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The role of video fragments of activity in collaborative solving of experimental-research tasks by adolescents

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Abstract

Context and relevance. The modern educational process actively integrates digital technologies; however, the didactic principles of their implementation, especially in the context of organizing collaborative research activities for adolescents, have not been sufficiently explored. Studying the role of video fragments of activity as a tool mediating group interaction appears important for developing effective educational methods in secondary school. **Objective.** To study the role of a new digital tool (video fragments of activity, VFA) as an instrument mediating group interaction among adolescents in the process of solving experimental research tasks. **Hypothesis.** The role of VFA in the process of collaborative problem-solving is determined by the function (meaning) that this tool begins to perform in joint activity. **Methods and materials.** V.V. Rubtsov's social-genetic method was applied. Based on its main principle regarding the mediation of task content through the methods of organizing participants' joint activity, the authors developed an original method called "Sticks." The main stage involved 60 students from grades 6–8. **Results.** The effectiveness of VFA as a mediating tool is determined by the transition from the function of passive "representation" to the function of active "model example" of joint activity. Such a transition, leading to substantive reflection and qualitative changes in the level of concept generalization and mode of interaction, is possible only with structured assistance from a teacher who organizes reflective analysis. **Conclusions.** Using video fragments of one's own activity represents the introduction of a new sign-symbolic tool which, when integrated into joint activity with pedagogical support, becomes an instrument for awareness and regulation of collaborative actions, promoting the development of theoretical thinking.

Keywords: video fragment of activity, joint activity, mediation, adolescents, theoretical thinking, reflection; social-genetic method

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Роль видеофрагментов деятельности в совместном решении подростками экспериментально-исследовательских задач

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Резюме

Контекст и актуальность. Современный образовательный процесс активно интегрирует цифровые технологии, однако дидактические принципы их внедрения, особенно в контексте организации совместной учебно-исследовательской деятельности подростков, раскрыты недостаточно. Изучение роли видеофрагментов деятельности как инструмента, опосредующего групповое взаимодействие, представляется важным для разработки эффективных образовательных методик в подростковой школе. **Цель.** Изучение роли нового цифрового средства (видеофрагментов деятельности, ВФД) как инструмента, опосредующего групповое взаимодействие подростков в процессе решения экспериментально-исследовательских задач. **Гипотеза.** Роль ВФД в процессе совместного решения определяется той функцией (значением), которую это средство начинает выполнять в совместной деятельности. **Методы и материалы.** Применялся социально-генетический метод В.В. Рубцова. На основании его основного принципа об опосредовании содержания задачи способами организации совместной деятельности самих участников была разработана авторская методика «Палочки». В основном этапе приняли участие 60 учащихся 6–8-х классов. **Результаты.** Эффективность ВФД как средства опосредования определяется переходом от функции пассивного «изображения» к функции активного «модельного образца» совместной деятельности. Такой переход, приводящий к содержательной рефлексии и качественным изменениям в уровне обобщения понятий и способе взаимодействия, возможен только при структурированной помощи педагога, организующего рефлексивный анализ. **Выводы.** Использование ВФ собственной деятельности представляет собой введение нового знаково-символического средства, которое, будучи встроено в совместную деятельность при педагогической поддержке, становится инструментом осознания и регуляции совместных действий, способствует развитию теоретического мышления.

Ключевые слова: видеофрагмент деятельности, совместная деятельность, опосредование, подростки, теоретическое мышление, рефлексия, социально-генетический метод

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Introduction

The relevance of the present study is determined by a contradiction between the mass integration of digital technologies in education and the deficit of methods for their substantive incorporation into the learning activities of adolescents (ages 12–15), particularly in the context of developing meta-subject competencies (Federal State Educational Standard for Basic General Education, 2020). Collaborative experimental-research activity represents an ideal context for cultivating adolescent subjecthood (Tsukerman, 2022); however, its potential in schools frequently remains unrealized due to the absence of tools for objectifying and analyzing group work.

The problem thus lies in substantiating the conditions for the effective use of digital technologies — specifically video — as a tool integrated into adolescents' collaborative activity itself.

The theoretical and methodological foundation of the study is the cultural-historical paradigm (L.S. Vygotsky) and the concept of developmental education (Davydov, 2004; Rubtsov, 2024), within which the development of thinking is associated with the organization of joint activity. Within this framework, digital technologies, including video, are conceptualized as a new means of mediation (Rubtsova, 2019). Critiquing the kind of digitalization that generates “uniform operationality” (Gromyko, 2023), the digital-cognitive approach substanti-

ates the design of environments in which visual elements function as semantic signs that externalize the workings of consciousness (Gromyko, Rubtsov, 2021). It is essential that digital tools convey not only the product but also the living process of meaning-making and activity development (Nechaev, 2020). Accordingly, video fragments designed in accordance with this logic can potentially function as an effective means of mediating joint activity, directly participating in the process of generating educational concepts and developing thinking.

In contemporary educational practice, video is predominantly used as visual didactic material and as a means of organizing reflection on ready-made content (Adaskina et al., 2021). Research confirms its potential for increasing engagement and learning outcomes, as well as for fostering awareness of the foundations of one's own actions through reflective analysis (Rubtsova, Ulanova, 2014; Konstantinova, 2023; Chen et al., 2025).

However, the role of video as a tool mediating the process of group interaction and joint activity has not been sufficiently studied. The scientific novelty of the present study lies in examining video fragments of adolescents' own collaborative activity (VFA) during problem-solving as a means of coordinating group dynamics and meaning-making (Rubtsova, 2019; Rubtsova, 2023). It is precisely this approach that holds particular value for the development of educational methods for adolescent audiences. The aim of the study is to examine the role of video fragments of activity (VFA) as an instrument mediating group interaction among adolescents in the process of solving experimental-research tasks. Hypothesis: a specially organized reflective analysis of VFA, introduced into the process of joint activity, will mediate the shift of participants' attention from the operational dimension of actions to their semantic foundations, thereby promoting the formation of a learning community and the development of theoretical thinking.

Materials and methods

To study the role of video fragments of activity (VFA), V.V. Rubtsov's social-genetic method (2024) was applied, as it is most appropriate for analyzing the processual characteristics of joint activity. On this basis, an original methodological complex was developed. Given the limitations of a classical experimental design, a mixed longitudinal design with within-group control was adopted. The design involved the stepwise introduction of VFA into the activity of all dyads ($N = 30$), followed by qualitative and quantitative analysis of changes. Its advantages include high internal validity (comparing each dyad with itself at different stages), a focus on processual dynamics, and ethical acceptability (all participants received access to the innovative method).

The sample for the main stage consisted of 60 students from grades 6–8 (ages 12–14) at a Moscow school. Statistical analysis was conducted on a subsample of 20 eighth-grade students.

Procedure and variables. Analysis was conducted across five key stages: (1) individual trial; (2) collaborative problem-solving without video analysis; (3) viewing VFA “without scaffolding”; (4) reflective analysis of VFA with reference to the “Master” role; (5) creation and presentation of the “best solution.” The independent variable was the stage of the study (five levels). The dependent variables were: problem-solving method (PSM), generalization level of concepts (GLC), and type of interaction (TI). The procedure, scales, and assessment forms for qualitative changes are described in detail in the methodological appendix (Konstantinova, 2026).

Data were processed using qualitative content analysis and nonparametric statistical methods (Friedman test).

Task specifics. The developed experimental-research task (see Appendix) is based on participants' everyday conceptions of the terms big, small, and arrange, and affords solutions at different levels of generalization — up to and including the theoretical level in the sense described by V.V. Davydov. Two modifications (individual and group) allow for the examination of changes in problem-solving methods across stages. The apparent simplicity of the task and its resolution within 5 minutes enable analysis of short video fragments without cognitive fatigue. The methodology allows for varying the organization of reflective interactions using video fragments of the problem-solving process (VFPSP), identifying the conditions under which difficulties are recognized both at the operational level and at the level of the meanings of the concepts used. An important feature is that the task itself becomes experimental-research at a certain stage of the solution, when participants begin to experiment not only with coordinated movements but also with the meanings of the concepts they employ.

Logical-subject analysis of the task.

The subject of the task / unit of contradiction is the element “stick,” which can simultaneously be characterized as “big” (B) or “small” (S) depending on the chosen basis for comparison. The task is grounded in a relationship of magnitudes that becomes meaningful only through the comparison of elements. The initial relationship is as follows: one and the same element can occupy different positions in different series (seriations built in ascending and descending order) — being B in one series and S in another. Upon multiplication — that is, when the relationship between the two series is identified — the middle stick can be simultaneously both B and S.

The *logic of the concept* (the subject-content essence of the concept) lies in the fact that the solver multiplies the relationship between different series (ascending and descending). The odd element becomes the unit of contradiction with respect to those initial relationships that

the child must hold simultaneously in order to master the concept; the methodology is built upon this principle. In the course of solving the task, the concept of “big/small” — as a relationship of magnitudes — is concretized and objectified through comparison with elements of different series, and is imbued with new meaning that transcends the dichotomy of everyday definitions.

Construction of the initial relationship. The task is designed as a subject-based model of a complex relationship — the multiplication of seriations on opposing grounds. The rules do not merely create constraints; they embody the logic of the concept of B/S itself, establishing the operational structure of its implementation and the logic of imbuing everyday concepts with meaning. The rule requiring the simultaneous performance of divided actions with big and small elements is the operational expression of this relationship, transforming it from an ideal construct into a concrete action. The condition that the task is considered solved only when the meaning of the concepts B and S corresponds to the operations performed with B and S elements establishes the logic for testing everyday definitions and progressively refining the meanings of B/S up to the theoretical level of generalization.

The individual stage reveals the capacity to simultaneously hold two relational magnitudes while adhering to the rules. The collaborative stage demonstrates how the organization of interaction becomes the condition for concept formation. Thus, at the individual stage the task is diagnostic, whereas at the collaborative stage it is developmental: it provokes a transition from a learning action to experimental-research one, in which the content of the concept is revealed through collaborative activity aimed at overcoming constraints. The key trap embedded in the task design is that at the individual level the rule requiring correspondence between definitions and actions is perceived as redundant, since the defini-

tions appear to be self-consistent; at the collaborative level, however, this rule becomes a necessary condition and tool for solving the task.

A particularly important role in the collaborative solution of such a task using VFA is played by the teacher, who acts as: a fixer of contradictions, sharpening discrepancies between declared and actual correspondence; an organizer of expertise, translating emotional disputes into a procedure for checking the correspondence between the “protocol” (video, forms) and the “norm” (definitions in the form); an organizer of semiotic translation, rendering the identified problem in a sign-symbolic plane based on participants’ forms and video; and an organizer of reflection, creating conditions for analyzing the collaborative problem-solving method from different role-based positions and guiding inquiry into questions such as: “What criteria did you use to divide elements into ‘big and small’ — objective or subjective?” and “Do your actions correspond to your definitions?”

Results

The percentage distribution of all respondents by problem-solving method at Stage 1 (Table 1) indicated that 58% of all respondents solved the task using the first method (“object-manipulative”), 42% used the second method (“operational”), and the third — “semantic” — method, in which concept definitions correspond to modes of action, was used by no participant. Qualitative analysis of the definitions and problem-solving methods at Stage 1 (Table 2) revealed that 62% of respondents’ definitions were of an absolute, subjective-evaluative character (B — “the biggest”; “something larger than me”; “when an object takes up a lot of space”), or definitions were given through synonyms, antonyms, or parts

Table 1
Percentage distribution of students from different grades by problem-solving methods at Stage 1

| Grade | Individual problem-solving methods | | |
|-------|------------------------------------|--------|-------|
| | First | Second | Third |
| 6 | 65 | 35 | 0 |
| 7 | 50 | 50 | 0 |
| 8 | 60 | 40 | 0 |
| Total | 58 | 42 | 0 |

Table 2
Percentage distribution of students from different grades by generalization level of a concept (GLC) at Stage 1

| Grade | VOII / GLC | | | | | |
|-------|------------|-------|-----|-------|-------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 6 | 0% | 60% | 35% | 5% | 0 | 0% |
| 7 | 0% | 5% | 40% | 35% | 20 | 0% |
| 8 | 0% | 15% | 30% | 25% | 20 | 10% |
| Total | 0% | 26,7% | 35% | 21,7% | 13,3% | 3,33% |

of speech (S – “tiny”, “not big”, “an adjective”); approximately 22% of definitions reflected figurative meanings (B – “adult”, “responsible”); and approximately 16% offered definitions through comparison with an average (B – “someone or something larger than average statistics”, “bigger than usual, than the average”).

Qualitative analysis of Stage 3 results reveals how schoolchildren responded to independent viewing of video recordings of their own solutions. Overall, across the sample, the majority of participants (63,3%) did not feel the need to change anything following independent viewing. Among sixth-graders, the desire to make changes after viewing was split evenly (50/50), while in grades 7 and 8, considerably fewer participants wished to make corrections compared to those satisfied with the result (30% vs. 70% in both grades). Crucially, actual corrective activity differed substantially from declared intentions. Despite 36,7% expressing a desire to revise their work, only 10% actually made corrections to their solutions, and only 11,7% made corrections to their definitions. This indicates that passive observation of one’s own actions is insufficient to trigger reflection and self-correction in the majority of students.

Qualitative analysis of sixth-graders’ written responses to the prompt “What is your reaction to what you saw?” at Stage 3 revealed a predominance of emotional and evaluative reactions such as: “We basically look smart from the outside. That’s enough” and “We worked as a team” – which stood in contrast to the introduction of actual changes. The most telling group of responses reflected an acknowledgment of errors without subsequent corrective action: “We saw that we were doing it wrong”; “We understood that something was off”; “Confusion and some conclusions”; “I understood the mistake, but I don’t know how to fix it yet.” These responses register a “gap” but fail to specify its nature.

Even the awareness of rule violations – as in “I noticed that we didn’t always follow the rules” – was accompanied by changes in only three sixth-graders, of whom two altered only their definitions of “arrange,” and only one made changes to all definitions.

Previously conducted statistical analysis of the eighth-grade subsample (N = 20; Konstantinova, 2026) confirmed the high significance and consistency of the identified qualitative changes relative to the dynamics of three key indicators across stages: GLC, PSM, and TI. The most substantial changes occurred at the final stages associated with in-depth reflection.

1. Pairwise comparisons of GLC results showed that significant growth occurred precisely at the final stages associated with in-depth reflection: in the transition from Stage 3 to Stage 4 (p = 0,008) and from Stage 4 to Stage 5 (p = 0,008). At Stage 5, the lowest GLC level (GLC = 2) disappeared entirely, while the highest level (GLC = 5–6) increased from 10% to 50%. Positive GLC dynamics were demonstrated by 70% of participants (14 out of 20).

2. In comparing PSM across stages, a progressive transformation was observed: from dominance of the object-manipulative method (PSM = 1 in 65% at Stage 1), through operational coordination at Stages 2, 3, and 4 (peak PSM = 2 in 90% at Stage 4), to the semantic-reflective method (PSM = 3 in 90%) at Stage 5.

Comparison of TI across stages revealed a significant shift from pseudo-organizational interaction (70% at early stages) to organizational-reflective interaction (60% at Stage 5). Significant growth began after Stage 4. In total, 80% of participants (16 out of 20) improved the quality of interaction with their partner.

3. Across all three key parameters – GLC, PSM, and TI – statistically significant positive changes were recorded. The transformation of problem-solving methods proved particularly noteworthy: participants pro-

Table 3

Percentage of students who made changes after viewing the VFPR ‘without supports’

| Grade | I want to change something | | Making changes to decisions | | Making changes to definitions | |
|-------|----------------------------|-------|-----------------------------|-----|-------------------------------|-------|
| | Yes | No | Yes | No | Yes | No |
| 6 | 50% | 50% | 15% | 85% | 15% | 85% |
| 7 | 30% | 70% | 5% | 95% | 15% | 85% |
| 8 | 30% | 70% | 10% | 90% | 5% | 95% |
| Total | 36,7% | 63,3% | 10% | 90% | 11,7% | 88,3% |

Table 4

Percentage of students who made changes after viewing the VFPR ‘with supports’

| Grade | Formulated the difficulties | | Proposed solution improvements | | Made changes to the definitions | |
|-------|-----------------------------|-------|--------------------------------|-----|---------------------------------|-------|
| | Yes | No | Yes | No | Yes | No |
| 6 | 80% | 20% | 100% | 0% | 25% | 75% |
| 7 | 75% | 25% | 70% | 30% | 50% | 50% |
| 8 | 60% | 40% | 55% | 45% | 40% | 60% |
| Total | 71.7% | 28.3% | 75% | 25% | 38.3% | 61.7% |

gressed consistently from object-manipulative actions through operational coordination to a semantic-reflective approach. The majority of participants demonstrated improvement across indicators, confirming the cumulative effect of the applied method and its effectiveness for the development of higher forms of thinking and interaction.

Comparative analysis of qualitative and quantitative data across stages allows for the differentiation of the effects associated with different modes of incorporating video fragments into the collaborative problem-solving process among 12–14-year-old adolescents.

Viewing VFA “without scaffolding” (Stage 3) elicited predominantly emotional and evaluative reactions (“funny”, “we looked smart”). Despite 36,7% of students indicating a desire to make changes, only 11,7% made real corrections to concept definitions and only 10% made corrections to problem-solving methods. This attests to the inadequacy of this format for initiating substantive reflection. Qualitative analysis of written responses demonstrated a predominance of surface-level statements (“We saw that we were doing it wrong”) without a transition to analyzing causes or developing a plan of correction.

Reflective analysis with the “Master” scaffolding (Stage 4) represented a turning point. It was at this stage that 71,7% of participants began diagnosing substantive difficulties (“The definitions don’t correspond to the solution”; “The problem of the middle stick”), and the quantitative indicators (GLC and TI) showed their first significant growth. VFA ceased to be merely a recording and became a working tool — a “model example” — for checking the correspondence between action and norm (definition).

Creating the “best solution” (Stage 5) served as a phase of objectification and generalization of a new mode of activity. The necessity of constructing an example comprehensible to others required dyads to reach final agreement on and verbalization of new, relational definitions (“everything is relative”, “bigger/smaller in comparison”) and strategies, thereby consolidating the achieved progress — a development reflected in a jump in the PSM indicator.

Analysis of video protocols and record forms revealed a substantive conceptual evolution. For example, in seventh-grade dyad #2, a transition occurred from absolute, subject-concrete definitions (“B — something larger than me”) at Stages 1–2 to relational and systemic formulations at Stage 5: “B/S = someone/something that, in comparison, is bigger/smaller than others according to the chosen criterion.” Interaction transformed in parallel: from pseudo-organizational type (one participant dominating) to organizational-reflective, expressed in joint decision-making following discussion of a coordination strategy.

Age-specific features of VFA-mediated reflection become apparent when Stage 3 and Stage 4 data are compared across grades (Tables 3 and Table 4).

Grade 6: High operational efficiency (100% proposed improvements) but minimal changes in definitions (25%), indicating that the focus of reflection was on refining the procedure.

Grade 7: A sharp increase in changes to definitions (50%), evidencing a “conceptual breakthrough” — a shift in focus toward semantic foundations.

Grade 8: A decrease in externally observable indicators accompanied by deepened reflection, reflecting a transition to a systemic-personal level of analysis of the conditions for the effectiveness of joint activity.

Video performed different functions at different stages: from the “doubling” of reality to creating a space for pausing, analyzing, and redesigning collective activity.

Discussion

The results of the individual stage revealed a predominance of problem-solving approaches that allowed participants to “bypass the problem” (58%), and of solutions achieved through operational-level coordination of actions (42%). This breakdown corresponds precisely to the conceptual content of B/S. The condition requiring that one’s actions correspond to one’s own definitions is perceived as redundant at the individual stage, since the definitions appear to be internally consistent.

The findings demonstrate that the role of VFA in adolescents’ collaborative work is not static and is determined by the function that this tool comes to perform in the process of collaborative problem-solving under adult guidance. The data allow for the identification of three fundamentally different modes of working with video, corresponding to the stages of the study.

1. Independent viewing of the video recording (Stage 3) served, for the majority of participants (63,3%), primarily an emotional-social rather than an educational-reflective function. Despite 36,7% of students expressing a desire to change something, only 11,7% made actual corrections to concept definitions and only 10% made corrections to problem-solving methods. Reflection remained surface-level in character (“what” rather than “how and why”) and did not become the basis for concrete action (“I don’t know how to fix it”). These findings point to the fundamental limitations of a passive-observation format: video remained an external, emotionally charged object that recorded action but did not mediate its analysis. At this stage, adolescents lacked the internal tools for the substantive decoding of joint action, and VFA functioned as a “representation of activity.”

2. A qualitative leap occurred at Stage 4, when the teacher’s introduction of reflective scaffolding and the

“Master” role-position shifted VFA into the mode of a psychological tool. Participants’ articulation of difficulties (“the definition doesn’t correspond to the solution”; “the problem of the middle stick”) constituted evidence of the emergence of a new object of joint activity – a discrepancy between the present action (recorded on video) and the ideal norm (the original or reconstructed definition). VFA ceased to be merely a recording and was transformed into a working tool – a “model example” – for checking correspondence. It is precisely this transition that accounts for the statistically significant growth in GLC and TI observed after this stage. The results underscore the critical importance of structured adult support: the teacher serves as the architect of sign-based mediation, creates cultural forms for analysis (schemas, protocols), and translates emotional reactions into the subject of substantive dialogue.

3. The problem-solving process, organized as a cycle of “hypothesis (definition) → experiment (VFA) → reflective analysis → correction,” constitutes the collaborative construction and testing of successive models of activity. Particularly telling is the pattern of PSM dynamics: the sharp transition from operational coordination (PSM = 2) to the semantic method (PSM = 3) at the Stage 4→5 transition ($p < 0,001$) points to a cumulative effect of the method. A dyad that has undergone reflection on contradictions constructs a new shared tool – a relational definition (“everything is relative”, “bigger/smaller in comparison”) – which then functions as the regulator for the next cycle of actions in creating the “best solution.” Thus, the group’s zone of proximal development (ZPD) expands through the production of its own cultural tools for coordination. The actualization of communication and reflection processes – the transition from pseudo-organizational to organizational-reflective interaction – functions here not merely as a background condition but as a direct indicator and mechanism of mastery of higher-level concepts.

The age-specific features of reflective analysis revealed in the data confirm the multi-layered nature of this process. Among sixth-graders, reflection was oriented toward the refinement of a comprehensible algorithm (operational efficiency); among seventh-graders, a shift occurred toward semantic foundations and conceptual restructuring; and among eighth-graders, reflection moved to a systemic-personal level of analysis of the conditions for the effectiveness of joint activity as a whole. This progression represents an evolution of thinking from the operational to the systemic-personal level.

Taken together, the presented findings allow for a more precise characterization of the system-forming role of the teacher as a mediator who organizes the process through which VFA is imbued with meaning

and transformed into a means of mediation, generating within the group new self-regulatory tools – generalized concepts and reflective norms of interaction. Questions regarding the specifics of pedagogical intervention, optimal tutoring strategies, and age-related features of reflective video analysis constitute a promising direction for future research.

Conclusions

The conducted study provided empirical grounds for substantiating the role of video fragments of activity (VFA) as a means of mediating adolescents’ collaborative educational work. Within the framework of cultural-historical and activity-based approaches, employing the social-genetic method, it was demonstrated that the developmental potential of this digital tool does not unfold spontaneously but is realized under the conditions of specially organized activity.

1. The inclusion of VFA in the process of collaborative solution by adolescents of experimental-research tasks is determined by the meaning (function) that this tool performs in the course of collaborative problem-solving.

2. At least three distinct modes of incorporating VFA into adolescents’ joint activity are possible:

- in the function of “representation of activity”;
- in the function of “generalized action schema,” determining the operational composition of actions performed by the participants;
- in the function of “model example” of activity, providing mediation of the task object’s content through participants’ own modes of interaction.

3. The inclusion of VFA in joint activity in the function of a model example is the defining characteristic distinguishing an experimental-research task from other types of tasks solved by adolescents: the model example becomes the means of mediating the task object’s content through the modes of organizing joint activity.

4. Solving experimental-research tasks using VFA expands the ZPD through dynamic modeling of modes of organizing joint activity, thereby promoting a higher level of concept mastery among adolescents.

5. The application of VFA in the collaborative problem-solving process requires structured pedagogical support for organizing reflective analysis of the video content in the format of a developmental dialogue – involving guiding questions, verification algorithms, use of different role-based positions for analysis, and the formation of functional consensual norms.

Limitations. Limited sample size, limited access to video data processing, labor-intensive video data processing, novelty of the developed methodology.

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Appendix

Append. Tasks. <https://doi.org/10.17759/pse.2025300>_____

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The author declare no conflict of interest.

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