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Fostering authentic inquiry at multiple levels through participatory action research

Susanne Oyrer[a], Beatrix Hauer[a], Anke Hesse[a], Gudrun Keplinger[a], Johannes Reitinger[b]

[a]*Private University of Education of the Diocese of Linz,*
[b]*Centre for Teacher Education, University of Vienna, Vienna, Austria*
susanne.oyrer@ph-linz.at

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Participatory action research processes (PAR) have proven to be effective with regard to advancement in education. This paper explores how an inquiry-oriented teaching approach can be realised in secondary school in a participatory process involving three levels, namely pupils, teachers, and a supporting team of researchers. The intention of the developmental project is to unfold certain criteria typical of participatory inquiry-learning arrangements on all these levels. The aim of the study is to understand the parameters conducive to the evolvement of the criteria of inquiry learning and the specific methods teachers use in their lessons. This is achieved by quantitative analysis of data gathered by the practitioners and qualitative analysis of guided interviews of the supporting research team with eight teachers. It turns out that sound knowledge of the theory, support from researchers, participation in the learning experience of a group, and, most importantly, teachers' trust in the capabilities of the learners are crucial to the effective use of the participatory approach to inquiry in classrooms. It can be concluded that, reflection and analysis of actions in class will eventually result in new cycles of inquiry learning, thus fuelling the participatory action research cycle and the school developmental process.

KEYWORDS: bottom-up school development processes, inquiry learning, participatory action research

1. Introduction

In the last decade, teacher training has had to adjust to fast-changing demands on schools (Korthagen & Kessels, 1999) by favouring a more inquiry-oriented approach in all curricula, not only in science education (Brew & Saunders, 2020). Similarly, class participation has gained more importance in the educational system in recent years (Oser, Biedermann, & Ullrich, 2001; Oser & Biedermann, 2006). The goal is that children will acquire sound and deep understanding of the subject matter by being genuinely curious about it and actively involved in the learning process.

Our study examines how a participatory, inquiry-oriented teaching approach can be realised in secondary school through a participatory action research process. The aim is to meet the criteria of participatory inquiry learning on three levels, the level of the pupils, that of the teachers, and that of the external supporting team. Hence, every person involved in the project is expected to experience a sense of self-determination, authentic exploration, and active participation when it comes to creating knowledge of their own. Cooperation between a team of practitioners and the supporting team of researchers should serve as a stimulus to trigger school development on a larger scale in a participatory action research (PAR) project (Townsend, 2014; Eilks, 2014) in education (Stern, 2019).

In this article we first describe the theoretical concept of *Criteria-based Explorations in Education* or *CrEEd for Schools* (Reitinger & Oyrer, 2020), an inquiry-oriented model for bottom-up school developmental processes. Subsequently, we discuss the results of qualitative and quantitative examination of four hypotheses evaluating the progress of our project. Finally, we offer recommendations on how the action research process should be implemented.

2. The *Theoretical Concept of Criteria-based Explorations in Education* or *CrEEd for Schools*

Our study is based on the concept *CrEEd for Schools* (Reitinger & Oyrer, 2020). Consequently, we argue that school development should stem from the genuine interest of participating teachers (figure 1; [1]), that it can only be successful if innovation starts in the classrooms (Rauch & Senger, 2009), and that it builds on joint reflection and propensity for reframing didactic concepts. *CrEEd for Schools* involves practitioners as well as researchers. The latter encourage theory-based reflection and provide relevant feedback, thereby stimulating the action research process. Teachers, on the other hand, actively participate in the research process by incorporating the new findings into their lesson planning. Hence, the successful implementation of *CrEEd for Schools* can be regarded as a process of participatory action research (PAR; Eilks, 2014).

The major goal of this implementation is to support teachers in deliberately and consistently prioritizing the interests of the pupils when planning their lessons. Thereby, the *CrEEd* concept provides a framework for a course of action that is consistently oriented towards the criteria of inquiry learning. Because the criteria of inquiry learning and participation are the two key elements of *CrEEd for Schools*, our understanding of both these basic components will be explained further in the following section.

The key role of the criteria of inquiry learning

Drawing on constructivist views of learning, the one fundamental idea common to various conceptualizations of inquiry learning is learner-centeredness, which describes the learners' active role in gaining knowledge and their teachers' support in this process (Dewey, 1933; Aulls & Shore, 2008; Capps, Crawford, & Constas, 2012; Fichten & Meyer, 2014; Huber, 2004; Jang, Reeve, & Halusic, 2016; Littleton, Scanlon, & Sharples, 2011; Reeve, 2004). Thus, inquiry learning arrangements offer space for individual development, decision making (Brew & Saunders, 2020), active thinking, and drawing of conclusions (Minner, Levy, & Century, 2009). It often includes a cycle of action phases that can be compared to generic practices in science (Mieg, 2019). Despite some differences in the concrete designs of the action phases, Pedaste, Mäeots, Siiman, de Jong, van Riesen, Kamp, Manoli, Zacharia, and Tsourlidaki (2015) identify five core features of inquiry-oriented teaching: *orientation, conceptualization, investigation, conclusion*, and *discussion*.

Similarly, the theory of inquiry learning arrangements (TILA; Reitinger, 2013; Reitinger, Haberfellner, & Keplinger, 2016) lays down four main criteria, defined as *criteria of inquiry learning*. Those are participation-oriented and can be met to various degrees and in different combinations within inquiry learning arrangements. The more they unfold, the more considerable is the inquiry learning process (Kreutzer & Reitinger, 2020). As the criteria are essential to the school developmental process described in this article, they will now be laid out in more detail.

To begin with, (1) *experience-based hypothesizing* takes place when learners are genuinely interested in a topic, they pose questions and make assumptions as to how their questions might be answered. Also, space should be allowed for (2) *authentic exploration* which provides for intrinsically motivated research on a chosen topic. When this criterion is met, the learners pursue their research goals with a certain degree of commitment and endurance. The third criterion, (3) *critical discourse*, takes visible shape when the learners' findings are discussed and reflected on. This discourse may also include the research process itself; both problems and outcomes may be highlighted. Finally, (4) *conclusion-based transfer* gives learners a chance to demonstrate their competencies and share their findings and discoveries. They are offered possibilities or self-created ideas to implement their new knowledge in a wider context or to introduce it to a larger audience (Reitinger, 2013; Reitinger, Schude, Cihlars & Bosse, 2020).

Transferring these criteria to our project, the practitioners in this study were given the possibility to (1) pose their own questions, (2) explore individual strategies to implement inquiry learning in their classrooms, (3) talk about their experiences with colleagues and members of the supporting team of researchers, and (4) eventually show their findings to other staff members.

Participatory Action Research as key element for school development

In educational action research (Rauch, Zehetmeier, & Posch, 2019; Feldmann, Altrichter, Posch, & Somekh, 2018), practitioners collaborate with external researchers, who function as facilitators, supporters, and supervisors of the collaborative research. In this process, research questions which address practical issues are mutually agreed upon (Townsend, 2014). When all stakeholders identify problems through mutual understanding, find solutions, and thus generate theoretical knowledge which will eventually result in practical improvements, this process of action research is called *Participatory Action Research* (PAR; Eilks, 2014).

With regard to inquiry learning, Aulls and Shore (2008) point out that reflecting on one´s own practice is highly pertinent in inquiry learning arrangements, in that the act of reflecting is in itself authentic and explorative. They also argue that the interest in improving one´s own actions in the classroom is a vital prerequisite for teaching others in an inquiry-oriented way. Earl & Ussher (2016) describe reflective practice as an essential way of professional development and emphasize that *inquiry as research* and *inquiry as professional development* are in themselves two forms of reflective practice and action research, which eventually result in a useful change of practice (p. 51).

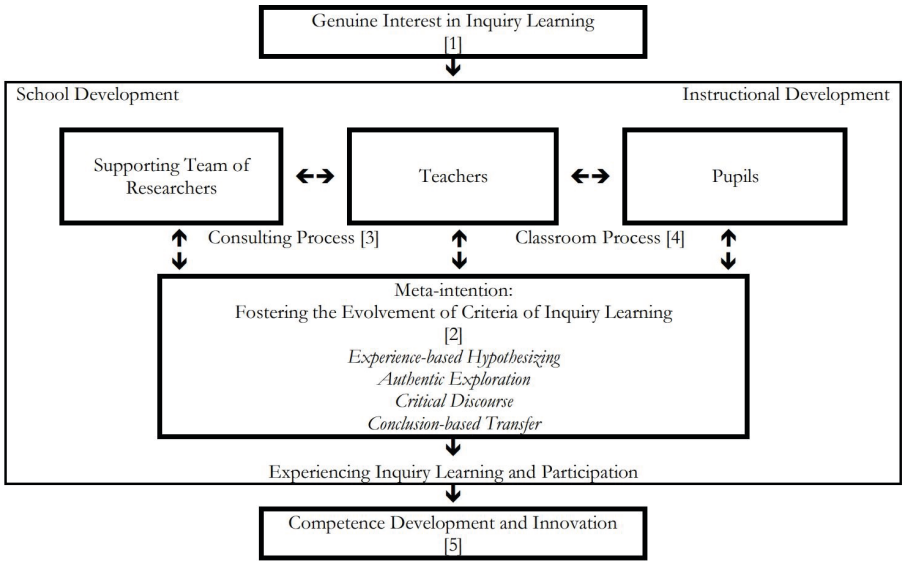
For the teachers involved in the project, the scaffold of the four criteria of inquiry learning served as a tool for meta-reflection. It is assumed that if teachers are willing to scrutinize their practices for the criteria of inquiry learning, they gradually gain more autonomy as well as trust in their own abilities to analyze, reflect, and improve their inquiry-oriented way of teaching (Altrichter & Reitinger, 2019).

CrEEd for Schools - inquiry learning on multiple levels

The innovative feature of *CrEEd for Schools* is the implementation of inquiry learning on several levels: first, on the level of the lessons given in the classrooms (figure 1; [4]), where pupils experience a participatory, inquiry-oriented way of learning; second, on the level of the teachers who try to implement inquiry learning in their classes. Their own learning process represents the essence of the school developmental process because the advancement of the didactical concepts of individual teachers will eventually lead to an increase in competencies and innovation on school level (figure 1; [5]). Third, the members of the external supporting team of researchers support the teachers in their pursuit of extending their personal knowledge (figure 1; [3]) and have a genuine interest in the success of the bottom-up school developmental process. Ideally, the optimum performance of the desired developmental process achieved through *CrEEd for Schools* culminates in *Participatory Action Research*, where each participating individual pursues their crucial interest (Korthagen & Kessels, 1999), while all players in the project work

together on an equal footing and mutually exchange their experiences and knowledge in a collaborative and innovative process (Corno & Randi, 1997).

FIG. 1. *Model structure of CrEEd for Schools (Reitinger & Oyrer, 2020)*



3. Description of the study

The project started with an initiative by the headmaster of an Austrian secondary school, who intended to allow for more creativity, inquiry, and participation during lessons at school. In addition, a team of researchers was looking for a possibility to disseminate their findings about inquiry-based learning arrangements and the implementation in a school developmental process.

In consultation with the headmaster, a first workshop was organized in which the criteria of inquiry learning were described in detail. Teachers were strongly advised to join, but, according to the PAR process, attendance was not mandatory. Hence, out of a group of about 25 teachers only five teachers fully committed to going through a practical phase of preparing and teaching lessons according to *CrEEd*. In this process, they received first-hand information on the practical realisation of the teaching concept. Another workshop, which offered professional reflection on the actual classroom procedures, ended the first action research cycle at the end of the term and, at the same time, started a new cycle for the summer term. While the first implementation period (first action research cycle) could be regarded as a piloting phase or a test period, the second period requested stronger commitment to the joint research project. The five teachers, plus three more teachers who joined the project put their names on a list of participants in the project. They were all genuinely interested in inquiry-based learning, but the three new participants had

not been able to join the project earlier due to various assignments in the school administration. The newcomers received a short introduction to inquiry-oriented learning arrangements, albeit less detailed than the first group. One of them wanted to apply the new teaching approach in class but decided against the collection of quantitative or qualitative data. Again, daily school activities and other administrative tasks limited this teacher´s ability to take advantage of the full potential of the project. The others regarded the suggested research procedure as suitable for their own professional development and fully committed to it.

Research questions and hypotheses

In correspondence with the PAR-process, research was conducted on three equivalent levels. One level (L1) represented the quality of learning in the classrooms, determining whether pupils' learning experiences matched the criteria of inquiry-based exploration. On another level, the teachers explored together with the supporting team of researchers whether their methods were applicable to initiate and foster inquiry learning and participation in class (L2). On the level of school development (L3), it was investigated in how far the perceived quality of teaching matched the results of the quantitative study, and which procedures and methods were conducive to the inquiry learning process. Hence, the following research questions were examined on the three different levels (see Table 1).

TAB. 1. *Research questions*

L1	*Q1*	Do CrEEd learning arrangements lead to a stronger evolvement of inquiry learning than conventional instruction?
	Q2	Which levels of evolvement do the criteria of inquiry learning reach?
L2	$Q3_a$	Which parameters are regarded by the teachers as being conducive to the evolvement of the criteria of inquiry learning?
	$Q4_a$	Which methods and procedures do teachers apply to foster inquiry learning?
L3	$Q3_b$	Can the degree of evolvement of the criteria of inquiry learning be better understood when analysing the teachers' descriptions of their work in class?
	$Q4_b$	How do the perceived evolvement of inquiry learning in a teacher´s class and the teacher´s methods and materials used in inquiry learning arrangements correlate?

Derived from these questions, the following hypotheses were put forward (see Table 2).

TAB. 2. *Hypotheses derived from the research questions*

L1	*H1*	CrEEd learning arrangements lead to a stronger evolvement of inquiry learning than conventional instruction.
	H2	The four criteria of inquiry learning evolve to different extents during the CrEEd learning arrangements of the teachers.

L2	$H3_a$	There are certain parameters that the teachers consider to be conducive to the evolvement of inquiry learning.
	$H4_a$	There are characteristic methods and procedures teachers apply to foster inquiry learning.
L3	$H3_b$	There are correlations between the pupils´ experienced evolvement of inquiry learning and the individual, practical concept of the teacher who teaches the class.
	$H4_b$	There are correlations between the pupils´ perceived evolvement of inquiry learning and the teachers´ methods or procedures in inquiry learning arrangements.

Research design

In a quasi-experimental design, the evolvement of inquiry learning was examined in thirteen classes following a post-interventional procedure (N = 229 pupils, 13 classes, seven teachers) by using a standardized instrument called *SVF*[1]*-Kurzskala* (Permanschlager, Reitinger, Reitinger, Seyfried, & Waid, 2018). This 5-point Likert scale measures the extent to which self-determination, trust-based learning, and the four criteria of inquiry learning (experience-based hypothesizing, authentic exploration, critical discourse, conclusion-based transfer) are experienced by the learners. (1: I strongly disagree, to 5: I strongly agree). A mixed between-within subjects analysis of variance (ANOVA; general linear model; Pallant, 2007, pp. 266–274) was performed to assess the impact of two interventions, namely of a conventional learning arrangement (conv) and an inquiry learning arrangement (creed) on the pupils' ratings of the four criteria. Thus, variations of the perceived evolvement of the criteria of inquiry learning of each participating child, and of the class as a whole, were compared in the two different educational settings. Additionally, *t*-tests were carried out for data of six teachers comparing conventional learning (conv) to inquiry learning (creed); teacher 7 delivered only data for the creed intervention. With these six single *t*-tests, we checked significances of mean differences on the basis of an alpha-corrected *p*-level (Bonferroni-correction: $p_{corrected} = .05/$ [number of tests]; Field, 2009, p. 373).

Furthermore, data for the qualitative analysis was obtained by conducting guided interviews at the end of the second practical phase with the eight teachers who had been trying to implement inquiry learning in their classes. The qualitative content analysis was performed according to Mayring (2014), and categories were established collaboratively, inductively and deductively, in a team of three researchers (Cornish, Gillispie, & Zittoun, 2013). For six of the interviewed teachers, the aforementioned quantitative data was gathered from their pupils so that methodological triangulation (Denzin, 2017) was possible. Finally, the results provided a basis for feedback and reflection on the action research process.

1 *SVF* refers to the German terms *Selbstbestimmung* (self-determination), *Vertrauen* (trust), and *Forschendes Lernen* (inquiry learning).

4. Results

In the following section, the results of the quantitative (H1, H2) and qualitative ($H3_{a/b}$, $H4_{a/b}$) analyses are presented.

Analysis of the evolvement of inquiry learning (H1, H2)

We compared the performances of inquiry learning (*t*-test, ANOVA) within *CrEEd* learning arrangements (creed) and conventional learning arrangements (conv), as addressed in H1. Surprisingly, there was no significant general effect ($t[229] = .522$, n. s.) between the two groups of students ($M_{creed} = 3.58$; $M_{conv} = 3.61$). Even six alpha-corrected *t*-tests calculated for each of the teachers could not identify a single significant difference between *CrEEd* learning arrangements and conventional instructional lessons (see Table 3). However, when comparing single means differentiated according to the participating teachers (creed/conv*teacher), a significant interaction effect unveils, $F(5, 224) = 4.130$, $p < .01$, $eta^2 = .084$. This effect was mainly due to partially positive performances (teachers A and B) and partially negative performances (teachers D and F)(see differences of means in Table 3).

TAB. 3. *Performance of inquiry learning; mean value (M); standard deviation (SD); not significant (n.s.); creed, inquiry teaching approach according to CrEEd; conv, conventional teaching*

Intervention	*Teacher*						
	A	B	C	D	E	F	G
creed	*M* = 4.21	*M* = 4.07	*M* = 3.26	*M* = 3.55	*M* = 3.54	*M* = 3.41	*M* = 4,04
	SD = .60	*SD* = .77	*SD* = .89	*SD* = .89	*SD* = .64	*SD* = .74	*SD* = .65
conv	*M* = 3.95	*M* = 3.80	*M* = 3.19	*M* = 3.97	*M* = 3.51	*M* = 3.63	
	SD = .60	*SD* = .94	*SD* = .72	*SD* = .78	*SD* = .60	*SD* = .85	
Difference	*.26*	*.27*	*.07*	*-.42*	*.03*	*-.22*	
of Means	*(n. s.)*	*(n. s.)*	*(n. s.)*	*(n. s.)*	*(n. s.)*	*(n. s.)*	

Missing data for teacher G (conv) and teacher H (creed, conv).

Therefore, hypothesis H1 – stronger evolvement of inquiry learning in *CrEEd* learning arrangements – was not confirmed. Nevertheless, it is notable that all single *CrEEd* lessons as well as conventional lessons have means above the middle of the applied scale (compared also to mean value of 3.088; Permanschlager et al., 2018, p. 51), which indicates a general tendency towards inquiry learning.

Regarding hypothesis H2 – the four criteria of inquiry learning evolve to different extents during the *CrEEd* learning arrangements of the teachers – differences between the observed *CrEEd* learning arrangements concerning the evolvement of the criteria of inquiry learning could be determined. The results of a mixed between-within subjects ANOVA (criteria*teacher) show a significant interaction effect, $F(18, 723) = 4.260$, $p < .001$, $eta^2 = 096$. This led us to conclude that various criteria seem to have been met to considerably different extents by the participants in the study. Table 4 visualizes single means of all measured criteria within the *CrEEd* learning arrangements for the seven teachers A to G.

TAB. 4. *Means (M) and Standard Deviations (SD) of the single criteria of inquiry learning within the 'creed' intervention – differentiated by teachers*

Criterion	*Teacher – ('creed' intervention)*						
	A	B	C	D	E	F	G
Experience-based hypothesizing	*M* = 4.29 *SD* = .64	*M* = 4.60 *SD* = .50	*M* = 3.56 *SD* = 1.03	*M* = 3.73 *SD* = 1.16	*M* = 3.69 *SD* = .98	*M* = 3.53 *SD* = 1.14	*M* = 4.22 *SD* = .73
Authentic exploration	*M* = 4.00 *SD* = .95	*M* = 4.24 *SD* = 1.17	*M* = 3.46 *SD* = 1.25	*M* = 3.66 *SD* = 1.26	*M* = 4.05 *SD* = 1.02	*M* = 3.43 *SD* = 1.01	*M* = 3.94 *SD* = .87
Critical discourse	*M* = 4.67 *SD* = .66	*M* = 3.52 *SD* = 1.26	*M* = 3.63 *SD* = 1.18	*M* = 4.10 *SD* = 1.09	*M* = 3.58 *SD* = .85	*M* = 3.80 *SD* = 1.06	*M* = 4.67 *SD* = .77
Conclusion-based transfer	*M* = 3.90 *SD* = .94	*M* = 3.92 *SD* = 1.00	*M* = 2.40 *SD* = 1.23	*M* = 2.71 *SD* = 1.44	*M* = 2.83 *SD* = .98	*M* = 2.87 *SD* = 1.22	*M* = 3.33 *SD* = 1.03

Missing data for Teacher H

Analysis of conducive parameters, methods and materials ($H3_{a+b}$ and $H4_{a+b}$) by means of Qualitative and Mixed-Methods Analysis

In the following section, the results of the qualitative analysis of the data obtained from interviews with eight teachers will be presented to discuss hypotheses $H3_{a/b}$ and $H4_{a/b}$.

With regard to hypothesis $H3_a$ – the parameters regarded by the teachers as being conducive to the evolvement of the criteria of inquiry learning – all interviewees were able to name important factors, from which the following four categories (C1 to C4) could be established (see Table 5).

TAB. 5. *Categories derived from qualitative analysis of interviews concerning parameters regarded conducive to the evolvement of the criteria of inquiry learning*

Category	*Label*	*Examples*
C_1	scholarly exchange	support by experts, input and discussion regarding the theory of inquiry learning
C_2	communication with colleagues	talking to other teachers teaching the same subject(s)
C_3	general conditions and resources	library, blocking of lessons, time slots for exchange with colleagues
C_4	attitude and mindset of the teacher	student-centeredness, openness towards development of one's own teaching skills

In addition, some inhibiting factors were named, e. g. constraints imposed by strict guidelines in the curricula and time pressure. Moreover, not being a novice teacher and therefore falling back into old patterns was seen as problematic.

Hypothesis $H3_b$ – there are correlations between the pupils' experienced evolvement of inquiry learning and the individual, practical concept of the teacher who teaches the class – will be discussed by highlighting similarities and differences among the participants in the study regarding the results of both the quantitative and qualitative analysis.

Starting with the teachers whose quantitative data was above zero or showed a low but positive trend towards inquiry learning respectively (Table 2), statements could be allocated to all four categories. For three of the teachers attached crucial importance to knowing that one's teaching is placed on a sound theoretical footing and that one is part of a community of practitioners pursuing similar goals was considered as conducive (C1, C2), and so was a good relationship between teacher and learners which allows for effective communication (C4). One of these teachers, however, stated that in one of the two subjects in which the inquiry learning took place, it was more difficult to fully adopt the student-centered approach, primarily because of constraints imposed by rather strict guidelines in the curriculum and generally more pressure to perform. This might be a possible explanation why the positive trend towards inquiry learning of this teacher was less marked than that of the other two participants.

Differences between the teachers of this group could be spotted regarding C3, general conditions and resources. Two participants stated that the length of instruction time and also the teaching materials were not sufficient, whereas one teacher was happy with the general conditions under which the teaching and learning took place. Regarding the teacher whose data revealed the least marked positive trend towards inquiry learning, it could be seen that C1 and C2 were not reflected in the statements. None of the statements could be assigned to category C3, time was only referred to as an inhibiting factor. C4, attention and mindset of the teacher, was referred to in two ways: first, the teacher described inquiry

learning as a principle which had already been applied for a while and hence was new neither to the teacher nor the students; second, the teacher regarded teacher-centeredness as more timesaving and effective at times, especially in order not to deviate too far from a specific topic.

Finally, the two teachers whose quantitative data showed a negative trend with respect to inquiry learning will be looked at in more detail. Scholarly exchange (C1) and communication with colleagues (C2) were mentioned, but both teachers also expressed a wish to intensify this exchange, which seemed impossible at that point because of time constraints. They would have liked to get more detailed, specific and definite ideas regarding methods and possible lesson plans. Being given the opportunity to organize the lessons into double periods was regarded as conducive to the realization of inquiry learning (C3). When it comes to C4, the teachers expressed doubt especially about young learners' ability to work independently, which is why much of the teaching and learning took place in a plenary. One teacher explained that the pupils' questions somehow got lost in the process and were not developed into hypotheses. They concluded that some topics might not be suitable for inquiry learning.

Regarding hypothesis $H4_a$ – there are characteristic methods and procedures teachers apply to foster the evolvement of the individual criteria of inquiry learning – the analysis of the data indicates that it is primarily interest in the topic, hypothesizing, and authentic exploration which are at the center of teachers' attention. For those criteria of inquiry learning, the statements of the teachers can be assigned to four categories (C5 to C8) (see Table 6).

TAB. 6. *Categories derived from qualitative data concerning characteristic methods and procedures applied by the teachers*

Category	*Label*
C_5	Examples of materials for stimulating interest and hypothesizing
C_6	Examples of methods for stimulating interest and hypothesizing
C_7	Examples of materials for authentic exploration
C_8	Examples of methods for authentic exploration

C5 included documentaries about current and relevant events, lists of topics including sub-topics and questions about the topic, extracts from films, image vignettes, texts, and examples of possible products which could be developed in the inquiry learning phase. Those materials were used (C6) to trigger discussions, speculate about possible answers to questions raised, pose new questions, and provide pupils with a choice.

For authentic exploration, age-appropriate materials such as textbooks, a collection of weblinks, experiment kits, and visuals were named as suitable learning and teaching materials (C7).

With regard to the methods used (C8), on the one hand, flexibility and openness regarding time management, group sizes, ways of working, teacher-learner-centeredness, forms of assessment, and teacher support were listed. On the other hand, providing a clear structure, e.g. detailed guidelines on a handout, visualization of the process, reminders, and resorting to already well-known teaching concepts were mentioned.

Hypothesis $H4_b$ – there is a correlation between pupils´ perceived evolvement of inquiry learning and the teachers´ methods or procedures in inquiry learning arrangements – will be addressed by grouping the participants with regard to similar interaction effects.

The most noticeable difference between the teachers who performed higher in the inquiry learning arrangements and those who scored lower, was that the statements of the former group could be allocated to all four categories. Materials were named that could be applied to hypothesizing and authentic exploration (C5, C7), but more importantly many methods were described which seemed to be closely related to the above-described teacher attitude and mindset (C4). Examples include flexible grouping according to the pupils' needs, pre-selecting sources on topics which might be meaningful for the pupils, and support when finding and formulating hypotheses and research questions (C6). The following were listed as methods for authentic exploration (C8): trying things out, individually or in groups, allowing phases of student-teaching, interviewing experts, including fellow pupils who had already conducted some research, and facilitating pupils' self-assessment, maximizing the amount of student participation, supporting research, providing a structure and time frame, avoiding falling back into old teaching patterns of behavior, remaining open to different methods (no specific method), giving continuous support and thought-provoking input, and posing additional questions.

For the teacher whose data showed the least positive trend, it can be noted that C6 was represented insofar as clear (step-by-step) instructions, a structure for formulating questions, and learner-centeredness in this phase of the lesson seemed crucial to the teacher.

There was no noticeable difference regarding the materials used by the different groups of teachers (C5, C7). However, teachers whose trend in mean values for inquiry learning was negative described inquiry learning as lacking structure. One teacher went so far as to say that interference of the teacher was considered as an impediment to the inquiry learning process. Openness was equated to a reduction of support by the teacher and the teachers tended to resort to already well-known methods instead of trying new ways.

Summing up, in the present study, scholarly exchange (C1), communication with colleagues (C2), and an attitude and mindset of the teacher which allows for student-centeredness and openness towards development of one's own teaching skills

(C4), methods for stimulating interest and hypothesizing (C6), and methods for authentic exploration (C8) seem to have brought about a positive interaction effect.

5. Discussion and implications

In this section, the results will be discussed with regard to the three levels on which our research took place.

On level 1 (L1), where we address the question of how pupils perceived the inquiry learning process, no significant difference could be spotted to their learning experience in conventional settings and hypothesis 1 – *CrEEd* learning arrangements lead to a stronger evolvement of inquiry learning than conventional instruction – could not be confirmed. The results indicate that the input provided had not yet had an impact on the learning situation in class. This phenomenon is by no means atypical for the implementation of inquiry learning arrangements (Capps, Crawford, & Constas, 2012). However, the patterns for the different teachers indicating that the various criteria evolved to different extents (see Table 3, H2) will provide valuable information as to which criteria could be focused on more in the next cycle of action research.

This is where level 2 (L2) comes in, i.e. teachers' perceptions of how inquiry learning can be fostered in the classroom and reflection on methods and procedures ($H3_a$, $H4_a$). A closer look at the data reveals that the mean values of all participating practitioners are above the mean value of the scale (statistical mean = 3.088; Permanschlager et al., 2018, p. 51) (see Table 3), suggesting that a general tendency in the teachers´ lessons towards inquiry learning already existed before the PAR-process started. This is why it seems even more important to connect any future work to the four categories which could be established, especially the ones which can be influenced by the team of researchers. As attitudes tend to be more difficult to change (C4; c. f. Haddock & Maio, 2004; Michel & Shoda, 1995), it seems reasonable to start off by providing opportunities for exchange with experts in the field and colleagues teaching the same subject. Moreover, a certain degree of flexibility with regard to blocking of lessons and access to resources might benefit the implementation process. In addition, teachers seem to have an extensive repertoire of methods which they can use to awaken interest, consider hypotheses, and make pupils explore a topic area in an authentic manner. They do not, however, refer to ways in which *critical discourse* and *conclusion-based transfer* can be guided. This would, again, provide a starting point for further input from the experts in inquiry learning.

On the third level of our investigation (L3), the interrelation between the learners' perceived evolvement of the criteria of inquiry learning and the teachers' individual practical concepts, methods, and materials will be in the focus of our discussion ($H3_b$, $H4_b$). When it comes to the overall teaching approach, the

triangulation of the data asserts the importance of a professional learning community, in which practitioners and researchers exchange ideas on a regular basis. Moreover, it reveals that teachers need to be sincerely open to new ideas and willing to stick to student-centered learning processes even if those might seem less time-efficient. As teachers feel constrained by packed curricula, for further action research one might consider a thorough analysis of the competences listed with regard to core elements, as this might free teachers from slavishly following the tasks provided in textbooks they might use. Looking at the methods and materials mentioned by the interviewees, what sticks out is that student-centeredness must not be equaled with lack of support from the teacher. The key term seems to be flexibility within a clear structure and time frame. As already described above, teachers can draw on a large collection of methods, so the focus needs to be on practicing to pick and choose according to the needs of the learners. Moreover, age-appropriate pre-selection of materials and sources as well as formulating additional questions could be worked on.

Regarding the PAR-process in general, it was noticed that the participation of the teachers increased in the course of the project, a phenomenon also described in the literature (Townsend, 2014; Eilks, 2014). At the beginning of the project, the teachers were simply curiously embracing the new theoretical approach and experimented with it to enrich their everyday teaching. By and by, they learned to trust the knowledge continuously acquired in the process, and became more confident in the pupils' competencies (Clayton, Kilbane, & McCarthy, 2017). Also, their interest in the overall project and the critical engagement in the theoretical concept of inquiry teaching became more important. All participating teachers became increasingly interested in scientific results and started to acknowledge the importance of further professional development. All in all, this seems to provide a sound basis for further action research cycles.

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