some things.
Team flow experience		
Flow can be experienced in a team	Participants confirm having experienced shared flow in the team, no further explanations	There are those moments when we experience flow as a team.
Interaction	Direct communication, active interaction, conversations	Yes, definitely just by interacting. So, the individual flow is really that you kind of sink into your figures and can block out everything around you. Of course, it's a different situation in the team because you have an incredible amount of interaction and it's a different way of working, a different feeling.
Engage with each other	Be aware of the others and their needs, strengths, habits, etc.	But it's very different because you're always interacting and therefore you're not that deep in the task because you're also focused on the other person and not just on the task.

Clear shared goals	Move in the same directions, work on the same objectives, have the same vision for the start-up	The fun thing is that everyone has the same vision for a topic at that moment, and that means we're all going in the same direction.
Focus of attention	Team members work in a focused way	One is simply more focused. You notice that very strongly when this flow experience occurs together.
Individual flow	Combination of individual flow experiences, can but does not have to be a joint task	So I had the feeling that in the team it's mainly about one idea sparking the other.
Team flow situations		
Creative tasks	Design, social media post creation, prototype design, free writing	With design issues, it was the case.
Strategic tasks	Strategy of the start-up, planning, business plan development	It's a bit similar with sales. Sales itself is not an area where I get into the flow, but the development of possible sales territories and target groups is something I also find very exciting in any case.
Product development	Working on the product itself	So it's also super exciting when you can really imagine what the product looks like and then finally have the product in your hand at some point. That's very cool and fun, because it's really about what you want to do in the end.
Interest	Tasks that fit one's interests and abilities; that are meaningful and fun to do	I think that's more of a question of topics. There are things that are more fun and things that are less fun.
Collaborative tasks	Work together on one task	Meanwhile also when we built our website, where the four of us sat together and met up.
Interaction	Discussions, talking to each other, meetings	And that's how it was, that we always communicated with each other throughout the day. Person A does this, person B does that, person C and D do

		that together. That was a very fulfilling experience or a good feeling […]
New tasks	Novel tasks, engaging in new things together	So especially when it's new things, when there's new things coming up, we're getting involved in something new at this time.
Factors conducive to team flow		
Well-being	Team members in a good mood, well-rested, psychically and physically in good shape, no conflicts in the team	Just, have everyone slept well, did everyone eat well?
Clear goals	Clear objectives within of a task, structure, knowing what to do	So I also believe a clear goal, okay, we're now going to discuss this and that for an hour, that the task is clearly defined.
Moderate stress	A moderate pressure or mild stress, being excited, stage fright	Then this, I'll call it positive stress before the launch, as I said, is definitely something that has brought us forward.
Autonomy	Sense of control, freedom to make decisions	And when there is a phase where we are both very excited about our plans, about our startup, get very involved in it, mentally as well, and also both have the capacity to do so, because we are both also people who still have a lot to do outside of the startup […]
Positive feedback	Affirmations, recognition from others, positive feedback from the task itself, first achievements	When we then took this step and also contacted everyone and also received the first feedback and then also the positive feedback, that was such a point.
Meaningfulness	Belief in own idea and potential of the start-up; task is perceived as significant, meaningful	And since then, however, it is there and there is also the enthusiasm, belief, inner conviction, intrinsic conviction, passion, etc. […]
Personal contact	Meetings in person (instead of online communication)	So I think in this case one factor was that we saw each other in person after a long time, that it was something special,

		so that motivated us in this case and that was simply an influencing factor.
Environment	Influences from the environment, weather, workplace design, external factors	And then it was also the environment. I'm very sure that it was extremely because of it. […] [In the co-working space] they have different rooms for co-working or for seminars or something like that, and the rooms are especially designed to stimulate creativity, and that really works.
Tranquility / no distractions	Quiet environment	Definitely being isolated from outside influences, whether it's in a co-working space, going into a team room, that you're isolated, being isolated from also electronic influencing factors, cell phone and so forth.
Interest	Tasks matching own interests and preferences	[…] it just depends extremely on how enjoyable the tasks are or not.
Common basis	Matching of prior knowledge, expertise, skills, abilities of team members, joint work on specific task is possible	And then also, what it comes down to in the end, is what competencies do the team members bring with them?
Commitment	Shared goals, identification, pleasure of working together	[…] if you just have a healthy environment with people who are as different as possible, but still all have a desire to work on the same topic.
Team spirit	Knowing each other, knowing and thus accepting each other's strengths and interests, nonjudgmental interactions, open atmosphere, supporting each other, trusting each other	So there really has to be a deep fundamental trust […]
Factors inhibiting team flow		

Physical limitations	Physical constraints, limitations, lack of physical resources	But I definitely think if you're stressed, then you shouldn't make important decisions, [or] when you're kind of hungry, tired.
Overload	High demands, when one does not know what to expect, unknown task, high difficulty, challenge	Yes, I could imagine, I don't know exactly how you could describe it, but if you don't really get into the activity […]. Then I think it's hard to get involved. So there could also be activities where many people are not so inspired and just can't think of anything. And then I think it becomes difficult.
Routine	Lack of new challenges, getting used to tasks that are getting boring with time	Sometimes, when you're in the daily routine or you're not making good progress on something, on an existing issue, then I notice that it leads to fewer experiences like this.
Failure	Things don't work out as planned, unexpected incidents; negative feedback	Um. Yes, of course, when you realize that maybe in [city A], for example, it's going really well and in [city B] it's not going so well. That takes away the flow, or it has taken away the flow a bit, because [city B] hasn't developed as well as we expected.
Lack of feedback / result visibility	Progress in small steps whose result is not immediately apparent in the big picture, little feedback from the task	And I notice that it doesn't quite work that way, because we don't achieve these steps, this result in a way that is visible step by step, but rather it is somehow very fragmented.
Multitasking	Other tasks, e.g. regular job, academic studies, private life, multiple tasks at a time	We also have the problem, of course, that not everyone always has time. Two of our co-founders also have full-time jobs. So it's difficult, let's say, to take the whole day. But when we do, it always has a positive effect for us.
Dependence	Waiting for feedback, dependence on input from	I think with the website in particular it was the case that we simply couldn't

	others; dependence on the functioning of technical equipment	continue in the meantime and first had to solve certain problems in order to implement the things further and then it could only be done by one person.
Distraction	Distraction in terms of noise, other people, environmental factors	Yes, noise in any case. Or anything that is simply annoying in some way. Such common disruptive factors.
Online communication / virtual meetings	Lack of personal contact, lack of goal-oriented direct communication	And best of all, I have to say, in personal contact with people, virtually I have never experienced that a good flow has developed, rather it was always very exhausting and stressful.
Conflicts	Disagreements with co-founders, conflicts in the private sphere that affect	Well, disagreements, as well. Half a year ago, there was a really critical situation, because we had disagreements in the team. That definitely killed the flow for a few weeks.
Stress / pressure	Stressful work phases, lack of time	So somehow, on an evening before a working day or so I think, it wouldn't have gone like that. So that you also really – yes, of course, you can also look at it negatively that it was on a weekend day – but I think we also need that that it was the whole day. Enough time, so again this no time pressure.
Lack of common basis	Different levels of knowledge, different assumptions; different levels of commitment to the start-up idea	When one is more convinced than the other. Let’s say when the common mission is disrupted.
Consequences of team flow		
Satisfaction	Being satisfied with what one has achieved, seeing what one has accomplished; fulfillment	I think the most important thing is joy and hope.
Motivation	Be encouraged, more motivated to continue	And I think all the participation of the others also motivated the others again,

	working, less doubts, more willing to take risks, motivate each other	because "oh great, now there's a totally fantastic idea from this one and that one, awesome".
Better progress	Work more productively, work more efficiently, faster	Being focused and in the flow together, then you can achieve quite a lot.
Better results	Results get better (not only achieved faster, but also in terms of quality)	In the end, I would say, definitely a better work result […]
Team spirit	Growing closer as a team, trust; communication, mutual interaction	Well, at that moment, it feels like we're getting closer again in the team, I'd say, or more closely connected, that's what I would call it now, from a team perspective. And that you just feel more like a unit, or this team spirit, that we shape and are the company.
Collective efficacy	Have confidence in oneself as a team and the team's skills	And I think it has this effect above all, that you get the feeling of all the things you can accomplish.
Vulnerable to setbacks	Being torn out of team flow even harder experience to handle for a team, difficulties in getting back to a positive state	However, if you're always in this flow mode, things are going very well, you're making progress, then you can also become dissatisfied quite quickly if small things now set you back again, for example.
Focus	Strong focus of attention, suppress external factors	Um, maybe if it actually goes into too much detail on specific things.

9.2. Appendix B: Study III

Figure 9.1: Introduction to Mural (Introduction 1)

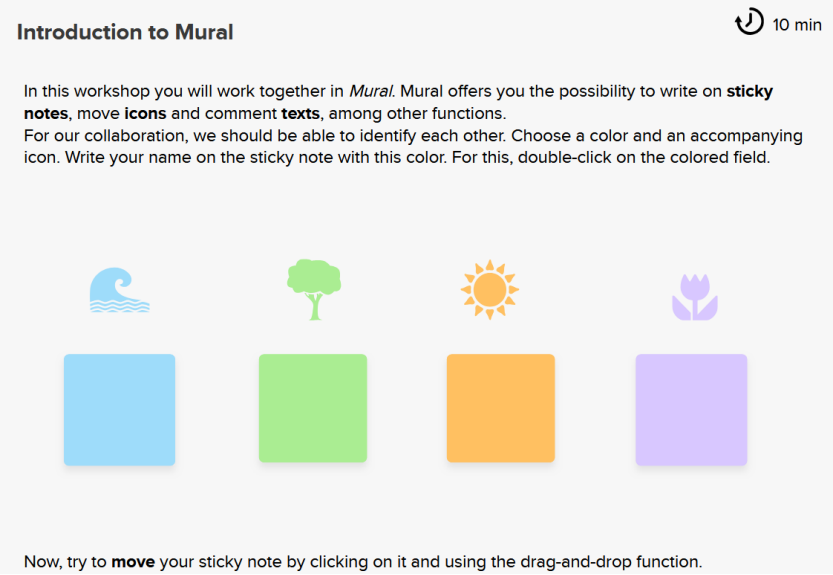


Figure 9.2: Introduce yourself (Introduction 2)

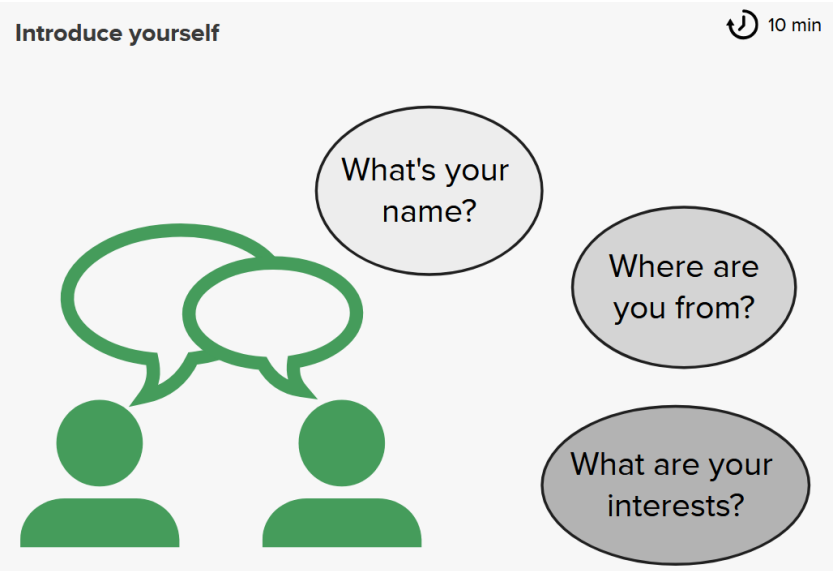


Figure 9.3: Two truths and a lie (Task 1)

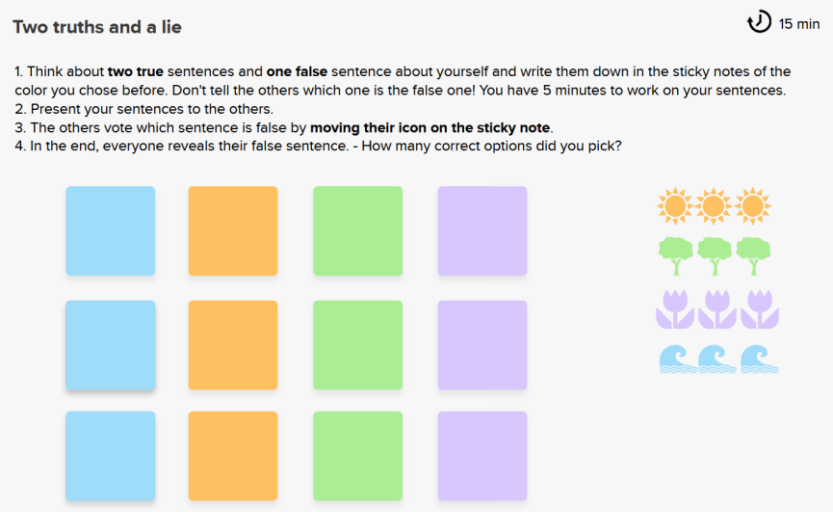


Figure 9.4: LEGO® warm-up: Let's build a bird (Task 2)

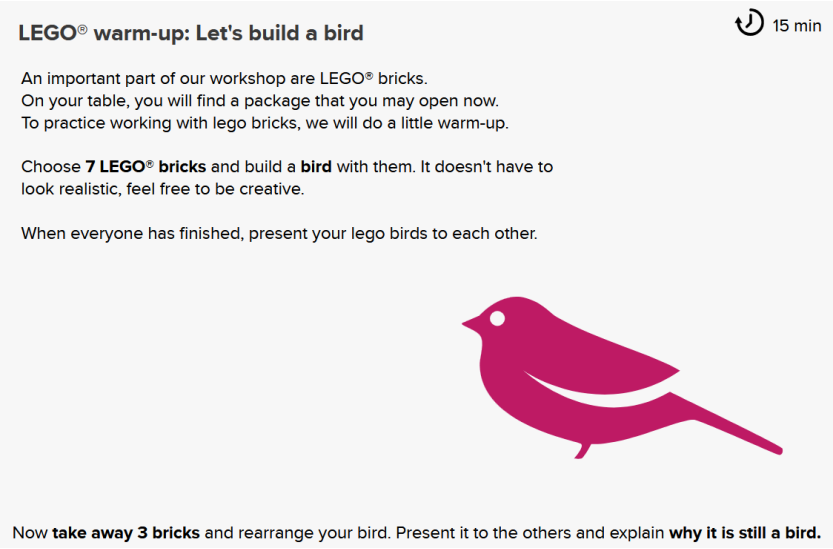


Figure 9.5: The UN sustainable development goals (Task 3)

The UN sustainable development goals 35 min

Now it's time for the development of your start-up idea. Your start-up should be **sustainable** - that means it follows one of the **Sustainable Development Goals (SDGs)**. The Sustainable Development Goals (SDGs) are goals that the United Nations set for the development of our society and environment. In creating a sustainable start-up, your ideas should be inspired by these goals.

Below you will find an overview of the different goals.

Each team member has a **reader** in front of them with information on the different goals. Read through the goals, choose 2-3 goals that seem the most interesting to you and explain to the other members in the team what your chosen goals are about and why you chose them.

Now that you have learned about the SDGs your team members have chosen, you should **select the goals that are most relevant** to you as a team. Move your personal **icon** to the goals that you find most interesting and important.

When everyone has assigned their icons, discuss which one is most important to you as a whole group. Choose **one SDG as a problem to solve that you want to focus your start-up on.**

Write your start-up's SDG in the box:

Explain why you chose this SDG for your start-up.

Figure 9.6: Golden Circle (Tasks 4 and 5)

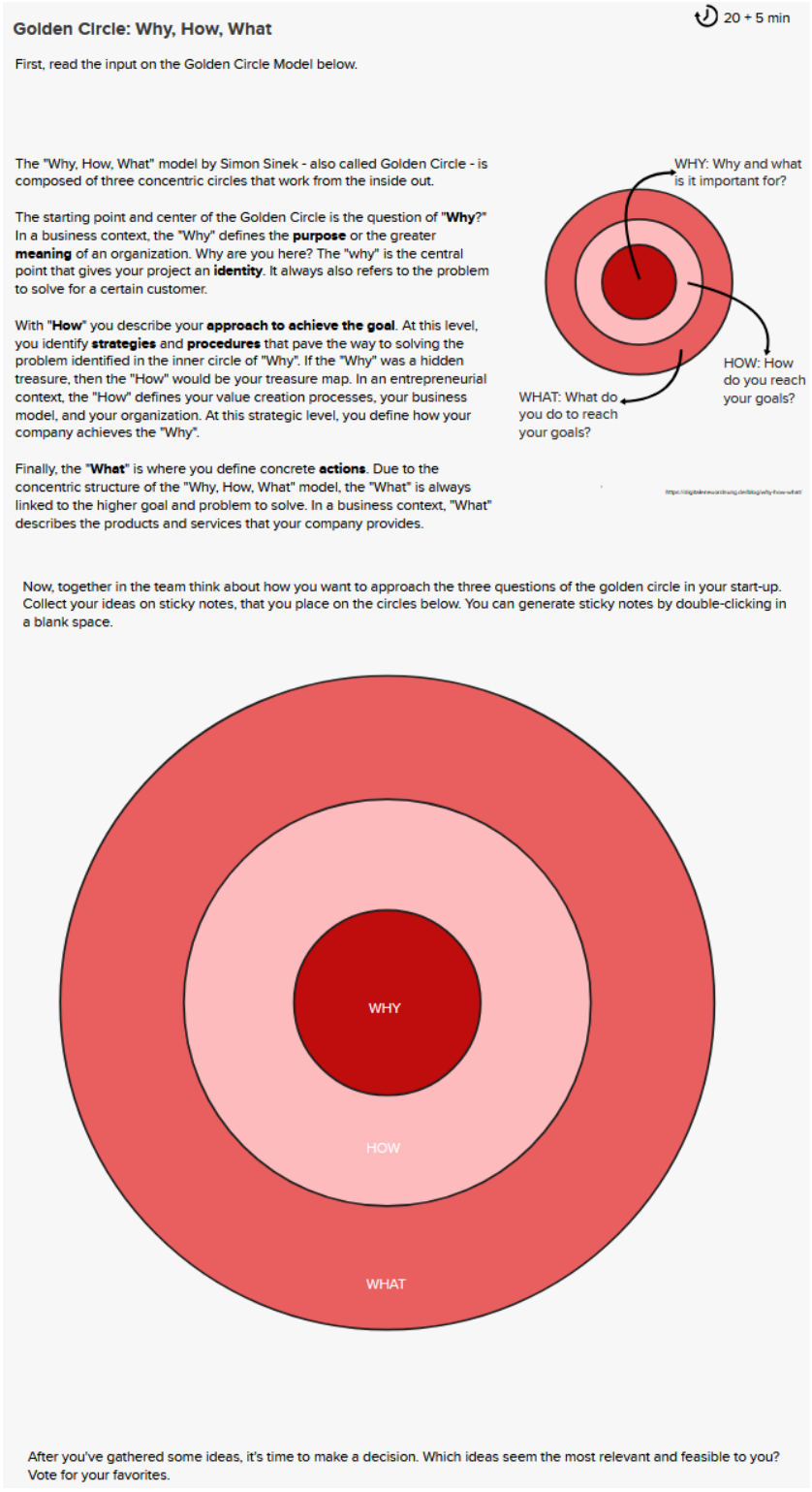


Figure 9.7: LEGO®: Build a mascot (Task 6)

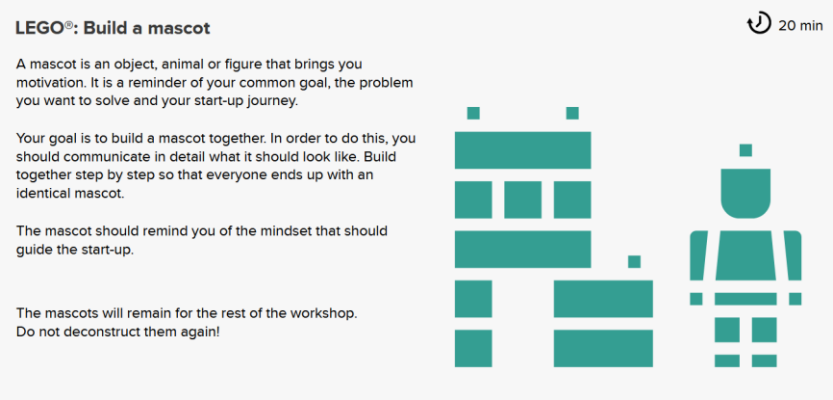


Figure 9.8: Your prototype (Task 7)

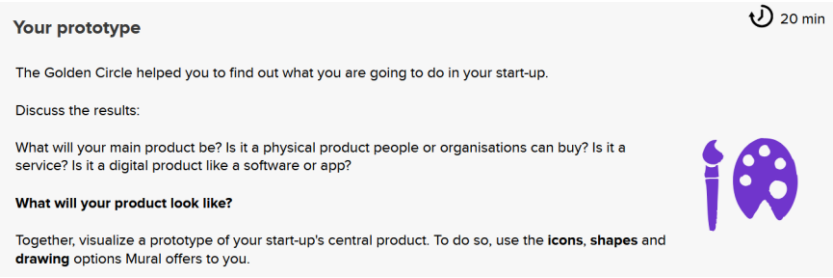


Figure 9.9: The story of your start-up (Task 8)

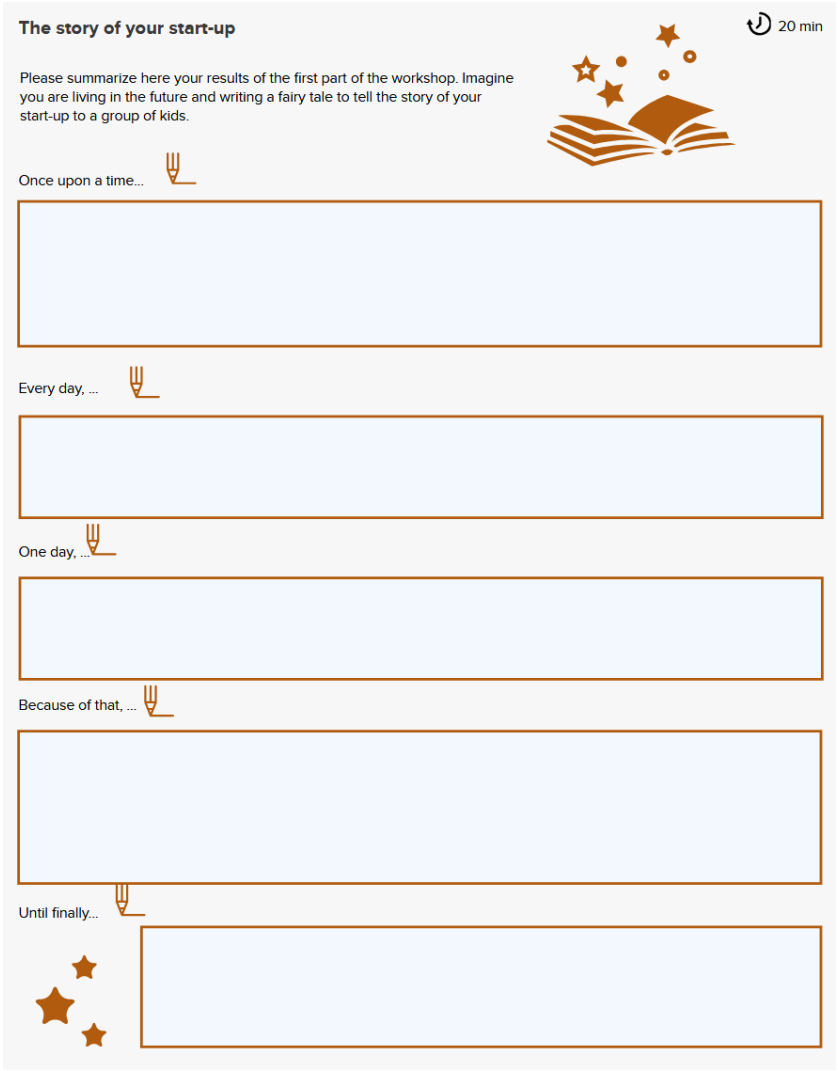


Figure 9.10: Find a name for your start-up (Task 9)

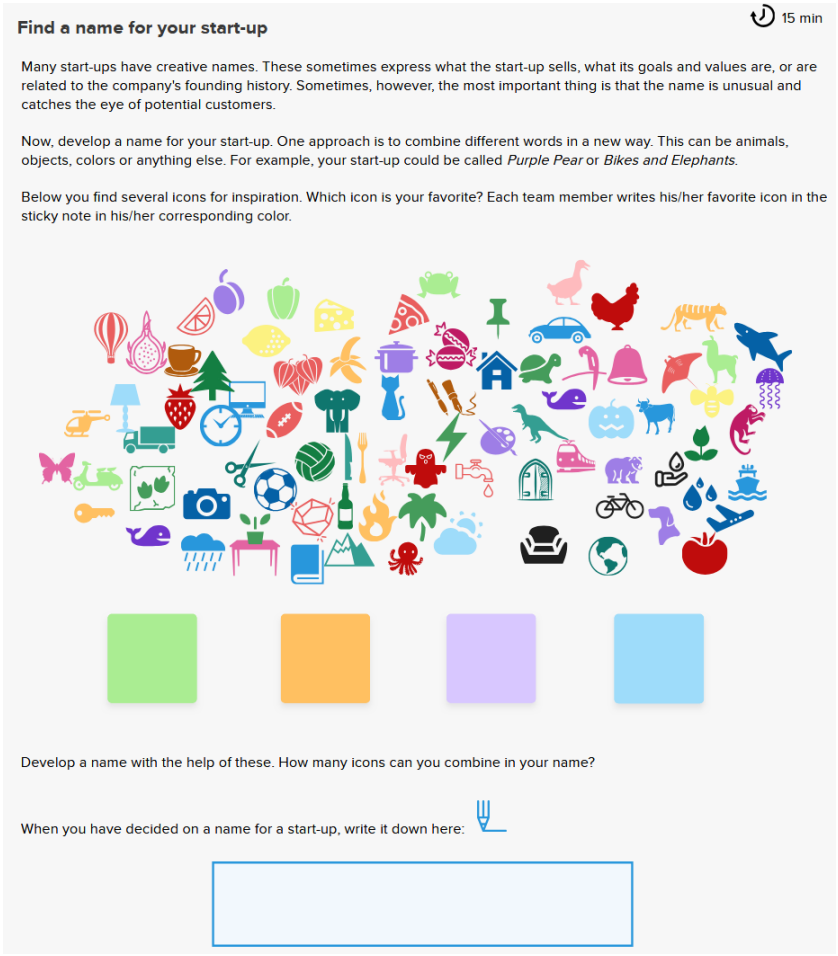


Figure 9.11: Resources (Task 10)

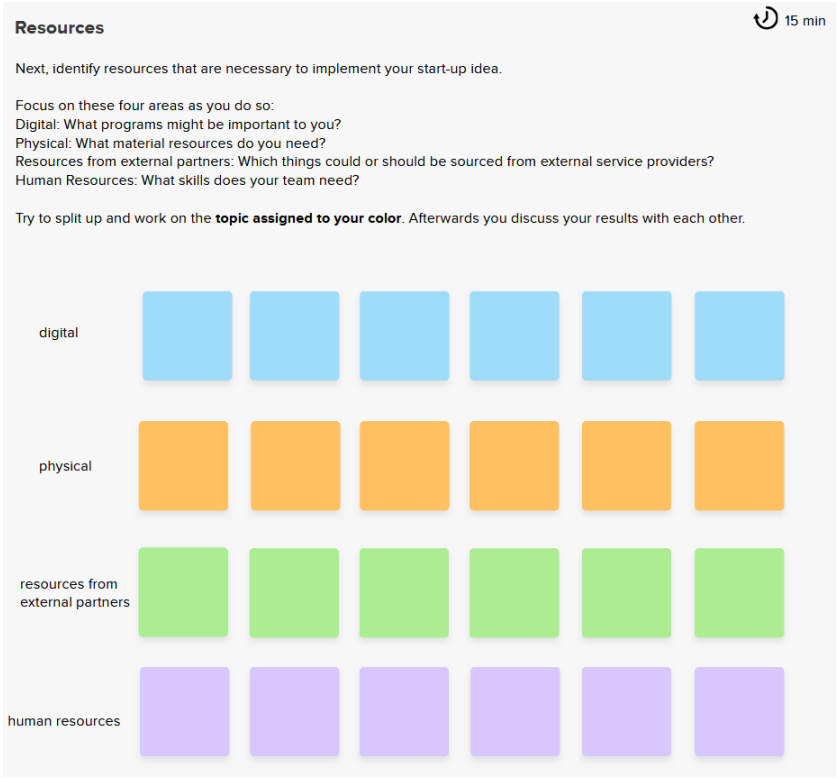


Figure 9.12: LEGO®: Create a buyer persona (Task 11)

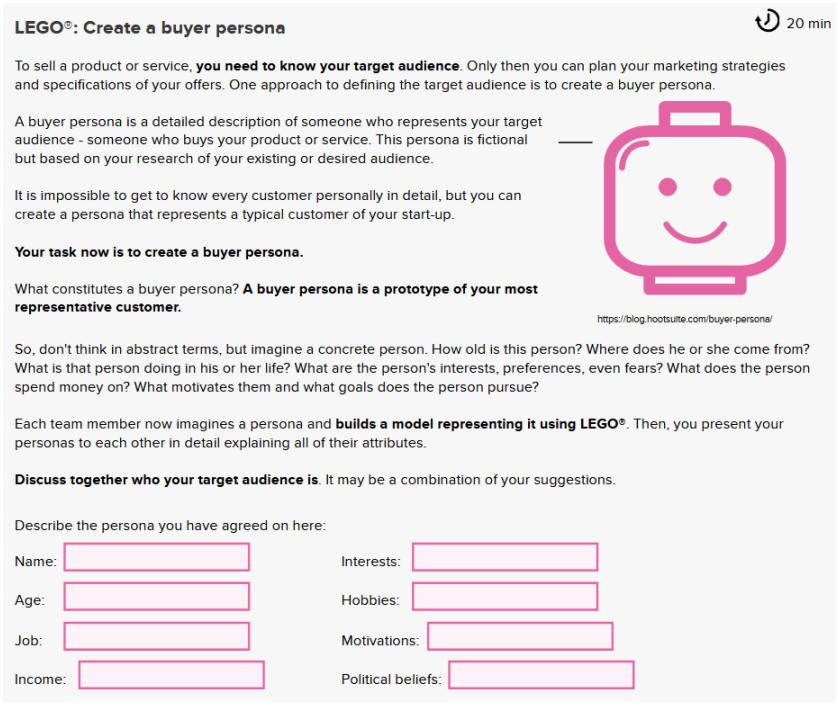


Figure 9.13: Channels and customer relationships (Task 12)

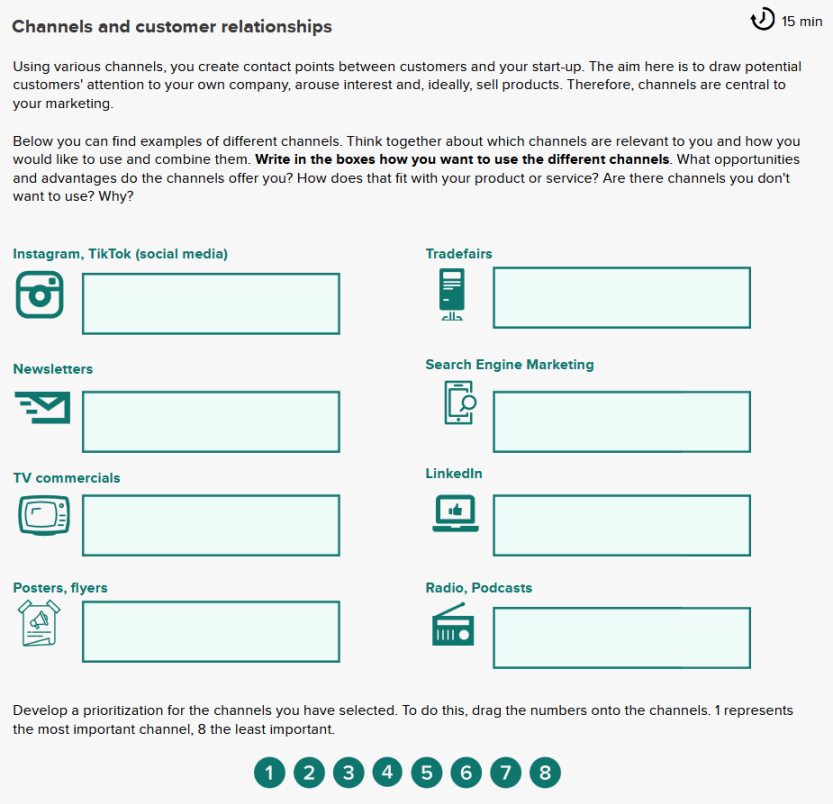


Figure 9.14: LEGO®: Design a logo (Task 13)

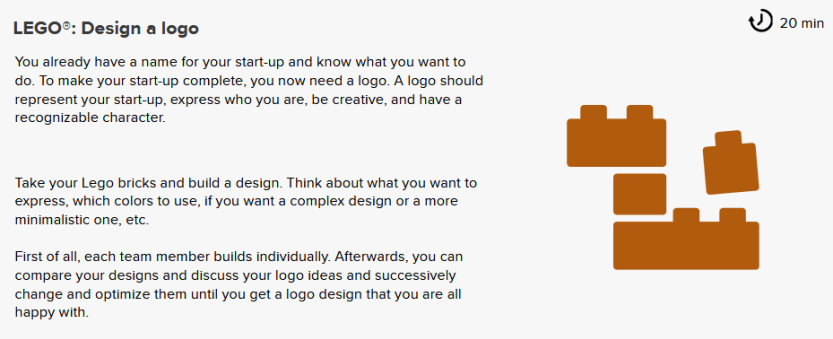


Figure 9.15: Elevator pitch (Task 14)

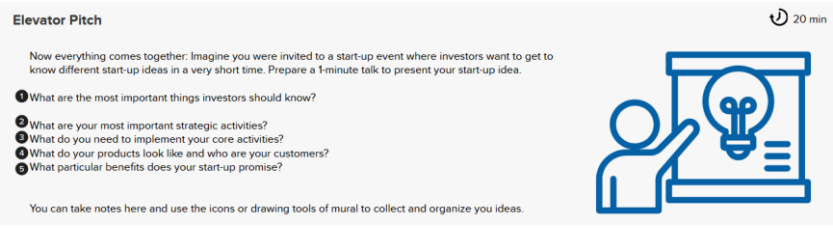
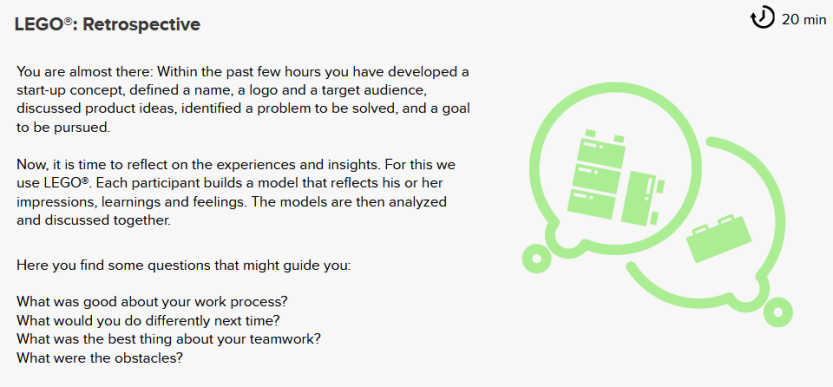


Figure 9.16: LEGO®: Retrospective (Task 15)



9.3. Appendix C: Additional analyses

Table 9.2: Differences between participants in Germany and Poland in the communication parameters and team flow

		Mascot task				*Prototype* task			
		t	*df*	*p*	*d*	*t*	*df*	*p*	*d*
Count	Total speech actions	-0.65	92	.517	-.13	-0.26	91	.793	-.06
	Total interruptions	1.03	92	.152	.21	0.17	92	.866	.04
	Positive interruptions	0.60	92	.549	.12	0.12	92	.905	.03
	Negative interruptions	1.74	74.6	.094	.36	0.33	92	.741	.07
	Total questions	0.53	92	.601	.11	0.96	92	.342	.20
	Open questions	-0.28	92	.780	-.06	0.45	92	.654	.09
	Closed questions	1.05	92	.298	.22	0.63	92	.530	.13
	Laughter	0.75	92	.455	.16	-0.20	92	.841	-.04
Duration	Total speech actions	-2.03	92	.046	-.42	-0.28	91	.780	-.06
	Total interruptions	1.00	92	.319	.21	0.90	92	.370	.19
	Positive interruptions	0.34	92	.733	.07	1.01	92	.317	.21
	Negative interruptions	1.27	92	.206	.26	0.26	92	.795	.05
	Total questions	0.51	92	.609	.11	0.94	92	.176	.19
	Open questions	0.01	92	.996	.00	0.60	92	.547	.13
	Closed questions	0.65	92	.259	.13	0.82	92	.413	.17
	Laughter	0.50	92	.622	.10	-0.16	92	.870	-.03
Team flow experience		-0.12	85	.904	-.03	-0.19	84	.848	-.04

Table 9.3: Differences in mean team flow between LEGO® tasks and non-LEGO® tasks of the whole workshop day

LEGO® tasks		non-LEGO® tasks				
M	*SD*	*M*	*SD*	*t*	*df*	*p*
80.77	12.83	75.27	14.82	6.57	104	<.001