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Evaluation of Reflective Behavior in Agile Product Development: a Theoretical Categorization to Evaluate the Effectiveness of Retrospectives in Engineering Teams

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Abstract: Reflection is an enabler for team learning and continuous adaption of used processes and methods. Although reflection is an integral part of agile development many engineers lack an understanding of reflective behavior and reflection competencies. In this paper, we perform a Case Study to analyze and measure the impact and outcome of structured reflection in engineering teams. The underlying question is whether the effectiveness of retrospectives can be derived from certain reflection behaviors and outcomes. Based on the findings we propose a theoretical categorization for reflection outcomes.

Keywords: Product Development, Collaborative Design, Design Teams, Reflective Behavior, Retrospective

1 Introduction

Due to the increasing complexity of new requirements in the engineering environment, engineering procedures have to be changed quickly, and engineers must adapt what they have already learned or learn new things. Engineering tools, engineering methods and engineering teams change quickly and therefore effective adaptation processes must be implemented. The ability to reflect and learn from experiences is one of the most effective tools in learning processes (Davis et al., 2003). Communication in small teams and thus regular retrospectives to adjust activities in engineering design and factors that influence targeted or non-targeted retrospectives are key elements for successful reflection. Retrospectives act as a catalyst for change, trigger action, enable learning by the whole team and go beyond checklists for project audits or superficial project closures (Derby et al., 2006). Human communication is a decisive factor for efficient collaboration at the key interfaces in engineering processes. Reflection on communication is necessary to trigger active reflection on communication and to reflect the perception of a particular situation by the individuals working together at the interfaces (Maier et al., 2006). To solve potential problems within an engineering team, observation is generally considered to be one of the elementary methods for recording certain behaviors, and their frequency and thus analyzing complex behavioral processes. Observation can be used as a method for recording activities in engineering processes. (Badke-Schaub and Frankenberger, 2004) Retrospectives, for example, can be used as a tool to improve engineering processes or promote the learning process and influence the working environment. (Jovanović et al., 2016) This paper aims to analyze and measure whether structured and moderated retrospectives can positively impact the learning process of engineering teams and whether the effectiveness of retrospectives can be derived from certain reflection behaviors (reflection patterns). For this purpose, 6 structured and moderated retrospectives in engineering teams (2 - 6 engineers per meeting) from industrial practice are conducted and evaluated with the help of tools developed from previous work: Combination of the tool for carrying out structured reflection “Reflection Canvas”, c.f. Ammersdörfer et al. (2022) and coding scheme for measuring reflective behavior “reflAct4teams-Short”, c.f. Ammersdörfer et al. (2023). Subsequently, the outcomes for follow-up activities (next sprints and retrospectives) generated during the planning phase are identified and categorized based on theoretical learning constructs to carry out an initial quality assessment of the measures for the outcomes of retrospectives.

2 Importance of reflection in agile product development

Reflection is a conscious and goal-oriented process in which teams recapitulate their experiences from various (engineering) situations (e.g., recapitulation of past actions, root cause analysis, search for solutions, decisions, etc.) and re-evaluate them in the current context to adapt future (engineering) actions. Therefore, in addition to the actual reflection, adaptation processes are also central to the concept of team reflexivity. (West, 2000) Accordingly, an effective reflection process requires a systematization of the processes and people involved in reflection, the consideration of different time horizons (e.g., past, present, future), and reflection in different dimensions (e.g., social, process, goal) (Weixelbaum, 2016). Davis et al. (2003) also emphasize the importance of the reflective skills of engineers and that it is important to teach and learn them. One tool that can support reflection in product development and in the implementation of new engineering methods, is the retrospective. Retrospectives are team meetings in which, for example, current or past engineering design activities are reflected upon. These are considered as an important component of agile working principles (e.g., in the SCRUM framework). (Dingsøyr et al., 2018) A retrospective meeting embodies the reflection-on-action, in which the teams reflect after completing their sprint (Andriyani et al., 2017). In various literature-based works and related models and procedures for the successful implementation of retrospectives, it is pointed out that reflection results must be evaluated from different perspectives. For example, West's (1994) Team-Reflexivity-Model considers both the "Task Reflexivity" dimension and the "Social Reflexivity" dimension. In the Reflection Canvas according to Ammersdörfer et al. (2022), the reflection procedure is carried out in a structured manner according to 3 phases (1. Feedback, 2. Reflection, 3. Planning) and reflection itself is divided into different dimensions (social, process, goal) and levels (strategic, tactical, operational). Andriyani et al. (2017) differentiate between three levels of reflection (reporting and responding, relating and reasoning, reconstructing) and emphasize that reflection should be structured to derive positive effects on learning success and the improvement of engineering activities. Especially in an agile context, the focus is on the team, cross-disciplinary collaboration, and the exchange of knowledge to learn from each other, and therefore the learning effects of reflection outcomes should be transparent for the team.

2.1 Evaluating reflection in agile product development

In literature, there is no consensus about appropriate methods for evaluating reflective behavior in retrospectives. The definition of reflection and retrospectives can vary depending on the research domain and application field, which complicates uniform measurement. There are two basic approaches to evaluating retrospectives in practice, namely structural and process-analytical methods. Structural analytical methods capture a 'snapshot' of the current situation (Kauffeld et al., 2018). This implies that conclusions about the outcomes of retrospectives are primarily drawn based on questionnaires and thus on subjective statements from participants. This approach allows us to differentiate between process-related, outcome-related, task-related, and social-related aspects of reflection (Figl and Saunders, 2011; van Knippenberg et al., 2006). The advantages of this approach include the ability to capture rapid feedback with minimal participant effort in completing the questionnaire. However, structural analytical methods merely reflect the subjective opinions of participants, which may be influenced by memory effects and similar biases (Salvia and Meisel, 1980). One way to introduce more objectivity into evaluation is through process-analytical methods. This analysis prioritizes the process, focusing particularly on the actual behavior of participants (Kauffeld and Lehmann-Willenbrock, 2012). Consequently, neutral data on the specific behaviors of participants in different conversational situations is captured, independent of participant subjectivity. Ideally, these data are based on a coding scheme facilitating consistent and uniform behavior analysis. Examples of such coding schemes include act4teams (a comprehensive coding scheme for the general analysis of work meetings and teamwork; Kauffeld and Lehmann-Willenbrock, 2012) or reflAct4teams-short (Ammersdörfer et al., 2023), as an adapted shorter version focusing primarily on reflective behavioral components. Overall, several methods exist to evaluate reflection. However, the relevance lies in how the evaluation can be utilized for further optimizing retrospectives. The suitability of an evaluation method is therefore primarily shown in the optimization potential (the planned measures and adjustments are successfully implemented in the next sprint), which it contains as needed, where both structural and process analytical methods may prove suitable.

2.2 Measuring effectiveness of retrospectives in agile product development

To measure the effectiveness of retrospectives, it is necessary to know how a retrospective meeting is structured (e.g., define agenda, duration, framework data, reflection objectives, activities in advance), which dimensions must be addressed in a retrospective to reflect successfully, and which outcome are expected from the retrospective (c.f. left part in Figure 1). Marshburn (2018) has analyzed the effectiveness of retrospectives in various literature sources and found that conducting retrospectives helps teams to make sustainable progress in projects and activities, respond to changes, and implement measures for improvement. Moreover, retrospectives enable communication problems to be solved by sharing knowledge across disciplines. To conduct an effective retrospective, it is important to focus on broader areas and multiple dimensions in the reflection, rather than just on individual, specific aspects of the team such as individual work processes or methods (Marshburn, 2018). When measuring the effectiveness of reflection, the reflexivity of engineering teams should be considered too, because following the concept of "Team Reflexivity" (West, 1994), this model contributes to the possibility of learning and development (self-development) of teams and thus to positive effects on team performance (c.f. middle section in Figure 1). It defines two fundamental dimensions for successful teamwork: Task Reflexivity (focus on task and goal orientation) and Social Reflexivity (focus on collaboration and conflict resolution within the team). Schippers et al. (2012) address the hypothesized direct (influence on team learning, final team performance) and indirect (influence on initial team performance) effects of team reflexivity (c.f. right part in Figure 1). For teams, retrospectives are an opportunity to improve product quality, productivity, and estimation skills, but this requires both empiricism and agility (Erdoğan et al., 2017). From the above references and their findings on measuring the effectiveness of retrospectives, the following **types of effectiveness**, that retrospectives deliver, can be summarized:

- **Team effectiveness:** Retrospectives support teams to improve their collaboration and resolve conflicts. (Proposed measured variables: *Team performance, degree of collaboration, degree of heterogeneity in teams*)

- **Process effectiveness:** Through regular retrospective analysis of development activities, engineering teams can recognize which activities have worked effectively or brought sustainable progress in the project or need to be improved. (Proposed measured variable: *Degree of target achievement*)

- **Learning effectiveness:** Retrospectives promote continuous learning within the team and the personal development of team members. (Proposed measured variables: *Learning success*, *competence growth*, e.g. measuring with the Learning Transfer Evaluation Model according to Thalheimer (2018))

- **Problem-solving effectiveness:** Retrospectives support engineering teams in identifying changes, uncertainties, and problems, reacting to them, and implementing concrete measures for improvement. (Proposed measured variables: *Process quality, customer satisfaction, rate of improvement*)

- **Communication effectiveness:** Retrospectives can avoid communication problems by sharing knowledge across disciplines and improving communication within the team. (Proposed measured variables: *Team performance, Frequency of conflicts)*

Figure 1 summarizes the procedure for the evaluation of reflection results and the focus of this paper on the social dimension of reflection and the planning of concrete measures for the next sprint based on the literature. Furthermore, the model and the impact on the evaluation of team success are shown.

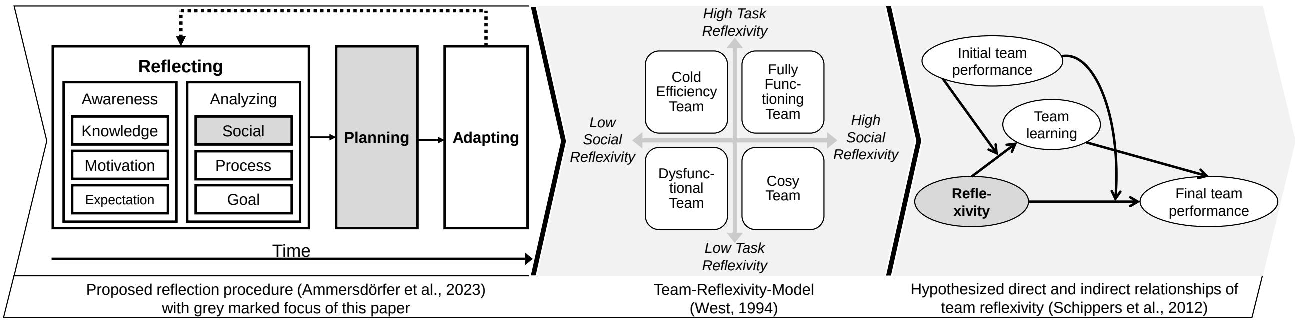

Figure 1. Proposed procedure for evaluation reflection results according to Ammersdörfer et al. (2023); Schippers et al. (2012); West (1994)

An important aspect of retrospectives is the outcome of retrospectives and the added value of the generated outcomes. Table 1 provides an overview of the proposed outcomes of retrospectives according to Rubin (2013) and gives engineering examples from the Case Study of this paper.

Table 1. Overview of outcomes of retrospectives in the engineering context according to Rubin (2013)

Outcome of retrospectives	**Description of the outcome**	**Application examples in the engineering context based on the Case Study**
Improvement measures	Concrete improvement measures that the team wants to implement in the next sprint.	Create more links to requirements by linking model descriptions to the requirements in the system definition and design phase of the engineering process.
Awareness of a backlog of insights	Awareness of a backlog of insights that the team could not tackle in the following sprint, but only in the future.	Expansion of the level of detail of the influences (e.g. risk assessment) on the functions of a system in the further phases of the engineering process.
Improved team cohesion	Intensive and improved collaboration and cooperation within the team and across interfaces.	Communication with interfaces such as cost calculation or software engineering in the acquisition phase of the engineering process.

In most cases, the outcomes of a retrospective should be seen as input for the subsequent sprints. Thereby the outcomes are also relevant for the subsequent retrospectives, which should take place (iteratively) after each sprint to adapt or change the planned measures (e.g., adaptation of development methods or development activities) in the adaptation and learning process. These adapted activities should then be applied in the next sprint and reflected on again, to evaluate the success of the adaptation. Reflection in the broadest sense therefore offers an opportunity to be used as an enabler for change. In particular, the specific definition and planning of measures are crucial for the success of reflection, since planning is fundamentally considered an indispensable prerequisite for individuals, teams, and organizations to act in a targeted manner and to be successful. It is also known that research has identified significant heterogeneity in the effects of team planning (teams that achieve positive effects, but also teams that achieve negative effects in the relationship between planning and team performance), so the assumption that planning in teams is important for the effective pursuit of goals and the achievement of successes do not always have a sustainable impact (Konradt et al., 2023).

2.3 Research Objectives and Procedure

To support engineers in their engineering activities and to make the reflection process more effective, it is necessary to integrate reflection into the design process and to ensure the effectiveness of reflection. Building on the first separately considered evaluations of the reflection tool for structured reflection, the "Reflection Canvas" (Ammersdörfer et al., 2022) and coding scheme for measuring reflective behavior "reflAct4teams-short" (Ammersdörfer et al., 2023) from previous work, this paper aims to combine the Reflection Canvas and the coding scheme in one retrospective meeting to measure the effectiveness of structured reflection. For this purpose, 6 moderated, live-coded retrospective meetings were conducted and evaluated in industrial practice on engineering activities in pilot projects (small real engineering projects in a test environment accompanied by the research institution to test and adapt tools, methods, and engineering procedures) as part of a research project. The behavior of engineers from practice is used to evaluate whether the application of reflection in a structured and moderated manner has positive effects on further activities by counting the frequency. This paper aims to derive initial findings and theoretical approaches to the effectiveness of reflection from the evaluations. In particular, the question of whether patterns of reflection can be recognized and whether they influence the effectiveness of reflection, on which levels and in which dimensions of reflection (e.g. reflection in a social and procedural dimension) reflection takes place, will be examined. Furthermore, this paper will analyze in which dimensions a lot of reflection takes place, a high learning effect is achieved and thus potential for improvement can be achieved. This leads to the following research questions:

1. What is an effective reflection procedure and in which dimensions should reflection take place to maximize the potential for improvement in engineering teams?
2. How can outcomes from retrospective meetings be categorized to evaluate the effectiveness of reflection?

To answer these research questions, we first analyzed the importance of reflection in agile product development (Section 2) and provided options for evaluating reflection in agile product development from existing approaches (Section 2.1). Section 2.2 presents approaches for measuring the effectiveness of retrospectives and the outcomes of retrospectives to provide a measurement basis for the evaluation. Section 3 presents and evaluates a Case Study with 6 retrospective meetings conducted in engineering teams from industrial practice. Section 4 uses the evaluation of the Case Study to derive a first categorization of reflection outcomes according to theoretical learning constructs. Section 5 summarizes the results and provides an outlook for future research.

3 Case Study and Evaluation of retrospectives in engineering teams

This Case Study presents the reflection results from 6 retrospective meetings with a total of 17 participating engineers in varying constellations in the meetings and provides an initial assessment of the reflexive behavior of engineering teams. The retrospective meetings for data collection took place online and were structured as follows: Brief introduction by the moderator to the object of reflection to which the reflection is to relate, then the three phases of feedback, reflection, and planning are gone through one after the other using the Reflection Canvas. The individual phases are briefly explained by the moderator and then introductory key questions are asked (e.g. Feedback Phase: What was achieved? How was the task fulfilled?; Reflection Phase – social dimension: Could all the expertise/ challenges of the various team members be taken into account?; Planning Phase: What adjustments are necessary to support the team in achieving its goals?). The team discusses in the three phases and collects the findings in writing in the Reflection Canvas (prepared on a virtual whiteboard). The retrospectives are intended to investigate how the quality of reflection can be assessed and how measures to improve development projects can be identified. Furthermore, the retrospective meetings aim to measure typical reflective behavior to assess the effectiveness of reflection and reflective competence. The Study design and an initial evaluation of the results are presented in the following sections.

3.1 Behavior-based evaluation strategies and experimental conditions

To gain insight into the research questions posed in this paper, a Study was conducted with engineers from industry. As the participants were engineers from small and medium-sized companies, the team retrospectives were intended to simulate an agile environment and raise awareness of agile working practices. The continuous implementation of retrospectives should establish agile structures in the organizations and create awareness. Retrospectives have a positive effect on the agility of a team if the focus is on continuous process improvement. (Marshburn, 2018) This promotes continuous development and adaptation to changing situations, which strengthens the agility of the team (team performance, team effectiveness, c.f. Section 2.2) or the organization. The focus was on the effect of a structured reflection procedure and the behavior-based evaluation. As part of this paper, 6 retrospective, structured, moderated (by an expert in integrated product development), and live-coded (by an expert in work and organizational psychology) meetings were held with engineering teams of 2 to 6 engineers from engineering for various use cases (e.g. machinery and plant engineering, software development, etc.) with a duration of 60 minutes per meeting, as shown in Table 2 as an overview.

Table 2. Experimental Conditions of the 6 retrospective meetings

Meeting No.	Context of application and objective of reflection	Team size	Team composition	Tools used	Meeting structure
1	Implementation of different engineering methods to support the requirements and function analysis in the system definition and design phase of the engineering process.	6	Mechanical Engineering, Software Engineering, Sales	Reflection Canvas, Coding Scheme (V1)	1. Feedback 2. Reflection 3. Planning
2	Implementation of different engineering methods to support the requirements and function analysis in the system definition and design phase of the engineering process.	6	Mechanical Engineering, Software Engineering, Sales	Reflection Canvas, Coding Scheme (V1)	1. Feedback 2. Reflection 3. Planning
3	Implementation of the creative technique "Morphological Box" to identify and analyze system solution approaches in the offer phase of the engineering process.	5	Mechanical Engineering, Software Engineering, Business Administration	Reflection Canvas, Coding Scheme (V1)	1. Feedback 2. Reflection 3. Planning
4	Implementation of the engineering methods "Requirements List" and "Function Modeling" to support the requirements and function analysis in the system definition and design phase of the engineering process.	3	Mechanical Engineering, Sales	Reflection Canvas, Coding Scheme (V2)	1. Feedback 2. Reflection 3. Planning
5	Implementation of the engineering method "Stakeholder Analysis" to analyze the system environment in the system definition and design phase of the engineering process.	2	Software Engineering	Reflection Canvas, Coding Scheme (V2)	1. Feedback 2. Reflection 3. Planning
6	Implementation of the engineering method "Use Case Analysis" to support the requirements and functional analysis in the acquisition phase of the engineering process.	3	Engineering Management, Mechanical Engineering, Software Engineering	Reflection Canvas, Coding Scheme (V2)	1. Feedback 2. Reflection 3. Planning

In each of the 6 retrospectives conducted in this Case Study, structured reflection was carried out with the support of the Reflection Canvas (Ammersdörfer et al., 2022) and an external moderator guiding the retrospective. At the same time, each session was live-coded in the background by an expert from work and organizational psychology using the coding scheme reflAct4teams-short (Ammersdörfer et al., 2023). ReflAct4teams-short differentiates between feedback, reflection, and outcome following the model presented in Figure 1. The focus is on goal- and process-related (summarized as task-related) as well as social-related statements. A frequency measurement was used to measure the dimension (social, process, goal) from which the engineers reflected and how the reflective behavior influenced further activities in the engineering process. For the engineering teams of the reflection meetings 1 to 3, there is only one value at the feedback and measure level, as this prior version of the coding scheme (Version: V1) does not differentiate between goal, process, or social focus (c.f. Figure 2). Due to further developments and practical testing of the coding system, an extended and adapted coding system (Version: V2) was used for meetings 4 to 6, which additionally differentiates between process-related, goal-related, and social-related feedback and measures (c.f. Figure 2). This extension allows a more differentiated view of the relationships between task- and social-related feedback, reflection, and measures and can provide information about effects between the three dimensions in the future. It became both pragmatic (too many codes complicate live coding and thus the reduction should simplify the coding scheme) and content-related (some codes from V1 were not observed in any reflection session, e.g., willingness to change and therefore combined into one code) Reasons decided to adapt the coding scheme. The content of versions V1 and V2 is still comparable, but the adapted coding scheme (V2) allows a more detailed analysis, in which relevant codes are detailed and unused codes are outsourced. Accordingly, the three dimensions (social, process, goal) were added in the feedback and planning phases to carry out a more detailed evaluation. In V1, only the phase reflection was additionally divided into three dimensions. To provide a better overview of the context of the retrospectives and the meeting conditions, the background information, and details of the individual meetings 1 to 6 are summarized again in Table 2. Section 3.2 presents the results of the Case Study and Section 3.3 shows the findings of the Study and discusses the effectiveness of the retrospectives in agile engineering.

3.2 Results of the Case Study

The results of the Case Study are given in Figure 2 and are described in this Section. Due to the small sample size, we have refrained from an aggregated evaluation and will describe the courses of reflection individually below.

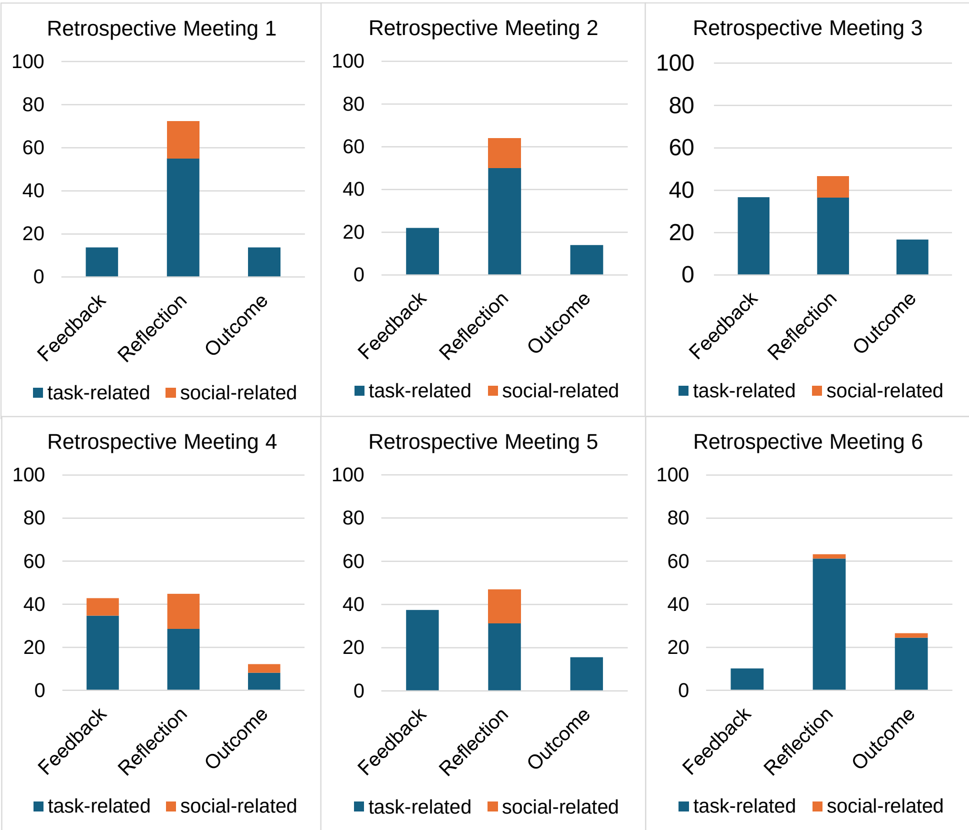

Figure 2. Relative frequency of different codes in the coding scheme and first evaluation of the frequency of task- and social-related team reflexivity in the three phases of the reflection procedure with 6 engineering teams

All codes in the reflection meetings were converted into percentages for better comparability and to be able to interpret the data independently of the length of the reflection session. Therefore, the evaluation is based on 100% total duration and frequency, and this is broken down into percentages. At 14%, retrospective meeting 1 is characterized by a low proportion of feedback and outcomes. 72% of the discussions were coded as reflective behavior, with 55% being task-related and 17% social reflection. The low level of feedback and outcome is striking despite a large proportion of reflection. A similar picture emerges in retrospective meeting 2. Feedback covers 22% of the discussions, while task-related reflection is at 50% and social reflection at 14%. Outcomes account for the lowest frequency at 14%. Retrospective meeting 2 again shows that there is a high degree of reflection, especially task-related reflection, with only a low production of outcomes. The picture changes slightly for retrospective meeting 3. Here, at 37%, more than a third of the discussions consist of feedback. Another 37% task-related and 10% social reflection resulted in a total of 47% overall reflection in the meeting. At 17%, the outcome again represents the lowest value, although they are higher here than in the previous meetings. Retrospective meeting 4 also shows a balanced ratio of 43% feedback and 45% reflection. The focus is on task-related components, with 35% for feedback and 29% for reflection. Of the total of 12% measures, two-thirds can be allocated to the task focus and one-third to the social focus. Retrospective meeting 5 shows a high proportion of feedback at 37%, albeit exclusively task-related. Reflection accounts for 47% of the discussions, 31% of which are task-related and 16% social. The outcomes account for 16% of the discussions but are exclusively task-related. Finally, retrospective meeting 6 shows a very low and exclusively task-related feedback share of 10%. The 63% share of reflection is also mainly task-related at 61%. With a constellation of little feedback and a lot of reflection, retrospective meeting 6 shows the largest proportion of outcomes at 27%, 25% of which are task-related. Overall, it can be seen, that the proportion of reflection was most pronounced in all meetings. The more detailed interpretation and evaluation are described in section 3.3.

3.3 Findings on the Case Study

In the evaluation of the Case Study in Figure 2, it can be observed that the feedback in retrospective meeting 4 was more extensive overall than in all other meetings. Furthermore, meeting 4 is also the only meeting that shows social-related feedback. Although significantly more feedback was given in meeting 4 than in meeting 6, for example, the outcome in meeting 4 is much lower than in meeting 6. This relationship cannot yet be explained due to the small sample size and no patterns can yet be identified. This should be investigated in more detail to see whether there are any interactions regarding feedback and outcome. Looking at the intensity of the reflection bars in Figure 2, it can be seen that the reflection bars do not appear to have a direct influence on the outcome. If we compare meeting 1 and meeting 3, the proportion of reflection is significantly higher in meeting 1 than in meeting 3 and the outcome is almost the same. Furthermore, it can be observed that in meeting 5, for example, a high proportion of reflection is socially related, but no proportion is socially related to the outcome. In meeting 6, on the other hand, there is little social-related reflection and almost the same low proportion of social-related aspects in the outcome. Overall, it can be stated that no fixed pattern between feedback, reflection, and measures can be identified in the 6 meetings observed. The low number of social-related statements at the feedback and outcome level is striking. At the reflection level, on the other hand, the social reference is more pronounced, even if it is only a small proportion overall. Furthermore, it can be seen that social reflection is also possible without prior social feedback and without subsequent social outcomes. Without exception, it can be stated that the reflection part was the longest part in all meetings, but the number of social aspects varied. Furthermore, it can be observed that the outcome component does not vary as much between the different meetings as the reflection and feedback components. As no concrete patterns of reflection can be identified, there is a need to refine the categorization of the results to determine impact relationships and to be able to make statements about the effectiveness of reflection. Section 4 therefore categorizes exemplary Case Study outcomes to assign them to learning theory constructs (Jungclaus and Schaper, 2021) to address learning effects in the reflection process.

4 Proposed theoretical categorizations for retrospective outcomes

Since no clear reflection pattern has been found in the Case Study, this paper deals with the possibility of evaluating outcomes from reflection meetings regarding effectiveness. Reflection is a form of learning and a learning process. Therefore, this paper focuses on the planning phase of the reflection and considers the outcomes as learning results to give an initial assessment of the effectiveness. For this purpose, literature in the learning context is used to check which fields are currently still open and which generated outcomes already address learning constructs. Therefore, Section 4 provides an initial assessment and assignment of outcomes (defined measures) to learning-theoretical constructs defined by Jungclaus and Schaper (2021) in the context of agile sprint learning. In Figure 3, a selection of the affected codes in the coding scheme and the corresponding defined outcomes (planned measures) from the Case Study (exemplary selection from all 6 meetings) are listed in the blue columns. The outcomes are then, based on the descriptions of the learning constructs (gray column on the far right), assigned (by colored arrows) to the learning theory constructs (gray column on the right) to represent the effect relationships. However, for transferable results, it require a larger sample size and continuous sprint support of the engineering teams with regular retrospectives, to check whether the outcomes have been implemented in the follow-up sprint or whether adjustments need to be made. Nevertheless, the number of incoming arrows should give an initial assessment of the effects of the outcomes on the learning process and which competencies (e.g., self-reflection, motivation, personal responsibility) can be promoted by effective reflection. Another aspect that should be considered when categorizing the impact of retrospectives on the outcomes is the resource-efficient development of processes, systems, methods, and collaboration. Sustainably developed processes or systems are one of the greatest challenges of change. (Ballard, 2005) To approach change programs for sustainability, (Ballard, 2005) has developed a simple model with the three prerequisites of "awareness", "agency" (the identification of meaningful response options), and "connection" with other people. According to Ballard (2005), "action and reflection" is a crucial process. Collaborative action research is particularly well suited to supporting associations, as team members can support each other in their work through exchange and create a safe space for processing their experiences (Ballard, 2005). Accordingly, the social dimension should be particularly promoted and further developed with the outcomes of retrospectives. The exchange, understanding, and a safe environment (e.g. team well-being) in an extra meeting for reflection create trust and thus a long-term, sustainably developed process and collaboration within the engineering team.

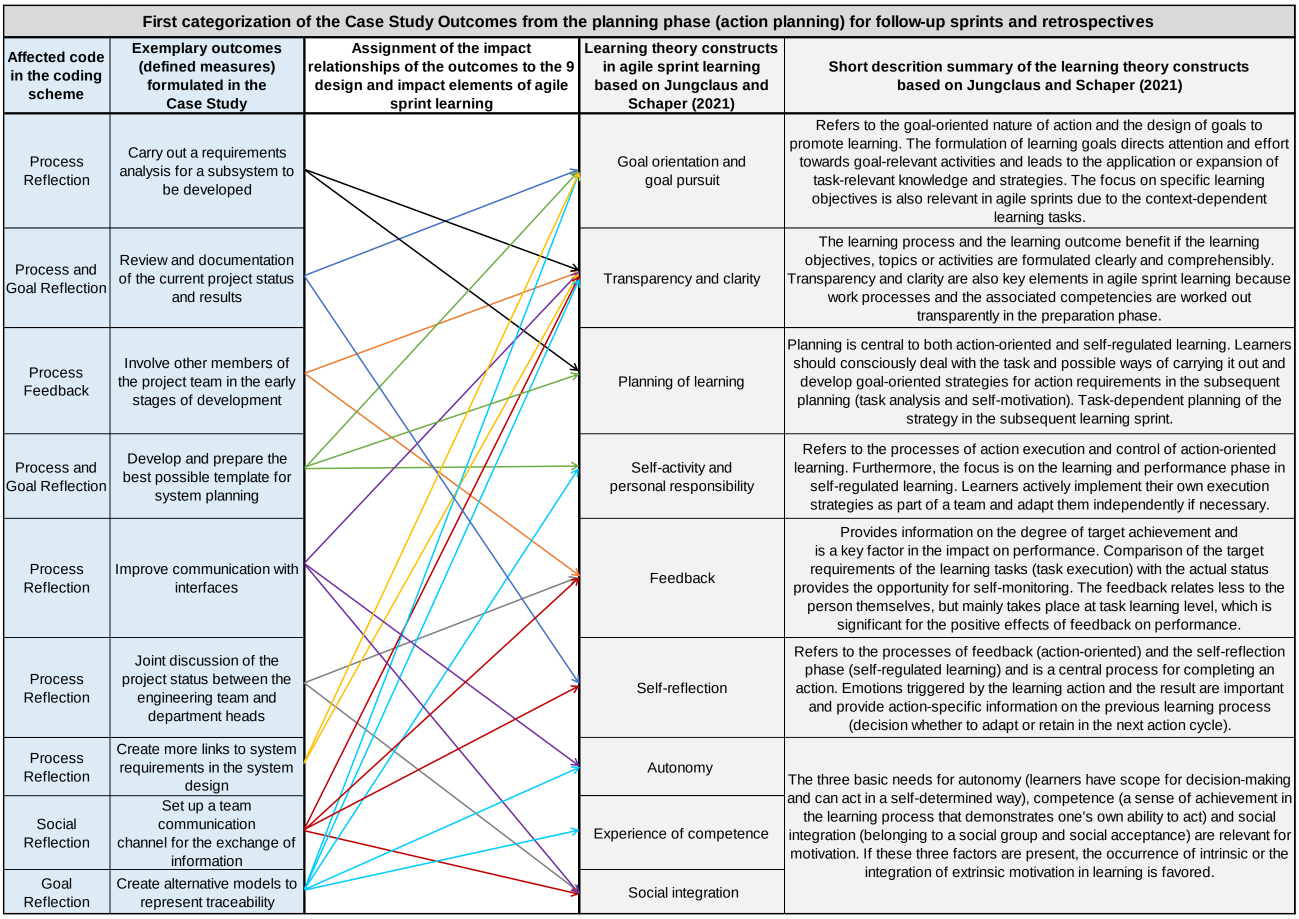

Figure 3. First characterization of outcomes from retrospective meetings and their influences on learning theory constructs based on (Jungclaus and Schaper, 2021)

5 Conclusion and Further Research

Scientific research and practical applications show that reflection can have a relevant influence on team processes (e.g., (Konradt et al., 2016). In practice, this relevance is primarily realized through agile strategies such as retrospectives. To gain a more precise insight into processes within these retrospectives, this Study analyzed how engineers already reflect and derived potential factors for optimizing these reflection structures. To answer the first research question of what an effective reflection process is and in which dimensions reflection should take place to maximize the potential for improvement, Section 2.2 first analyzes the basics for the evaluation and measurement of reflection. Hence, a proposed procedure (c.f. Figure 1) for reflection is developed and types of effectiveness that emerge from retrospectives are derived (c.f. Section 2.2). To analyze and measure how moderated retrospectives positively influence the learning process of engineering teams, as defined in the objective of the paper, a Case Study with 6 engineering teams is conducted. The second part of the objective is also investigated, i.e. whether the effectiveness of retrospectives can be derived from certain reflection behaviors (reflection patterns). However, to be able to assess this in an agile context, i.e. in regular retrospectives and continuous adjustment loops of processes, methods, or team tasks, multiple iterations are missing in this Study. This is a limitation of the paper and at the same time a finding that will be included in future research. To this end, several sprints (e.g. introduction and application of an engineering method) are accompanied by the same engineering team, and a retrospective is conducted after each sprint to make the best possible use of the potential for improvement and to be able to recognize reflexive patterns of behavior. This iterative approach is intended to generate sustainable outcomes from the retrospectives (e.g. resource-efficient developed processes). The repetition of the reflection sessions is intended to create a long-term sense of well-being in the team and therefore a sustainable sense of security among the team members to reflect. The retrospective meetings in this Case Study are moderated and structured with the help of the Reflection Canvas and carried out and evaluated using reflAct4teams-Short to focus on the reflexive behavior of the engineering teams. It was found that there were very few socially oriented statements in the feedback in the social-related aspects and the outcomes of the task-related measures outweighed. The second research question, how the outcomes of retrospective meetings can be categorized to evaluate the effectiveness of reflection, is answered by categorizing the outcomes into learning theory constructs. Therefore, a first theory-based categorization of the outcomes according to learning theory constructs in agile sprints (Jungclaus and Schaper, 2021) was used and a first evaluation regarding the effectiveness of the reflection was made. However, a generalizable evaluation can only be made with a larger sample, continuous reflection cycles, and monitoring of several sprints in succession to be able to derive patterns. With its descriptive analytical approach, this Study raises several new questions for reflection in the engineering context. As initial indications of learning effects are derived from the outcomes of retrospectives in Section 4, future research should investigate how retrospectives promote learning in teams and how this can be measured in terms of effectiveness. To provide concrete pointers for future research, these are presented below in relation to the individual, team, and framework conditions/the organization. At an individual level, the focus is primarily on the development of reflective competence. This is described as the ability to analyze one's own actions, work, and emotional world by means of examining and questioning considerations (Schmal, 2018) and is fundamental for reflective processes at the team level. Reflective competence can be promoted, for example, through knowledge about reflection and concrete practice. Further research would be interesting, for example, into how different constellations of reflective competence affect retrospectives (e.g., in the form of compensatory effects). Furthermore, there is the question of the relationship between reflective competence and the degree of structuring of retrospectives - here, for example, it could be assumed that highly structured reflections become obsolete due to a high level of competence. At the team level, the question of interpersonal processes arises. Our Case Study has shown that reflection in engineering contexts takes place primarily with a strong focus on tasks. For further research, it would be relevant to see what ratio of task and social focus is needed for maximum effectiveness in the context of engineering retrospectives. There is further the question of how different conditions within the team (e.g., conflicts, sympathies, stress) affect reflection. We know from research, for example, that mood can play a major role in the processing of team tasks (Schneider et al., 2018). How do these affect reflective processes? At the organizational level, the question of enabling framework conditions comes into play. A Study by Otte et al. (2018), for example, showed that the interplay between the quality of reflection, which is primarily designed at individual and team level, and quantity plays a major role. It has been shown that regular reflection, as provided for in an agile context, can increase the effectiveness of reflection. At the same time, there also seems to be a limit to the effectiveness of reflection about quantity (Oldeweme et al., 2023). For further research in the engineering context, this raises the question of which organizational factors can support the use of reflection (e.g., promoting structured implementation and time spaces, offering help and support, specifically promoting reflection skills). Overall, the evaluation of reflection meetings can give an initial assessment of the frequency of reflection in the different dimensions. The seemingly important social dimension of reflection is often neglected because the focus is more on the processes and goals of engineering activities. The first categorization of the outcomes based on the learning theory constructs makes it clear again which learning effects and improvement potentials both on the team level (e.g., transparency) and on the individual level (e.g., self-reflection) can be triggered by reflection. How the effectiveness can be increased must be evaluated based on several reflection cycles and a longer sprint accompaniment of a team to give a more concrete assessment.

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