Assessing and Increasing In*nova*tiveness of SMEs in the Context of Their *Demo*graphic Development

The Joint Project NovaDemo

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Abstract

The joint project NovaDemo focuses on assessing and increasing innovativeness of SMEs in the context of their demographic development. Based on analyses of age structure and innovation process analyses, a project-specific diagnostic instrument, the NovaDemo assessment tool, was developed. It is used to determine individual and group-specific innovativeness. At the individual level, four innovativeness types were identified: the "averagely creative innovation driver", the "slightly creative team worker", the "highly creative balanced type" and the "averagely creative reserved type". Based on these insights, the NovaDemo training programme was developed to increase innovativeness. The close proximity of learning and work situations in terms of time and content allows for the optimisation of efficiency thanks to a work-integrated execution adapted to the respective working group.

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1 NovaDemo Joint Project Content and Process Description

As part of the demographic development in Germany, many companies have to face the challenge of maintaining consistently high quality of results with an increasingly aging workforce [1]. To nevertheless ensure or even increase the competitiveness of small and medium sized enterprises (SME), it is necessary to determine and subsequently increase their innovativeness at individual and group level.

The NovaDemo joint project explores this issue. The detailed requirement and baseline analyses comprise in addition to the age structure analysis of east German SMEs a comprehensive innovation process analysis in the form of qualitative interviews. These analyses form the basis for the derivation of seven innovation-relevant personality traits, which are described in Sect. 2.1. Subsequently, a diagnostic instrument for determining the individual and group-specific innovativeness was developed (refer to Sect. 2.2). The execution (refer to Sect. 2.3) as well as the most significant results at the individual and group-specific levels (refer to Sects. 2.4 and 2.5) are described in more detail. To specifically train and increase innovativeness the work-integrated NovaDemo training programme was subsequently developed (refer to Sects. 3.1 and 3.2). In addition to the sampling description (refer to Sect. 3.3), selected evaluation results of the NovaDemo training programme are presented from the participants' perspective (refer to Sect. 3.4). Furthermore, the insights gained will be made freely accessible to other companies. To achieve this, a short version of the NovaDemo assessment tool and of the NovaDemo training programme was derived. We will not present NovaDemo^{light} in this paper and refer you to the publication by Schmicker et al. [7].

This joint project is composed of three partners. The *Lehrstuhl für Arbeitswissenschaft und Arbeitsgestaltung, Otto-von-Guericke-Universität in Magdeburg* focuses mainly on the theoretical conception of the newly developed instruments and methods. The *METOP GmbH, An-Institut der Otto-von-Guericke-Universität Magdeburg*, acts as a link between science and industry and transfers the project-specific developments to the industry partner. The *Schunk Sintermetalltechnik GmbH* in the German city of Thale is the industry partner for the project. All practical tests took place at their premises. Additionally, the two transfer partners *Innovations- und Gründerzentrum Magdeburg GmbH* and *PMC Pulvermetallurgisches Kompetenz-Centrum Thale GmbH* facilitated the knowledge transfer to other companies and industries.

2 Innovativeness Assessment at Individual and Group Level Using the NovaDemo Assessment Tool

2.1 Objective and Theoretical Background of the NovaDemo Assessment Tool

The objective of the NovaDemo assessment tool is the assessment of the innovativeness of individuals and mixed-aged teams.

A key starting point for the development of the NovaDemo assessment tool is the internal innovation process analysis (in form of qualitatively conducted interviews). In addition to the extraction of innovation-relevant personality traits, one objective was the development of a project-specific innovation process model. As previous innovation process models (for example VDI Guideline 2221) had a strong technical, process and economic focus and did not place much emphasis on individual or social factors in innovation processes, the adaptation of conventional innovation process models seems reasonable.

Based on comprehensive literature research and the 13 conducted qualitative innovation process analyses, it was possible to develop seven innovation-relevant personality traits for the NovaDemo joint project (refer to Table 1). These personality traits illustrate the project-specific meaning of innovativeness and are determined with the NovaDemo assessment tool by the targeted use of an appropriate group exercise as well as tests and questionnaires.

Another significant result of the innovation process analysis is the graphical innovation process model (refer to Fig. 1).

Figure 1 shows firstly the phases of the invention process (upper part of the figure). Following the provision of the idea impulse, the idea generation begins. Subsequently, it is necessary to evaluate and refine these ideas before initiating the planning phase. The final step of the invention process is the implementation (here meaning the creation of a prototype). Due to the recursive loops, all phases are inter-connected and if necessary can be repeated. Secondly, the figure illustrates the relationship between the work required and the frequency of the social interactions during the individual phases (lower part of the figure).

Furthermore, a tabular innovation process model was created. It describes the individual phases in more detail and explains in depths the psychological, social, and ergonomic processes of the innovation process. Table 2 shows a more detailed list of psychological barriers to innovativeness based on the barrier model by Schlick [6], which was developed with the help of innovation process analyses and literature research.

Please refer to the dissertation by Wassmann [8] for a more detailed description of the social and ergonomic processes and further results.

Table 1 Innovation-relevant personality traits [8, p. 186 f.]

Innovation-relevant personality traits	Explanations/examples
Creativity	Creativity is understood as purely intellectual creative power—factors such as usefulness and feasibility have (as yet) no role to play at this level. Creativity is one of the most important elements of the individual innovativeness
Absence of mental barriers during the innovation process	Psychological innovation barriers are hindrances that have a negative impact on the progress of innovation processes. Individuals without psychological innovation barriers are able to protect the sensitive innovation process in all phases from harmful interferences
Social skills	Three important aspects of social skills are: (1) Assertiveness appropriate to the situation, (2) an adequate adaptability to social expectations and values of the respective group and (3) the skill to overcome personal conflicts constructively
Performance motivation	The higher the professional performance motivation of an individual, the more committed to achieving the respective objectives the individual is. Performance motivated individuals are also very confident of success
Methodical expertise	Individuals with a high level of methodical expertise have, for example, sound knowledge about creativity techniques, decision-making methods and moderation techniques. Furthermore, they know how to communicate these methods to a group and which method is useful for which situation
Ability to cooperate	Ability to cooperate describes to what extent an individual is able to cooperate with other individuals within a group and to what extent the individual is happy doing so. Additionally, the ability to cooperate refers to the skill to be able to maintain a common work climate for the whole team
Ability to communicate	Ability to communicate does not only encompass the verbal and non-verbal communication of information, but also what is commonly understood to be a 'good listener'

2.2 Structure of the NovaDemo Assessment Tool

The NovaDemo assessment tool is structured in two blocks, which are organised as illustrated in Table 3. Block I consists of a video-documented structured group exercise. These innovative design tasks illustrate an invention process most succinctly. Next, project-specific procedures are used for the assessment of innovation-relevant personality traits in Block II in addition to standard creativity tests and questionnaires.

The procedures selected for assessing the innovativeness closely reflect the seven innovation-relevant personality traits (please refer to Table 1). This way the individual level as well as the group level may be analysed. To validate the newly developed procedures already established tools were used (refer to Table 4).

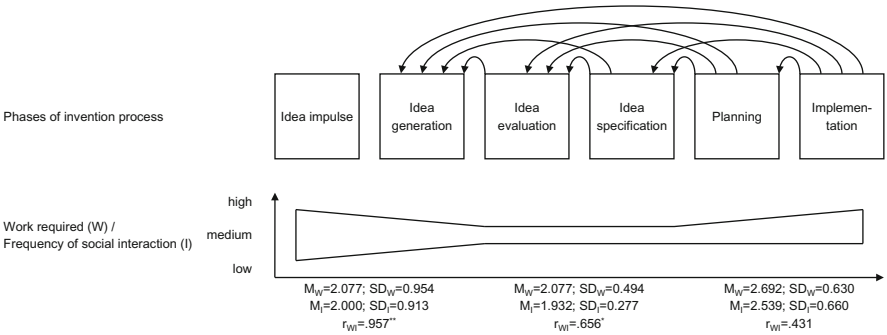

Fig. 1 Graphical innovation process model [8, p. 178]

Table 2 A more detailed list of barriers to innovativeness—psychological barriers (based on [8, p. 182])

Reason for barriers	Explanations/examples
Knowledge and thought patterns	Rejection of new ideas, habitual routines, insisting on ones own opinion, egoism, preconceptions, inability for self-criticism, lacking ability to solve conflicts, blinkered mind-set, forming an opinion too quickly
Inhibiting cognitions	Fear of risks, fear of changes, authority dependence, wanting to fulfil the expectations of others, wanting to give in, search for the perfect solution, low self-confidence, not wanting to impose ones ideas on others, fear to accept responsibility for new ideas
Motivation and activity-orientation related processes	Fear of commitment, indecisiveness, lack of inquisitiveness, flaws when defining objectives, lack of perseverance, satisfaction with the current achievements

2.3 Trialling the NovaDemo Assessment Tool

The NovaDemo assessment tool was tested from July to October 2013 under laboratory testing conditions and within the operational context of the industry partner. In total 94 participants took part in the tests. 32 % of the total sample were women. The age of the participants ranged from 18 to 79. 39.4 % of the participants were aged between 18 and 30, 17 % were between 31 and 50, and 43.6 % were 51 or older.

The ideal group consisted, corresponding to the actual operational situation determined during the baseline analysis, of six participants, with two women and four men as well as two younger and four older working together in the group exercise. Unfortunately, it was not possible to achieve this composition for all tests. To be able to make a statement regarding the relation between the age structure within the group and its innovativeness, five age-homogeneous young and five age-heterogeneous groups were observed in the laboratory.

Table 3 Blocks, content and duration of the NovaDemo assessment tool [8, p. 230]

Block		Content	Duration
Block I	Welcome and preparation	– Mutual introduction of the assessors and the participants – Explanations regarding the experiment process – Informing the participants about data protection and obtaining consent to record video footage	Approx. 10 min
	Structured group exercise	– Participants perform the group exercise based on continuous instructions by the assessors	Approx. 90 min
Break		– Respite for the participants	Approx. 15 min
Block II	Questionnaire and tests	– Participants answer the questionnaire and take the tests – The assessors introduce each procedure and provide (additional) verbal instructions – Freely selectable short break (approx. 5 min)	Approx. 90 min
	Saying goodbye	– Answering any questions the participants may have – Saying goodbye	Approx. 5 min
Total duration			Approx. 3.5 h

Following a short welcome by the assessors, the assignment for the structured group exercise was presented to the participants. The objective was to build a floatable pirate boat with the highest possible load capacity using only provided materials. Here the individual phases of the invention process (refer to Fig. 1) were completed under set time limits (the implementation phase being the exception). The success criteria included (1) the amount of the used materials in grams, (2) the time spent (in minutes) to build the boat during the implementation phase and (3) the maximum load capacity of the boat (measured by continuously loading glass marbles until the boat sunk).

Furthermore, an expert rating regarding the usefulness and originality of the boat as well as regarding the successful cooperation within the group was carried out. Figures 2 and 3 show examples of a “good” and a “bad” pirate boat. Additionally, an objective assessment at individual and group-specific level was made by trained observers using video recordings of the group exercises and structured observation sheets.

Next, the participants answered the questionnaires and performed the tests listed in Table 4.

2.4 Results of the NovaDemo Assessment Tool at Individual Level

Applying the cluster analysis four different innovativeness types were determined, which are presented using their profile paths (refer to Fig. 4). These differ significantly for all seven ascertained personality traits (refer to Table 1).

Table 4 Overview of all the procedures used in the NovaDemo assessment tool as well as the operationalised constructs [8, p. 194]

Title/description of the procedure	Operationalised variables/constructs	Self-development (S) or for validation (V)
Structured group exercise (observation at group level)	Social-sociological barriers, group climate, specific and general evaluation of the invention phases, evaluation of the innovation performance	S
Structured group exercise (observation at individual level)	Personality (Big Five), social skills, performance motivation, methodical expertise, ability to cooperate, ability to communicate	S
Questionnaire on socio-demographic information	Socio-demographic background information	S
Evaluation questionnaire for the group exercise	Reflection on the group exercise from the participants perspective (among others regarding the assignment, the collaboration, the joint approach)	S
Questionnaire for assessing innovation-relevant personality traits	Personality (Big Five), social skills, performance motivation, methodical expertise, ability to cooperate, ability to communicate	S
Tests for determining verbal and figurative and graphic creativity	Verbal and figurative creativity	S
Questionnaire for assessing psychological innovation barriers	Knowledge and thought patterns, inhibiting cognitions, motivation and activity-orientation related processes	S
NEO five factors inventory	Personality (Big Five)	V
Social skills inventory—abbreviated version	Social orientation, offensiveness, self-guidance, reflexibility	V
Performance motivation inventory—abbreviated version	Professional performance motivation	V
Extracts from the Berlin intelligence structure test	Verbal and figurative graphical inventiveness	V

The spread of the found innovativeness types among the test persons were as followed:

– “the averagely creative innovation driver”: 27 %
– “the slightly creative team worker”: 20 %
– “the highly-creative balanced type”: 33 %
– “the averagely creative reserved type”: 20 %

No differences regarding the allocation to these clusters and the gender were found [8].

Weight of the boat: 30 g
Construction time: 22 minutes
Load capacity: 34 marbles

Overall efficiency*: 1.53
Expert rating of the boat: positive
Progress of the innovation process average

* Overall efficiency = (weight of the boat in grams / number of loaded glass marbles) + (construction time of the boat in minutes / number of loaded glass marbles)

Fig. 2 Example for a "good" result [7]

Weight of the boat: 26 g
Construction time: 41 minutes
Load capacity: 5 marbles

Overall efficiency*: 13.40
Expert rating of the boat: negative
Progress of the innovation process negative to average

* Overall efficiency = (weight of the boat in grams / number of loaded glass marbles) + (construction time of the boat in minutes / number of loaded glass marbles)

Fig. 3 Example for a "bad" result [7]

The variable 'age' showed significant correlations to two of the seven innovation-relevant personality traits. A negative relation between creativity and age and a positive relation between absence of barriers during the innovation process and the age of the participants was determined [8].

2.5 Results of the NovaDemo Assessment Tool at Group Level

Regarding the innovativeness at group level the resulting distribution of the four innovativeness types is shown in Fig. 5. The groups were assessed regarding their overall efficiency and according to the expert ratings (refer to Figs. 2 and 3) and subsequently rated as "little innovative", "averagely innovate" or "highly innovative". A balanced mix of the four ascertained innovativeness types seems recommendable for an at least averagely innovative team.

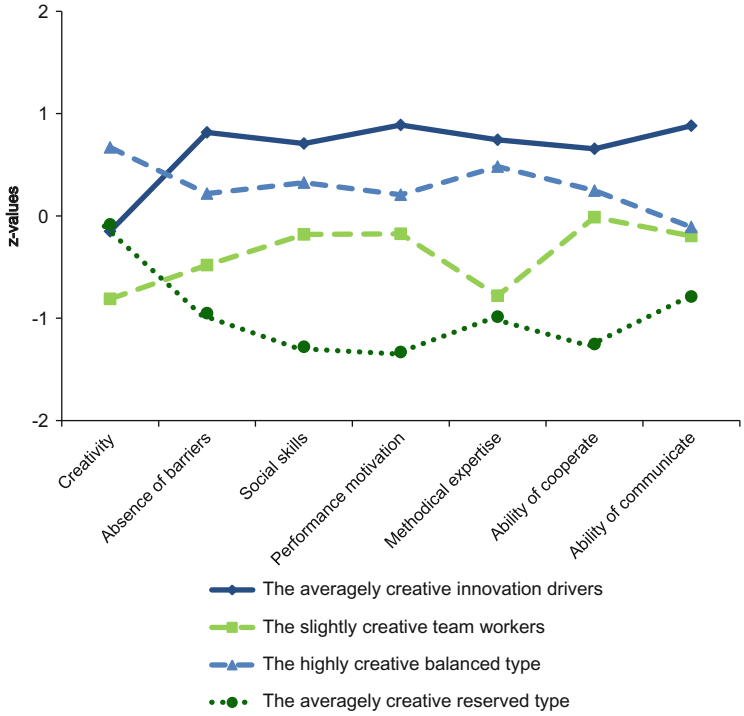

Fig. 4 Profile paths and z-standardised mean values of the four innovativeness types for the seven innovation-relevant personality traits [9, p. 215]

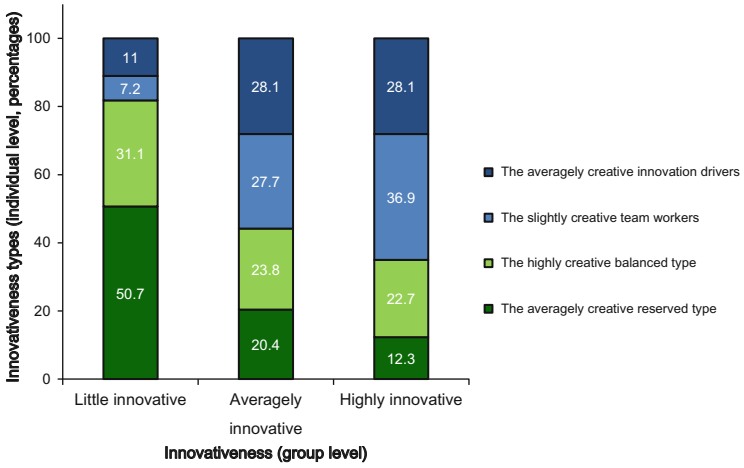

Fig. 5 The spread of the four innovativeness types across three groups with varying levels of innovativeness (in percentage) [8, p. 279])

3 Increasing Innovativeness at Individual and Group Level with the NovaDemo Training Programme

3.1 Objective and Theoretical Background of the NovaDemo Training Programme

The NovaDemo training programme is directly based on the insights gained using the assessment tool and aims to increase the individual and group-specific innovativeness. The personal strengths of the individuals are to be incorporated into the team composition and into the work process in an optimum manner. Here, the maintenance of a balanced mix of the four innovativeness types is of high importance.

To increase efficiency, the training units are conducted in a work-integrated manner (meaning "on the job", based on Conradi [2]). Real meeting situations are accompanied by the trainers to allow for direct knowledge transfer and feedback. The design of the training measures (meaning regarding duration, working hours, proximity to work content, location, and trainer) was developed together with the industry partner applying a participatory approach. Particularly suitable for the execution are meetings with innovation character that take place in regular intervals and with the same participants attending each meeting. Furthermore, the majority of the group members should have taken part in the NovaDemo assessment.

3.2 Structure of the NovaDemo Training Programme

The trained areas of competence within the training programme relate directly to the seven innovation-relevant personality traits, which were ascertained using the NovaDemo assessment tool (refer to Table 1). The training programme focuses on the following competency categories (refer to Table 5):

All training groups take part in the basic module to ensure a common knowledge base. Regarding the elective units, the participants may decide for themselves which training units the trainers should present and which are most suitable for the respective team. To ensure a time-efficient execution, the training units are work-integrated (refer to Fig. 6). This further reduces the spatial, time and content distance between training and work situations, which in turn has a positive effect on the knowledge transfer [3]. If taking part in the basic module plus the four elective modules, the participants invest about four extra hours **Fehler! Verweisquelle konnte nicht gefunden werden.**

In total, the training programme consists of five content-coordinated progressive components. At the start of a meeting, the trainer imparts subject-relevant competencies (= component 1). To make the imparted knowledge accessible at the company for the long-term, so-called "reminders" with concise summaries of the training content are handed out at the end of the training (= component 2). All "reminders" may be accessed at any time in the respective meeting rooms in a dedicated method box by the training participants. Component 3 comprises

Table 5 Training units of the NovaDemo training programme [4]

Basic module
– Communication beneficial for improving the team spirit
Elective module

– Creativity
– Absence of barriers in the innovation process
– Social skills
  – Avoidance and handling of conflicts
  – Assert ones own objectives
– Methodical expertise
  – Decision-making and assessment methods
  – Innovation conducive moderation
  – Structured problem solving
  – Goal-oriented specification
  – Sustainable scheduling
– Ability to cooperate

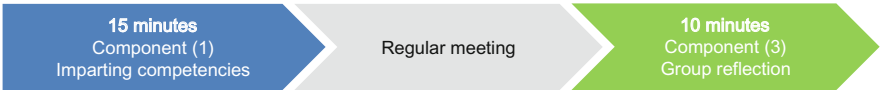

Fig. 6 Work-integrated process of the NovaDemo training programme [4]

worksheets for self- and group reflection. Using the worksheets allows the participants to outline their own progress and reveal their personal improvement potential. During the group reflection, strengths and weaknesses of the group regarding a specific competency category may be determined. The innovation advisor (= component 4; Kramer et al. [5]) is a knowledge resource providing the complete content of the components 1, 2, and 3 to interested parties online and is freely accessible (https://wikis.ovgu.de/iaf-ag/doku.php). Furthermore, during a consultation with the trainer all participants had the opportunity to discuss topics, which were not to be debated in the presence of the team.

3.3 Description of the NovaDemo Training Programme Sample

As an example, the training programme was tested in three meeting groups with representatives of the industry partner. The execution period started in April 2014 and ended in February 2015. Table 6 shows the age structure and the gender ratio. Figure 7 illustrates the spread of the innovativeness types within the training groups.

3.4 Evaluation of the NovaDemo Training Programme

Using a specifically designed evaluation questionnaires, the opinion of the participants regarding the practical feasibility of the training programme was

Table 6 Socio-demographic characteristics of the sample (training programme) [7, p. 221 f.]

Training group	N	Gender	Age group
1	3	♀: 33.3 % ♂: 66.7 %	Younger: 0.0 % Middle aged: 66.7 % Older: 33.3 %
2	12	♀: 8.3 % ♂: 91.7 %	Younger: 0.0 % Middle aged: 41.7 % Older: 58.3 %
3	8	♀: 12.5 % ♂: 87.5 %	Younger: 37.5 % Middle aged: 50.0 % Older: 12.5 %
Total	23	♀: 13.0 % ♂: 87.0 %	Younger: 13.0 % Middle aged: 47.8 % Older: 39.1 %

Notes: Age groups: Younger (up to 30 years of age), middle aged (31–50 years of age), older (from 50 years of age)

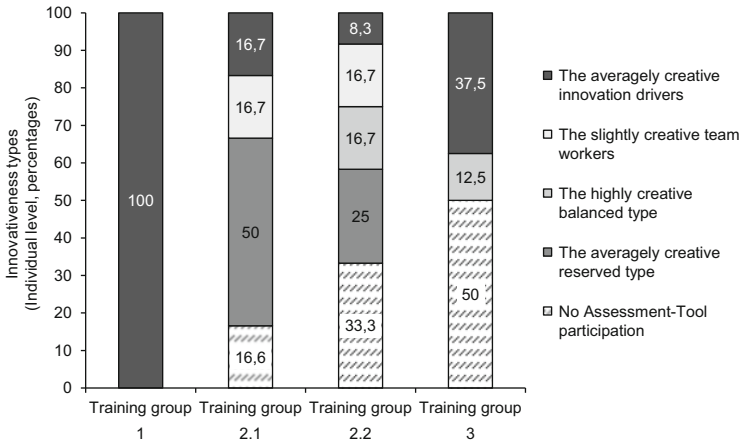

Fig. 7 Spread of the innovativeness types in the individual training groups [7, p. 223]

assessed. The items were rated using a five-point Likert scale, with 1 meaning, "I do not agree" and 5 meaning "I agree". In total, seven training participants evaluated the measures. Table 7 shows general statements on the NovaDemo training programme.

Based on these ratings, it is assumed that the participants' overall impression of the training programme as well as its content, execution, the procedure and the trainers was positive. Selected statements regarding the efficiency of the training programme also indicate concurrence with the relevant statements (refer to Table 8).

Table 7 General statements on the NovaDemo training programme (N = 7) [7, p. 239]

General statements on the NovaDemo training programme	M	SD
Overall I got a positive impression of the training programme	4.0	0.9
In my opinion, the training was well and logically structured	4.1	0.8
In my opinion, the content of the explanations was comprehensible and understandable	4.3	0.7

$M_{Overall} = 4.1$

Table 8 Statements on the efficiency of the NovaDemo training programme (N = 7) [7, p. 239]

Statements on the efficiency of the training programme	M	SD
I liked it that no special preparation was required for the individual training units	4.4	0.7
The scope of the training content was sufficiently informative	4.4	0.7
In my opinion, the ratio between the usefulness of the training programme and time spent and personal efforts made is adequate	3.7	0.7

Table 9 Statements on effectiveness and practical feasibility in general (N = 7) [7, p. 240]

Statements on effectiveness and practical feasibility	M	SD
The training gave me new insights and strengthened my understanding and my competencies	3.4	0.9
I can imagine integrating the insights gained during the training programme into my daily work routine	3.9	0.6
I am hoping that my participation in the training programme will have a positive impact on my personal (not professional) development	3.4	0.9
I expect that participating in the training programme will increase my innovativeness	3.1	0.6
I am hoping that participating in the training programme will increase my innovativeness at group level (meaning within the innovation team)	3.3	1.2
I think that thanks to the integration of the training times into existing meetings, it was possible to focus on real work situations, which in turn created practical relevance	3.6	0.9

$M_{Overall} = 3.2$

With $M_{Overall} = 3.7$ the structure as well as the process of the training programme were found to be good. Furthermore, the participants were able to rate the duration of the training using a three-step scale (too long [1], adequate [2], too short [3]). Due to the mean value of M = 2.4 (SD = 0.5) it is assumed that the duration of the training was adequate, but tended to be considered as too short. The statements on effectiveness and practical feasibility also received positive ratings (refer to Table 9).

Based on these results, a time-delayed impact of these training measures may be assumed. The participants indicated a personal increase in knowledge through the training programme between 20 % and 70 %. All training groups estimated the increase in overarching competencies to be at 50 %. Table 10 illustrates the overall rating of the NovaDemo training programme.

Table 10 Statements regarding the final rating and satisfaction (N = 7) [7, p. 241]

Statements regarding the final rating and satisfaction	M	SD
In my opinion the training programme is suitable to train the innovativeness of individuals	3.6	0.9
In my opinion the training programme is suitable to train innovativeness at group level	3.9	0.8
I think that participating in this training programme will have a positive long-term impact on the company's success	3.4	0.9

The participants "enjoyed" taking part in the training programme (M = 4.1; SD = 1.0) and would recommend it in its current form (M = 3.7; SD = 0.7). At the end, the participants were asked to apply an overall rating between 1.0 ("very good") and 5.0 ("insufficient") to the training. With a mean value of 2.4 (SD = 0.6) the training was on average rated as good. Overall, these ratings suggest that the applicability of the training programme in SMEs appears appropriate and promising.

Improvement suggestions were only made regarding the organisational framework conditions. No criticism regarding the content of the concepts was made.

4 Summary of the Most Significant Insights of the NovaDemo Joint Project

The NovaDemo joint project delivers significant insights regarding the understanding of innovativeness at individual and group level for both science and industry.

The NovaDemo innovation process model consists of six phases (idea impulse, idea generation, idea evaluation, idea specification, planning, and implementation) that are inter-connected through recursive loops and may be repeated. Furthermore, effort and frequency of social interactions differ depending on the respective phase within the invention process.

Based on the seven innovation-relevant personality traits (creativity, absence of barriers, performance motivation, methodical expertise, ability to cooperate, ability to communicate), the four innovativeness types "the averagely creative innovation driver", "the slightly creative team worker", "the highly-creative balanced type" and "the averagely creative reserved type" were identified at individual level using the NovaDemo assessment tool and cluster analytical calculations. In this present study, a balanced mix of these four types delivered an at least averagely innovative result.

The NovaDemo training programme is intended to increase innovativeness and is carried out in a work-integrated manner. The training units relate closely to the different innovativeness types and are individually adapted to the composition within the respective groups. The five components of the training programme (imparting of competencies, method box, worksheets for self- and group reflection, innovation advisor, consultation) serve a successful knowledge transfer and the

sustainability of the training measures. Furthermore, the participants' open-mindedness and acceptance regarding the training programme had a positive impact on its success and effectiveness.

NovaDemo^{light} is the abbreviated version of the presented instruments and methods and is intended to allow professionals to make an initial assessment (in the form of a screening) and to increase the innovativeness independently in their own company.

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