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**Special section:**
**On the 100th anniversary of N.F. Talyzina**

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# Special section:
# ON THE 100th ANNIVERSARY OF N.F. TALYZINA

## On the Mastery of Elementary Geometric Concepts[¤]

Nina F. Talyzina

*Lomonosov Moscow State University, Moscow, Russia*

Our research is part of a cycle of works on the study of mental actions undertaken by P.Ya. Gal'perin. All the studies of this cycle were performed with a variety of specific materials: arithmetic, algebraic, grammatical, etc. The differences in the material allow us to discover different aspects of the general process of mastering knowledge. Geometry, combining a high degree of abstraction with the visual and concrete, is of particular interest from this standpoint.

We took elementary geometric concepts as the subject of our research: "line," "angle," "angle bisector," "perpendicular," "adjacent angles," and "supplementary angles."

[¤] We publish here the report by N.F. Talyzina to a Conference on Psychology in 1955 and released two years later in the proceedings of that conference (N.F. Talyzina [1957]. In B.G. Anan'yev et al. [Eds.], *Materialy soveshchaniia po psikhologii. July 1–6, 1955*. Moscow: Publishing House of the Academy of Pedagogical Sciences of the RSFSR.) This report is of particular interest, since it describes some of the first formative experiments based on the theory of planned stage-by-stage formation of mental actions; the text does not yet discuss the formation of actions, but only the application of the attributes of concepts to solving problems. The text presents the results of a study of the formation of elementary geometric concepts according to the theory of planned stage-by-stage formation of mental actions and concepts. Twenty-two subjects from grades 6–9 formed geometric concepts such as "line," "angle," "angle bisector," "perpendicular," "adjacent angles," and "supplementary angles." These attributes were formed in the process of their application to solving different types of problems. Observational and then formative (training) experiments were performed individually. The article contains excerpts from the subjects' protocols as they solved the problems. It was shown that stage-by-stage development (identifying attributes from a definition, saying them aloud, and then applying them to solving problems) leads to mastery not only of the geometric concepts themselves, but also of the method of action with definitions in general, allowing students to transfer the method they have learned to concepts from another field of knowledge.

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To identify how these concepts are mastered in the process of academic instruction, we first performed an *observational experiment.*

The mastery of concepts was studied as they were applied to solving various geometric problems. The problems varied in several of their attributes:

1. The degree of complexity: in some it was required to use several of the concepts of interest to us, and in others only one; in some, a geometric phenomenon was presented in isolation, and in others it was included in one system of other geometric phenomena or another, some known and some unknown to the subjects;
2. The completeness of the problem conditions: some problems were presented with sufficient conditions, others had missing ones;
3. The conditions specified in the problem conditions and the illustration: in some, the illustration corresponded to the conditions, and in others it contradicted them.

The problems in which the illustration corresponded to the problem conditions were presented first without an illustration, and then with one. Finally, the subjects had to solve the problems silently, and only if they encountered a difficulty were they allowed to speak aloud or in a whisper.

The experiments were performed with 22 students of grades 6–9 who had different degrees of proficiency in geometry.

In the observational experiment, first of all, *different levels of mastery of the geometric concepts were established.* The results generally confirm the process of mastering knowledge that was found in earlier studies of this research cycle, but they can serve to characterize in greater detail the levels established in those studies.

Second, a number of defects in the mastery of knowledge were found that had been repeatedly noted in the works of N.A. Menchinskaia, E.N. Kabanova-Meller, V.I. Zykova, and others. The main ones are these:

1. Great unevenness in the mastery of concepts, both within one grade and across different grades.
2. The majority of subjects in grades 6–7 do not know how to use necessary and sufficient attributes to establish whether a particular geometric phenomenon is present under the conditions specified in a given problem. As a rule, these subjects give correct definitions; that is, they know the necessary and sufficient attributes, but when solving problems they do not rely on them, but rather on a visual image of the relevant geometric phenomenon.
3. A significant proportion of sixth graders do not know how to construct an illustration that accords with both the definition given to them and with the problem conditions; they also cannot pick out the elements specified in the problem conditions on the illustration.

All these facts were of auxiliary importance for us: they allowed us to establish the directions along which various properties of the concept to be mastered should be developed.

*The training experiment* was aimed at forming complete geometric concepts and identifying their influence on the formation of further geometric concepts. Taking into account the data obtained in P.Ya. Gal'perin's studies on the formation of mental actions and concepts, as well as the results of the observational experiment, we devoted special attention to the organization of action to apply attributes of concepts to the solution of various geometric problems.

This was expressed as follows.

First, from all of the attributes to be mastered, we singled out those that were necessary and sufficient to determine the presence or absence of the relevant phenomenon in the material presented.

Second, these attributes were given initially in a "materialized" visual form (written out on a card), then in a verbal form (spoken aloud by the subject), and only after that did the subject use them silently.

Third, we explained how to apply the attributes of a concept and asked for a consistent and undeviating application of all these attributes to the material presented.

Fourth, the problems were specially selected: not only were problems with sufficient conditions and a suitable illustration presented for the pupils to solve, but also various problems with missing conditions and differences between orally formulated conditions and drawings.

Considerable attention was also paid to the subject's depiction of various geometric phenomena in accordance with orally presented conditions, and the identification of orally presented phenomena both on the illustration and on models of some of the geometric figures.

Two pupils were chosen as subjects. One of them, a sixth grader who was not doing well, was unable to solve a single problem in the observational experiment. She was described by her mathematics teacher as hopeless. The second subject was a fifth grader (who was not studying geometry), who had a grade of "three" [satisfactory — translator's note] in arithmetic.

The first concept that we formed in our subjects was that of "straight line." As a defining attribute, we compared a straight line with a taut thread. Alongside the concept of "straight line," we introduced the concepts of "curved line" and "broken line." The subjects were given a thread and a card on which the attributes of these lines were written out and illustrations of them were provided.

Thirty problems were given to them to solve. In the problem conditions, either attributes were given that corresponded to one of the lines, or a task was formulated that the subjects had to perform on the proposed model or illustration (to determine, for example, which lines make up a triangle, the letter *a, u*, etc.

Furthermore, problems were introduced in which the illustration contradicted the problem conditions or contained only one of the types of lines that met the given conditions. Several problems were presented with no illustration.

When solving problems for which the conditions described attributes of a line, we asked the subjects to use cards on which the attributes were written out, but in problems that required determination of the type of line on a model or illustration, the subjects used only a thread. It should be noted that starting already with the second problem, the subjects tried to "eyeball it," but the experimenter kept forcing them in the first 10 problems to use the card or thread.

After receiving the answer, we asked the subjects to substantiate it (if they had not already done so on their own) and to point out the corresponding geometric shapes in the illustration. In problems where the illustration did not match the problem conditions, we asked for a picture that would match the conditions.

After the first 10 problems were solved, we introduced the subjects to the properties of a straight line: a) only one straight line can be drawn between two points, b) a straight line is the shortest distance between two points. These attributes were used in solving subsequent problems.

When solving all the other problems, the subjects, following our instruction, first spoke these attributes aloud, and then used them silently.

Subject K. (fifth grader) solved 28 out of the 30 problems quite correctly, and each time she defended her solution, referring to the problem conditions. Here are some examples.

Problem No. 7. "The girl drew a line on the paper with blue ink. Then she took a red thread, laid it on the line, and stretched it out. When she asked her brother what he saw, he said he saw a red thread. Why didn't the brother see the line the girl had drawn in ink?" The illustration showed a straight line.

Subject: It's a straight line because a straight line aligns with the thread.

Experimenter: And if a curve had been drawn, how would you solve the problem?

Subject: It would be drawn incorrectly. It's a straight line.

Problem No. 25. "A pedestrian and a cyclist are moving between points A and B. The pedestrian takes the shortest route, but the cyclist takes a detour because the road is bad. Along what lines did the travelers move?"

The subject reads the problem to herself and immediately says: "The pedestrian walked in a straight line, but the cyclist — we don't know: maybe along a curve, maybe along a broken line."

Experimenter: Or maybe in a straight line?

Subject: The pedestrian goes in a straight line, since it says that he is taking the shortest route, and there can only be one straight line between two points. That means the other one is not going in a straight line.

Two of the problems gave this subject some trouble. Under the conditions given for these problems, it was possible to establish only the absence of attributes of a straight line. It was still necessary to determine what type of line was shown. The answer should have been: a curve or a broken line. The subject at first gave only one of those as an answer. She added the second possible option only after an additional question from the experimenter.

It should be noted that in one of these problems, the inaccuracy of the answer was apparently because the word "twisted" was used in the problem condition. The subject took this to be an attribute of a curved line. Asked by the experimenter why she believed that the route follows a curved line, the subject answered: "the route *twisted*."

Subject N. (sixth grader) also solved the absolute majority of the problems correctly right away. In four of the problems, when solving them silently to herself, she first gave incorrect answers. In these cases, the experimenter asked her to speak aloud the attributes of the line and to look again at the problem conditions. After that, the subject gave the correct solution for all of the problems.

The second concept we developed was that of "angle." Unlike the concept of "straight line," the angle contains two attributes: a) two rays; b) emanating from one point.

The preliminary dialogue showed that subject K. (fifth grader) was only ab le to draw an angle, whereas subject N. (sixth grader) knew the definition of an angle and drew it correctly. However, she could not identify the attributes necessary to establish the presence of an angle. In our preliminary explanation, we emphasized that an angle can only exist when both attributes are present in the problem conditions. Cases were analyzed when only one of the attributes was present. The way we approached formation of the concept was in general the same as for the concept of "straight line," but with half as many problems. The attributes were also first written out on a card, then spoken aloud, and finally, silently.

As in the previous series, the subjects immediately solved the vast majority of problems correctly, and they easily substantiated their solutions, stating the missing attributes without difficulty.

An example was the solution of *problem No. 7* by subject N. (sixth grader), in which two arcs intersect at point *M*. The subject is required to figure out what shapes they form. The illustration shows arcs that are close to being straight lines.

Subject: These are not angles: you need to have rays — those are straight lines — and they have to intersect or proceed from one point, but these are arcs — curves — which means there are no angles.

Experimenter: What attribute is there that is for angles?

Subject: A point in common.

Experimenter: What is missing?

Subject: These are curves, but we need straight lines.

A similar thing happened in solving other problems.

The subjects made mistakes in several cases. Subject K. (fifth grader) gave the wrong answer to three problems. In one of them, two rays and a point were presented, but it was not said that the rays emanate from that point. The subject did not notice this and answered that there was an angle. After being prompted to check again, the error was fixed.

In the other two problems, an error was made because the attributes were presented in an indirect form. Thus, in one of the problems, two intersecting lines were shown. It was necessary to establish whether the resulting figures would be angles. Since we had not familiarized the subject with the intersections of lines, she was not able to establish the existence of a common point from the information she was given. "It doesn't say anything about a point," says the subject. Characteristically, the subject did not consider the presence of angles in the illustration. She was looking for attributes of an angle in the problem conditions.

Subject N. (sixth grader), as in the previous series, made several mistakes while solving the problems silently. But in all cases, when she went back to the attributes, repeating them aloud, she independently corrected the error. Thus, for example, in one of the problems a point *A* and two rays were shown. The question was what figure was formed. The illustration depicts an angle. The subject says there is an angle. She explained it like this: "Point *A* — this is a vertex, two rays come out of it. And if the rays come from one point, then an angle is formed." The experimenter suggests

naming the attributes of an angle and looking to see if they are all there in the problem conditions. The subject detects an error: "The illustration is wrong; the problem conditions do not say that the rays come *from one* point." The experimenter asks for another illustration that matches the problem conditions. The subject separately draws point *A* and two rays.

*In this way, by objectifying the attributes of concepts and showing a method of acting with them, the vast majority of problems requiring the use of these attributes were solved correctly by the subjects. If a wrong solution was chosen, the use of attributes in an objectified form allowed the subjects to independently correct the mistake.*

When forming the next concept — "angle bisector" — we decided to see whether the method of action would be transferred from one concept to another. To this end, when forming the concept of "angle bisector," we did not conduct a stage-by-stage development of attributes. With subject K. (fifth grader), we drew the bisector of an angle and gave a definition. Subject N. (sixth grader) did it on her own. We asked the subjects to identify the attributes by which one can learn whether the problem conditions describe a bisector. Both subjects were able to do it. After that, the subjects were asked to solve the problems silently right away. The problems to be solved were taken from the observational experiment, requiring the use of the concept of "angle bisector." Subject K. (fifth grader) solved them for the first time. Subject N. (sixth grader) had dealt with them in the observational experiment, but had not solved any of them.

All the problems were solved quickly and correctly by both subjects, and subject N. (sixth grader) solved five out of six silently, and solved only one aloud, in which the attributes of the bisector were included in a system of geometric concepts unfamiliar to her.

Subject K. (fifth grader) solved all the problems silently, and she was given not six, but eight.

As an illustration, we will compare the solution of two problems by subject N. (sixth grader) in both the observational and training experiments.

*Problem No. 2.* "In a triangle, a straight line is drawn from the vertex to the base so that it divides the angle at the vertex into two equal parts. Will this line be the bisector of the angle at the vertex?" An illustration was provided, in which the triangle is indicated by the letters *A, B,*and *C.* The bisector of the angle at the vertex is indicated by the letters *B* and *D.*

*The observational experiment.*

Long pause.

Subject: It will be.

Experimenter: Why?

Subject: Because it divides the triangle into two equal angles.

Experimenter: Name these angles.

Subject. *AB... AD...*No (she can't name them).

Experimenter: Name the line that bisects the angle.

Subject: Line *B... BD* (names it correctly).

Experimenter: What equal angles did it form?

Subject: *BDC* (wrong).

Experimenter: Show it with a pencil (subject can't do it). Which angle did it divide into two equal parts?

Subject: circles the letters *A, B,* and *D.*

We see that the subject cannot name and point out the angle in which the bisector is drawn and the angles it forms. Furthermore, she does not connect the angle in which the bisector is drawn with the angles formed after the division: she points out the bisector correctly (in the angle at the vertex), but shows the angles it forms at the point of intersection of the bisector with the base of the triangle. When the experimenter then asked again why she believed that *BD* is a bisector, the subject answered: "It divides the angles, which means it is straight at the vertex, so it is a bisector."

We see that while at first the subject indicated one attribute of a bisector: "It divides the triangle into two equal angles," now she indicates a completely different attribute: "It divides the angles, is straight at the top." She does not identify the necessary and sufficient attributes of a bisector, although she gives the correct definition.

*In the training experiment,* this is how she solved the same problem:

Reads the problem to herself. Traces the line with her finger. Begins to list aloud the attributes of a bisector. The experimenter interrupts: "Have you solved the problem yet?"

Subject: I solved it. It is a bisector.

Experimenter: Why?

The subject correctly names the attributes of a bisector, indicates their presence in the problem conditions, correctly shows the angles that are formed.

Another example. *Problem No. 5.* A bisector is given in the problem conditions, but the illustration shows a straight line, in a position quite different from that of a bisector. The angle is labeled *A, B,*and C, and the bisector is labeled *A* and *D.*

*In the observational experiment,* the subject at first says there is a bisector. "If we measure it with a protractor... No... we have to measure it first with a protractor." The subject measures it, sees that the angles are not equal, decides that it is not a bisector. She reads the problem conditions again, which say that the straight line divides the angle into two equal parts, and says that it only divides the angle *DAC* into equal parts.

Experimenter: Where are the equal parts?

Subject: Side *AB* is equal to side *AD,* but side *AC* is not equal to side *AD,* so the straight line is not a bisector.

We see that the subject cannot escape the confusion created by the discrepancy between the problem conditions and the illustration. The subject readily concludes that there is no bisector, easily changes its attributes.

*In the training experiment,* the subject approaches the solution to this problem like this: after reading the problem to herself, she quickly begins to recite the problem conditions aloud. The experimenter interrupts: "Have you solved the problem?"

Subject: Yes, the illustration is not for this problem: the problem is about a bisector, but that's not in the illustration.

Experimenter: Why did you think it was a bisector?

The subject correctly identifies the attributes of a bisector, shows that they are present in the problem conditions, and adds: "In the illustration, the line has in com-

mon with the bisector that the line comes from the vertex, but it does not bisect the angle." She quickly measures it with a protractor: "One is 40°, the other is 10°."

The same thing occurred when this subject was solving other problems: helplessness in the observational experiment, but confident, quick, and correct solution of the same problems in the training experiment.

Subject K. solved the problems in the training experiment just as easily. As an example, we give her solution to *Problem No. 6*.

The problem conditions describe a straight line that divides a given angle in a ratio of 3:8. The subject has to establish whether this line is the bisector of the given angle. An illustration was provided, in which a straight line is placed in the position of the bisector.

The subject reads the problem and quickly says: "This won't be a bisector."

Experimenter: Why?

Subject: Because the ratio is 3:8. It would have to be 3:3 or 8:8.

Experimenter: Are there any attributes of a bisector?

Subject: Yes. An *angle* is given, with a *straight line* drawn inside it.

Experimenter: What attribute is missing?

Subject: That it divides this angle into two equal parts.

Note that the discrepancy between the illustration and the problem conditions does not bother this subject either.

Thus we see that the necessary and sufficient attributes are clearly identified by both subjects; they use them correctly even when the illustration contradicts the problem conditions, which had previously led subject N. to complete confusion. Since we did not do any additional work with the concept of "angle bisector" with subject N., and subject K. was basically dealing with this concept for the first time, this can only be explained as follows: when forming the concepts of "straight line" and "angle," the subjects learned *a certain method of acting with these concepts, which they transferred to the concept of "angle bisector."* In other words: *there was a generalization of the method of action with the attributes of concepts of this type.*

In subject N. (sixth grader), such a transfer was also found for the concepts of "adjacent angles," "supplementary angles," and "perpendicular." When establishing the concepts of adjacent and supplementary angles, as well as when establishing the bisector and the perpendicular, the subject immediately took the right path, skillfully using the attributes of the concept, but she only solved the easiest problems in her head, whereas for more difficult problems, she pronounced the attributes aloud, then searched for them aloud in the problem conditions.

So, when solving *Problem No. 8,* in which two angles were presented that had a common vertex and a common side, and it was required to determine whether the angles would be adjacent, the subject reasons aloud as follows: "Given two angles, they have a common vertex, a common side ... We know that they are adjacent when there are two angles, a common vertex, and a common side. That's three."

Experimenter: Have you made up your mind?

Subject: No.

Experimenter: Well, please continue.

Subject: But the problem conditions doesn't say that the side is between the others. According to the statement they are not adjacent, but according to the illustra-

tion they are. But we have to rely on the problem conditions (the problem is solved correctly).

We see that the subject approaches the task confidently, immediately takes the right path, but solves it only when she works through it aloud. Obviously, the transfer at a lower level in this case is explained by the fact that the concepts of "adjacent angles" and "supplementary angles" include many attributes compared to the bisector and the perpendicular, and these attributes are more difficult to pick out in the problem conditions.

With subject K., we did not check the transfer to other concepts, except for the bisector.

The phenomenon of transfer during the formation of geometric concepts was also described in a University student's work performed under our guidance.

These results provide a basis to think that with careful stage-by-stage development of the elementary concepts, during which the method of action with the attributes of these concepts is also mastered, formation of the basic system of geometric concepts will not be difficult and will proceed faster, without careful development in stages.

In the formation of concepts through action with objectified attributes, another series of facts was discovered, also related to *generalization of concepts,* but of a different kind. If the facts we are looking at suggest generalization occurring within *a system of concepts,* then these facts also suggest generalization occurring within *one concept.*

The first type of generalization is generalization of *the method of action* with concepts; the second, which we now discuss, is *generalization of the concept according to the material.*

This type of generalization was shown in the fact that, with our method of training, the subjects were not bound by particular features of the illustration, as is usually the case in school assignments. Specifically, this was expressed as follows:

First, when solving problems, the subjects were not only not bothered, but were not even surprised by the unusual position of the illustration.

Second, the subjects, at the experimenter's request, readily presented different versions of the illustrations. So, for example, after introducing the definitions of right, obtuse, and acute angles, and of the perpendicular, the experimenter asked subject N. (sixth grader) to present different acute, right, and obtuse angles, and different perpendiculars. The subject presented them in quite varied spatial configurations.

Third, even after the same spatial position was deliberately presented many times, a quite different position of the figure did not cause difficulties. So, when forming the concept of "straight line" in subject K. (fifth grader), we deliberately presented only the horizontal position of the straight line. A preliminary interchange showed that the subject only calls horizontal and vertical lines "straight lines," and calls oblique lines "slanted." "It's not straight," says the subject. We deliberately did not correct her. During the training, a horizontal line was also drawn on a card along with the attributes. The first six problems were presented with horizontal lines. The subject tested all of them with a thread. In the seventh problem, a vertical line was shown, and in the eighth problem, an oblique line. The experimenter asked the subject to say what type

of line it was, without reading the problem and without using a thread. The subject quickly and confidently answered that it was a straight line. When the experimenter asked why she thought that, the subject replied, "It will align with a taut string." Thus, in the subject's definition of a straight line, only alignment with the thread matters, i.e., the attribute that had been presented to her, which she had worked with. After that, she was given an array of straight lines, in the most diverse spatial positions. The subject just as confidently answered that they were all straight lines.

It should be noted that even after a long break, freedom from the particulars of the illustration is preserved. Thus, five months after subject N. (sixth grader) had solved problems that required the use of the concept of "perpendicular," we gave her a problem that asked how to find out which lines in the illustration are perpendicular. The illustration shows four perpendiculars in unusual positions and one oblique line in the normal position, the oblique line having a very small angle of inclination. The subject gave the following answer: "You need to measure it; where there is a right angle, there is a perpendicular." When the experimenter asked which lines seemed to her to be perpendicular, the subject identified all four correctly; as for the oblique line, she said that it would not be perpendicular.

These results give us reason to think that, under certain conditions, a concept can be generalized even without variations in the illustration.

Apparently, students' well-known difficulties when encountering an illustration in an unusual position, which suggest insufficient generalization of concepts, are explained by the particular ways in which they have learned. In school assignments, students are not, as a rule, given the attributes of a concept in an objectified form; they are not taught to use these attributes for specific tasks. By no means everyone can do it on their own. For that reason, in a significant proportion of students, the definition of a concept that can be reproduced by them without error appears "not to be working," and the illustration that was given to them when the concept was defined spontaneously becomes the actual reference point. When trained in this way, a large number of variations of the illustration becomes necessary for the gradual identification and generalization of the attributes of the concept.

That is a very good confirmation of the fact that when operating with geometric concepts, a visual image often serves as a reference point. In geometry, adjacent angles are defined as angles that have a common vertex and a common side. We also introduced this definition in the training experiment. But since we asked our subjects to use the attributes of the concept, here is what happened: subject N. (sixth grader) told us that the angle and the part of this angle adjacent to one of its sides were adjacent. When we tried to object, she replied that they fit with the attributes presented, and we had to agree, and then introduce an additional attribute: the common side has to be located between the other sides of the angles.

This suggests that not only students, but also those who teach them and write textbooks for them, sometimes think visually in practice, and not applying the attributes of a concept.

Since from the very beginning we presented the attributes in a single, generalized, and objectified form and taught the subjects to use them as criteria for what to look for in the problem conditions, rather than in an illustration of specific problems, the subjects were freed from the constraint of particular features of the illustration. It

should be noted that it also may have mattered that the attribute itself was not established when the concept of "straight line" was formed: the subject was free to pull the thread into different spatial configurations. This could be decisive for generalization of the concept of "straight line." Independence from the specifics of the illustration in the application of other concepts might already have been the result of a transfer. So far, this is only one possible conjecture, needing factual verification.

So, the essence of the results we have presented is as follows:

1. With the stage-by-stage working out of several elementary concepts, the method of action is mastered along with the concepts themselves, and is transferred to subsequent concepts, which therefore can be formed immediately at the level of already achieved skills.
2. Provided that the attributes of a concept are not stated in only a generalized form, but are also given objectively and applied as criteria for the presence or absence of the relevant phenomenon, they are mastered from the very beginning in a generalized way, and their generalization by varying the material becomes superfluous.

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# Activity-Based Approach to the Teaching and Psychology of Insightful Problem Solving: Scientific Concepts as a Form of Constructive Criticism

Alexander N. Romashchuk[a*]

[a]*Lomonosov Moscow State University, Moscow, Russia*

*Corresponding author. E-mail: ofitsran@mail.ru

**Background.** This article is dedicated to the 100-year anniversary of the birth of N.F. Talyzina and contains an assessment of the prospects for developing ways to master a scientific concept, in theories of learning according to the activity approach. The assessment takes into account achievements following the approach of L.S. Vygotsky, the "conceptual changes" approach, and theories of the psychology of insightful problem solving.

**Objective.** To demonstrate the necessity and productivity of the activity approach to scientific concepts that students learn as forms of constructive criticism.

**Method.** A comparative analysis of the theories of the activity approach to learning, the approach of L.S. Vygotsky, the "conceptual changes" approach, and theories of the psychology of insightful problem solving, from the standpoint of identifying the most effective way of mastering scientific concepts.

**Results.** The main substantiated thesis of the article is that mastery of a scientific concept is most effective when it is presented as a form of constructive criticism of another concept.

**Conclusion.** Taking into account the conceptual forms of constructive criticism allows us to outline the actual paths of development of the activity approach to learning. These forms were developed, on the one hand, through the methodology of science, and on the other, in a less developed way, through the psychology of insightful problem solving, with reliance on certain forms of "critical" action. In particular, when using a special kind of obstacle to teach a task, it is proposed to use the analysis of "full insight" to reveal a special type of reason for an erroneous action.

***Keywords:***
activity theory of learning, conceptual change, naive concepts, scientific concepts, constructive criticism, insightful solution, full insight

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While I was still a graduate student, friends from the laboratory of educational psychology recommended me to the head of the laboratory for the vacant position of engineer, and N.F. Talyzina, after giving me a test assignment, took me on for this position. During my work in the laboratory, Nina Fedorovna taught me a number of most important lessons for professional life, one of which is directly related to the topic of this article.

With all the almost mathematical clarity and rigor of N.F. Talyzina's theory, when discussing the reports of the laboratory staff, she demonstrated amazing flexibility, lively interest in discussing different approaches, and welcomed alternative theories and views. She showed great wisdom in everything, including when we visited her hospitable home, and performed some small work assignments, which imbued all the activity in the laboratory with a sense of trust. This characteristic of Nina Fedorovna, her creation of an atmosphere of free discussion, is close to the main topic of this article: constructive criticism. Out of gratitude to her for those creatively active and free years in the laboratory, in her memory, I would like to designate this article as another report presented at a laboratory meeting, a farewell report.

## Introduction

For various theories of the activity approach to learning, one of the unresolved problems is the ambiguous answer to the question of what relationship newly formed concepts have to concepts already existing in the student's mind. Let us first discuss the content and meaning of this problem.

Galperin most succinctly outlined the specifics of his theory during his lectures on psychology, first in separating the structure of an object and the structure of action with the given object, and, second, in his emphasis in teaching on the means by which the action is carried out and which correspond to the structure of the object (Galperin, 2002). Talyzina endorses these positions in her approach: "The fundamental difference between our approach to the study of the process of concept formation and the previously considered one [that of L.S. Vygotsky] lies in the fact that, first, we study this process from the aspect of activity, of actions associated with the formation and functioning of concepts. Second, the formation of actions associated with a concept can be traced not in conditions of spontaneous mastery, but in conditions of comprehensive control over the course of their formation" (Talyzina, 2018, p. 191). According to Talyzina, all this control is aimed at combating formalism, in particular, the "verbalism" of knowledge, which she partially reproaches even Vygotsky for not having sufficiently overcome (Talyzina, 2018, p. 188).

Control of the formation of an action presupposes, first of all, a fully generalized orienting basis of action. In turn, the completeness of the orienting basis of action leads to the idea that concepts are adequate not individually, but only in a system with other concepts. The generalization of action is most often understood as the possession of more general methods of cognitive activity, which serve for the derivation of individual concepts. For example, the action of summarizing concepts is considered by Talyzina as the basis for deriving not only mathematical concepts, but all scientific concepts that have a conjunctive structure of attributes in their definition (Talyzina,

1995). And this derivation is considered the main method of overcoming formalism in the mastery of a concept (Talyzina, 1995).

Despite all their differences in the understanding of learning with V.V. Davydov, another representative of the activity approach, such theses as the derivability of a learning concept, its activity basis, and the systemic nature of the concept unite his theory with those of Talyzina and Galperin (Davydov, 1996). All three theories have one more common feature, which is that the system of concepts is formed, as it were, from a "clean slate," and is not, for example, transformed from another system of the student's concepts. This feature and its significance can be considered most conveniently on the basis of the relationship between naïve and scientific concepts, a relationship that in many ways sharpens the issue of the formalism of knowledge.

Talyzina describes the relationship of naïve and scientific concepts in controlled learning as follows: "In that regard, the prevailing naïve ideas were transformed before our eyes with the help of this technique; they rose to a new level. The child did not question the result obtained by the learned method if it contradicted his habitual conception. On the contrary, he stated and substantiated the fallacy of his previous conceptions ('It turns out that the whale is not a fish; I thought it was a fish.' If the experimenter then said: 'But it lives in the sea like a fish,' this did not confuse the subject: 'It doesn't matter that it lives in the sea. It feeds its young with milk, which means it is a mammal.') Naïve concepts, having undergone a transformation, began to function with new content in the future" (Talyzina, 2018, pp. 230–231). But according to the described results of the study, it is not entirely clear in what sense the naïve concept is transformed and begins to function with new content and what role the statement of the fallacy of these naïve concepts plays here. This uncertainty was identified already in the early works of the author of the activity approach, A.N. Leontiev: "It is obvious that the generalization that lies behind the word 'lever' for the student, and the generalization that is the scientific concept of the lever, as it appears in the system of a given science, do not coincide.... In reality, this process [of the development of a generalization] obviously consists in the fact that the primary generalization behind the corresponding word, for example, behind the word 'lever,' develops in the child, is restructured, i.e., it rises to a new and higher level, and in the ideal case, it finally turns out to coincide with the generalization that is presented in the scientific concept of 'lever' " (Leontiev, 2003, p. 325).

## The Problem of Transition from One System of Scientific or Naïve Concepts to Another

What happens to the student's previously existing system during the mastery of a new system of concepts in the same subject area — whether the second one replaces the first or whether they begin to interact and if so in what form — this is the question that is most sharply posed when discussing the role of naïve concepts in the mastery of scientific ones.

A separate approach to "conceptual changes" arose as a reaction to the fact that many researchers and educators, when teaching scientific concepts to students, have

encountered resistance from mundane thinking, "naïve concepts." This approach identified such features of mundane thinking as resilience and systemicity (Keil, 1999; Vosniadou, 2019). Numerous studies using the "conceptual changes" approach have established how children's thinking resists restructuring, remodeling, seems to reject externally introduced, alien singular concepts, and can be changed only as a whole, by "frameworks" or "theories": "Conceptual development involves not just enrichment or elaboration of the existing knowledge systems but their considerable reorganization or restructuring. Conceptual change involves change in core concepts, conceptions, or conceptualizations (including rules, models, and theories). It concerns a large-scale restructuring of the existing knowledge system" (Inagaki & Hatano, 2013, pp. 195–196). At the same time, for this approach, the idea of the afunctionality of children's thinking turned out to be dominant, that it does not have its own functions, but is only preliminary to adult thinking (cf. Romashchuk, 2008). This was reflected in the idea of "misconception," and this expressed the attitude towards naive theories as having the exclusively negative role of offering "resistance" to the acquisition of scientific knowledge.

Although representatives of "conceptual changes" quite often refer to Vygotsky's works, it is important to emphasize that he designated two variants for understanding the transition from one system of concepts to another. The first variant is the replacement of the old system ("structure") of concepts with a new system. The second is the transformation of the old system into the new. The "late" Vygotsky advocated the transformation variant: "The child forms a new structure of generalization, first for a few concepts, usually newly acquired, for example, in the learning process; when he has mastered this new structure, by virtue of this alone he restructures and transforms the structure of all previous concepts" (Vygotsky, 1934, pp. 261–262). The new structure at the same time makes it possible "to move to a new and higher plane of logical operations. The old concepts, being involved in these operations of a higher type of thinking in comparison with the former ones, change by themselves in their structure" (Vygotsky, 1934). For example, a system of algebraic concepts is formed not alongside and not instead of a system of arithmetic ones, but through generalizations of the arithmetic concepts. For Vygotsky, the thesis that each scientific concept is included in a system (as structures of a special type) was especially important: a concept is like a cell in living tissue, not "like peas poured into a bag," but is always included in a system of other concepts (Vygotsky, 1934).

That said, Vygotsky also finds reasons for the absence of these ideas in his study of the stages of development of syncretes and complexes (cf. Vygotsky, 1934, Chapter 4). The fact that in L.S. Sakharov's study of artificial concepts, the stages of concept development were described as concentric circles rather than as a spiral of development (i.e., as complementing one another rather than as one stage superseding the previous one), according to Vygotsky himself, was influenced by the particular features of the methodology. A more complex form of transformation was demonstrated by J. Shif's research (cf. Vygotsky, 1934, Chapter 6): the final stage in these experiments (the system of "true concepts") was achieved not by displacing or replacing an naïve concept with a scientific one, but by simultaneously transforming both. The naïve concept is transformed into the form of the scientific concept, and the scientific is enriched with the content of the everyday.

Thus, the common element in the positions of Vygotsky and the "conceptual changes" approach is the understanding of children's thinking as a complex, holistic formation that resists simple replacement by "adult" thinking. The main difference between these approaches lies in their analysis of the transition from naïve to scientific concepts. According to Vygotsky, the transition is carried out through a special type of transformation ("sublation") of naïve concepts by scientific ones, and not by replacing the first with the second, as in the "conceptual changes" approach and the theories of the activity approach to learning. This completely changes the logic of the relationship between the two systems of concepts: the naïve and the scientific. In particular, Vygotsky rethought the phenomenon of the incorrectness of not only naïve, but even of scientific concepts, the "formalism" of which is a necessary means for transforming naïve concepts.

It is important to understand that behind Vygotsky's theses here there is a more general methodological position, namely that of constructive criticism and an attitude towards the concept as the main form of this criticism.

## The Concept of 'Constructive Criticism': A Form of Criticism in L.S. Vygotsky's Approach

Constructive criticism is closely associated with the dialectical category of "sublation" [aufhebung, Russian *sniatie* — translator's note], Vygotsky's analysis of which, seems to us, has not yet received its deserved attention in the large literature on Vygotsky (see, for example, synthesizing works such as Asmolov, 2022; Daniels et al, 2007; Veresov, 2020), and even those specialized works dedicated to Vygosky's use of dialectics (e.g., Dafermos, 2015). First of all, Vygotsky uses the category of "sublation" fully consciously and deliberately: "It seems to us that in this case the relationship between the higher and lower forms may be best expressed by the recognition of what is usually called in dialectics sublation.... The double meaning of the German word "to sublate" must be recalled, says Hegel. By this word we mean first of all, 'to eliminate,' 'to negate,' and we say, according to this definition, that laws are repealed, 'abolished,' but the same word also means 'to preserve,' and we say that we will 'preserve' something. Using this word, we could say that elementary processes and the patterns governing them are buried in the highest form of behavior, i.e., they appear in it in a subordinate and hidden form" (Vygotsky, 1983a, pp. 113–114).

Vygotsky's orientation toward the category of "sublation" begins already in his first major work, "The Psychology of Art" (Vygotsky, 1998), and found its expression in a special form of critique of psychological concepts produced in this work. In "The Psychology of Art," Vygotsky's method is analogous to that of K. Marx in "Capital" (see Il'enkov, 1997). Thus, in the first three theoretical chapters, Vygotsky criticizes three theories of the psychology of art: art as an influence of content, art as an influence of form, and art as an organization of catharsis in the psychoanalytic sense. Then, using examples of a fable, a short story, and a tragedy, Vygotsky deduces an idea of the cultural mechanism of art, which ensures the simultaneous experience of directly opposite emotions. This cultural mechanism is constructed according to the principle of the collision of "thesis" and "antithesis": "From fable

to tragedy, the law of aesthetic reaction is one: it contains affect that develops in two opposite directions, which at the final point, like in a short circuit, finds its annihilation" (Vygotsky, 1998, p. 275). For the emergence of two opposite emotions (and not, for example, one ambivalent one), he uses the opposition of the form and content of a work of art. Since content and form can both develop relatively independently of each other, this makes it possible to simultaneously bring directly opposite emotions to the highest degree of intensity, to a culmination, within which catharsis should occur as a liberation from the "violence" of each of the natural feelings through their "mutual destruction." And then both the representatives of the objective school, concentrating on content, and the representatives of formalism, who emphasize the form, are partly right. But the representatives of psychoanalysis are also right, emphasizing the cathartic effect of art. All three of these criticized approaches are retained by Vygotsky in a sublated form. Vygotsky called this whole dynamic the three phases of aesthetic experience, the transformation of which moves a person from a passive to an active state. These three phases are easily correlated with the phases of "sublation": "thesis" — "antithesis" — "synthesis." Thus, according to Vygotsky's logic, a cultured person achieves freedom, free emotional experience.

In his later works, Vygotsky 'deepened and made more complex a similar type of constructive criticism of previous theories and individual concepts. Suffice it to recall the main critical goal of "The Historical Meaning of the Crisis in Psychology" (Vygotsky, 1983): the main contradiction identified in this work between "mechanistic, physiological psychology" and "higher, spiritual psychology" found its resolution in the logic of sublation of "lower, natural mental functions" into "higher, cultural mental functions" described in "The History of the Development of Higher Mental Functions" (Vygotsky, 1983b). The importance of this type of criticism for Marxism was most succinctly pointed out by E.V. Il'enkov, emphasizing that for Marx, constructive criticism was the main method of thinking, constructing a theory, and analyzing economic facts: "So that the reconciliation of critical accounts with previously developed theories is not at all a side issue, not at all a matter of secondary importance, but a necessary form of development of the theory itself, the only possible form of theoretical analysis of real facts" (Il'enkov, 1997, p. 219). Constructive criticism is aimed at retaining the "rational core" of the previous theory and at the same time sifting out all its historically transient content (Il'enkov, 1997). Vygotsky as a Marxist pointed out the same constructive attitude toward criticism: "The matter does not end with the discovery of the barrenness of the principle, with criticizing it by pointing to curiosities and exaggerations at which schoolchildren point their fingers. In other words, the history of a principle does not end with its simple expulsion from a sphere that does not belong to it, with its simple rejection. After all, we recall that an alien principle penetrated science by a bridge of facts, real-life analogies; no one denied this. The time during which this principle grew stronger and more dominant increased the number of facts on which its imaginary power was based — partly false, partly true. The critique of these facts, the critique of the principle itself, brings new facts into the purview of science. It is not just a matter of facts: a critique must give its own explanation for the colliding facts; the theories assimilate each other and on this basis the regeneration of the principle

takes place. Under the pressure of facts and alien theories, the newcomer changes its face" (Vygotsky, 1983a, pp. 355–356)

This type of criticism establishes a special form of transition from one theory to another, from one concept to another. But the question remains how relevant this form is not only for actual transitions in science, but also for the transitions between implicit and scientific theories in the learning process.

Of all the main theoreticians of the activity approach to learning, the clearest position was taken by V.V. Davydov: "Modern theoretical thinking in the process of its formation has assimilated the positive moments and means of empirical thinking, 'sublated' them in itself" (Davydov, 1972, p. 424). But in the curricula of developmental education, implementing the logic of sublation seems to have encountered certain problems. For example, an article by representatives of developmental education about the effectiveness of the transition from naïve to scientific concepts at the theoretical level, with reference to the positions of Vygotsky and Davydov, clearly formulates the thesis of the mutual enrichment of scientific and naïve concepts: "We are not talking about a scientific concept overcoming an naïve one, but about the intersection, the mutual enrichment of these two separate lines of development of conceptual thinking" (Davydov, 1972, p. 6). But enrichment apparently implies giving meaning to educational modeling by its inclusion in the form of a game: "Next, it will be shown that game heroes who embody the concepts being mastered first contribute to the emergence of a new quality of these concepts, and second become a support for the initiatives first-graders take with sound schemes" (Davydov, 1972, p. 7). Consequently, in the role of an naïve concept, the game form is used here, and not the content of any naïve concept. It is no coincidence that the article never mentions a single naïve concept, and does not even discuss their mutual enrichment with scientific concepts.

A.A. Margolis has presented a criticism of developmental learning similar to ours; he also sees the need for developmental education to have a fundamentally different understanding of "the relationship between the processes of learning and development, in which scientific concepts formed in the course of learning do not destroy and supplant the products of the development of the child's own thought in the form of those spontaneous concepts with which he begins the learning process" (Margolis, 2020, p. 9). And that the neglect by proponents of developmental education of the integrity of the system of naïve concepts, which makes more justified the point of view of V.S. Bibler's students that "in order to overcome, for example, a child's naive idea of number and ways of dealing with number, it is necessary to construct this idea as something integral, as an opponent, to understand the basis of such an idea and to construct in the subject ways of overcoming just such an idea — and not simply to organize the learning of the 'correct' concept" (Margolis, 2020, p. 16). For all the detail and depth of the criticism provided in the article, it leaves unchanged the main point disputed by Vygotsky: it cannot be a question of overcoming children's naive perceptions as such, but requires their sublation. It seems that an additional impetus to such efforts within the framework of developmental education may be provided by studying constructive criticism in the psychology of insightful problem solving.

## Constructive Criticism in Everyday Thinking: Thinking with Full Insight

Theoretical disputes and studies of insightful problem solving offer two variants for the mechanisms of this solution, one of which, "full insight," is an analogue of the mechanism of constructive criticism described above.

Initially, through the opposition of the Gestalt psychology of thinking and A. Newell and G. Simon's theory of problem space, insightful and regular problem solving were separated (cf., e.g., Metcalfe & Wiebe, 1987). Insightful problem solving was characterized by suddenness, a leap associated with the restructuring of a situation, and at the level of experience it was accompanied by an "aha-reaction," whereas the processes for solving regular problems had exactly the opposite characteristics: a gradual sequence of steps toward a solution, without sudden breaks and strong emotions in the process. There is a trend in modern psychology of problem solving to combine these two types of problem solving. One of the most meaningful attempts at such a combination was made in representational change theory by S. Ohlsson and G. Knoblich (Knoblich et al., 1999; Ohlsson, 2011). The authors of this theory criticize the most established and traditional understanding of insight as a complete and correct solution of a problem that suddenly appears in the mind, and they distinguish two components in the insightful solution: overcoming the state of an impasse and the appearance in the mind of the final solution. Two mechanisms are most fundamental for this: constraint relaxation and chunk decomposition (Ohlsson, 2011). A necessary, but not sufficient condition for insight from the point of view of representational change theory is that the problem solver has reached an impasse: "Insights occur after the problem solver has encountered an impasse, i.e., a mental state in which problem solving has come to a halt; all possibilities seem to have been exhausted and the problem solver cannot think of any way to proceed" (Ohlsson, 1992, p. 4). An impasse occurs when, having tried all the possible solutions known to the solver, none of them could solve the problem; the impasse signals that there are no more ideas left about how the problem could be solved. The reason for the impasse is in the incorrect initial representation of the problem. The impasse prepares the conditions for the mechanisms of "constraint relaxation" and "chunk decomposition," a restructuring of the faulty representation of the problem.

The authors of the theory, explaining the essence of the constraint relaxation mechanism, suggest that "problem solving might be less a matter of searching among possibilities than of redefining what to search for" (Knoblich et al., 1999, p. 1535). Using a simple example, they explain that if we need to break through a locked door, initially our actions are constrained by the idea that the door should remain intact, but then it may become necessary to look not for a key, but for an ax. In that case, the initial principle of the solution implied "opening the door," and constraint relaxation allowed us to change the task to "breaking down the door."

More specifically, the mechanisms of constraint relaxation and chunk decomposition can be explained by studying a series of matchstick numerical equality problems (Knoblich, 2001), which has become a classic within this approach. In all three tasks, the goal is formulated in the same way: to shift one match so that the equation becomes true (see *Figure 1*). The difference between the ease of solving problems is

explained by the different density of chunks, which is provided by different strengths of the constraints.

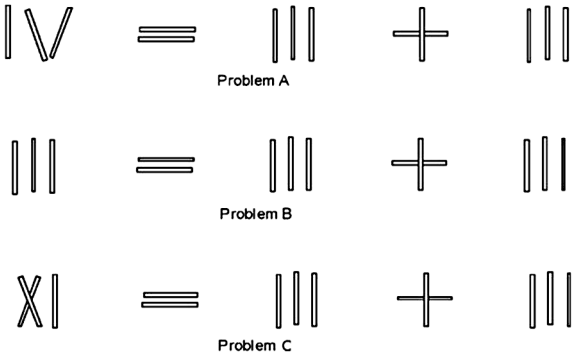


*Figure 1*. Arithmetic problems with matches

The first problem, "A" (Fig. 1), is the easiest, since the decomposition of a chunk for the solution does not require the weakening of any constraint, but only the search for options (if you shift the match from "IV" to the right, you will have "VI"). The third problem, C, is more difficult, because a constraint appears, since it is necessary to decompose this chunk, whose parts do not have an independent value (you need to move one match from "XI" so that you get "VI"). But the most difficult task is "B," since it requires weakening the constraint that determines the entire problem space associated with the requirement that only numbers need to be changed, but not operators (to solve it, you need to turn "=" into "+"). Thus, "constraint" in representational change theory means the same thing as the concept of functional fixedness in Gestalt psychology, and insight is meant as a form of overcoming fixedness — from relaxing a small constraint to relaxing a constraint that shifts from one problem space to another, i.e., a fundamentally different representation of the problem.

But the similarity of representational change theory to the classical Gestalt psychology of thinking is largely illusory. First of all, for K. Duncker and M. Wertheimer, insight was not a sufficient criterion for thinking. Thus, Duncker wrote: "As a result of training, unexpected insight often arises. It then immediately becomes clear to the person what the required action should be, and the curve of errors drops sharply. Yet the principle of action itself may remain unknown. Paradoxical as it may seem, it turns out that a connection that is not fully accessible to insight may become insightful. This paradox is easily resolved if we keep in mind that here the concept of 'insight' is used with two different meanings. Grasping the common principle of a number of situations does not yet provide comprehension of this principle itself, its inner 'why.' What is comprehended is that once this common principle is given, specific situations must be just as they are and not otherwise" (Duncker, 1965, p. 177). Duncker distinguishes between two types of insight, one of which he later calls partial insight (or "insight of the second degree"), and the other full insight. Duncker associated thinking in the narrow sense only with full insight, and indicated that the main criterion for distinguishing between the two kinds of insight was an understanding of the inner "why" of the solution principle.

Thus, the generally accepted criteria for insight — suddenness, the "aha-reaction," restructuring, and even finding the solution principle — are not, according to Duncker, criteria of thinking. To clarify, he gives a characteristic example: suppose the researcher gives the subject the task of guessing in which box the target object is hidden. The number and arrangement of boxes changes each time, but the researcher always uses the principle that the target object is hidden in the first box to the left of the middle of the entire group of boxes. As soon as the solver guesses the principle, he has an "epiphany" and will immediately solve the problems posed in the experiment. Since he understood the solution principle, but does not understand "why" this principle is a solution, this means that he has only a partial insight and an act of thinking has not occurred. But what is behind this "inner why," how are we to understand the main criterion for distinguishing between the two types of insight?

For Duncker, the difference between thinking and deciding by means of trial and error lies in the concept of "understanding the directionality of the conflict": "There is a fundamental difference between one *factor of conflict*, i.e., the presence of an action that does not lead to the desired result, and the *directionality of the conflict,* in which its nature is expressed" (Duncker, 1965, p. 37). The conflict is not just the absence of the desired result, but also an error in the method used to solve the problem ("action that does not lead to the desired result"). Thus, thinking begins with a critical analysis of an erroneous attempt to solve a problem. For clarification, he uses W. Köhler's concept of "excessively" — when a chimpanzee tries to reach a banana with its paw, this conflict can lead to the beginning of an insightful solution if the chimpanzee stops looking for other options to get the banana and tries to understand why it failed to do so with its paws, and what is "too much" when using this method (its paws are too short). Such an analysis will begin to direct real thinking further, since the chimpanzee will be directed not so much to the fruit itself, as to "lengthening my arm." It is with this analysis of the causes of the error that the concept of "why" is associated: "While the simple realization that 'this doesn't work' can only lead ***to a direct variation of the old method***, the realization of ***why*** it does not work, the recognition of the ***basis of the conflict,*** results in a correspondingly definite ***variation,*** which corrects the recognized defect in the proposed solution" (Duncker, 1965, p. 107). Thus, for Duncker, the main stage of thinking as full insight is essentially connected with constructive criticism of one's own erroneous way of solving a problem. Such criticism, which is aimed at understanding the reasons for the error, and its correction, leads to the transformation of the original method for solving the problem to a more suitable one ("a variation that corrects the perceived shortcoming of the proposed solution").

A similar position in highlighting the role of constructive criticism of one's own erroneous method of problem solving as the basis of the entire process of insightful problem solving was that of another major representative of the Gestalt psychology of thinking, M. Wertheimer (Wertheimer, 1987). His approach is especially valuable in that a significant part of his research involved problems used in school. Identifying the specifics of "thinking in the strict sense" as a holistically directed process, Wertheimer emphasizes the fundamental importance of understanding the disturbances that arise in solving a problem and striving to correct them: "Such a process is not a simple sum of individual steps, a set of operations that are not related to each other,

but is a single process of thinking generated by the awareness of gaps in the situation, the desire to correct them, to fix what is bad, to achieve inner harmony" (Duncker, 1965, p. 79). Like Duncker, he indicates the connection between the disturbance and the erroneous action not too emphatically, but quite definitely.

So, for example, to clarify the concept of "disturbance," Wertheimer taught students the solution of the problem of finding the area of a rectangle, and then gave a problem for the area of a parallelogram and registered whether an act of thinking occurs or not. Wertheimer gives the example of a girl who, in solving the given problem, demonstrated thinking. When she tries to use the area of a rectangle to solve the problem, she sees that the rectangle is only suitable for finding the area of the central part of the parallelogram, which means that this method does not directly lead to the correct solution. But then she begins to analyze the resulting disturbance and sees that using the area of the rectangle leads to an error because of the ends of the parallelogram (see *Figure 2*).

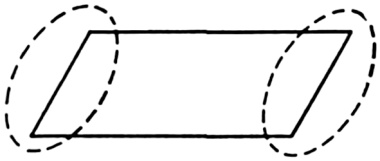

*Figure 2.* Locating the disturbance
in finding the area of a parallelogram

There are no right angles on the sides of the parallelogram, and the girl locates the disturbance in these two parts. And then the act of thinking is performed through an answer to the question of how to overcome the incorrect use of the area of a rectangle on a parallelogram. The girl's thinking, directed by analysis of the disturbance, concludes that if both parts presenting the disturbance are combined — cutting off the triangular end of the parallelogram on one side and adding it to the other side — then you will have a rectangle again. And thus the girl derives the formula for the area of a parallelogram by transforming, "adapting" the formula for the area of a rectangle. This derivation of the method of solution fully answers the question of "why" the new formula is a solution to the problem of the area of a parallelogram: because it is associated with the transformation of a parallelogram into a rectangle, the formula for the area of which is known.

The differences between the notion of "constraint" in representational change theory and the notion of "disturbance" in Gestalt psychology can be conveniently analyzed on the basis of Katona's "Five Squares" problem, since both constraint and disturbance have been investigated with respect to it. Katona's problem (see *Figure 3*) presents five squares arranged in the form of a cross, with the goal of rearranging three matchsticks to leave only four squares. The solution is to separate one square from the single structure. From the perspective of representational change theory, the onset of insight in this task is hindered by the constraint implicit in the subjects' idea of constructing the four required squares in a single configuration (Öllinger et al., 2014).

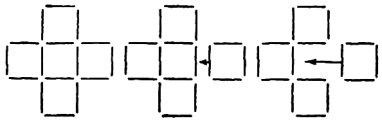

*Figure 3.* Katona's "five squares" problem

If we solve this problem by understanding what the disturbance is, then the following option becomes possible (Emel'ianova, 2020). When trying to understand why you can't manage to move three matches in the right way, you may encounter a contradiction: since each match is a side of a square, you need to rearrange the matches, reducing the squares, that is, *you have to reduce the number of squares without reducing the number of sides*. Understanding this disturbance leads us to examine the common, adjacent sides of the squares, which are the sources of the increase in the number of squares. In other words, with a holistically directed solution, we find that sides and matches are not the same thing, but there are common sides of squares, when one match forms the sides of two neighboring squares. The solution follows from the elimination of this disturbance: these common sides have to be separated. One of the principal consequences of using an understanding of the disturbance in solving the problem is that the resulting method of solution can be transferred to seemingly quite dissimilar problems (see Emel'ianova, 2020).

Thus, these two types of insight have exactly the opposite directionality. Partial insight emphasizes the interfering characteristics of erroneous trials, i.e., it identifies what the correct method of solution method should not possess, what "fixation" it should be free of. It is not by chance that the wording of the results of the analysis necessarily contain the negative particle "not" (the door should *not* be opened; in "match" numerical equations it is *not* necessary to change only the numerical values; you should *not* try to construct four triangles from six matches only on a plane, etc.). With full insight, on the other hand, something is revealed that an erroneous trial does not possess, but that a correct solution should have. This means that if we can see in constraint relaxation a critique of all the erroneous methods of a given problem space (the constraints on which must be weakened), then understanding the disturbance means precisely constructive criticism of a certain method of solving the problem, i.e., identifying what should be left in it and what should be changed to reach the right solution.

## Preconditions for Full Insight in the Developmental Education of D.B. El'konin-V.V. Davydov

There is a logic in developmental education that is similar to the logic of using the understanding of errors to produce full insight. It concerns the use of specially created obstacles to the development of understanding (a concept), which, in principle, is associated with learning activity as an activity to solve a learning problem: "The problem is unsolvable ('I don't know what to do, help me') is reformulated into an underdetermined problem ('I will be able to solve this problem, if…"). Here, where there is a contradiction between the method of action that the child already knows

and the new problem conditions, the student formulates *knowledge of his own ignorance*, i.e., poses the actual learning task" (Davydov, 1996, p. 213). A feature of the technique for creating the obstacles necessary to create a learning task is that the obstacle, on the one hand, should lead to the impossibility of using the already mastered method of solving a problem, and, on the other hand, to a particular reaction to this impossibility. The student's reaction should be not just rejection of the erroneous action and trying out other ones, but a particular thoughtful analysis of the situation. It is this analysis that transforms the problem from being, in Davydov's words, unsolvable, to being underdetermined. In other words, analysis of the impossibility of using a certain method of solving a problem should help to form specific knowledge about the correct method ("I can solve this problem if ..."), and not just to provide the information that the method being used to solve the problem is wrong. Compared to the mechanisms of full insight, this technique of developmental education skips the stage of identifying the role of an erroneous solution and analyzing the causes of this erroneousness. Considering this technique from the standpoint of the Gestalt psychology of thinking helps to emphasize the concept of "error" behind such concepts as "obstacle," "contradiction between the method of action and new conditions," and, therefore, to provide for the possibility of using the logic of constructive criticism. Let's look at this in a bit more detail.

This technique proposes the following sequential series of stages of transition from a practical to a learning task in the strict sense: 1) a practical task, 2) a "learning-practical task", 3) a "learning-theoretical task", 4) a learning task (Repkin & Repkina, 1997, pp. 199–208). A common methodology for shifting from one stage to the next is the creation of a special obstacle to solving the problem, which shifts the focus of the student from the final solution to overcoming this obstacle, and this overcoming becomes a problem of a new (the next) type. Thus, for example, such tasks as reading a word or finding the sum of numbers are practical problems. For the transition to the learning-practical stage, it is necessary, first of all, to provide preliminary training in a number of prerequisite actions, which are also practical in their result (e.g., separation of the sound shell of a word and its meaning, mastering the methods of analyzing the sound structure of a word and reflecting this structure in a graphic model). But secondly, and most importantly, it is necessary to introduce a complication to the conditions for implementation of these actions (for example, the presence of soft consonants in the word), which leads to the formation of a new intermediate goal associated with "the need to find out the connection between the conditions and methods of obtaining the result" (Davydov, 1996, p. 175).

Using such special obstacles in solving "learning-practical task", the activities of the students include concepts and related methods of thoughtful analysis and generalization, which leads the student to the need to solve a "learning-theoretical task" (for example, to perform a phonemic analysis of the word). And through a new complication in the process of finding a solution, the student is faced with the need to identify ways to analyze the concept as a developing system, which characterizes the learning task and the full formation of learning activity. For example, when switching to morphemic analysis (a necessary prerequisite for phonemic analysis of a word and for solving a spelling task, since the solution to the problem "determining the phoneme in the strong position" depends on morphemic analysis), the students have to

derive a system of particular concepts from the original concept of "parts of a word" (root, prefix, suffix, ending). "In other words, the methods of theoretical analysis of a concept serve as methods of constructing *systems* of concepts" (Repkin & Repkina, 1997, p. 206).

Thus, comprehension of the solution that arises when there are specially organized obstacles is the basis not just for deriving an individual concept, but for deriving through the construction of a system of concepts. The last thesis about the need for deriving the concept of building an integral system of concepts unites all three theories of the activity approach to learning that we are considering. But, first of all, none of them emphasizes the need for constructive criticism of the student's mistakes, and, secondly, the system of concepts being built is not based on the transformation of another system of concepts through constructive criticism (up to implicit naive theories). The introduction of these two forms of constructive criticism can be substantiated both by Vygotsky's theoretical analysis and by the experience of developing the psychology of insightful problem solving.

## Conclusion

The main thesis of the article is that mastery of a scientific concept is most effective when it is presented as a form of constructive criticism of another concept. This means that the concept should be mastered not simply by deriving it, transforming it from another concept (as they insist, for example, in developmental education, through derivation from a single concept, a concrete-universal, a "cell"), but by deriving it in the form of a special kind of criticism of the previous concept, i.e., in the form of sublation. On the other hand, criticism that necessarily arises in the learning process (for example, fixation on the student's mistakes) is most productive when it occurs in a conceptual form, as constructive criticism of an implicit understanding, of a "naive" concept.

To substantiate this thesis, the problem of the formalism of scientific concepts in learning and the resistance of naïve concepts to attempts to replace them with scientific ones play an important role. Analysis of these two aspects of a single problem leads to the proposition that the introduction of scientific concepts requires an understanding of their systemic nature, i.e., their inclusion in a theory. And, therefore, it turns into a question of the interaction of theories — the one from which the new concept being studied is derived, and the one to which the opposing concept belongs. Naïve concepts accentuate this by the fact that they represent one "naive" theory or another, and, moreover, it was precisely when discussing the relationship between scientific and naïve concepts that Vygotsky put forward the thesis about the need to transform the system of concepts, and not just to replace one with another. The philosophy of science, primarily based on German classical philosophy, suggests a solution in the concept of "constructive criticism." The psychology of thinking, through the contrast of partial and full insight with the simpler material of insightful problem solving that is much more widespread in everyday life, in turn reinforces the idea of constructive criticism as the main method for deriving a new way of solving a problem, i.e., a potential concept. The constructiveness of criticism in this case consists in understanding the reason for an error of inappropriate action in order to correct

the shortcoming of the method and transform it into an appropriate one. A holistic combination of all three approaches — the activity approach to learning, Vygotsky's approach, and the approach of the psychology of insightful problem solving — makes it possible theoretically and methodologically to concretize a position on mastery of a scientific concept as a form of constructive criticism.

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# The Deficits of Students' Orientation in Solving Proportion Problems, as Revealed through Task Modifications

Maria A. Yanishevskaya[a*]

[a] *Psychological Institute of Russian Academy of Education, Moscow, Russia*

*Corresponding author. E-mail: y_maria@mail.ru

**Background**. Using the Activity Theory of education (Galperin, 1992; Talyzina, 2018), this article examines the students' actions that constitute the early stages of forming the concept of ratios. The psychological analysis of mastery of this concept shows that it essentially depends on understanding the coordination of the changes of two independent values (area, velocity, density, etc.).

**Objective**. The present research considers differences in students' operations with numbers on various tasks, based on their comprehension of ratio relations (direct and inverse proportions); these differences are revealed through posing certain modified tasks, but may stay unnoticed in regular tasks. The goal of the study was to identify the criteria for adequate assessment of the sustainability of the students' orientation in modified tasks.

**Design**. A test of 15 tasks was designed based on Galperin's classification of task variations: domain specific, logical, and psychological. The formulation of the tasks disguised the operations needed to achieve the right answer, and sometimes even prompted the wrong solution. There were 12 tasks on direct proportions — four sample and eight modified; and three inverse proportion tasks: one sample and two modified. One hundred sixty (160) students (5–6th grade, 11–13 years old) took the test in writing.

**Results**. The comparison of students' performance on the sample and modified tasks showed significant differences. Modifications impaired the students' performance on both types of proportion problems (direct and inverse). Logical and psychological modifications had the most impact on the quality of the students' orientation and thus proved to be most indicative in terms of students' orientation quality assessment.

**Conclusion**. The data suggest the following: 1) that the concepts of proportionality which the students acquired from a regular school curriculum lack "generalization," and 2) that students' ability to apply the ratio concept is very sensitive to the way the word problem is presented. These findings are essential for evaluating students' multiplicative thinking: their actual level of comprehension cannot be revealed through their performance on regular tasks.

***Keywords:*** Concept acquisition, ratio concepts, assessment, task modification

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## Introduction

The Activity approach in education (Davydov, 2008; Galperin, 1992; Talyzina, 2018), as presented in most prominent theoretical and experimental works, demands to consider the basic concepts and their orientation meaning for designing one's own solution (instead of only acquiring "universal" skills and specific individual techniques). Being able to evaluate the quality of concept formation as the result of learning is hence an important goal within this approach. In the current research we explored some typical mistakes which emerge in calculations related to the concepts which imply consideration of two values comprising a ratio.

Since Piaget, ratio-based concepts have been at the center of psychological research (Inhelder & Piaget, 1958; Siegler, 2013; etc.). Students' application of such concepts (buoyancy, concentration, area, work, density, velocity, pressure, exchange rates, etc.) tends to be "troublesome" throughout school disciplines (Hecht et al., 2007; Lutfi et al., 2023; Obukhova, 1968). Mastering these concepts is vital for many school subjects, and at the same time these concepts are considered indicators of one's psychological development (Rubtsov, 2021).

Difficulties in using ratio-based concepts may impact students' advance in different discipline areas. Both psychologists and educators are in search of ways to prevent, or at least overcome, students' difficulties with learning ratio concepts (*e.g.*, Lamon, 2012; Lobato & Ellis, 2010; Matthews & Ellis, 2018; Watson et al., 2013). For example, Simon and Placa (2012) point to the inadequacy of introducing such concepts using "one-dimensional space;" they discuss the benefits of a "two-dimensional space" in presenting ratio problems. Still, the in-depth study of the mechanisms behind mastering ratio concepts remains a challenge.

Since we use the Activity theory (Chaiklin, 2019; Engeness, 2021; Galperin, 1992; Galperin & Talyzina, 1957, Podolskiy, 2022) and Developmental Instruction approach (Coles, 2021; Davydov, 2008) to teaching and learning at school, our interest focuses on the quality of concept formation during the transition period from primary to secondary education, when the children need to master mathematical concepts for the standard curriculum (11–13 years). Our previous studies on ratio concepts (Vysotskaya et al., 2017; Vysotskaya et al., 2020; Lobanova et al., 2022) outlined a feasible way to scaffold their formation: a number of teaching strategies (contexts, learning situations, models, etc.) and approaches to educational design were devised.

Since we planned to test all these ideas together within a teaching experiment, our first challenge was to devise the appropriate diagnostic tools. The widely used diagnostic procedures for assessing proportional reasoning include clinical interviews concerning problem-solving (Empson, Junk, Dominguez, & Turner, 2006; Inhelder & Piaget, 1958), individual written tests (Dole et al., 2012; Hilton et al., 2013; Martínez-Juste et al., 2023), practical tasks, and exploiting operations on magnitudes, distributed among participants (Rubtsov, 2021). However, the challenge of finding and designing indicative tasks remains urgent.

Talyzina (2018) highlights intellectual development itself as the core content to be diagnosed. Karpov & Talyzina (1989) outlined two basic principles for evaluating the level of students' mastery in some domain. First, it is necessary to identify the cognitive actions which lie behind the concepts. Second, one needs to select tasks

that allow you to assess the main parameters of these actions: form, generalization, consciousness, mastery, etc. (Karpov & Talyzina, 1989). This approach to diagnostics, deeply grounded in Activity Theory, has great potential to improve the quality of the educational process, by focusing on concept formation.

The present study focuses on one of these parameters — generalization — which indicates the sustainability of the "concept-mediated" orientation formed. Galperin described "generalization" as follows: "Therefore, the idea of generalized action means that the acting subject (the learner) is able to identify the significant conditions for the particular action among the variety of conditions in which he operates. … Therefore, a learner has to demonstrate stability, a degree of insensitivity to any interference, and be able to identify the significant conditions needed to perform the action" (cited by Engeness, 2020a, p.6).

Galperin (Engeness, 2020b) and Talyzina and Karpov (1989) suggest a feasible way to test "generalization" using task variations. An action is "generalized" if it can be performed under conditions that vary and sometimes are quite disruptive. According to Galperin (Engeness, 2020b), the tasks should vary in three ways: 1) the particular actions that help to solve the problems should be different; 2) the problems should include excessive information or be deficient; and 3) the problems should challenge seemingly obvious and standard conceptual features. The modifications of task conditions may thus involve:

Domain-specific types of material. This kind of modification focuses on the conceptual part of the task: what should be done to solve the problem? Merely varying numbers in a math problem does not constitute creating different types of tasks.

Logical variation means that there can be more data than is needed to solve the problem or/and some important data can be missing. Thus, there are four types of problems. First, most problems will contain data sufficient to solve the task, and there need be no excessive information. Second, there can be more data than is needed so that a student has to make some extra effort not to be distracted by irrelevant data. Third, some vital information may be missing, so that the task can only be solved in general terms. The fourth type of variation involves both extra and unnecessary data and the lack of necessary information.

Psychological variation relates to the process of solving the problem. Vividly represented and conceptual features of the material may either coincide or diverge: the appearance of the task (the wording, the order of data presentation, illustrations, etc.) itself directs students and give them hints as to what to do to get an answer — either correctly or incorrectly (for example, what arithmetic operations are implied). N.F. Talyzina and P.Ya. Galperin (1957) specially emphasized the importance of this task modification for evaluating the students' level of generalization while teaching — and for distinguishing between different levels of generalization in diagnostics.

We designed the tasks with variations to "maintain the tension" during concept acquisition: each task differed from the previous one, so that the students always had to reconsider the basis for their actions. At the same time such variations could also be used to evaluate the state of the students' concept development and the quality of their actions. The students' mistakes were considered signs of some deficiency in the orientation basis of their actions.

Many students who learn to solve ratio-based problems tend to produce a number of "roundabout" ways to succeed without applying "conceptual" understanding. Thus, an assessment should distinguish between the appropriate orientation concept-mediated procedure and "formally" correct solutions based on some random irrelevant features, which are enough for solving trivial sample tasks. Galperin's and Talyzina's approach to meaningful variations of task conditions should thus be productive for diagnostics design in this domain. The goal of our study was to identify the criteria for adequately assessing the sustainability of students' orientation in solving ratio-based problems through tasks modified in this way.

## Method

The research question was to assess the current quality of mastery of the proportionality concept by 5–6th grade students, since it is crucial for problem-solving in Math and for future promotion in the Natural Sciences.

One hundred sixty (160) students (5th-6th graders, 11–13-year-olds) of high and medium academic level from three urban schools participated in the study. The pen-and-paper test consisted of 15 tasks: 12 tasks based on direct proportion ("the more, the more" — type D) and three tasks based on inverse proportion ("the more, the less" — type I). The assessment was conducted in individual written form during a regular Math lesson. It took from 30 to 50 minutes to complete the assignment.

The tasks on the test were designed according to the typology of modifications introduced by Galperin (see Introduction):

1. Domain-specific task variations required diverse sequences of arithmetic operations to solve the problem, included numbers that were "inconvenient" for calculations, and presented data in different formats — pictures, dialogues, and diagrams.
2. The tasks with "logical" variations included only the necessary data or necessary data with excessive information. We did not suggest tasks with missing data, as they demand more in-depth analysis of students' solutions.
3. The tasks were "psychologically" varied through the contrast between their "vivid" and "conceptual" conditions. Thus, some of the modified tasks misled students to wrong solutions based on "eye-catching" details.

The majority of tasks contained one or more of the modifications listed above (type M, modified). Four tasks for direct proportions and one for inverse proportions contained no modifications (type S, "sample"). They were used as the reference points; students' performance on the other tasks were compared to the sample-tasks. The tasks below exemplify the modifications that we introduced.

The "shell" task was the "sample task": it exploits a familiar context; obvious operations lead to the right answer, and the calculations are simple.

> "Shell" task (№ 1), direct, sample (DS): Serge and Mike exchange pebbles and shells. They agreed that 4 stones can be exchanged for 5 seashells. How many shells will Mike get if he offers 12 stones?

The "coal" task contains the simplest math-specific modification: numbers that are inconvenient for mental calculation. According to P.Ya. Galperin, such tasks cannot be considered substantial modifications; the "real" modifications should concern changes in the actions required rather than the material itself.

> "Coal" task (№ 7) (DS): 12 g of coal produce 396 calories during combustion. It takes 12276 calories to boil a kettle. How much coal will it take to burn?

"Psychological" modification prevails in the "paint" task: students are prompted to use an additive strategy instead of a multiplicative (to add several jars, instead of using proportion). The modifications of this kind are most sensitive to the quality of students' "conceptual" actions.

> "Paint" task (№ 2), direct proportion, modified conditions (DM): Some children decided to paint the tribunes on the school stadium green, but they had only yellow (y) and blue (b) paints. Each student took several jars of yellow and blue and poured them together to make some green colour. Here are their paints:
> Alice: y y b b b  Gregory: y y y b b b b b  John: y y b b b b  Mike: y b b
> Nike: y y y y b b b b b b  Tim: y y y b b b b b b  Irene: y y y y b b b b b
> John began to paint his bench, but the paint ran out before he completed it. Does anyone have a mixture of the same shade to help John complete his bench?

In the "lawn" task students were prompted to use excessive data (the number of seeds needed to grow a regular lawn), so the problem involved both kinds of modification, logical and psychological. The description was lengthy, and the sequence of data presentation itself prompted students toward the wrong solution, since the extra data was introduced first.

> "Lawn" task (№ 8) (DM): To make a perfect lawn you have to prepare the soil, water and mow the lawn, and foremost, plant the seeds properly. The instruction says to plant one packet of seeds (120 g) over 4 square meters for a regular lawn, and for a beautiful dense lawn the same number of seeds should be spread over 3 square meters. Ivan Ivanovich decided to make a beautiful dense lawn in front of his house with an area of 24 square. How many grams of seeds does he need to sow?

The "pie"-task has subject-modification: part-whole relations had to be considered in addition to proportion. The task also demands comprehension that the weight of the pieces depends on both "sizes" — length and width.

> "Pie" task №10, inverse proportion, modified (IM): A big pie was cut in several pieces. One rectangular piece is 18 cm long and 12 cm wide. The other rectangular piece is 6 cm longer than the first one but weighs the same. "That's impossible!"- said Serge in surprise. *What reply do you agree with?*

## Results

The students' written work (160 completed forms) was analyzed: their performance on the sample and modified tasks was compared, and their notes (if any) were examined as indirect evidence of their reasoning.

The α-Cronbach difference for all fifteen tasks — 0.870 — indicates the internal consistency of the parameters of the diagnosis itself.

**Table 1**

*5th and 6th grade students' performance in sample and modified proportional tasks*

| | **Direct proportion** | | **Inverse proportion** | |
|---|---|---|---|---|
| | **Sample tasks** | **Modified tasks** | **Sample tasks** | **Modified tasks** |
| 5th grade | 82.4 | 62.1 | 65.4 | 46.7 |
| 6th grade | 86.5 | 66.2 | 67.8 | 45.5 |

There was no significant difference between the results of the 5th and 6th graders (F-test); thus, for further analyses we considered all 160 tests together.

*Figure 1* below compares the students' performance on the sample-tasks and the modified tasks.

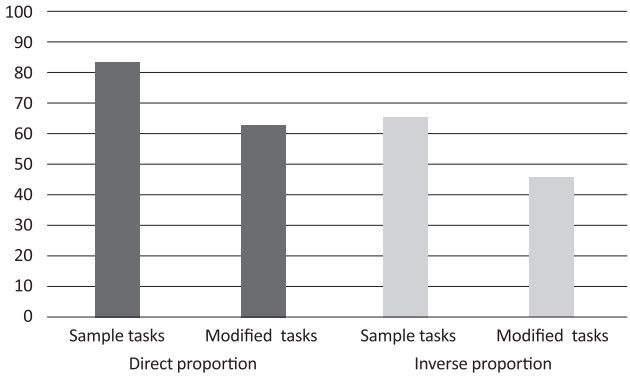


*Figure 1.* Students' performance in sample and in modified tasks

*Note. The differences between students' performance on the sample and modified tasks are significant for both types of proportion ($p < 0.01$, F-test). The differences between performance in direct-proportion and inverse-proportion tasks are also significant ($p < 0.01$, F-test).*

The results showed that students' operations with ratio concepts are sensitive to task variations. Tasks with "unusual" wording, excessive data, and a discrepancy between their visual and conceptual features yielded significantly worse results than regular (sample) tasks ($p < 0.01$) in both cases: for direct and inverse proportions.

Hierarchical cluster analysis was carried out to evaluate the "similarity" in students' performance across different tasks. The dendrogram is shown below (*Figure 2*).

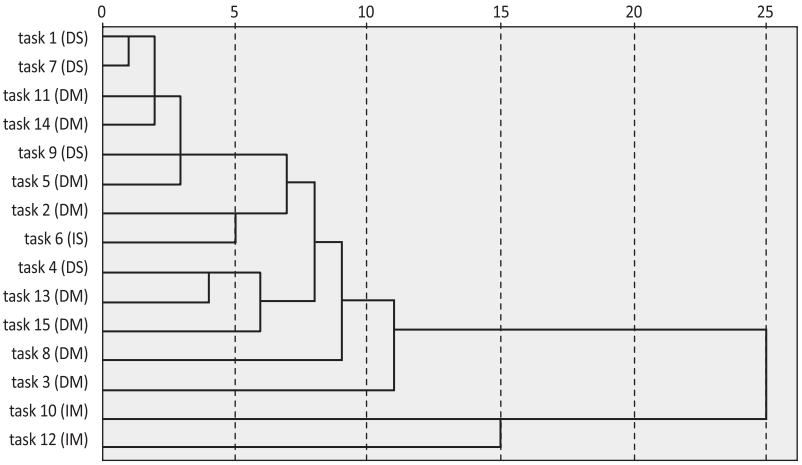


*Figure 2.* Students' performance: hierarchical cluster analysis of students' mistakes

The dendrogram allows us to analyze the tasks on which students performed similarly. One cluster can be distinguished among all tasks: the two tasks on inverse proportion (№10, the "pie" task, and the similar №12). Both tasks included variations and yielded significantly worse results than the others. At the same time the "sample" task featuring inverse proportions (task 6) was solved with the same level of competence as those with modified direct proportions. The necessity of considering the changes of two magnitudes with "opposite" arithmetic operations -- if one value is to be "multiplied," the other is to be "divided" — leads to well-known difficulties and mistakes in choosing the appropriate operations.

The "Coal" task (№7) was solved almost as well as the "shell" task (№1) (they both were the sample-tasks for direct proportions). As was mentioned above, this task was modified in only one aspect: the numbers were huge (3-5 digits) and did not allow mental calculation. As we see, this kind of modification had no significant influence on the students' performance. This result confirms Galperin's remark when he addressed educational designers: Changing tasks in the aspect of numbers only is not an essential modification, since it does not fundamentally affect the actions. However, in tasks with "small" numbers, but modified in the way the data is presented (a diagram of the ratio between salt and water in the DM task [№11], or a photo showing the sample portion of buttons in the DM task [№14]), the students' performance slightly worsened.

The most significant worsening of performance was observed in task №3 (DM) and the "lawn" task (№8) (DM), both of which contained extra data that either prompted wrong calculations or masked the right calculation by excessive wording. The result was that the text itself contained no hints of the sequence of arithmetic operations required.

## Discussion

The comparison of the results shows that the students were more successful on tasks that used direct proportions, and less successful on tasks concerning inverse proportions ($p<0.01$, F-test). Moreover, students' performance worsened if the tasks con-

tained modifications which "disguised" the typical calculation: extended wording, excessive data, and use of diagrams to present necessary information.

The most frequent mistakes made by the students were the following:

1. Applying an additive strategy instead of a multiplicative one. Here are some examples:

"Salad" task №5 (DM). According to the recipe, two boiled potatoes and three eggs are needed to make a salad. The cook wants to make the salad exactly by the recipe, but using nine eggs.

"You need to boil eight potatoes, — says the home Elf. — Because potatoes should be one less, than the eggs!"

"No! — argues the greedy Mouse. — Eight potatoes are too much! Six will be enough!"

How many potatoes should he prepare?

Student E. writes: *The home Elf is right! 3–2=1; 9–1=8*

"Train" task №4 (DS) The train covers 35 km in 25 minutes. What distance will the train cover in 35 minutes?

Student U. writes: *35–25=10; 35+10=45 kilometers*

Student A. writes: *1) 35–25=10 (minutes) — difference*

*2) 10·35=350 (km)*

In the "shells" task (DS) student D. writes: *21 shells!*

In the paint task (see above) the same student D. chooses Nike's paint (yyyy bbbbbb), which is plus two yellow and plus two blue measures, as compared to John's paint (yy bbbb).

"Pencil" task №9 (DS). Six copybooks cost as much as 16 pencil sets. John has enough money to buy only 15 copybooks. How many pencil sets he would be able to buy with his money?

Student I. writes: *16-6=10; 15+10 = 25* (pencil sets)

The additive strategy was also used for inverse proportion. In the "pie" task (IM) student K. writes: *If the second piece is 6 cm longer, it means, it is less in width exactly for this 6 cm — then it will weigh the same!*

2. Considering only one magnitude's changes with no reference to the changes of the other. Here are some examples:

For the coal task (see above) student C. writes: *12276:396=31 (g)* — and considers this to be the answer.

For task 1 (see above) student J. writes: *20:4=5 (shells)*

On the "paint" task, student V. writes: *yy bbbb; yy bbb*, and answers that *John should take Alice's paint*! Evidently, student V. relies on only one of the parameters for comparison. "Alice" was one of the most popular answers among incorrect replies.

On the "salad" task student T. writes: *8 (crossed out) 6 potatoes are needed. 8 potatoes in one salad are too much!*

The students sometimes made peculiar mistakes (regardless of the task type) which were not substantially connected to any meaning of the problem itself. These solutions looked as if students were merely applying familiar manipulations to the numbers in the task:

Student B. (in the "train" task) writes: *35·35=1225 (km) — it will cover;*

Student F. (in the "coal" task) writes: *12276:12=1023*; and the like.

The analysis of the results we obtained shows that the majority of students solved the "sample" tasks, which meant that they were able to operate values in a multiplicative relationship based on their usual school math training. When the modifications (especially psychological ones) were introduced, their orientation proved to be fragile. Here is an illustration from one of the diagnostic lessons: one of the students was solving the "salad" task and writing his answer, which was correct (6 potatoes). The teacher was passing by and asked him to write down the solution or some reasoning. The student looked again at the task and said: *"No, it is reasonable to prepare 8 potatoes indeed! It's more logical!"* — and "corrected" his answer.

Thus, the modifications, especially the logical and psychological ones, significantly impaired the students' performance. These modifications did not allow students to "guess" the familiar arithmetic operations according to the formal features of a text-problem (by its very wording and the numbers used). The necessity of reconstructing the substantial relations between the magnitudes to solve the problems became clear, as students failed even simple tasks when they were being distracted by an unusual format (long texts or diagrams).

The aim of this research was to use Galperin's and Talyzina's approach to designing diagnostic tasks which are sensitive toward the quality of the students' orientation underlying their ratio-based problem-solving.

Our analysis of the students' performance shows that their ability to apply the concepts was very sensitive to the way the problem's text was presented. Thus, in studying the acquisition of ratio concepts, we have to take into account that its actual level may be disguised by the students using "roundabout" ways to retrieve correct solutions from some random features which depend on the format in which the task is presented. The effects which we observed are typical and indicate the deficiency of generalization and other qualities of the action, as Galperin specified (Galperin, 1992, cited by Engeness, 2020a). The students' orientation for operating and transforming two magnitudes appears to have been invalid (an orientation they may have gained from previous learning experience): the students failed to consider the change of both values simultaneously, taking only one parameter's changes into account.

Our long-term goal is to design sound teaching strategies and educational materials, including digital support, to scaffold the means for formation of the consistent ratio concept. Thus, it is necessary to rely on the appropriate diagnostic tools to compare the results of innovative instructions to the results of traditional teaching. The current study was the first step in our attempt to address the problem of teaching multiplicative thinking comprehensively.

The principles of the research strategy which were introduced and grounded by P.Ya. Galperin and N.F. Talyzina, provide researchers with the diagnostic approach to reveal the actual level of new concepts' development. The "psychological" qualities of action — the consciousness, reasonability, generalization, and critical attitude — are more important than the external efficiency of the executive action performed in sample familiar tasks.

## Conclusion

The analysis of the students' mistakes was most crucial, since they pointed out the deficits in the orientation basis for solving problems in this domain. In addition to analyzing the mistakes made, one has to question what the correct solutions relied on? Did the students' solutions imply a conscious, sensible reasoning, or was there some "roundabout" method they used to get the right answer? It is obvious that one cannot rely entirely on students' success in regular tasks to evaluate the quality of their mastery of mathematical concepts. There can be ways of solving problems without adequate concepts, which ways will fail students whenever the tasks deviate from the typical ones. These issues demand future detailed research.

The findings of this study may be adopted by teachers and education designers to assess the quality of ratio-based concepts acquired by students during the transition period from primary to secondary education, since the mastery of these concepts is essential for students' success in the Math, Physics, and Chemistry disciplines.

## Limitations

Some of our tasks proved to be more sensitive than others; thus, for future research we plan to focus on the most critical tasks, while the number of "sample" control tasks may be reduced. The diagnostics presented in the study were limited mostly to students' answers; unfortunately, students often did not explicitly provide their reasoning despite the teacher's request. Thus, the "questioning" part should be improved to prompt argumentation from participants.

Students' poor performance on the inverse proportion tasks demands separate research on the psychological conditions for the formation of the corresponding concepts.

## Ethics Statement

The study followed the ethical guidelines of the Institutional Ethics Review Board.

## Informed Consent from the Participants' Legal Guardians (if the participants were minors)

Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

## Conflict of Interest

The author declares no conflict of interest.

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# The Galperin–Talyzina Method of Psychological Investigation of the Genesis of Cognitive Processes

Andréa Maturano Longarezi[a*],
Iury Kesley Marques de Oliveira Martins[b]

[a]*Uberlandia Federal University, Uberlandia, Brazil*
[b]*Goias Federal University, Goiania, Brazil*

*Corresponding author. E-mail: andrea.longarezi@gmail.com

**Background.** Piotr Ya. Galperin and his collaborator Nina F. Talyzina performed solid experimental work which led them to propose the theory of stage-by-stage formation of mental actions and concepts, as well as a method to investigate cognitive processes, whose conceptual and procedural streamlining demands analysis and systematization.

**Objective.** To investigate the formative experiment of P.Ya. Galperin and N.F. Talyzina, with the aim of analyzing their contributions to the method of psychological investigation of cognitive processes.

**Design.** The article is part of a theoretical research project on developmental didactics systems, of which the Galperin–Talyzina system is one. Russian works by the two authors and their translations into English, Spanish, and Portuguese, as well as works by other psychologists and educators from the Galperin–Talyzina school, were sources of the work.

**Results.** The experiments of P.Ya. Galperin and N.F. Talyzina studied, promoted, and analyzed the assimilation of new knowledge and mental actions, by introducing different conditions. The article systematizes the stages and procedures of such experiments, as well as the series and steps of diagnosis of the developmental level and the formation of mental actions and concepts, in relation to the type of Orienting Basis of an Action (OBA).

**Conclusion.** The theory was built on the basis of simultaneous production of a method to study the genesis of the cognitive processes and the theory of stage-by-stage formation of mental actions and concepts; it led us to define the method of P.Ya. Galperin and N.F. Talyzina as a gradual formation experiment.

***Keywords:*** cultural-historical psychology, developmental didactics, experimental method, gradual formation experiment, P.Ya. Galperin, N.F. Talyzina

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## Introduction

Piotr Ya. Galperin (1902–1988) performed solid experimental work in the methodology of psychological investigation, and was internationally recognized. Nina F. Talyzina (1923-2018) effectively participated in the ongoing experimental activity and consolidated herself as a prominent collaborator of the system. The contributions of their work are not limited to the proposal of a theory; above all, they include a method for investigation in the area of psychology.

Soviet, Russian, and international psychological literature recognize Galperin as an important contributor to Marxist psychology, with special attention to the genesis of cognitive processes. A bibliographic review in the field allows us to highlight the relevance of Galperin's work (Arievitch & Haenen, 2005; Haenen, 1988, 1993; Karpov, 1983; León, 2019; Longarezi, 2020a, 2020b, 2021a, 2021b; Núnez, Pinheiro, & Gonçalves, 2019; Puentes & Longarezi, 2020; Solovieva, 2014a, 2014b, 2014c; Solovieva & Rojas, 2020; Talizina, Solovieva, & Quitanar Rojas, 2017). Galperin opened up a new object of study for psychology (orientation as the primordial function of the psyche), proposed a theoretical approach for this object (the stage-by-stage formation of mental actions), and designed a method for its apprehension (the gradual formation experiment, as we have named it).

Galperin and his collaborators produced over 800 experimental works (Galperin, 1950, 1957 [2001b], 1957 [2001d], 1959 [2001c], 1959 [2017], 1959, 1965 [2001a], 1965, 1976 [1992a], 1977 [1992b], 1977 [1992c], 1978 [1992d], etc.), and he stands out as an important contributor to the theoretical framework of Soviet psychology and didactics, including a new perspective that made him a pioneer, not only for his theoretical collaboration, but also for his determination of "orientation as a fundamental function of psyche" as an object of psychology, which constitutes an essential element in all his theoretical and methodological propositions.

Galperin's importance was recognized by several important representatives of Soviet psychology (A.V. Zaporozhets, A.R. Luria, A.N. Leontiev, D.B. Elkonin, V.V. Davydov, and V.P. Zinchenko, among others). Our bibliographic review of the experiment inaugurated and developed by the author to building the Galperin–Talyzina[1] system, gives visibility to the deepness, amplitude, and consistency of the experimental work of Galperin and his collaborators. Moreover, it is important to highlight the impact of his theoretical and scientific enterprise on the psychological theory of that period.

Galperin worked along with several researchers and groups, since his entrance to the Kharkov school in 1930, his entrance to Moscow State University in 1943, and his experimental work after the promulgation, in 1958, of the resolution "*On the work of the Pedagogical Science Academy of the Transcaucasian Soviet Federative Socialist Republic and on the tightening of its bonds with the schools and centers of pedagogical investigation*."

Before considering the relevance of the author's contributions to psychological investigation and developmental didactics, we look at the experimental method

[1] Even though there is no consensus that the productions of P.Ya. Galperin and N.F. Talyzina are a didactic system, that idea was supported by a recent study which demonstrated the veracity of such understanding. Cf.: Puentes & Longarezi (2020).

which was produced along with Galperin's gradual formation theory[2] as an object in the current article, which has as a focus the contributions of historical-cultural psychological investigation.

## Method

The current work analyzes the formative experiment in the Galperin–Talyzina system, highlighting the main contributions made to the method of psychological investigation of cognitive processes. The study consists of theoretical research, for which a significant part of the author's work was consulted (Galperin, 1950, 1959, 1965, 1966, 1979, 1983, 1976 [1992a], 1977 [1992b], 1977 [1992c], 1978 [1992d], 1965 [2001a], 1957 [2001b], 1959 [2001c], 1957 [2001d], 1959 [2001e], 1959 [2001f]). Works dealing mainly with the research method of the Galperin–Talyzina didactic system were selected, as well as those about the theory of stage-by-stage formation. In addition to monographic works and scientific studies by psychologists and educators who worked with him or in parallel to him, we reviewed the work of critics and researchers of the Galperin school. The theoretical research was based on the original sources in Russian, or translations into English, Spanish, and Portuguese. Analysis and synthesis produced in the investigation followed a documental research process, searching for information and interpretative meanings, "…the path and movement tracked in the building of the study were to identify, select, interpret, produce 'pieces' and the way of best fitting them together to construct an understanding of what has been produced about the experiment" (Longarezi, 2019, p. 169). We emphasize that this work is part of a major study of developmental didactic systems, of which the Galperin–Talyzina system is one. Therefore, the research problem was to characterize the research method produced by the group coordinated by Galperin as a starting point for future studies of the similarities and differences of experimental work carried out by representatives of different developmental didactic systems.

## Results and Discussion: Study of the Genesis of Cognitive Processes

The great academic and scientific contribution of P.Ya. Galperin resulted in studies that led to a method of investigating the genesis of cognitive processes, *the theory of stage-by-stage formation of mental actions* (Galperin, 1966, 1976 [1979]). Galperin´s career started in the 1930s and the experimental programs in education took place in the 1950s; the elaboration of the theory took place especially from 1940 to 1970, focusing the author's theoretical thought on children approximately 6 to 11 years old, an age when the main activity is study.

Among the aims of the method, three are specifically remarkable: 1. to define the stages of the formation of concepts and mental actions, with a focus on the psy-

[2] Although the stages have gone through several terms and classifications, in the history of Galperin's method and *the theory of stage-by-stage formation of mental actions and concepts*, in general, they are: 1. Motivational stage; 2. OBA stage; 3. Stage of the formation of materialized action; 4. Stage of formation of the action in the external verbal language; 5. Stage of formation of the action in the inner verbal language; and 6. Stage of mental action.

chological orientation of activity; 2. to defend the inseparability of knowledge and ability in this formation process, showing that concept formation takes place in unity with the formation of mental actions; and 3. to create the conditions for theoretical thought to develop between the ages of 5 and 6 years, through the mediation of the object in its material or materialized form.

Galperin announced his theory in 1952, presenting it as "a hypothesis of the formation of mental actions," at the first of three conferences of the All-Union Experimental Medicine Institute, which marked the "rebirth of psychology," after the decree of 1936, which put an end to the positions and responsibilities of paedologists at schools and banned paedology as a university subject. Not originally developed as a pedagogical theory, it was conceived as "a theory of the ontogenetic formation of psychic activity" (Talizina, 1988, p. 137); as this ontogeny is an assimilation process in collaboration with other people, it has been, simultaneously, a didactic process; thus: "this theory is, at the same time, an assimilation theory, a learning theory" (Talizina, 1988, p. 137).

The basis for the creation of such a theory is in the understanding of the existing genesis relationship between mental operations and external practical actions. This suggests that a child's thought develops through a connection with objective activity (the direct handling of objects). Galperin investigated the conditions of transformation of an external action (in a gradual form) into an inner action, going through a series of successive stages, each one forming the basis for the following stage; this was the general principle of his method and followed him in the formative experiments or gradual ones that he performed.

From this perspective, the method and theory predict the disclosure of the inner structure of the action, inaccessible to direct external observation, but existing objectively (Shabel'nikov, 2012); and reveals the mechanisms, laws, and conditions for the formation of the constitutive aspects of mental activity. Along with the research done by Galperin and his collaborators about the stage-by-stage formation of mental actions and concepts, there is also a need for an assessment of the quality of the formed action.

### *The Gradual Formation Experiment: Conception, Stages, and Methodology*

Galperin proposed an investigative method of the formative kind, which we have named "a gradual formation experiment" (Longarezi, 2021a; 2021b), and which has also been named "a systematic experiment" (Haenen, 1993), because the process is "a systematic formation" (Galperin, 1983; Haenen, 1993), which is the same as "the stage-by-stage formation of mental actions and conceptions."

The genesis of such studies is connected to the history of the formative experiment, the methodology used in the context of historical-cultural psychology since the initial works of L.S. Vygotsky [transliterated in Portuguese as Vygotsky in the bibliography and citations] (1896–1934), with the genesis-cause method; with later investigations by A.N. Leontiev (1903–1979), A.R. Luria (1902–1977), A.V. Zaporozhets (1905–1981), L.V. Zankov (1901–1977), P.Ya. Galperin (1902–1988), D.B. Elkonin (1904–1984), V.V. Davydov (1930–1998), V.V. Repkin (1927), and their groups of collaborators.

From the experimental perspective developed by Galperin, the experiment targets the formation of scientific thought in the child, and the conditions that promote the formation of mental actions. We may understand the formative experiment, under the perspective assumed by Galperin, as a work of intervention which studies, promotes, and analyzes the "assimilation of knowledge and its new actions during the introduction of different conditions in the process of its formation" (Talizina, 2000, p. 29). The formative experiment consists, therefore, in a process of psychological-pedagogical intervention which aims at studying the formation and development processes of mental actions; it consists, thus, of the developmental process of learning during stages that permit the formation of mental actions.

The formative experiments predict the following steps: "1. delimitation of the objective: specifying a hypothesis in a determined task; 2. planning of the experimental steps; 3. the experiment itself: obtaining of data; 4. data analysis; and 5. the conclusions which the data may permit us to reach" (Talizina, 2000, p. 27).

The methodology of the gradual formation experiment, in turn, includes: explanation for the subjects of the components of the concept; presentation of such components on cards; presentation of the determination of the phenomenon as a drawing or in written form; explanation by the subject of each of the elements from the drawing or the phrase; repetition of the operation, aloud, without using the cards; application of the concept in all its possibilities, thus creating the conditions for its generalization; and repetition of the actions at different levels (Galperin, 1957 [2001b]).

### *Diagnosis of the Developmental Level and the Formation of Mental Actions and Concepts*

In the experiments by Galperin, Talyzina, and their collaborators, the stages of the child's intellectual development were diagnosed by using different forms of the Orienting Basis of an Action (OBA)[3] (concrete, perceptual/through images, and/or logical-verbal), which permitted, beyond the identification of acceptability in collaboration, the delimitation of the developmental level of the student, that is, the potential of their developmental zone: "... the formation experiment (for diagnosis) rests on the zone of proximal development, in which the psychologist builds (forms) in the child the action or the new habit. Therefore, the use of the zone of proximal development for diagnosis of the intellect, requires the selection of actions (tasks) that are new

[3] The Orienting Basis of an Action (OBA) consists of "the anticipated representation of the task, as well as the orientation system necessary to its fulfillment, [which] are part of a future plan of action, the basis for its guidance." (Galperin, 1959 [2001c], p. 46). "In the OBA, the theoretical model of learning activity is expressed as an operation system which regulates and drives learning into the specific conditions. It refers to the correct and rational building of the executive part" (Núñez & Oliveira, 2013, p. 299). Gal'perin, in his text *Types of orientation and types of formation of actions and concepts* (Galperin, 1959 [2001e]), characterizes several types of OBA, according to different levels of support. According to the author, the types of orientation are reduced, fundamentally, to three: "If the subject cannot form a complete guiding image of the new action and the experimenter cannot help, this image is incomplete and one has obtained the first type of guiding. If the same experimenter shows him the complete orienting basis of an action and demands an intense investigation of such, one obtains the second type of guiding. Finally, if the subject builds a complete orienting image in an individual way, one obtains a third type of orientation in the task" (Galperin, 1959 [2001e], p. 41).

(unknown) and, at the same time, accessible to the child; that is, they are found in the child's zone of proximal development. During the formation of the new intellectual action, the psychologist helps the child as an orienting basis of an action, providing the kind of support the child needs; the child's work on that basis shows whether the child is able to accept help or not, whether the help has been effective or not. In other words, the concept of an orienting basis of an action leads to an understanding of the support which the psychologist gives the child during the formative experiment" (Solovieva, 2014a, p. 148).

In the experiments, children were presented with new intellectual actions, with problems to solve. This process presumes two stages. In the first, an OBA is presented on the concrete plane, so that the possibilities of doing it on the logical-verbal plane, with concrete images and concrete actions, may be investigated. The second stage presumes providing an OBA on the logical-verbal plane, to later raise the possibilities of an independent execution on the same plane. If it is not developed on this plane, it is presented in the form of images, and if a solution is still not possible, it is finally presented in concrete form.

In the experimental process, if the objective is diagnostic, it is important that the movement be from the upper plane (logical-verbal) to the lower plane (concrete), and if the intention is to form actions as an educational process, the movement should be in the opposite direction.

Actions do not need to be kept in execution; that is, it is possible to suppress some of them if the child executes the action on the upper level, the logical-verbal plane; that means that the child does not need to go through all the actions (of lower levels). The logical-verbal is, therefore, the first "indicator of the qualitative and global criterion of the child's developmental level (Karpov, 1983)" (Solovieva, 2014a, p. 151). The second indicator is the success of the activity mediated by OBA. If the child does not perform the action at a logical-verbal level, they are advised to try it using the OBA scheme provided. "If the first criterion is related to the intellectual development plane on which the child performs the action, the second criterion is related to the intellectual development plane on which the child accepts the Orienting Basis of an Action, which is provided by the psychologist" (Solovieva, 2014a, p. 151).

These experiments revealed that the highest plane on which the child accepts the OBA scheme signals that the child's development corresponds to the highest plane on which he or she performs the new action. In the studies of intellectual development, the experiments assume two indicators and/or criteria, which also points out two ways of assessing the developmental planes: the execution plane and acceptance of the adult's explanation of the scheme.

The experiments reveal the correlation between the level of generalization and consciousness, if the plane of intellectual development is on the logical-formal plane. That means that the experiments done by Galperin and his collaborators establish a relationship of dependence between the characteristics of the action and its form (Le, Van An, 1995).

Investigations, not restricted to the former Soviet Union like the works done in Moscow (Talyzina & Karpov, 1987; Karpov, 1983), and including studies in Vietnam (Le, Van An, 1995) and China (Chzhao Hunchzhun, 1995), revealed methods of psychological diagnosis whose data demonstrated that success in the formation of

scientific concepts does not depend only on chronological age (the periodization of the child development process), but also on the child's intellectual development plane (Solovieva, 2014a; Zaporozhets, 1996).

The experimental method for diagnosis and the formation of the concept and mental action includes, at least, two series to be described below, so that the reader understands the collaborative movement of the subject in relationship with the other students, as well as the place of OBA in the whole experimental process. Let us go to the first series of the study.

### *The First Series of the Experiment*

The first series of the experiment for assessment of the level of intellectual development includes three stages: 1. *identification of the newness of the action*; 2. *presenting of OBA;* and 3. *checking the intellectual development level in the Possible Development Zone (PDZ)* (Solovieva, 2014a).

Stage 1 consists of *identifying the newness of the action*. The known action may be assessed from other characteristics of the action, be it the level of automatization, reflection, assimilation, reduction, or even generalization. However, concerning the assessment of the newness of the action, this is presented at a lower level, on the plane of concrete actions. If the child does not solve the problem on this plane, it means that the action is new to that child. If the child solves the problem and one intends to verify the level of assimilation of the action, the stage may include verifying it at the logical-verbal level. The experimenter may require only identification of whether the action is new or not, but may want to delimit the level of assimilation, on the verbal, perceptive, or concrete plane.

To check those, verbal problems are presented. If they are solved (without collaboration) one may conclude "that the assimilation plane of such action was logical-verbal and that this child already has the orienting basis of an action enough to solve this intellectual action in an independent way" (Solovieva, 2014b, p. 187). That means this child's action is on a logical-verbal plane, in the child's PDZ. For these cases, checking the newness of the action ends in the first series of the experiment and we proceed to the second. If the child does not solve one of the problems, the object is presented in a material form. If both are solved, it means that the level of development is on the plane of concrete images. If one of the problems is not solved, the level is on the plane of concrete actions. From the conclusions of this stage, we proceed to the second series of the experiment.

To sum up, from *checking the newness of the action,* if the action is new, we proceed to the following stage of OBA; if the opposite happens, the child is presented with problems at a verbal level; if the problem is still not solved, it is presented in the form of images.

Stage 2 comprehends the *presentation of OBA* and it starts as soon as the newness of the action is verified and also its respective level of assimilation, when it composes part of the experiment. When one is working on the first series of the experiment, the OBA scheme is presented on the plane of concrete actions and it takes place at different levels of collaboration, from a more rudimentary level of OBA to its complete scheme.

If after the explanation of the problem the child quickly solves it, that means that the child has assimilated the scheme at a lower level of support[4], the first level. When the problem is solved with only the first level of support, the psychologist experimenter starts verifying it in his plan of independent execution and, if there is no success, proceeds to the second level. In general, a calculation is performed of the percentage of children who solve the problem at the first level in different social classes. At the second level, greater support is offered, although it does not constitute the complete level of orientation. At that level, the experimenter repeats the procedure adopted in the first level; however, support goes a little further. Explanations are followed by concrete actions, so that by offering support, in a complete way or not, the experimenter keeps creating the conditions for the child to solve the problem independently. This process takes place as long as it makes it possible for the child to solve the problem. If a correct solution is found from this second level of support, the child is instructed to solve the problem independently. Once solved, the identification of the upper plane of independent execution is followed. However, if success has not been achieved for this resolution, the psychologist proceeds to the third level of support.

The third level consists of a complete explanation, using all available procedures to solve the problem. The explanation, followed by a concrete demonstration, is open to the manipulation of objects, from which observation, comparison, and the establishment of relationships take place. Manipulation is held at this level, in the most detailed form, because the experimenter points out all the elementary actions so that the problem may be solved. That is why the third level represents the complete scheme of OBA. Only after solving the problem, with support at this level, is the independent execution plan followed.

The aim of this stage of *the presentation of OBA* is to lead the child to understand the principle of the execution of the action, its logic; if the child does not solve the problem, he or she accepts the adult's explanation and copies it. If the child is not successful at one of these levels, it means that the adult may have made some procedural mistake.

Finally, stage 3 comprehends *verifying the intellectual level at the PDZ*. It is expected here that the child will solve the problem, and the independent execution may be observed from the upper plane of intellectual development. Thus, the problem is presented on the logical-verbal plane, perceptive and material, as explained, by the teacher to the child.

### *The Second Series of the Experiment*

In the second series of the experiment, another problem is introduced, called "third exclusion" or "elementary classification" (Solovieva, 2014a). What distinguishes this second series from the first one is that the OBA is present simultaneously on the three planes of intellectual development: logical-verbal, perceptive, and material. For each orienting basis, the solution to the problems needs to take place at the level presented.

Since the probability of aleatory responses is higher in this second series of the experiment, two types of problems are used. To verify the newness of the action, they are presented on the material plane. Just as for the first series of the experiment, if

[4] The term "support" is used in this text in the sense of collaboration, as discussed by L.S. Vygotsky.

the child does not solve them, that is because they are new; if not, the experimenter investigates their solution on the perceptive or logical-verbal level. The solution to the problem on these two planes points out that their real level is on the verbal plane of assimilation. But if at least one of them has not been solved, two other problems on perceptive plane are presented. The solution of both confirms the level of development on this plane; if this is not the result, the developmental level is on the material plane.

The difference in the elaboration of the scheme of OBA in this second series is that it is presented on the three planes simultaneously, starting with the upper plane and, on each plane, the three levels of support are used that, in this case, correspond to the elementary actions which compose the problem: the "action of similarity" (identification of the difference between the figures), the "action of corresponding pictures search" (the grouping of similar figures), and the "action of exclusion which differs from the others" (elimination of the different figure to maintain the similarity of the others).

In the orienting scheme on the verbal plane, the first level offers less support; it only points to the beginning of the solution to the problem. If this level of support is not enough for the solution to the problem, the orientation is repeated and a little more support is offered, a little more substantial support in the orientation to find the answer. If that is still not enough, the third level of support is more complete and includes not only the general orientations to find the solution, but the logical principle for its solution. In each of the levels of support, the experimenter repeats the previous orientation and introduces a new one, a little more incisive in the building of its response, up to the third level, in which the child, besides receiving all the explanations, also has access to the logic of the solution.

Verifying the PDZ on the logical-verbal plane thus includes the solution to two problems at the logical-verbal level, with an aim to avoid a possible aleatory correct response to the problem. Once both problems are solved, the student is exempted from the experiment. If a problem is not solved, it is presented with concrete images.

Instructions and answers are the same as for the scheme of orientation on the logical-verbal plane; departing from the three levels of support which goes from the least to the most complete, according to the responses of the student. Verifying the PDZ on the plane of concrete images was confirmed if, in the end, the child responds to the two problems; if this does not happen, the presentation of OBA at the concrete level proceeds.

This latter is accomplished, in turn, with the use and the direct manipulation of objects, receiving one, two or three levels of support, depending on the need demonstrated by the child. The PDZ on the concrete action plane is confirmed when, from the scheme of orienting with use of concrete objects, the child solves two problems independently. If this does not happen, it is evident that this type of action is not in the child's possible development zone.

These two series of the experiment describe the movement of the diagnostic which goes from the upper plane (logical-verbal) to the lower plane (concrete). It is important to recall, however, that the gradual formation of mental actions and concepts, in the educational and/or formative experimental of actions and concepts, follows a similar methodology, but from the lower plane (concrete) to the upper plane (logical-formal).

Experimental studies led to some conclusions which were, above all, important to the building of Galperin's theory and method: "a) Actions are formed along with sensory images and concepts about objects of such actions, images and concepts represent different aspects of the same process ... ; b) The mental plane is just one of the ideal planes. The other is the perceptive plane. It is possible that a third plane, independent of the activity of each person, is constituted by the plane of language. The mental plane is formed only on the basis of the verbal form of action; c) Action moves to the ideal plane, be it completely, or just in its orienting part ... ; d) Transference of action in the ideal plane, particularly the mental plane, reflects its objective content through each of these planes and is expressed by multiple variations, successive, of the form of action; e) Transference of action to the mental plane, its internalization, is just one aspect of its variation. Other aspects not less important are the variations of all connections of the action, of the measure of its differentiation, of the measure of its domain, of the time, of the rhythm and the indicators of force" (Galperin, 1969 [2001f], pp. 69–70).

To sum up, theoretical investigation of the study of the genesis of the cognitive processes permits us to affirm that the gradual formation experiment is also a formative procedure of cognitive processes, and the difference between the diagnosis and the formation of mental actions and concepts is just in the direction of the experimental movement.

## Conclusion

The present study of the experimental method developed by Galperin, in an intense collaborative work, confirms that his theory was built on the basis of simultaneous production of *a study method of the genesis of the cognitive process and a theory of stage-by-stage formation of mental actions and concepts*. This reinforces the pertinence of the experiment designation of gradual formation which we have assumed for Galperin's method.

We conclude that the OBA is an important instrument for forming new actions and concepts. Its elaboration is part of developmental learning processes in Galperin's perspective and it is the nuclear cell of the study method and the learning method proposed by the author and his collaborators.

Since orientation and interventions in actions may be understood as the collaboration processes which occur in the student's PDZ, a Vygotskyan reading of Galperin's theory includes observation of the teacher's role in the three meanings presented by Vygotsky (2003, 2007): as organizer, guide, and collaborator in the activity of students' learning-development. Such adult–child collaboration, based on the teacher's orientation and organization, are the methodological tools of formation and development as a gradual educational process by its nature of "gradual formation," taking into consideration Galperin's studies, which leads us to reaffirm the conclusion that his study method deserves the designation of "gradual formation experiment."

Advances that the works of P.Ya. Galperin have brought to psychology as well as education have been an object of growing interest of psychologists and educators (Alvarez & Solovieva, 2019; Arievitch & Haenen, 2005; Haenen, 1988, 1993; León, 2019; Longarezi, 2021a, 2021b; Longarezi & Puentes, 2013, 2017; Mendoza & Delgado, 2018; Núñez, León, & Ramalho, 2020; Núñez, Pinheiro, & Gonçalves, 2019; Núñez &

Ramalho, 2017, 2018; Puentes, Puentes, Araújo, & Claudino, 2018; Solovieva, 2014a, 2014b, 2014c; Solovieva & Rojas, 2013, 2020), who have put his theory and method on the scientific agenda and developed it in the scope of developmental theory in different countries. In this scenario, the current article is presented with its focus on the experimental method developed by Galperin and his collaborators.

## Author Contributions

A.L. conceived of the idea, developed the theory and methods, performed the analysis of data, and supervised the findings of this work. I.M. verified the conceptual variations and discussed it with A. L., did the translation to English and formatted this article. All authors discussed the results and contributed to the final manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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# Playing Online as Preparation for Mathematics: The Cultural-Historical Approach as an Alternative to Constructivism

Yulia Solovieva[a, b, c*], Luis Quintanar[b], Valeriya A. Plotnikova[c]

[a] *Autonomous University of Puebla, Mexico*
[b] *Autonomous University of Tlaxcala, Mexico*
[c] *Lomonosov Moscow State University, Moscow, Russia*

*Corresponding author. E-mail: aveivolosaliluy@gmail.com

**Background**. While the traditional method of teaching consists of repetition and memorization, the constructivist theory proposes independent discovery and free play. The cultural-historical approach, on the other hand, does not insist on the early introduction of formal mathematics as implicit or explicit knowledge. According to this outlook, important psychological developmental is necessary for the child before he/she can learn mathematics in primary school.

**Objective**. To present a methodology for organizing the play activity of children of preschool age by introducing symbolic means on the materialized and perceptual levels as an essential aspect of preparation for learning mathematical concepts in primary school.

**Design**. The experiment consisted in pedagogical work in the online modality by the authors at a private college in the city of Puebla, Mexico. Eighteen children from three levels of preschool education (from three to six years old) participated in 45-minute sessions three times per week. There were six children from each preschool level.

**Results**. It was shown that playing with roles online allows children at least partially to include different symbolic means in their activity. This allows the children not only to satisfy their curiosity and be positively engaged in the topic of the play, but also to develop symbolic functions as preparation for intellectual actions with numerical content in primary school.

**Conclusion**. The article shows a feasible way to organize preschool play with roles online and thus to scaffold the formation of children's imagination and ability to use symbolic means, which is important for future learning. The cultural-historical approach offers useful guidelines here, although more research is needed to support the development of children's symbolic function within math-specific activity, based on activity theory applied to learning.

***Keywords:*** introduction of mathematics, symbolic function, online methodology, innovative developmental methods, preschool development

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## Introduction

The question of how to begin teaching mathematics to youth is a matter of concern for psychologists, educators, and teachers internationally. In Latin America, assessments of students mathematical knowledge by international organizations persist in yielding very poor results (OGDE, 2016). This is caused by a profound crisis in the system of education, and the inability of educators to provide successful work with mathematical knowledge at the preschool age and in primary school. The predominant tendency of both public and private preschool and primary school institutions is to adopt the constructivist point of view of learning (SEP, 2017). In Brazil, the largest Latin American country, the most recent program of the Ministry of Education claimed that no special teaching of mathematics is necessary, because all children learn through interaction and communication in different contexts (Ministry of Education of Brazil, 2021). In the countries of Latin America, the constructivist approach to the teaching and learning process is frequently confused with the cultural-historical approach (Solovieva et al., 2022).

According to the constructivist approach, each child's learning is an independent and spontaneous process. Children construct their knowledge through broad social interaction in the family, the street, and the park, as well as in the classroom. School is considered as just one social institution among many others (Calva, Quijano, & Estrella, 2018). The role of the teacher is to facilitate and create conditions for development, but not to be responsible for this development. The teacher is a kind of observer, one participant among many others in the educational process, with no specific developmental role.

The constructivist approach also asserts that the primary requirement for development is to provide sensory enrichment for different perceptual modalities through contact with various objects, substances, and textures, so that the preschool classroom should have the relevant objects. Such objects and substances should have the physical characteristics of extension (length), dimension (area and volume), weight, and the space that they occupy; the objects might be counted and gathered into groups or combinations, and these combinations might be organized in different ways. At first glance, the constructivist position seems to be child-friendly and appropriate for early learning and for positive social interaction at preschool age. Each child may take any attractive object or toy, put it somewhere, exchange it with another child, or give it to the teacher and receive positive encouragement. There are no grades or long homework tasks, at least at preschool age. The whole atmosphere is positive and inclusive for all children. This method is broadly used not only in Mexico, but also in many other countries, in both private and public institutions; it is considered the best example of an active and innovative method for preschool and early school for developing mathematical abilities (Navarra & Larrea, 2018).

However, there are some weak points in the constructivist position. The first is that teaching and learning are understood as two isolated, separate processes. The role of the adult is only to assist and provide the sensory conditions for exploration (Luria, 2019). The second weakness is the lack of differentiation between non-specific exploration and manipulation of an object with no specific goal, and actions with cultural objectives. The third weakness is that there is no distinction between empirical

and theoretical-scientific concepts and the method of their introduction in preschool age and in primary school (Kazanskaya & Romashchuk, 2021). The children's work with concepts is always empirical, which means that they never grasp the mathematical concepts behind what they are learning. Teachers are convinced that empirical knowledge will lead spontaneously to theoretical knowledge. It is not at all clear how the child may arrive independently at some mathematical actions and concepts just by manipulating objects and textures An educator thus provides necessary conditions for learning, but never actually conveys knowledge (Montessori, 2004).

All actions in constructivist methodology are called games, but it is not clear what the word "game" means, since there are no explicit rules, motives, or goals for the collective realization of exploration and manipulation. Any kind of manipulative operation by the child with any object is called a "game." Specific mathematical content, such as quantity, measuring, the physical characteristics of objects, correspondence, seriation, and equalization, are implicitly included in the concrete material, supposedly providing the possibility of the child's spontaneous discovery of them. But there is no specific guidance for work with these materials.

Another serious problem is the absence of a clear relationship between numerical concepts and the representation of reality that stands behind these concepts. Each child can manipulate and explore each object while having no clarity about basic mathematical concepts. At the same time, it is not clear that this kind of exploration furthers the children's psychological development. The children experience joyful and friendly lessons, but never learn what the goal of mathematics is, what the measuring expresses, and why different signs and symbols are used.

In Mexico, as in other Latin American countries during the international pandemic, a real crisis began at all levels of the educational system, but especially at the preschool level. The constructivist approach showed its complete inability to provide adequate lessons online. All children were isolated and stayed at home for more than one year. Interaction with concrete sensory materials for spontaneous use by the children was not accessible in their day-to-day lives. Some children were able to use technology and take online classes, but most of them had extreme difficulties. Even children who had access to electronic technologies could not participate in long class periods online. Most young children in Mexico did not have such access, especially those attending public schools.

The major obstacle to teaching preschool children online was that the teachers had no specific methodology for working online (and still do not today). Recent studies have shown that preschool children have difficulty working with tactile recognition of objects after long periods of work with virtual media (Tikhomirova, Malykh, & Malykh, 2020). The only methodology used by teachers in Mexico was to send assignments to the children by WhatsApp, phone, or video calls, so that the parents became very busy receiving and fulfilling "home tasks" for long hours. Very few educational institutions were able to give continuous classes online.

The method of teaching online proposed in this article consists in organizing simultaneous sessions of play activity for preschoolers and general intellectual activities in the first grade of primary school as a collectively shared and guided activity. Such activities permit the introduction and strengthening at preschool age of psychological preparation for school and the introduction of basic mathematical knowledge,

which is the foundation for successful future learning of mathematics in primary school. Such work can only be provided in simultaneous online sessions by mutual work between the teacher and the children and might be accomplished with very little homework; that homework is always to be explained and checked by the teacher (Olivera Montaño et al, 2021; Solovieva & Quintanar, 2021). The whole conception of the use of play activity at preschool age is related to the meaningful periods of psychological development introduced by Vygotsky (1996) and continued by his followers (Elkonin, 1995; Fleer, 2022). Specifically, the periods of psychological development are understood as qualitative and long periods, each of which has its own guiding activity. Preschool age is a period of psychological development directed to formation of voluntary and symbolic activity (Elkonin, 1995; Salmina, 2017; Talyzina, 2019). It is possible to say that playing with roles is not specific preparation for mathematics, but general psychological preparation for intellectual activity, which is also useful for mathematics.

The goal of this article is to show the method for organizing play activity online for children of preschool age, which will prepare them for the introduction of general mathematical concepts based on the cultural-historical approach and psychological activity theory. The method, based on Elkonin's conception of playing activity (Elkonin, 1995), was applied during the pandemic in groups of preschool children in Mexico. The examples are provided from the authors' practical work under the direction of Kepler College in the city of Puebla. The authors are organizers and pedagogical advisers at the college and collected and organized the data obtained during the 2020–2021 pandemic.

## Preparation for Mathematics Through Online Play Activity

The Mexican Education System mandates preschool education starting at the age of three, and continuing for three years. All children enter primary school at the age of six. The program for preschool education includes introduction of mathematical knowledge in an implicit way, according to the constructivist approach (SEP, 2017).

Another proposal for preschool development comes from the cultural-historical theory introduced to psychology by L.S. Vygotsky. According to research conducted following this approach, the key components of psychological preparation for school are voluntary activity, imagination, self-reflection, and symbolic function (Salmina, 2013a, 2013b; Veraksa et al., 2022; Yudina, 2022). Symbolic function might be considered the basis for the proper introduction of mathematics at school (Davydov, 2000; Salmina, 2017). The problem in developing this function is that it is impossible to teach it directly as one would teach formal school subjects. Symbolic means (signs and symbols) can be used only for specific actions, which should not only be practical actions with material objects. Actions that require the use of symbolic means are actions of play activity and elementary intellectual actions. The play actions represent the content of the play activity, which promote the psychological development of the children, while at primary school age, intellectual activity becomes the central line of psychological development (Davydov, 2000).

During preschool, symbolic function might be broadly used in different kinds of play activity, such as table games, active games, and playing with roles. This last type

of play activity is especially interesting from the psychological point of view, because it represents an excellent example of collective and communicative activity, which is so useful for preschool development. Putting on a play involves the use of verbal and non-verbal actions to represent chosen roles in imaginary social situations according to a chosen topic or argument (Solovieva & Quintanar, 2019). It is possible to include a broad diversity of symbolic means in these imaginary situations. These might be of different levels of complexity, ranging from substitution to codification (regulation) of behavior, schematization, and modeling (Salmina, 1988, 2013b). Each new level subsumes the previous one: for example, codification is based on substitution; schematization includes substitution and codification; modeling uses substitution, codification, and schematization (*Table 1*). The levels might also be understood as different types of symbolic operations, since they might be used in different activities and situations on different subjects.

**Table 1**

*Types of symbolic operations in role playing*

| Type of symbolic operation | Content of the play | Example of action in the play |
|---|---|---|
| Substitution | One object is used instead of another | A small ball as a microphone |
| Codification / Regulation | Specific signs, which represent the rules or norms of action or behavior | Symbols, which show whether the Zoo is open or closed |
| Schematization | Plans, maps, and signs, which represent directions or distribution of elements in the space | Directions to follow in the Zoo |
| Modeling | Objects, symbolic means for rules and for movement and distribution in space, united in a global representation of the whole situation (complex objective) | The model of the Zoo |

The children themselves are not aware of the types or levels of symbolic functions, but they understand in general that they are representing and using different symbols in the play. Such a semi-conscious level of functioning might be called operations, according to the activity theory model, where the actions are psychological processes which are directed to conscious goals according to a predominant general motive (Leontiev, 1975). In this psychological model, the differentiation between operations and actions is one of the central aspects of cultural activity. The action is directed to a reflective, conscious goal, while the operation implies semi-conscious use of the material and physical means (including objects, gestures, and movements) which are necessary to achieve the goal of the action within the play or intellectual activity.

Such differentiation is useful for understanding the process of symbolic development in childhood, and for establishing its relationship with intellectual development and preparation for learning at school. At the stage of substitution, we propose to refer to representative use of symbols in play as symbolic operations instead of

symbolic actions, because the children do not follow the conscious goal of choosing specific symbolic means, but of fulfilling external representative action with an objective in mind.

The symbols are the means which serve to achieve another goal: communicative expression of the content of the role in a way understandable to another participant in the play. *Table 1* presents the types of symbolic operations which might be used in plays with roles.

While following the stages of development in putting on a play, such as codification, schematization, and modeling, the children start to perform symbolic actions, in which the goal is to create or choose the proper symbolic means before they can realize the actions of representation. In this case, the whole symbolic function may include different actions of election, creation, and valuation of symbolic means before the action of representation of a role in the play. On the other hand, at the beginning, at the stage of simple substitution, there is no creation of symbolic means; at this early stage, the children may only use external objects as substitutes for other objects. In the later stages, the children transform the operation of substitution into an act of creation of symbolic means.

Our previous studies have confirmed that symbolic means might be introduced by a teacher or created by the children during the stage of orientation and discussion before starting the process of putting on the play (Solovieva & Gonzales, 2017; Veraksa et al., 2022). Symbolic means might be introduced on the materialized or perceptual levels (Solovieva, Gonzales, & Quintanar, 2015). The possibility of introducing or creating symbolic means depends on the age of the children and on their experience with play activity in groups; constant participation in dialogues and active representation using objects and means allow children to achieve a high level of symbolic development. It is obvious that such a process of using symbolic means might be also called "actions." The children use symbolic means during play actions.

*Figure 1.* The play about *The Zoo*

*Figure 1* shows a face-to-face session of children putting on a play with roles on the topic of "The Zoo" in an experimental kindergarten before the pandemic (www.

colegiokepler.edu.mx). The use of symbolic means might be appreciated in this example, as the chairs represent "the cages" in the Zoo and the picture shows the cage with "wild big mammals".

## Method: Playing with Roles Online

The social and educational isolation experienced during the pandemic was a serious obstacle not only for communication in groups, but also for symbolic development by preschool children. The possibility of organizing simultaneous online classes for groups of preschool children was the only option for continuing playing with roles during the pandemic. The sessions of play activity with roles have their own proper organization (Solovieva & Quintanar, 2019). How was it possible to transfer such a methodology into online sessions, conserving the importance of the use and creation of symbols and signs?

### *Participants*

The method of online play sessions included orientation for playing activity and the process of play on each topic during collective dialogue and playing actions of children with the toys and other objects during the 45-minute sessions. Children from all three levels of preschool education (from ages three to six) were included in these sessions three times per week during the pandemic, in separate groups. There were six children per group from each preschool level, for a total of 18 children. Each teacher worked with groups of children from the first, second, and third level of preschool education.

### *Procedure*

All children took part in the simultaneous online sessions; on some occasions, the parents also participated, if their occupations allowed. All sessions were divided between orientation and realization of the play's activity.

The topic of the play, the roles, the actions, the objects, and possible symbols and signs were discussed during orientation. Each child, in front of the computer at home, selected the toys and the objects to use for the next session. All the elements and the procedure of the play were analyzed collectively by all the children. The sessions dedicated to playing activity took place with all participants, teacher, and children, each child at home with his or her own toys, objects, and external symbols. The children used material objects and toys at home and represented actions according to the role chosen for thematic play during the orientation and discussion. The children demonstrated all the actions of the play and representations on screen to the other participants and directed their oral expressions to the other "roles" (participants) in the play.

The whole situation was organized as if it were a face-to-face performance of a play. The children were introduced by a teacher to the social situation (for example, a pastry shop), the roles of this situation or topic (cook, clients, seller, receptionist, and so on), and the actions of each role (to cook, to buy, to offer, to pay, and so on). The teacher and the children decided about the objects, toys, and symbols, necessary for each topic. After explanation, the roles were distributed among the children, who then performed the roles in front of the computer, so that each participant could observe the actions and hear the oral expressions of the others.

Obviously, it is impossible to equate this activity with face-to-face sessions, because of the absence of direct eye, corporal, postural, and kinetic contact among all participants. It is very important to stress that such contact is essential for the psychological development of preschool age children.

## Results: The Effects of Online Inclusion of Symbolic Means, Essential Preparation for Learning Mathematics

Playing with roles online allows children at least partially to include different symbolic means in the content, although it is not possible to say that these procedures are the same as it in a face-to-face modality. The children need to share a real material space to exchange their ideas about creating symbolic media during online sessions. At the same time, in online sessions, the primary necessity is to explore and use specific material actions with objects and toys, so that all the children want to show and talk about their toys and the roles they have chosen.

In addition, online sessions of play activity with roles allowed the exchange of emotional expressions among the participants, by contrast with their loneliness at home during the pandemic. The children often got excited while playing their roles, and expressed positive emotions and positive relationships with each other and the adults during this online play situation.

*Figure 2* shows how the children showed their toys and objects to the other participants on screen, according to the chosen topic for the play. They used clothing as the attributes of their roles in the play. The figure shows the possibility of organizing children's joint role-playing online. It is important to stress that play activity online requires not only the constant inclusion of collective dialogue between the children and the educator on the topic of the play, but also the use of material objects and symbolic means. "Pure" online play makes no sense to children of preschool age.

*Figure 2.* The play *Pastry Shop*

The teacher noticed that during online sessions, the children performed the roles with great pleasure and interest.

In this unusual situation of online playing, the symbolic function takes second place to the content of the play, and requires more time and effort from the teacher. The teacher must put more emphasis on the implementation and collective creation of different symbolic means in the online modality than if the children were physically together. While putting on a play with roles in a face-to-face modality offers the broad possibility for the use and creation of symbolic means during the operations of substitution, codification, regulation, schematization, and modeling, it is necessary to modify this process for the online modality. *Figure 3* shows the use of symbolic means in a play with roles in the online modality, created by the children and used during the play.

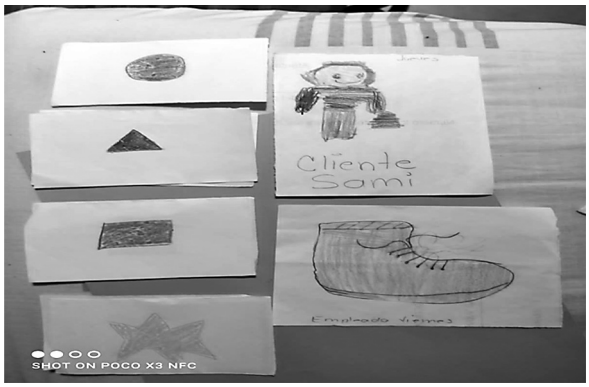


*Figure 3*. The symbols in the play *Shoe Store*.

In this example, you see the symbols for the play "Shoe Store" being used by the children. Each child prepared the symbols at home and showed the results to everybody on the screen. Examples of the children's actions during the play were photographed by the parents and sent to the teacher by e-mail (*Figure 3*). This example shows the use of symbols for the operation of codification: the "client" of the "store" may look for different types of shoes, represented with different colors and geometric figures. The symbolic operation of codification refers to representing the content of the play with the help of symbols that stand for different store departments. *Figure 4* shows another use of symbolic means in a play.

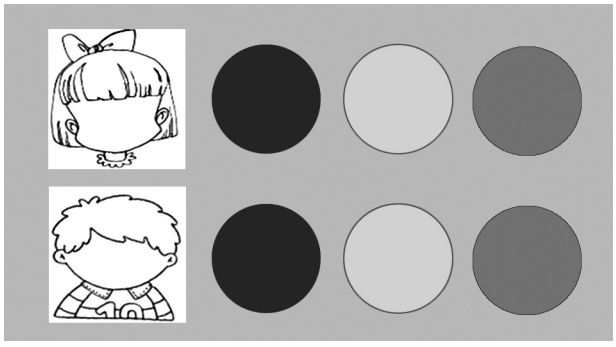

*Figure 4.* Symbols in the play *Hospital*

In *Figure 4*, we see how another operation of codification is used to determine the illness of a patient in a clinic. The red color designates patients with severe disease, yellow is for patients with moderate illness, and green identifies patients who are allowed to go home after a medical examination.

*Figure 5* presents a play in which complex modeling of a beauty salon can be observed. The children prepared the symbols for attending to clients who came to get their hair cut, dyed, or styled; their nails polished; and so on. All the signs were created by the children together during discussion online; each child has drawn the symbols on the board at home and shown them to the other participants.

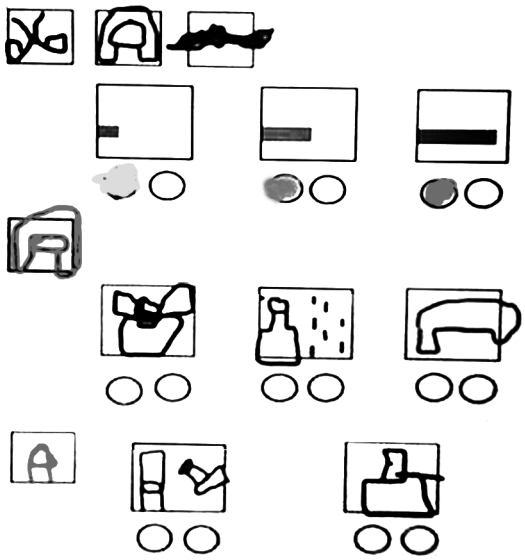

*Figure 5.* The modeling of *Beauty Salon*

In this example, the upper three squares show the "services of hair cutting, hairdressing, hair styling, and barber service." The next line shows the "length of hair" that each "client" wishes to have: short, medium, or long. The line in the middle shows the possibilities of "hair styling" as "stylish combing, hair washing, and hair drying." The bottom line shows the service only for nails: "cutting or painting." The circles with the colors show the price for each service. This complex model was created during online discussion and play by children in front of the screen.

In these examples, we see how the online modality of playing with roles might be used as a methodology for preschool children. The children use the objects and toys in their own homes, but, with the guidance of the teacher, can explain, introduce, and show the other children how to create different symbolic means. One interesting aspect of the methodology is that the children not only see examples and symbols on the screen as if they were in a movie, but they take part in creating all the details. The children talk to each other throughout the preparation of the play and during the play-acting itself.

*Figure 6* presents another example of the process of producing a play with roles online.

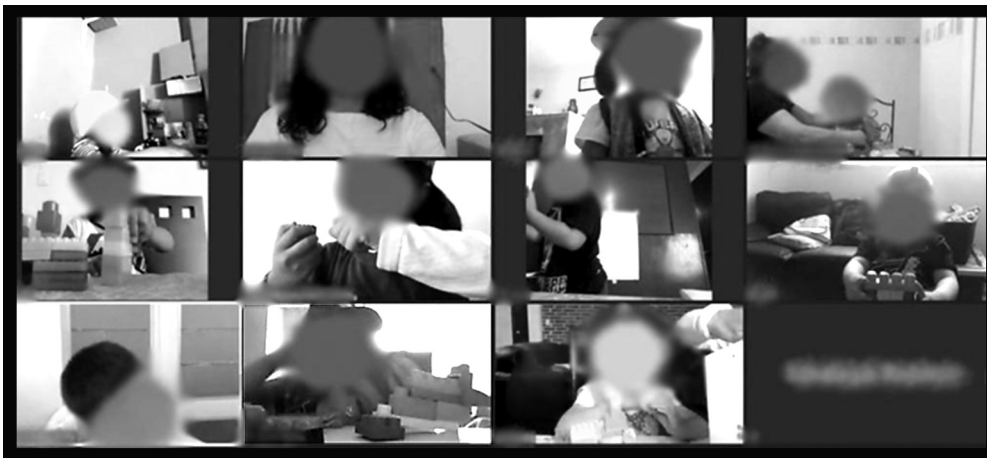

*Figure 6.* The play *Builders*

The figure shows how the children represented the play's roles by using concrete objects and toys and symbolic means for the roles of the builders, and blocks for the constructions of buildings. The children acted as "builders," choosing the models and materials for design of the buildings and towers in an imaginary city.

## Discussion and Methodological Reflection

The question of the optimal ways and time for preparation to introduce mathematical knowledge in childhood remains unsolved in psychology. This article has compared the constructivist and cultural-historical approaches to this important problem. Some examples of concrete implementation of the cultural-historical methodology at preschool age were presented. Online fulfilment of the actions of the roles in the play allowed the children to create and to use the symbols in each play. Such experience is essential for future learning of mathematics in primary school (Komarova, 2022; Rosas, 2019, 2021; Salmina, 1988). The use of symbolic means was achieved using actions of codification and modeling of the situation in the play.

It is possible to observe that while putting on a play in the online modality, the process of introduction and use of symbols has some particular features. There is no place for substitution of objects, since the children are showing and using their toys and interesting objects according to the topic of the play and the actions of the characters. Codification and regulation are also modified by the concrete and mechanical manipulation of the participants, who have to take turns for oral expression and action on the screen. The turns are regulated by the naming of each participant, as the children, one by one, answer the questions of the educator and of each other, or while they show action with their toys and objects on the screen. Schematization of the actions is complicated online, because there is no ability to move about or to perceive the movements of the others on screen, but some of our concrete examples of schematization are shown in Figures 3–5. Modeling is acceptable for use online;

however, the difficulty is that this level requires previous consistent work with the other levels. All these levels or types of symbolic actions should be understood by the children, so that they are able to propose different options, ideas, and solutions for each symbolic action.

The present study shows that the only real possibility for introducing symbolic functions is at the levels of codification and modeling of the situation in the play. The problem with the modeling level is that it is the most complex level of the development of symbolic function for preschool children. Not all children and not all grades of preschool education are prepared for this level of development of symbolic function. The level of modeling requires not only the representation or regulation of one's behavior, such as following a rule in a table game, but also requires the children's reflection about the elements of the material situation. This means that only in the third level of preschool education (when the children are between five and six years old) does the use of symbols become possible, as compared to the face-to-face modality, where the other levels of symbolic function have been included in our research starting with the second level of preschool education (the age between four and five years).

The use of symbolic means allowed the children not only to satisfy their curiosity and be positively engaged in the topic of the play, but also to develop symbolic functions as the basis for preparing for intellectual actions with numerical content in primary school. At the same time, it is necessary to be conscious that the effect of such development could never be compared with the same project carried out face-to-face.

There are some common and differential features between the constructivist and cultural-historical approaches to preschool learning of basic mathematical abilities.

The common feature of these two approaches is their rejection of explicit formal teaching of mathematics at preschool age. The constructivist approach chooses implicit inclusion of mathematical knowledge in actions of manipulation and exploration individually by each child. In this case, mathematical knowledge "is included" in the external materials and space of the classroom, such as magnitudes, quantities, measuring, seriation, and so on. All this content of basic mathematics is never presented directly to the child and never explained. That means that, during manipulation and exploration, the child learns nothing about magnitude, quantities, measuring, seriation, and correspondence. At the same time, there is no goal set for play activity, so that the child never knows how to play and what the purpose of the play is. The child is unconscious of all this implicit content of mathematical knowledge.

An interesting question remains: Is the teacher conscious of that content? How is it possible that the content, of which the child is unconscious, should pass into the consciousness of the child? If the whole process of developmental transition from unconscious to conscious knowledge is not clear at all, it becomes completely mysterious when teaching online. All the sensory conditions that are supposed to facilitate the discovery of mathematical knowledge by the child independently are simply absent in the online modality, as the child has no contact with external objects.

Another important feature of the constructivist position is that the children work in isolation, as each child completes his or her own independent manipula-

tion. The goal of this manipulation is not clear from the beginning to the end of the operation. It looks as if constructivism claims that implicit intuitive knowledge is the unique way of learning at preschool and primary school. The essential question remains unsolved: How might that alleged intuitive knowledge be converted into clear and conscious knowledge in adolescence? How might free play and manipulation automatically prepare, without any goal or reflection, the older child's mathematical abilities? A possible answer is that children either remain on the level of unclear intuition (the best variant) or totally lack any kind of mathematical knowledge (the worst option). The outcome is the poor level of success in learning mathematics in Mexico and other Latin American countries during international evaluations (OGDE, 2016).

The cultural-historical approach chooses another solution to the introduction of mathematical concepts. The process of teaching and learning is studied based on a unique psychological conception of development (Galperin, 2000; Podolskiy, 2009; Talyzina, 2018, 2019; Vygotsky, 1996). There is no place for implicit work with sensory isolated characteristics and operations. According to this conception, the preschool period of childhood should be dedicated to profound development of the symbolic function as the central element of preparation for learning mathematics in primary school (Salmina, 2013 a, b). According to Talyzina, playing activity should introduce and develop voluntary use of means and establishment of conscious goals in child's activity (Talyzina, 2019). According to this author, the possibility for establishing of conscious goals is central for psychological preparation for school learning. So, the child's inclusion in collective playing activity not only with distribution of roles, but also with distribution and creative of symbolic means is the best way for preparation of the child for learning at primary school.

The cultural-historical approach opens new possibilities for pedagogical work, including playing with roles online; it is one possible way for forming symbolic actions and providing preparation for introduction of mathematics in primary school (Sidneva et al., 2021; Solovieva & Quintanar, 2021). The accessible symbolic operations to be used in online sessions with groups of preschool children are operations of codification and modeling. The symbolic operation of codification is the most common operation in this modality; it is very attractive for children, and they may spend a long time designing different symbols for representation of rules, details, and content. The operation of modeling is rather complex and requires the use of external objects and of space. However, it is possible to introduce the children to the possibility of modeling an entire imaginary situation in a play featuring roles. As for the operations of substitution and schematization, they are rather complicated to be worked on in the online modality, as their proper inclusion requires movement and the use of different objects in real space during social interaction.

In our opinion, face-to-face sessions of play are ideal opportunities for the psychological development of preschool children. At the same time, online play sessions are useful for development of the symbolic function. To enrich the constructivist approach applied in Mexico, other possible symbolic operations should be considered for preschool age children, to provide better levels of preparation for the introduction of mathematics in primary school according to the cultural-historical approach and activity theory applied to the teaching and learning process.

The work during the pandemic allowed the authors to systematize the points of coincidence and fundamental difference between constructivism and the cultural-historical approach. *Table 2* presents this systematized comparison between the two approaches to work on mathematics with children of preschool age.

**Table 2**

*Comparison of constructivist and cultural-historical approach for preschool age*

| Content of comparison | Constructivist approach | Cultural-historical approach |
|---|---|---|
| Play activity | Free play | Organized thematic play with roles and rules |
| Plan of actions | Sensory empirical operations of manipulation or exploration with no distinction between concrete objects and symbols | Actions with material objects and toys, actions of materialized representation, creation and use of perceptive symbols, creation of schemes and plans |
| The role of an adult | Facilitation, observation, communication | Orientation for all elements of content of the play activity |
| Communication | Positive inclusive communication with no specific goals in free play and sensory exploration | Positive inclusive communication directed to fulfilment of the goals of play activity |
| Work with mathematical abilities | Implicit inclusion of empirical ideas of length, area, volume, weight, quantity, measuring, digits | Reflection on the necessity of use and creation of symbolic means as the content for representation, schematization, codification, and modeling in play activity; reflection about diversity of external, perceptive, and verbal symbols |
| Psychological results | High level of sensory manipulation and exploration without specific goal, no differentiation between plan of representation and means of representation | High level of development of symbolic function, reflection, voluntary activity, and imagination |

The most notable differences between the constructivist and cultural-historical approaches consist in the use of play activity and the inclusion of symbolic means in this activity (Bredikyte, 2012; Hakkarainen & Bredikyte, 2020). The work with symbolic functions is practically absent in the constructivist approach because the use of symbolic means is implicit. In this approach, the children never know reflectively whether they are using concrete sensory objects or symbols during manipulation.

On the contrary, according to the cultural-historical approach, the children who take part in the plays with roles not only understand the representative role of the symbols, but also may create them and use them collectively for a common purpose. Different methods for psychological development in preschool age provide different levels of readiness for school (Nisskaya, 2018; Sidneva, 2020; Nasledov et al., 2020). The conditions of educational sessions online during the pandemic allowed us to

work within the cultural-historical conception of development and offer play featuring role activity with inclusion of symbolic means. The constructivist approach in Mexico has no specific proposals for development under the conditions of pandemic, only offering the strategy of sending tasks, orally or as video, to the parents by WhatsApp. Very few preschool institutions in Mexico provided real simultaneous online sessions under the conditions of the pandemic.

Our future research will be directed to creation and testing of original methods for introduction of intellectual action and basic mathematical knowledge in primary school according to the cultural-historical approach and activity theory.

## Conclusions

The constructivist and the cultural-historical approaches are two different alternatives to the traditional, repetitive way of teaching mathematics at preschool age. Both methods provide an atmosphere of collaboration and positive affective communication for the children. The difference resides in the apprehension of the role and the content of the symbolic function in preparation for formal studies of mathematics. The constructivist position is based on free play and sensory exploration at preschool age and implicit work, with no reflection about the difference between practical and intellectual actions.

The cultural-historical approach proposes the introduction of organized thematic play with roles in preschool, which offers broad possibilities for symbolic development as a necessary platform for formal learning of mathematics in primary school. According to the cultural-historical conception, online sessions for preschool education might be organized as collective activities guided by the teacher. Such simultaneous online play sessions should include participation by the teacher and the children with the broad use of collective dialogue, material objects, drawings, and symbolic means, which require the proper introduction of gradual levels of symbolic operations: substitution, codification, schematization, and modeling.

## Limitations

The main limitations of our study are related to the impossibility of face-to-face work during the international pandemic and to the small groups of participants, which do not allow us to reliably declare statistical results.

## Ethics Statement

The study was carried out with informed consent from the parents of the children in day-to-day online lessons during the international pandemic organized by Kepler College in Puebla.

## Author Contributions

All authors took part in the design and realization of the research and in preparation of the text for publication.

## Conflict of Interest

The authors declare no conflict of interest.

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# Teaching in the Light of Activity Theory Applied to Preschool: Reflections on Brazilian Practice

Marcela Cristina de Moraes[a]

[a] *Federal University of Jataí, Brazil*

*Corresponding author. E-mail: marcela_moraes@ufj.edu.br

**Background.** Activity Theory applied by the teacher to preschool education favors the development of new psychological formations, such as perception, attention, memory, thought, language, and voluntary self-regulation, which prepare the child for school.

**Objective.** To highlight the contributions of N.F. Talyzina based on Activity Theory applied to preschool education and to reflect on the theory's use in the Brazilian education system.

**Design.** This article is theoretically built from research in a sandwich doctorate program in Puebla, Mexico and internship supervision practices for psychologist training at a public university in Brazil's central-west region.

**Results.** Activity Theory is seldom applied to teaching, including in Brazil, and there is little knowledge about the scientific contributions of one of its practitioners, the late N.F. Talyzina. We chose the preschool stage as the focus of our reflections, and we maintain that the introduction of role-playing as the main activity in early childhood education promotes the development of psychological neoformations and prepares the child for the next stage of school. Finally, we present the internship practices in applied psychology in a Brazilian children's group, with evidence of advances.

**Conclusion.** There is a need for expansion of the formative experiments reported here to the Brazilian population, for scientific dissemination of the results, and promotion of teacher training and qualification in Activity Theory.

***Keywords:***
cultural-historical, activity theory, teaching practice, early childhood education, role-playing

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## Introduction

Activity Theory applied to teaching is rarely used in educational systems, being restricted to some centers of followers and researchers, including Kepler College (Colegio Kepler), in the city of Puebla, Mexico (Solovieva & Quintanar, 2015), where I had the pleasure of collecting data for my doctorate (Moraes, 2018) and evaluating the positive effects of using Activity Theory in preschool.

Nina F. Talyzina is little known in Brazil, and her theoretical contributions are not applied in the education system. The Studies and Research Group on Developmental Didactics and Teacher Professionalization (Grupo de Estudos e Pesquisas em Didática Desenvolvimental e Profissionalização Docente, GEPEDI) organized a series of publications to present to Brazilian readers the biographical profiles and contributions of Russian theorists linked to Marxist historical-cultural psychology. Among these are two chapters dedicated to N.F. Talyzina: "Aportaciones de N.F. Talizina para la psicologia y el desarrollo de la educación en el mundo y America Latina ("Contributions of N.F. Talyzina to psychology and the development of education in the world and Latin America) (Solovieva & Quintanar, 2015) and "Vias para la formación de la motivación escolar (Ways to form school motivation)" (Talyzina, 1923, trad. Pedrini & Malusá, 2017).

A survey on the CAPES portal, an important national database, pointed to increased publications in the last eight years about Activity Theory Applied to Mathematics Teaching, referencing Talyzina's productions. Few works, however, pertain to the preschool stage.

Studies and experiments of Brazilian teaching practice are justified in order to expand the dissemination of the Activity Theory's contributions to the preschool stage and its use in the educational system.

According to V. Davydov (1988), the concept of activity was initially introduced to psychological theory by L.S. Vygotsky (1896–1934), followed by great contributions by S.L. Rubinstein and A.N. Leontiev. At the end of the 1930s, Leontiev and Rubinstein began investigations of the formation and development of the psyche and consciousness and further developed the concept of activity. However, they differed in their understanding of activity and its relationship to the psyche, which led to different didactic systems.

One principle that explains the relationship between psychology and activity is that the human psyche is presented and constituted in activity (Rubinstein, 1986; Talyzina, 2009). People use their psyche to guide themselves and solve their problems. Interaction with the social environment, where problems are solved, is called an activity. With that in mind, the person

> …participates as the active initiator, not a psyche recipient. The person performs not only external practical actions, but also psychic actions. The psyche is not only a picture of the world and a system of images, but also a system of actions (Talyzina, 2009, p. 14).

The individual subject reproduces historical-cultural forms of activity through internalization, by participating in the collective and socially organized realization of the activity; this activity thus becomes individual and internal (Davydov, 1988; Vygotsky, 2006).

One of Leontiev's premises, supported by the *German Ideology* of Marx and Engels, is that people modify their thoughts when acting on the outside world. In this sense, "what people are is determined by their activity" (Leontiev, 1978, p. 21).

A person's life is a set of successive activities, activity being the intermediate point between the material and the ideal, between the object and the mind. The activity's role is to guide the person through the world of objects. However, it is important to highlight that this activity only has recognition and importance if it becomes part of collective life, subordinated to a system of social relations. Thus, individuals' place in society and living conditions influence their activity (Leontiev, 2009).

Following Vygotsky's guidelines, the investigator in a scientific study must work with the most elementary unit that carries all the characteristics and qualities of the analyzed phenomenon. In the case of activity, it is action that carries the whole (Talyzina, 2009).

Rubinstein (1989), cited by Talyzina (2009), states that action is the unit that carries the specificity of the activity, because activity and action have the same structure,

> ... goal, motive, the object towards which the action is directed, the determined set of operations that act and the model according to which the subject acts. The action constitutes the act of the subject's vital activity. Finally, the action, like the activity, is subjective; that is, it belongs to the subject and always participates as an activity of a concrete personality (Talyzina, 2009, p. 16).

Actions are seen as processes directed towards a goal resulting from the historical development of the person, who is part of a society organized by work. It is observed in primitive divisions of labor, that the partial results achieved do not satisfy particular needs, but are satisfied by their participation in the product of common activity obtained through social relations (Leontiev, 1978, 2009).

The proposal to study human activity, the person's relationship with the environment, is not simply a change of nomenclature, in which psychological functions are exchanged for psychological activity. The change is at the level of theoretical understanding, in which "the real process of human interactions with the world" is analyzed without working with isolated elements (Talyzina, 2009, p. 15).

It is from this initial relationship with the world of things and the world of people that personality develops. Over time, reality expands, moving from the narrow circle of people and objects around them to knowable and representable reality. "The real 'field' that now determines its actions is not simply the present, but the existing one, which exists objectively or at times only in an illusory form" (Leontiev, 1978, p. 163). Thus, personality formation is a process with no end, consisting of several stages whose qualitative particularities result from concrete conditions and circumstances (Leontiev, 1978).

It is worthwhile here to clarify parenthetically that it is not just any type of contact between the adult and the child that promotes development. This adult-child relationship must go beyond the social and contextual aspects, which refer to social learning, and should be considered the acquisition of human experience — the psychological tools accumulated throughout history within a given culture (Quintanar & Solovieva, 2017). In this sense, Vygotsky argues, based on the periodization of child development, that for each psychological age, there is a cen-

tral formation and accessory formations that lead to psychological development (Vygotsky, 2006).

Things presented to children by adults acquire functional meaning. Thus the "objectified activity of the child acquires a tool structure, so much so that communication becomes verbal, through language" (Leontiev, 1978, p.161).

Finally, we conclude that "the object of psychological analysis is not the psyche as such, but the activity, whose elements can be external, material, and internal, psychic" (Talyzina, 2009, p.22).

Next, we reflect on Activity Theory's contributions to understanding the preschool stage.

### *Role-Playing as the Main Activity of the Preschool Phase*

At each age, there is always a central formation as a guide for the whole process, and there are also partial processes, which are accessory lines of development. These central and partial lines alternate with changing ages; each stage has its own structure (Vygotsky, 2006).

The child is capable of performing various activities in specific social situations. Still, there is a main activity that will boost psychological development at that particular stage of the child's life. Through this activity, the child acquires new psychological aspects (Solovieva & Quintanar, 2012).

Therefore, the essence of each age is in the new formations, which are:

> ... the new type of structure of the personality and its activity, those mental and social changes that first appear at a given age and that mainly and basically determine the child's consciousness, his relation to the environment, his internal and external life, the whole course of his development during a given period (Vygotsky, 2006, p. 254).

Each chronological/psychological age is favored by a specific social situation, in which the main activities need to be developed with the support, guidance, and conscious participation of the adult/educator. It is this that will promote the psychological development of the child (neoformations).

At preschool age, the organism is in intense development, and the gains in the physical aspect offer children greater independence. This will interfere with their relationship with the adult. That is: "joint activity is replaced by the independent fulfillment of the instructions given by the adult" (Mukhina, 1980, p. 56).

There is an increased awareness of one's own "I" and one's actions, and a growing interest in the world of adults and their activities. It is this need to know the adult world that leads to the game in its most developed form, i.e., role-playing as the main activity of the preschool phase, which allows the modeling in the child of social relations. An isolated action with an object has no meaning. It only acquires social meaning and real motivation when this action is part of human relations. This is possible in role-playing (Elkonin, 2009).

Therefore, the thematic social of role-playing will be a fertile field allowing the child to develop knowledge of social relationships and thereby acquire new psychological formations. "The orientation towards his colleagues, towards the opinion of

the nascent community, forms the social sense in the little one: the spirit of initiative, the ability to follow the group, to share feelings, etc." (Mukhina, 1980, p. 58).

Some studies conducted in Mexico and Colombia (Gárcia et al., 2013; González & Solovieva, 2014; González et al., 2011; Moraes, 2018; Solovieva et al., 2015) indicate the psychological development of children in preschool when using thematic social role-playing as the main activity.

In Brazil, we also have some studies (Andrade, 2017; Colussi, 2016; Colussi & Szymanski, 2020; Souza, 2010; Steinle, 2013; Vieira, 2017) that point to the use of role-playing in early childhood education as an important activity for the development of the creative imagination, of higher psychological functions, favoring the regulatory role of language, contributing to the children's singularization process and the development of the voluntary activity.

At preschool age, role-playing occupies an important space in children's development, allowing them to experience adult social life playfully. Social roles are experienced within the game, where rules are respected, and conflicts are managed according to the children's abilities. This promotes role-playing as the main activity of preschool age (Venguer, 1976).

In light of this, Elkonin (1980) points out that:

> ... the game's world has its rigid laws, which are reflections or copies of the real relations existing between people and objects or between one object and another. The game is not a world of fantasies and conventionalism, but a world of reality without conventionalism, reconstituted solely by unique ways (p. 212).

Given the theoretical and practical evidence of the importance of role-playing for child development, it is worth considering how teachers can organize and use it. Early childhood education's task is to develop a pedagogical way to work with role-playing, focusing on social relationships. For that, we highlight some mediations that the teacher can perform, such as: "playing together with the children; reading stories about a theme that the child is playing with in their games; organizing a visit to one of the situations present in the child's play, etc." (Nascimento et al., 2009, p. 301).

Furthermore, it is important to disseminate a method proposed by Solovieva and Quintanar (2012), which was developed at Kepler College and has been used in several studies (Bonilla-Sanchez & Solovieva, 2016; Gárcia et al., 2013; González et al., 2011; González & Solovieva, 2014; Solovieva et al., 2015), with favorable results for child development.

This proposal can be developed with children from 3 to 6 years of age, as at this stage, there is an interest in adults' actions and attitudes, and it can also be used with children who have developmental difficulties. This activity should be introduced gradually at the preschool stage. It starts with acting with concrete objects and then with substitute objects, until reaching the most developed way of playing social roles, which almost does not require using objects. The school must respect these steps when introducing role-playing, considering that the same theme can be developed differently, depending on the stage of the group (Solovieva & Quintanar, 2012).

A program for game activity in preschool institutions should consider the following steps: discuss and propose a theme; define and choose roles; analyze and define

what each character does; analyze and define the means (objects) that will be used, and, finally, analyze the activity performed, highlighting who performed the role properly, what needs to be improved (Solovieva & Quintanar, 2012).

Observing and recording the children's progress and the characteristics of their voluntary activity are important. It is worth mentioning advances such as: taking initiative to propose new themes and characters; new verbal and non-verbal actions, different from those defined together with the adult; reduction in the use of objects and dependence on materialization (Solovieva & Quintanar, 2012).

The role-playing game is structurally organized into three functional parts: planning/organization (guiding), execution, and control/reflection, according to the functional parts of every activity (Talyzina, 2009). The guiding part concerns the concrete conditions necessary for achievement of the action. Execution is the work in action, transforming the material or ideal object. The control part is the confrontation between the results obtained and the initial model, making necessary corrections in the guiding and executing parts (Talyzina, 1988).

The "action guiding base" is the theoretical and practical information that helps the child to perform the requested action. In role-playing game activity, "the guiding base represents much simpler and more accessible training for the child than school learning activity" (Solovieva & Quintanar, 2012, p. 67).

In role-playing, the teacher uses the action guiding base to distribute roles for verbal and non-verbal actions. The teacher can use different strategies to form verbal actions, depending on the children's developmental level. At the beginning, the teacher can offer examples of words and phrases that can be used according to the social situation. "Children take up this verbal material by imitation, animation and help, in which the teacher initiates the word and the sentence, while the children continue and develop it" (Solovieva & Quintanar, 2012, p. 69).

On the other hand, the guide basis for the formation of non-verbal actions in the game includes several actions, but "initially it is about actions with objects and symbolic ones, which must be formed at the preschool stage. The more complex actions are gradually included by example, imitation or verbal suggestions from the adult" (Solovieva & Quintanar, 2012, p. 69). At a higher developmental level of role-playing activity, children follow their guidelines for performing verbal and non-verbal actions.

Finally, the thematic social role-playing game is not a pastime. It has objectives presented by the teacher and reasons that awaken the children to participate in the activity. Through this method, children improve coexistence, develop language, respect for others, flexibility in actions and thinking, and improve communication strategies, cooperation, and skills to resolve conflicts, develop imagination and self-regulation skills (González & Solovieva, 2014; Veraksa & Veresov, 2022).

Given the theoretical and practical evidence of this didactic strategy for developing preschool children, it is worth reflecting on teaching practice in Brazil.

### *Teaching Practice in Brazilian Preschool*

Most institutions dedicated to early childhood education face a welfarist past, as the first institutions designed for this age group emerged to serve poor children and es-

pecially children of working women. Education was more focused on moral issues, as the children needed to adapt, leaving aside intellectual issues (D. Saviani, 2012).

Over time, there has been a demand for these institutions, whose main objective is basic care, to offer quality care and time, that is, more comprehensive care. The new pedagogical ideas also presented information about child development, addressing the need for greater attention to childhood with specialized professionals. N. Saviani (2012) points out that private institutions adopted these transformations over time, although public ones did not advance in the same proportion.

The recognition of early childhood education as the first stage of basic education in Brazil, by the Law of Guidelines and Bases for National Education (Lei de Diretrizes e Bases para a Educação Nacional - LDBEN) (1996), was an important achievement. However, it was not enough to guarantee major transformations for two reasons: the non-mandatory nature of this school phase, and the idea that the preschool phase would not be configured as a stage of school education (N. Saviani, 2012).

The result is confusion, where we have, on the one hand, institutions that believe that the preschool stage needs to be a free, informal space with a curriculum built by the children themselves (Prado & Azevedo, 2012), and on the other, we find early childhood education that suffers from premature literacy: "for the child to learn, in fact, to read, write and deal with numbers – with understanding, resourcefulness, and autonomy – much has to be done, in the formation of their mental processes" (N. Saviani, 2012, p. 70). However, we need to overcome the worldwide trend of focusing on the cognitive development of young children with practices distanced from play (Fleer, 2022).

Arce (2013) credits part of this confusion to Brazil's National Curriculum Guidelines for Early Childhood Education (Diretrizes Curriculares Nacionais para a Educação Infantil), which presents two guiding axes, i.e., interactions and games that are not defined and explored in the document. In practice, "Early Childhood Education is not school" (Arce, p.18) and, therefore, children need the freedom to play and interact among themselves without adult intervention to curb their creativity.

> Although the premise "playing + freedom = happy child" is entangled with the definition of what it means to be a child and childhood in our country, it is incomplete, not contributing to the knowledge of who a child really is and, much less, so that the pedagogical work presents itself as something efficient, generating development in Early Childhood Education (Arce, 2013, p.18).

It is necessary to clarify that the teacher has a fundamental role in early childhood education as a mediator of cultural products constructed throughout history. Therefore, the child needs to have the opportunity to:

> explore objects through manipulation, and understand their function and social utility, such as appropriating literature in moments of storytelling or even playing social role-playing, among others. Thus, the greater this involvement is, the greater their cultural appropriation and objectification process and, therefore, the more qualitative their imaginative and creative activity will be (Steinle, 2013, p. 115).

Silva and Lima (2015), in a survey conducted at an early childhood education school, found through observations and interviews that teachers recognized playing

as an important part of children's development. Thus, it should be part of the routine, without intervention from the adult. They also found that interventions by the teachers were restricted to situations of conflict. The same was observed by Singer et al. (2014) in a survey of Dutch nurseries, where teachers spend most of their time moving around without getting involved in the children's play, and this has a negative impact.

In this way, most of the games were free, without the teacher's intervention, and there were also games proposed by the teachers that did not always work due to complex rules that left the children disinterested. However, it is necessary "to recognize play as a tool that should be used not only to distract the child or occupy him, but to allow him to advance in his development through enriching experiences" (Silva & Lima, 2015, p. 61). It is worth mentioning that

> …at the institution, it is easy to identify how much children already play using the experiences acquired in other social relationships. Yet, we want to emphasize the importance of playing, which can further contribute to child development, mediated by the teacher (Silva & Lima, 2015, p. 63).

Thus, the importance of playing and the time allocated for it depends not only on the schools' curricula, but also and mainly on the training of teachers who work with early childhood education. Specific theoretical knowledge of psychological development, pedagogical knowledge of content, didactics, and methodologies must be indicated for each age group.

This knowledge needs to reach the schools of early childhood education, and this is the goal of the internship for training psychologists, which I coordinate at a public university in the central-west region of Brazil. In the next section, we report on an experience with positive results.

## *Activity Theory Applied to Preschool Through Internships for Professional Training in Psychology*

Vygotsky sees education, in a broad sense of intersubjective social practice and not necessarily dependent on a structure, as essential for individual psychological development and the subject's personality. A great leap in development is linked to the human capacity to create and risk following other paths (González, 2007).

From this perspective, teachers play an active role in the teaching and learning processes, as it is up to them to promote all children's development. A contrary stance would be to identify cognitive skills that previously existed in the child and ensure external conditions for them to develop. This approach is the cause of many school failures, because if teachers believe that a student is born with cognitive abilities, then those with difficulties would also have innate cognitive problems and, thus, be unable to learn. So the teacher would have nothing to do (Talyzina, 2009).

Given this,

> [t]he intentional and planned influence of teaching on personality formation has been very small, and, among the reasons for this, we highlight both the conception of personality grounded in traditional psychology and the consequent lack of knowledge about its development, which includes the recognition of the most powerful experiences for its formation at the different age stages (Martins, 2006, p. 27).

School failure and learning problems are common situations that interfere with the lives of many children. Nevertheless, little or nothing is done to resolve them; most of the time, they are accepted as simply facts. Sometimes, administrative changes are made to school contents for each subject, insertion and/or removal of subjects, and age group changes according to the school year, but "they do not propose specific alternatives that make it possible to solve this problem or reconsider programs and teaching methods" (Solovieva & Quintanar, 2009, p. 7; Talyzina, 2009).

In this sense, Vieira (2017) warns that:

> ... our capitalist society increasingly encourages meritocracy, punishments, individual stimuli and incentives and all the bourgeois behaviors that Vygotsky tried to combat. We form individualistic, selfish people, incapable of postponing satisfaction and controlling impulses, with all these characteristics present in the so-called "learning problems" for which students are blamed, disregarding that they are formed by production relations (p. 61).

Children who have low development of the voluntary self-regulation when they reach school age[1] are subject to the following complaints from the teacher: they do not include themselves in the group activity in the room, do not follow the teacher's instructions, are often distracted, do not complete tasks in the allocated time, cannot organize notebooks, are impulsive, uninhibited or passive and dependent (Salmina & Filimonova, 2001).

These are the complaints we received in the internship in school psychology, developed in schools of early childhood education and elementary education of a public university in the central-west region of Brazil. Therefore, there is a need to find a path that does not hold children responsible for their difficulties at school, but rather promotes the development of psychological neoformations that can contribute to their success.

In 2017, the author of this text completed a sandwich doctorate (Program of Sandwich Doctorate Abroad, PDSE), funded by the Coordination for the Improvement of Higher Education Personnel-Brazil (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior-Brasil — CAPES). In a master's program in Diagnosis and Neuropsychological Rehabilitation at the Benemérita Universidad Autónoma de Puebla in Mexico, it was possible to participate in courses under the supervision of Prof. Dr. Yulia Solovieva. Part of the data from a doctoral research project (Moraes, 2018) was collected at Colegio Kepler, where role-playing is one of the main foci of the work developed by teachers of children from 3 to 6 years old. The teachers used the methodology for introducing role-playing by stages in early childhood education developed by Solovieva and Quintanar (2012).

In the last five years, internship supervisions have been carried out in early childhood education based on Activity Theory, with positive results. *Table 1* summarizes the adaptations made to ensure the involvement of the class with the role-playing and the evolution in the development of the game level.

The program presented above comprised 12 sessions, which already resulted in advances in the game level. The class teacher identified changes in the children's actions at other times in the class, such as greater control of behavior, greater understanding of the instructions for the proposed activities, and respect for the rules (Sousa, 2023).

[1] We consider school age to be the period after the age of 6, when the child leaves early childhood education and goes to Elementary School I (Talyzina, 2009).

**Table 1**

*Introduction of role-playing in a Brazilian public school*

| Steps | Early games (1st to 4th) | Intermediate games (5th to 9th) | Final games (10th to 12th) |
|---|---|---|---|
| **Planning** Theme Choice | • The adult suggested the theme (most common — restaurant).<br>• Introduction of the topic using a child´s video representing the social situation;<br>• Students found it difficult to talk about the topic. | • Students discuss interests and preferences — restaurant game turned pizzeria at the students´ request.<br>• The adult suggested new themes: vaccine room, market, and pet shop. | • Students chose the ice cream store theme by themselves.<br>• The student who suggested the idea felt important when the adult and the group accepted the suggestion. |
| **Planning** Presentation and Division of Roles | • The mediator adult uses two-option questions: Who works at the restaurant: the fireman or the waiter?<br>• Students had difficulties thinking about roles.<br>• The number of students in the class (30 children) made dividing the roles difficult. | • Students can list the roles according to the theme of the game.<br>• Students need clothes, accessories, and tools that characterize the characters.<br>• Division of the group, through verbal agreement, into two sub-groups (characters and observers);<br>• Children have difficulty staying in the previously divided role. | • Students can list the roles and suggest new roles during the game.<br>• Division of the group between observers and characters using a marking with colored ink on the hand;<br>• There has been an increase in staying on the role until the end of the game. |
| **Planning** Symbol Construction | • The adult constructed less complex symbols (e.g., cardboard with an option) without the children's participation.<br>• Children's difficulty in following the guidelines of the symbols. | • Symbols defined and built together with the children;<br>• Symbols with more elements facilitated the child's verbal and non-verbal actions.<br>• Children were encouraged to construct the symbols but were unsuccessful because of the short time set for the games. | • Children use easily constructed symbols. |
| **Planning** Rules Definition | • Rules defined by the adult with the children´s participation;<br>• Difficulties following the rules due to not understanding the game's purpose. | • Rules defined together with the children;<br>• Need to build new rules after the first round and time for reflection;<br>• Symbolization of the rules on the board. | • Internalization of rules and performance according to what was defined in the group. |
| **Planning** Choice of Objects | • Attachment to the objects defined for role-playing;<br>• Child chooses the character according to the work object.<br>• The adult presents the objects at the beginning of the game. | • Students are unaware of the social utility of some objects.<br>• Necessity of resuming the object game with new themes (vaccine room, pet shop). | • Students use the objects according to their social function.<br>• There is still an attachment to objects for the game realization. How ever, this has boosted the game's development.<br>• The children are capable of using substitute objects. |

| Steps | Early games (1st to 4th) | Intermediate games (5th to 9th) | Final games (10th to 12th) |
|---|---|---|---|
| **Game Execution** | • Children have difficulty staying in their social roles.<br>• Children are distracted by objects.<br>• They do not understand the purpose of the game.<br>• They have difficulty playing with the group. | • Increased awareness of the purpose of the game;<br>• Children develop verbal and non-verbal actions according to the theme, supported by objects and symbols.<br>• They get excited when the intern arrives at the start of the game. | • Children understand the need to remain in the role until the end of the round.<br>• The game develops with greater autonomy on the part of the children and less interference from the adult.<br>• The children suggest new themes, characters and verbal and non-verbal actions.<br>• Increased cooperation among peers. |
| **Reflection and Control** | • Students resist participating in reflection and control.<br>• Get distracted easily. | • They participate by answering the mediating questions (What was the game today? How did the waiter serve the customers?) | • Students took advantage of the role of observers to point out mistakes while the game was taking place.<br>• Students identify failures more easily and correct their peers.<br>• They can identify mistakes and successes. |

*Note: Data taken from Ana Beatriz Oliveira de Sousa's Course Completion Work (2023) built through an experience report in an internship and extension project, with role-playing developed with a group of 5- to 6-year-olds.*

Given the positive results, the goal is to continue with the interventions with more sessions and involve the class teacher in the process so that she can continue the work. It is also proposed to organize a training course for early childhood education teachers based on the experiences developed in the municipality, so that Activity Theory applied to preschool can be used by teachers and included in the education system in the future.

## Final Considerations

We achieved the article's objective by highlighting N.F. Talyzina's methodology applied to the preschool stage, as shown by the favorable development records when the teacher systematized and organized students' activity. It is up to the teacher to understand that role-playing is the main activity that leverages the development of children between 3 and 6 years old and that it must be worked on at school through the action's guiding base.

We advocate the continuing training of teachers of early childhood education from the perspective of Historical-Cultural Theory and Activity Theory, so that they can contribute to the transformation of pedagogical practice with actions that ensure the approach of children with the tools of culture, with the provision of diversified

materials, and with planned teaching considering the knowledge accumulated by humanity.

Finally, there is a need to expand formative experiments to the Brazilian population, with scientific dissemination of the results.

## Conflict of Interest

The author declares no conflict of interest.

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# A Dynamic Evaluation of the Process of Solving Mathematical Problems, according to N.F. Talyzina's Method

Yolanda Rosas-Rivera[a*], Yulia Solovieva[b, c, d]

[a] *National Pedagogic University, Mexico City, Mexico*
[b] *Autonomous University of Puebla, Mexico*
[c] *Autonomous University of Tlaxcala, Mexico*
[d] *Lomonosov Moscow State University, Russia*

*Corresponding author. E-mail: npyolandarosas@gmail.com

**Background.** The process of teaching mathematics represents a challenge for primary education, due to the different perspectives and disciplines involved. In addition, as an active and flexible process, it requires feedback on what the students actually achieved. An analysis of the different learning and development outcomes allows the teacher to understand the mathematical content and the method of teaching it in the classroom, with the objective of promoting the students' conceptual development.

**Objective.** The objective of our study was to analyze the general skills for problem solving which students developed, by applying dynamic evaluation.

**Design.** A verification method was used to identify the students' abilities and difficulties. A protocol for evaluating the process of solving mathematical problems was organized. The assessment included four simple problems and four complex ones. The participants were 15 students in the third grade of primary school attending a private school located in Mexico City.

**Results.** The results showed that the students identified the types of mathematical operations (addition, subtraction, multiplication, and division) required to solve the problems as their objective. Therefore, their preparation of a solution plan, its execution, and its verification were based only on empirical thinking and quantitative information.

**Conclusions.** We concluded that problem-solving is an intellectual activity that requires conceptual development to carry out a solution plan, execute it, and verify it, in addition to the main objective of answering the question posed by the problem. We propose that these characteristics be included in the organization of mathematics teaching in order to develop mathematical thinking.

***Keywords:***
math learning, mathematical concepts, mathematical thinking, math assessment, mathematical operations

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## Introduction

The teaching and learning of mathematics together comprise a process of knowledge acquisition in which both teachers and students participate. Likewise, it requires various activities and actions with objects that facilitate such acquisition. There are several factors related to the teaching-learning process that have been investigated: for example, teaching practices (Weiss et.al., 2019); learning strategies (Reséndiz, Block, & Carrillo, 2013); the use of didactic materials (De Castro & Palop, 2019); the participation of non-formal knowledge; etc. Therefore, the problem-solving process involves a level of complexity that implies that teachers and researchers understand both mathematical content and the way it should be taught in the classroom, especially if it is in the early years, when a child's thinking tends to be limited to the immediate characteristics of the reality around them (direct perception) (Vygotsky, 1993; 1995).

According to Cantoral (2006), the process of teaching and learning must include an object for interaction between the teacher and the students; the particular interaction proposed by these authors is the game. However, it is possible to identify those new important changes in teaching proposals, didactic materials, the use of technology, and the mathematical content to be taught (from algorithms to mathematical concepts), which are necessary to improve the whole process (Ávila, 2006). The results obtained from these modifications have not yet been evident in studies of teachers' understanding of the process (Arévalo, 2015), the students' learning (Rosas & Solovieva, 2019), or students' psychological development (Solovieva et al., 2020; 2021).

In teaching mathematics, the teacher must not simply present the mathematical tasks, but also demonstrate the actions that the student must carry out in order to solve the tasks and obtain generalized learning (Talizina, 2019; Weiss, et.al., 2019). For this, the teacher must know the type of intellectual actions and mathematical concepts that are included in the mathematical tasks, specifically in the solution of mathematical problems. Intellectual action is understood as an action oriented towards a conscious objective, which cannot be reached by applying a direct and impulsive solution, or available in the domain of generalized relations and action procedures (Davidov, 1988). That is, according to the cited authors, the teaching of mathematics requires knowledge of the concepts of mathematics and intellectual development (Reséndiz, Block, & Carrillo, 2013; Rosas & Solovieva, 2019; Talizina, 2019; Weiss, et. al., 2019).

The functional parts of intellectual actions identified in the studies by Talyzina (2017; 2019) are as follows: orientation, execution, and verification. There are investigations that have proposed the ways to formulate and develop intellectual actions through solving problems (García & Tintorer, 2016; Granados & Rodríguez, 2011; Nikola & Talizina, 2017; Rosas, Solovieva, & Quintanar, 2017; Volodarskaya, 2017). García and Tintóreo (2016), Granados and Rodríguez (2011), Nikola and Talizina (2017), Rosas, Solovieva and Quintanar (2017) and Volodarskaya (2017) have implemented teaching methods for formulating the process of problem-solving in basic education. Their proposals include a mathematical content (arithmetic, algebra, or geometry) and the identification of mathematical concepts in different contextual situations. The use of these methods allows us to identify all the students' procedures which lead to a solution.

## The process of solving mathematical problems

According to activity theory as applied to teaching, it is possible to understand and study thinking as an inherited formal function that is used to solve mathematical problems, or the content of a system of intellectual actions that are developed during the solution of mathematical problems, and evolved through a series of stages (Nikola & Talizina, 2017). Nikola y Talizina (2017) believe that general thinking skills can be assimilated in one of two ways: the spontaneous method and the directed one. The spontaneous method consists in applying habits of thought not conceived as specific objects of assimilation; these habits are the means of the action. They do not have a reflective or conscious character; in addition, their acquisition occurs from the assimilation of knowledge and solving specific problems, so the results cannot be generalized. Thus, they are limited in their application.

The directed method requires consideration of the thinking skills involved as objects of assimilation. The process of forming thinking skills is significantly reduced in time because it has a directed and organized nature. It is possible to identify both pathways of assimilation in the forms and methods of teaching mathematics in classrooms involved in basic education (Reséndiz, Block, & Carrillo, 2013; Rosas & Solovieva, 2019; Weiss et al., 2019). Therefore, it is necessary to reflect on our theoretical perspective.

Mathematical problems require the knowledge of applied mathematics itself and involve situations that include a topic expressed in the language of mathematics. Also, it is possible to identify the basic elements of mathematical problems and understand their relationships. Some topics addressed in mathematical problems involve situations that relate to students' everyday experiences; for example, buying and selling. Students can solve problems of this type without understanding the specific mathematical meaning of the concepts of "price, value, quantity, and product."

However, there are other topics that are studied in schools, which are difficult to relate mathematically to everyday experience, as is the case with topics like "movement," "velocity," "volume," and "distances," or theoretical situations that involve the proof and application of theorems, as in the case of geometry (Butkin, 2017). Therefore, it is necessary for the teacher to organize the essential actions and direct the student's attention to them so that they can understand and successfully solve any mathematical problem, regardless of the theme and their daily experience.

According to a psychological analysis of the problem-solving process, the activity of solving mathematical problems has a psychological structure. It is necessary to consider this structure in order to organize the complete orientation and direct the students. The structure goes as follows: 1) an objective, which consists of answering the question posed; 2) understanding the conditions; 3) retention of information; 4) elaboration of a general plan or solution strategy; 5) execution of the plan; and 6) verification of the solution (Luria & Tsvetkova, 1987; Tsvetkova, 1999).

It is also necessary to mention that mathematical problems have various characteristics: 1) they can be simple or complex, depending on the operations that are necessary (direct or intermediate); 2) they can establish known or new mathematical relationships (I have solved a similar problem or it is the first time it is presented to me); 3) they can be problems designed by the teacher, by a classmate, or by oneself; 4) they can be presented in writing, audio-verbally, or dictated; or 5) they can have

a solution or not have a solution. Problems without a solution are those which don't include complete information, have insufficient information provided, include information unrelated to the final question, or do not pose a question at all (Luria & Tsvetkova, 1987; Tsvetkova, 1999).

In summary, the study of problem-solving requires both specific knowledge of mathematics and of the psychological actions involved in this process. Therefore, the objective of our study was to analyze the thinking skills developed by students to solve mathematical problems in a typical primary school in Mexico. A verification method was used to identify the abilities and difficulties of the students through a dynamic evaluation based on the application of activity theory to teaching (Talizina, 2000; 2017; 2019). The results are intended to contribute to reflections on the teaching of mathematics and its objectives.

## Methods

The method used in the study was experimental verification as proposed by Talyzina (2000; 2019). According to Talizina (2000), the experimental method is characterized by: 1) the establishment of an objective; 2) planning the steps of the experiment; 3) carrying out the experiment; 4) analysis of the data obtained by the researchers; and 5) the conclusions that the data allow the researchers to reach.

The verification method aims to characterize the current state of existing phenomena. It also allows the identification of the starting level of knowledge and skills for the assimilation of a concept (Talizina, 2000, 2017; Nikola & Talizina, 2017).

### *Participants*

The selection of the participants was intentional. The private school selected for the study is located in Mexico City. The school uses the programs of the Secretary of Public Education as the main teaching method. This school was also considered because it has only one group of third graders and only 22 students in total. Such a number of pupils facilitates participation in research projects that aim to analyze and improve the process of teaching and learning of mathematics. The main pedagogical approach, used by the Secretary of Public Education in Mexico, is that of competences, which are supposed to be acquired through key learning (SEP, 2017). The third grade of primary school was selected because the Basic Education program establishes that it is in this grade that the four basic mathematical operations must be learned, and problem-solving is proposed for teaching them.

A private school was chosen because it was possible to get an agreement to allow educational research aimed at improving its teaching methods. The school is located in the southern district of Mexico City. The participants were 15 regular students of the third grade of primary school: five boys and ten girls. The students had an average age of 8.5 years. Nine students (five girls and four boys) got high marks in mathematics (a 10 on a scale of 1 to 10). Six students (five girls and one boy) got a mark of 7 (same scale), and the teacher reported them having some difficulties in learning mathematics (solving of mathematical operations, mental calculations, and understanding mathematical problems).

### *Procedure*

The research was organized in the following phases: 1) selection of the participants — the research project was presented to the school director to organize the application dates; 2) design of assessment (protocol and materials) — selection of the tasks which were based on previous formative studies (Rosas, 2013; Rosas, Solovieva & Quintanar, 2019); and 3) individual evaluations.

The evaluation phase was carried out individually in the classroom, with no external distractions. Each evaluation lasted approximately one hour. The evaluator went to the classroom and asked the group teacher for authorization to work with each student. Then, the evaluator asked the student to sit down and welcomed him or her. Subsequently, there was a friendly interaction to find out the student's name and some of his or her interests in mathematics. Also, a general idea of the study was explained to him or her.

The content of the evaluation consisted of reading a problem at least three times to each student, and asking him or her to write down what was needed to solve the problem. Finally, the student had to explain the method for finding the correct answer to each problem and the whole process of solution. If the students had doubts, several kinds of support were provided: verbal (mathematical explanation, explanation of the structure of the problem, repetition of information or reflective questions about the content of the problem); perceptual (concrete drawing of the conditions or elaboration of diagrams); or materialized (use of sticks for arithmetical operations).

### *Instrument of evaluation*

The evaluation was organized based on the works of Nikola & Talyzina (2017), Talyzina (2017), and Tsvetkova (1999). The protocol proposal has been previously published in works by Rosas, Solovieva, and Quintanar (2019). The present publication presents the tasks that correspond to the topic of solving mathematical problems.

The tasks of the protocol consisted of: a) simple problems (may require an operation to be solved) and complex problems (may require more than one operation to be solved); b) problems requiring the four basic mathematical operations (addition, subtraction, multiplication, and division); c) problems featuring thematic situations — processes (distance), buying and selling, distribution, increase and decrease of a measure; d) problems with and without solutions; and e) problems with both quantitative and qualitative questions. According to Talyzina (2017) and Tsvetkova (1999), considering this range of characteristics makes it possible to identify general thinking skills.

The following are the problems we presented to the children.

*Simple problems:*

a) The train has covered the distance of 98 km in 11 hours; how many km does the train travel in one hour? (Division)
b) The library "The little prince" contains 40 books, which are distributed on 5 shelves. If teacher Lupita puts the same number of books on each shelf, how many books are on each shelf? (Division)

c) There were 19 chocolates in the box. The children ate some of the chocolates and 11 were left; how many chocolates did they eat? (Subtraction)
d) For 12 days, 48 km of the road were built; how many cars passed during a day? (no solution).

*Complex problems:*

a) Renata and Daniel went to the market and bought the following items: 2 kilograms of apple, 300 grams of sugar, and 1 kilogram of pasta; how many grams did they buy in total? (conversion of measurements/ addition)
b) Gaby is three times as old as her sister Sofía. If Sofía is 7 years old, how old is Gaby? (multiplication/ more times)
c) In the Children's Museum, the first room has 64 play activities, and the second room has four times less. How many play activities are there in the second room? (division/ less times)
d) Axel and Daniel played three rounds of penalties. If in the first round Axel scored 20 respectively goals and Daniel scored 18 goals, in the second round they scored 35 to 20 and in the third 15 to 50, who won? With how many goals? (qualitative-quantitative question).

## Results

First, the students expressed that their liking for mathematics and the way their teacher teaches it. One student commented that her teacher was nice and that she liked to go to the blackboard to solve problems. Another student mentioned that her teacher explains a problem to her several times when she does not understand it. The children did not show any concern in relation to the difficulties they had during their work with the experimental protocol; they expressed interest in solving the problems in all the proposed tasks. However, they did not ask questions, they did not request support, and they waited to be told what they should do to resolve their difficulties.

The preliminary results were described by the number of problems solved correctly, incompletely, and incorrectly. Subsequently, the types of errors made by the students were described and organized according to the types of problems they had.

In the process of solving the simple problems, all the pupils were able to identify and to solve the mathematical operation of the subtraction problem (decrease) and the division problem (distribution), but they were unable to answer the question posed by the problem. In addition, no student managed to solve the problems of processes (distance), and the one without a solution.

In solving the complex problems, all the pupils had difficulties in identifying the intermediate operations (measurement conversion, less times-division and more times-multiplication). Although the students were able to carry out the intermediate operations with the help of an adult, they proceeded without understanding and never reached the solution.

These general results allowed us to identify the students' specific difficulties during the process of trying to solve the problems. These difficulties were: 1) difficulties in actually answering the question posed, instead of which the students only identi-

fied the mathematical operations needed for a solution; 2) difficulties in understanding the intermediate and non-immediate operations; 3) difficulties in identifying the mathematical operations and the solution of the algorithm; and 4) difficulties in counting.

The results are presented below for each type of the problem, along with a description of the types of errors and the types of help which were provided to the students during the process of solving the problems.

In the simple problems (*Table 1*), in general, the students had difficulties in counting, using and converting the decimal number system, identifying the measuring unit, and completing the answer to the problem. The students were able to solve the problem about the library (division) and the chocolates (subtraction) incompletely. The students counted verbally and with the help of their fingers, although they did not answer the final question the problem posed; they only identified the result of the mathematical operation. In addition, the students made mistakes in the two problems involving data on distance and time processes.

**Table 1**

*Answers to the simple problems*

| Type of problems | Answers | Types of errors | Types of support |
|---|---|---|---|
| A train traveled 98 km in 11 hours; how many km does the train travel in one hour? | a) Impossibility<br>b) 48<br>c) 11 | • Difficulty understanding the relationship between data<br>• Difficulty organizing the data in the algorithm<br>• Difficulty understanding the processes of distance and time | • Mathematical explanation of the data through the schematic drawing<br>• Organization of the data in the algorithm, writing of the decimal numerical system |
| A 48-km road is being built; how many cars pass during a day? | a) None because they were building it<br>b) 12 + 48<br>c) 1<br>d) 4<br>e) 48 | • Difficulty in analyzing and relating the parts of the problem<br>• Difficulty finding other ways to solve | • Explanation and division of the structure of the problem<br>• Reflexive questions towards the structure of the problem |

*Note. Table 1 contains the answers of the pupils to the simple problems.*

In the problem about the train, the students had difficulties imagining the situation of the problem; they focused on the content of the train, on describing what it was like, and expressing their interest in it. For example, some students said they had seen a train but not had the experience of traveling on one. The type of help consisted of reflecting on the situation and understanding its quantitative relationship; that is, the train was not important but what was happening with the train. Once they understood what was happening, they were able to identify by a process of elimination that the strategy needed was division. For example, the students said addition was not useful, because the problem does not ask for a total of something; nor was

subtraction useful. The children used division: it would be 98 divided by 2, and thus they obtained the result of 48 (miscount). Later they commented that the answer was 11 because the data on the hours was included.

The second type of help given to them was a kind of representative perceptual support, based on drawing two points to represent the start and end of the distance covered by the train, and the line to represent the path of the train. The students understood the data that they had to find, but they did not know how to organize the data in the division algorithm; so they were oriented to describing the components of the division and placing the corresponding data. Finally, the students made mistakes in counting. The children solved the multiplication problems verbally, but they had counting errors so they were helped to verify their counting by writing the partial results.

The second common difficulty was the problem which had no solution (the last simple problem). The students did not identify the elements of the problem, but focused only on the numbers. They proposed to answer with addition or with the repetition of the quantitative data of the problem, thinking that the solution was embedded in the problem. The verbal support of an adult presented the structure of the mathematical problem: the description of a situation and the question posed by the problem. With such support, the students were able to understand that each part of the problem consisted of specific information, which must be related to the final question. With the help of reflective questions, students had to understand what situation posed the problem? Who is he talking about? What data is mentioned? How should the solution to the problem be planned? What is the question that must be answered? What do we want to know or find in the problem? Do we have enough information to answer this question?

*Table 2* presents the difficulties the students had while trying to solve the complex problems. They had significant difficulties understanding the mathematical operations required for intermediate actions; for example, those of conversion to the decimal number system, or identifying the operation of division as the reduction of a given measure to a quantity of time. In the problems with the conversion of the weight measurements, the students operated directly with the data. Although when they were asked about the relationship of a kilo to grams, the students could say that a kilo is equal to a thousand grams, in the context of the problem, they could not identify how the corresponding conversions should be performed. So, the first type of support was to write the equivalence; the second support was to identify the measurement in which the data was presented and the corresponding conversion, which was required to answer the question posed by the problem. Subsequently, the data was organized correctly, and intermediate operations were added. Finally, the students answered the problem.

In the problem about Gaby's age, the students had difficulty understanding the relationship between the data. Some students used the addition operation directly, other students responded with multiplication but could not explain why they used multiplication. There were also difficulties in counting and verifying their responses. The type of support that was given to them was a mathematical explanation of multiplication and an analysis of the situation of the problem so that they understood the reason for using the multiplication operation. However, no one answered the problem completely; they only mentioned the result of the multiplication.

**Table 2**

*Answers to complex problems*

| Type of problems | Answers | Types of errors | Types of support |
|---|---|---|---|
| Renata and Daniel went to the market and bought the following: 2 kilos of apple, 300 grams of sugar and 1 kilo of pasta. How many grams did they buy in total? | a) 603<br>b) 6000<br>c) 301<br>d) 303<br>e) 600 | • Difficulties in identifying measurement and conversion<br>• Identify the hierarchical value of the number | • Explanation and writing of the decimal number system<br>• Organization of the data in the algorithm; writing of the decimal numerical system |
| Gaby is three times as old as her sister, Sofía. If Sofía is 7 years old, how old is Gaby? | a) 10<br>b) 4<br>c) 22<br>d) 20 | • Difficulty understanding the relationship between data<br>• Difficulties in identifying the mathematical operation<br>• Counting difficulties | • Reflexive questions towards the information of the problem<br>• Explanation and division of the structure of the problem<br>• Explanation of the multiplication operation |
| In the children's museum, the first room has 64 play activities and in the second there are 4 times less. How many play activities are there in the second room? | 160<br>60<br>200 | • Difficulty in analyzing and relating the parts of the problem<br>• Difficulty finding other ways to solve the problem | • Explanation and division of the structure of the problem<br>• Reflexive questions towards the structure of the problem |
| Axel and Daniel played three rounds of penalties. If in the first round the score was 20 to 18 goals respectively, in the second 35 to 20, and in the third 15 to 50, who won? for how many goals? | a) Daniel for 10 goals<br>b) Daniel because he made 50 more<br>c) Second won, scored 8 more | • Difficulty in organizing the data<br>• Responded impulsively | • Write the data in order<br>• Reflexive questions towards the structure of the problem |

*Note. Table 2 contains the answers of the pupils while trying to solve the complex problems.*

In the problem about the children's museum, a division operation is posed, which is expressed by the term "less times," which does not imply a direct subtraction but the use of division. Some students responded with direct subtraction (64–4 = 60); others tried an operation of multiplication (4 times 40, or 4 times 50). The type of support that was given to them consisted in an analysis of the relationship between the data, along with the explanation that the decrease should not be performed directly but with the help of the given measurement. The students understood the importance of using division. Although they had difficulties solving the problem with the division algorithm, the students were confused about the decimal number system of the result and in the location of the quotient and the remainder.

In the problem about Axel and Daniel, the students had difficulty organizing the information. They combined the quantitative data, so they had to write the data in two columns. They also focused on the final data (50 goals) to answer who was the winner; however, they could not identify the difference between the goals. Therefore, the students had to receive support to identify the information, organize it, and respond through mathematical operations.

Finally, the results obtained in the study showed that the students have developed the following thinking skills: 1) identification of an objective: the mathematical operation; 2) elaboration of the plan: identification of the direct mathematical operations needed (addition, subtraction); 3) execution of the plan: choosing mathematical operations with an estimation strategy, despite difficulties in the conversion of measuring units and in understanding the decimal numerical system, and incomplete solution of algorithms; and 4) verification of the result. (But they only verified the quantitative operations, without actively reflecting on their strategies.

## Discussion

The objective of this research was to analyze the thinking skills developed by a group of primary school students (private school, third grade). Based on the proposed dynamic evaluation, the following characteristics of their thinking skills were identified, which might be described as: 1) the empirical nature of the process of solution; 2) the use of habits and mechanized actions for solving problems; 3) the reproduction of actions with no reflection; and 4) problem solving without some kind of intellectual activity by the pupils. These characteristics of thinking are related to the general social interaction which the students engage in both at school and in their daily activities. According to Davidov (1988) and Talyzina (2017), this shows that the school is not developing the theoretical thinking that mathematics knowledge requires.

The data we obtained allows us to observe that the students acquired their knowledge from the immediate experience of reality, both in class and in their daily lives, and that the operations they used were quantitative; this information coincides with the study carried out by Reséndiz, et al. (2017). For example, one student who helped sell products in his father's establishment, had acquired the habit of recognizing the results of multiplication operations (for example, 7 times 3, 40 times 5). Another student mentioned that her teacher had taught her strategies for solving problems, which consisted of interpreting key words (*i.e.,* total = addition, by = multiplication, and between = division). However, both students had difficulties when carrying out operations which used the formal multiplication and division algorithm. When the algorithms of the four mathematical operations are taught in elementary school, each algorithm has a sequence of operations to achieve a result. In the case of division, it is possible to use the subtraction algorithm or the multiplication algorithm.

According to Salmina (2017), students can solve mathematical operations mechanically or by using memory because they may use some operations that might have been used in their daily lives. At the same time, the same pupils might have symbolic and logical difficulties on problems that require operating according to mathematical concepts and signs. In addition, in the evaluations, the students made mistakes in understanding and handling the decimal number system. The pupils had

difficulties with the use of materialized supports (use of sticks for proper counting) and in the conversion of measuring units. The most effective type of support was the use of drawings to represent the concrete situations, mentioned in the problems.

The second characteristic was the use of habits and mechanized actions without reflection on the logic of the problems during the process of finding the solution. The students could not reflect on their actions; they did not understand what information was relevant and what was irrelevant to the problems. The students only proposed to find the correct mathematical operation and to solve the problem directly, even if they did not understand what the whole problem was about and the quantitative relationships between the data.

In the problem with the train, for example, the students selected the operation of division because they tried to use direct operations of addition, subtraction, and multiplication unsuccessfully. They did not understand the quantitative relationship, which depended on the use of the measurements according to a specific ratio (km/hr). The children were only focused on the object (the train) and the quantities (the numbers mentioned in the problem). Despite provision of perceptual support (drawing a schematic for the problem), the pupils could not identify which part of the drawing represented the distance and which represented the period of time. Also, the students verified their answers with the results of the mathematical operations. For example, they commented that "the result is 8 because 98 divided by 11 is 8," and they did not use decimal numbers or the remainder (the sign) in the operation of division. They never noticed their misunderstanding of the problem and the mistakes related to this misunderstanding.

According to the results, the pupils didn't understand the relationship between physical magnitudes, and even the external help of an adult didn't allow them to arrive at the solution to this problem. The prior understanding of physical concepts, especially that of process and its duration, is necessary for solving math problems in primary school (Obukhova, 1968), but the traditional educational program doesn't include these processes, which is one of the great obstacles to the children understanding the process of problem-solving at school.

In light of the analysis by Cantoral et al. (2005) on the process of problem-solving, it is possible to observe the chilren's predominant use of daily isolated situations instead of generation of mathematical and conceptual thinking. Such daily isolated situations are preferentially used by practically all teachers as a strategy of working with the problems. The teachers in the classroom do not spend time to generate argumentation, create strategies, or provoke self-reflection. This makes it difficult for the student to ask himself: what should I do? How do I think about the problem? Do I have another way to solve it? How do I know that I achieved the right result? What mistakes did I make? How did I correct them? and so on. In addition, Arévalo (2015) mentions that the prevalence of individual work hinders students from being able to ask questions and be able to support themselves for learning.

The third characteristic is the tendency to repeat one's previous actions. The students frequently relied on a strategy of trial and error, which means that they had problems in counting and in understanding the mathematical operations. Their main route was to repeat operations for each problem with no reflection on their use. The pupils knew the steps that must be carried out in the algorithms. With no clear un-

derstanding of the structure of the decimal number system, they made spatial errors (confusion about the location of the digit in the structure of the number, confusion of the minuend and subtrahend, confusion about the conversion of measurements). These errors were corrected when the elements of the structure of number were explained to the students. This structure might be represented as the magnitude, the unit of measurement, and the number of times the measurement was used (Salmina, 2017; Talizina, 2017; Rosas, 2019).

One type of help consisted of writing each number in the decimal system. With this help, the students understood that the operations which they called "borrowing" are conversions of the measuring units. The formation of theoretical mathematical concepts allows the student to understand the various connections and actions between the elements in the structure of number. In this case the concept of number allows the students to understand the mathematical actions and to create their own mathematical problems (Rosas, 2019).

Finally, the pupils' problem-solving did not represent any kind of intellectual activity. Their main objective was to find the mathematical operation and to solve it. Thus, their actions were impulsive, their results were incomplete, and they had difficulty in solving complex problems. According to Luria and Tsvetkova (1987), Nikola and Talyzina (2017), Tsvetkova (1999), and Solovieva (2022), the process of problem-solving aims to answer the question posed. The question will guide the student to select whatever information is relevant to the problem and whatever is not. For example, in the problem with no solution that was used for the evaluation, the students had difficulties understanding that a problem can have no quantitative solution at all. In addition, the pupils carried out several mathematical operations in an effort to solve this problem. If they had attended to the question, then they would have avoided such failed efforts.

This type of error indicates the absence of consistent work with the students to organize their intellectual activity. This absence is common in primary schools and shows the deficiencies in teaching method not only for problem solving, but also for the introduction of mathematical concepts. The relevance of developing thinking skills in primary school is an objective of psychological development that education must achieve; this has been proposed by Vygotsky (1995) and his followers (Davidov, 1988; Galperin, 2009; Talizina, 2017). In addition, in other countries, such as Colombia and Brazil, this line of studies was continued (García & Tintóreo 2016; Granados & Hernandez, 2011; Rosas, 2013; Rosas & Solovieva, 2019).

The authors of this article also consider the students' development of scientific concepts to be a predictor of overall successful learning in basic education. Although the students managed to mechanize some actions, their difficulties showed up in their lack of understanding of situations that are not related to direct perception. In our study the problem that the children had the greatest difficulty understanding was the train route, because the students had seen a train but could not represent the time and the relationship with the distance covered.

In summary, the results of our study allowed us to discover that the students participating in the evaluation showed empirical thinking, produced by habits, practical experience, and the tendency to repeat their previous actions. These results lead us to propose work with mathematical concepts in primary education and the organi-

zation of the process of problem-solving as an intellectual activity. The introduction and gradual development of intellectual activity may have a positive effect on the students' psychological development. Conceptual thinking represents a new qualitative stage in a child's development (Vygotsky, 1993, 1995). In addition, incorporation of various types of external help may encourage the students to access a reflective solution. External help might be presented at different levels of the actions: material, perceptual, and verbal (Solovieva, 2022).

In Mexico, students are evaluated only quantitatively (Arévalo, 2015; Rosas, 2019; Weiss, et al., 2017). It is thought that learning success is related to mental actions and taking less time to reach a solution (quick solutions). The teaching of mathematics is seen as the repetition of operations in an abstract way with no relationship to the situations presented by the problems, which are considered as practical solutions of day-to-day life. In other studies (Rosas, 2013; Rosas & Solovieva, 2019), the lack of a conceptual explanation of mathematical content was observed during the process of teaching in primary schools. The digits were only associated with the counting of concrete objects. For example, the use of one cube assumes the value of 1 unit, while the cubes of another color represent the unit of 10 or 100. When the colors were changed or absent, the pupils became unable to carry out any kind of operation (Rosas & Solovieva, 2019).

According to Talyzina (2017; 2019), traditional teaching calls for the formation of absolute concepts and abstract answers. For example, it is thought that if a student achieves mental calculations in less time, he or she is capable in mathematics. In our study, the insistence of the students on solving the tasks mentally and quickly with no reflection was also observed. According to Talyzina (2017) and Galperin (2009), before the work on mental level, problem solving must be formed on different levels of execution: material, perceptive, and external verbal. Traditional education never used these levels of intellectual actions, so that the pupils may only memorize direct mechanical solutions.

The data from our study shows that another means of teaching and evaluation of learning exists. Dynamic evaluation shows the possibility and necessity of using intellectual actions on different levels, such as level of materialized, perceptive, and verbal actions (Veraksa, et al., 2022). The important aspect of solving a problem is the understanding of the conceptual content of the problem, so that the student may reflectively act with each element of the problem, not in isolation but jointly as a complex intellectual action (Solovieva, et al., 2021; Solovieva, Quintanar, & Sidneva, 2023).

## Conclusion

The first conclusion relates to the use of dynamic evaluation. Dynamic evaluation allows us to provide types of external help by an adult. In addition, the possibility of constant interaction of the teachers with the students tends to increase the students' level of motivation. They become aware of their actions and their mistakes. The various types of external help allow them to understand what they are doing. So, dynamic evaluation impacts cognitive and affective development, in this case, cognitive interest in mathematical knowledge.

The second conclusion concerns the content of the problem-solving process in primary school. In this study, the problem-solving used in primary school can be viewed as a mathematical task, not as an intellectual activity of the pupil. Therefore, the students participating in the study were only able solve problems as a means of practicing mathematical operations, not as a way of developing concepts and applying them in different situations (everyday, theoretical, empirical, etc.)

Lastly, activity theory applied to teaching provides methodological theoretical tools for the study of the learning-teaching process of mathematics. The works of Talyzina (2017; 2019) and Nikola & Talyzina (2017) provide both a conceptual knowledge of mathematics, and of psychological development and pedagogical forms of work in the classroom. The results of our study show the possibility of providing necessary external help not only during the process of solving problems, but also earlier, starting from the formation of the concept of number and the decimal system (Rosas, 2019; Rosas & Solovieva, 2019; Veraksa et al, 2022).

## Limitations

The limitation in this investigation is related to the possibility of generalizing the results from such a small sample. Work with larger populations would allow us to characterize the process of mathematical problem-solving more completely and provide more complex strategies.

## Ethics Statement

The research conducted according to ethical principles at the Universidad Iberoamericana of Puebla, Mexico. The degree committee of the doctoral program in educational research reviewed the ethical guidelines for student participation.

## Informed Consent from the Participants' Legal Guardians (if the participants were minors)

In this research, parents and teachers signed informed consents. The students gave their consent to participating voluntarily.

## Author Contributions

All authors developed the theory and performed the computations, verified the analytical methods, supervised the research findings, discussed the results, and contributed to the final manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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# The Contributions of Nina Fedorovna Talyzina to Research Developed in Brazilian Postgraduate Programs

Luiz Fernando Pereira[a*], Isauro Beltrán Núñez[a], Alison Luan Ferreira da Silva[a], Maria Helena de Andrade[a], Frank Madson Araújo de Melo[a], Marcus Vinicius de Faria Oliveira[b]

[a] *Federal University of Rio Grande do Norte, Natal, Brazil*
[b] *Federal Institute of Education, Science and Technology of Rio Grande do Norte, Natal, Brazil*

[*] Corresponding author. E-mail: luizfernandoifrn@gmail.com

**Background.** Nina Fedorovna Talyzina was a Russian psychologist, whose theories have been applied in educational research in many countries around the world, including Brazil. Her name is mainly connected to the Activity Theory of Learning (ATL), which has been dubbed the Galperin-Talyzina system of developmental didactics.

**Objective**. Investigate how N.F. Talyzina's ideas are applied in dissertations and theses developed in postgraduate programs in Brazil.

**Design.** Our research was a bibliographic review which used the state of the question method to examine how Talyzina's ideas are applied in Brazilian academic publications. Data were gathered from three responsible databases – the Brazilian Digital Library, the CAPES Catalogue, and the Institutional Repositories (1987–2022). The method of content analysis was used for data analysis, according to pre-determined categories.

**Results.** We found a prevalence of research based on the methodology of formative experiments carried out at different educational levels. Skills, scientific concept- formation, and problem-solving were the objects of investigation in most of the studies. The ideas proposed by L.S. Vygotsky, A.N. Leontiev, P.Ya. Galperin, and V.V. Davidov were expressed through references to Talyzina's work as the theoretical basis of many studies, thus evidencing a crucial dialogue with the Cultural-Historical School (CHS).

**Conclusion.** Our study points out the growing interest in Talyzina's ideas, specifically her Activity Theory of Learning, which can be attributed to comprehensive dialogues with the ideas of L.S. Vygotsky and A.N. Leontiev which predominate in Brazilian research.

***Keywords:***
activity theory of learning (ATL), Brazilian research, bibliographic review, cultural-historical school (CHS), developmental didactics

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## Introduction

Nina Fedorovna Talyzina (1923–2018) was a researcher and professor at the Department of Educational and Pedagogical Psychology at the Faculty of Psychology at M. Lomonosov Moscow State University. She has been recognized as one of the most noted Soviet/Russian psychologists, especially in the area of educational psychology. She studied learning processes and critically analyzed both behaviorist and cognitive approaches, concluding that both imposed limitations on students' psychological development (Talyzina, 2023a). Her work is known in Brazil as the Activity Theory of Learning (ATL), and aims to understand the nature and process of assimilation, and creative appropriation of subjects in the school context (Núñez, Fariñas & Ramalho, 2020). However, as Solovieva & Quintanar (2015) state, her scientific ideas are more extensive since they cover a significant diversity of topics that were part of her scientific career at the aforementioned world-renowned university.

The ATL (Talyzina, 2023a) has been widely used to support research in education and the teaching-learning processes in the school context in several countries. In the opinion of Semenov (2014a), it is the methodological basis for psychological and pedagogical research, as well as for practical pedagogy. It is a theory with a solid psychopedagogical component, supported by a significant volume of research results in classroom contexts, and has become a reference for studying teaching and learning processes (Solovieva & Quintanar, 2020). The importance of this theory is also emphasized by authors such as Gabay (2014), and Semenov (2014a). In the opinion of Zhdan (2013), the ATL is possibly the richest of all modern psychological theories, as it is a fundamental theory of human activity as an explanatory principle.

According to N.F. Talyzina, the foundations of the ATL were laid in the theoretical system of P.Ya. Galperin (Talyzina, 2002). It is true that her theory is not a specific application or extension of Galperin's ideas (which comprised a more general psychology), but rather a new theory with its own identity, although it strongly shares Galperin's theoretical and methodological assumptions, as Gabay explained (2012). The ATL also has its foundations in A.N. Leontiev's Activity Theory, as N.F. Talyzina herself recognized. In developing her theory, she demonstrated the possibility of connecting the contributions of P.Ya. Galperin and A.N. Leontiev in order to understand teaching processes (Talyzina, 2002), and highlighted their contributions to improving psychodiagnosis (Talyzina & Karpov, 1987; Talyzina, 2020), psychological mechanisms of generalization (Talyzina, 2001), motivation (Talyzina, 2017), qualitative parameters of the orienting base of action (Talyzina, 2002), and the question of the psyche as an activity (Talyzina, 2023a). Her theory also brought important contributions to the activity approach in Psychology (Talyzina, 1984).

N.F. Talyzina had (and still has) an important influence on the training of researchers in several countries in Europe, Asia, Africa, and Latin America. These include countries such as Spain, Finland, Japan, Germany, Mexico, and Cuba, where she developed in-person activities for several years. In these and other countries, many of her works have been translated and published. In the case of Brazil, her influence on educational research began in the 2000s (Núñez et al, 2020).

The appearance of N.F. Talyzina's research in postgraduate programs in Brazil, according to Puentes & Longarezi (2020) and Longarezi (2020), was associated with the growth of studies based on Activity Theory. These studies can be understood from

the perspectives of two major research groups: a) the Cultural-Historical Activity Theory (CHAT) perspective based on the works of L.S. Vygotsky, A.N. Leontiev, J.V. Wertsch, and Y. Engeström; and b) the perspective of the Activity Approach based on the works of L.S. Vygotsky, A.N. Leontiev, P.Ya. Galperin, V.V. Davidov, N.F. Talyzina, L.V. Zankov, V.V. Repkin, and D.B. Elkonin on the paradigm of developmental teaching. This second perspective is held by a significant group of researchers in Brazil, a country in which the Galperin-Talyzina framework is recognized as a system within the Cultural-Historical School (CHS) (Puentes & Longarezi, 2020).

Several theoretical studies and research reports based on the contributions of N.F. Talyzina have been published in Brazil (Feitosa, Mendoza & Delgado, 2022; Farias & Rego, 2020; Marco, Cecho & Lopes, 2021; Moraes & Borges, 2021). It is important to highlight the point of view of the researchers who integrate the ideas of N.F. Talyzina, P.Ya. Galperin, and especially those of L.S. Vygotsky and A.N. Leontiev. In this sense, we also emphasize the publication of the book *Developmental Teaching: The Galperin-Talyzina Theoretical System,* published by Editora Científica Digital in the year 2021, which consists of 10 chapters written by authors from various countries, such as Brazil, Mexico, Cuba, and Russia. Also noteworthy is the scientific journal *Obutchénie*, which is published by the Federal University of Uberlândia (UFU); this journal, founded in 2017, appears quarterly and has frequently published papers linked to N.F. Talyzina's ideas.

The increasing interest in Talyzina's ideas constitutes the main justification for conducting this study of the state of the question involving academic publications. As Ortiz Torres (2018) argues, this type of study is important whenever research on an issue is growing and the volume of information is increasing. Thus investigations may have reached the density where systematization of what has been produced is needed, as well as the identification of emerging aspects necessary for continuing its growth and developing new productive lines of research.

## Methods

This study consisted of an investigation of the state of question type (Ferreira, 2002; Nóbrega-Therrien & Therrien, 2004), considered from the perspective of a bibliographic review, to analyze the inclusion of Talyzina's ideas in dissertations and theses produced in postgraduate programs in Brazil.

Romanowski & Ens (2006) and Ortiz Torres (2018) have highlighted regular procedures for bibliographic research through applying the method of the state of the question. The method includes: 1) choice of descriptors; 2) definition of databases to be consulted; 3) definition of criteria for data selection; 4) collection of data to constitute a corpus; 5) analysis of content; and 6) data organization and analysis by categories.

### 1. *Choice of descriptors*

We adopted the following expressions as descriptors or keywords: Talyzina; Activity Theory; Activity Theory of Learning; Theory of Approximation of Activity; and Talyzina's Theory of Teaching Direction. These expressions seemed representative of those needed to find academic publications related to the research objective.

**2.** ***Definition of the databases***

We used three databases for the search, as described below:

a) the Brazilian Digital Library of Theses and Dissertations (BDTD). This database has been constituted and maintained by a large collaborative effort involving 127 Brazilian research institutions, which freely publicize thousands of dissertations and theses, allowing wide dissemination of research produced in Brazil. The BDTD has received its data from postgraduate programs since 1987. (Link: https://bdtd.ibict.br/vufind/)

b) the Thesis and Dissertations Catalogue of The Coordination of Improvement of Higher Education Personnel (CAPES). CAPES is a governmental agency for regulating, funding, and evaluating all postgraduate programs in Brazil. It was launched in 2002 and brings together all the dissertations and theses defended in Brazil or by Brazilians abroad. Link: http://catalogodeteses.capes.gov.br/catalogo-teses/#!/

c) Repositories of Higher Education Institutions. Many dissertations and theses produced in new research institutions that are not yet part of the BDTD or CAPES Catalogue are stored in their institutional databases. For data collection, there are unlisted Higher Education Institutions because their institutional repositories were not found or not available in the period of investigation.

In this work, we intended to use the BDTD and CAPES databases in a complementary way, supplemented by data found in some institutional repositories, which allow us to obtain a complete sampling of the Brazilian academic publications (dissertations and theses).

**3.** ***Definition of the criteria for data selection***

Initially, we selected from the dissertations and theses available in the databases — including the first and most recent studies developed in Brazil (2003 to 2022) — those using Talyzina's theory as a foundation in their theoretical matrix, as well as those in which this theory was used in a complementary way.

***4. Collection of data to constitute the corpus***

Using the presented descriptors and criteria (items 1 and 3), we found a total of 61 dissertations (master's level) and 33 Ph.D. theses, totaling 94 academic publications using Talyzina's ideas at the graduate level. This overview reveals a part of what has been produced in Brazilian research on this author's ideas.

***5. Analysis of content***

Data analysis was performed using the content analysis method (Bardin, 2016; Franco, 2018; Amado, 2000). According to Bardin (2016), content analysis comprises two basic procedures:

a) *Exploration of the material.* Procedures were carried out by reading titles and abstracts of the 94 literary productions to get an overview of their general characteristics.

b) *Data processing and interpretation.* This refers to generating inferences on the corpus, getting results that allow us to identify the objectives of the investigation. The following categories for interpretation of the data were constituted in light of the responses for such characteristics: 1) exhaustive, which means that all elements of the replies can be included in them; 2) mutually exclusive, which means that each element can only be part of a single category; 3) objective, meaning that they must be defined in a precise manner that avoids ambiguity; and 4) relevant, meaning that they must be appropriate to the research objectives (Ortiz Torres, 2018).

For the analysis, the data were grouped and processed in three steps:

*Step 1.* Initially, the dissertations and theses were categorized into two groups depending on whether Talyzina's ideas were applied as the main or supplementary reference of the theoretical matrix. Subsequently, the academic publications were divided into those in which Talyzina was the main author cited (06) and those in which Talyzina was a supplementary author discussed (88).

*Step 2.* All 94 productions were sorted according to the following categories: 1) type of academic production (master's or Ph.D.); 2) year of production; 3) educational level of the participants (Primary, Elementary, Middle or High School, Higher Education); 4) subjects related to the study; 5) type of study; and 6) study object and references from authors related to the CHS.

*Step 3.* A characterization of the specific references that supported the academic publications: Talyzina's works used in the study (book and/or paper) and references from other authors who are part of the CHS.

### 6. *Data organization and analysis by categories*

The Microsoft Excel software was used to organize the information from each academic publication. The data set was analyzed by the research authors who elaborated the tables which made it possible to perform quantitative and qualitative analyses based on descriptive statistics; *i.e.,* the distribution of frequencies or percentages from data presented in tables, according to the research objective (Hair et al., 2014). Analyses were individually performed by different researchers, who shared and discussed their results to reach a consensus at the conclusion of the research, which increased the reliability of the findings (Flick, 2020).

## Results

The results were presented in relation to the study questions formulated from the general objective, with the purpose of showing the relevant aspects of the data.

### *The academic production of studies based on N.F. Talyzina's theoretical ideas*

The search for academic publications (master's and Ph.D. levels) linked to the theoretical ideas of N.F. Talyzina in the consulted databases, allowed us to identify a total of 94 academic papers, 61 of which were at the master's level and 33 at the Ph.D.

level. For a better understanding of the place of N.F. Talyzina's ideas in the theoretical references that support the studies, the publications were classified into two groups: a) those in which the author's ideas formed the core of the theoretical matrix; and b) those in which the ideas were constituents of the references, without representing the core. The results of this classification are shown in *Table 1*.

**Table 1**

*Academic publications per postgraduate level*

| Publication | Talyzina's ideas used in the central core of the theoretical matrix | Talyzina's ideas related to the core of the theoretical matrix | Total |
|---|---|---|---|
| **master's level** | 4 | 57 | 61 |
| **Ph.D. level** | 2 | 31 | 33 |
| **Total** | 6 | 88 | 94 |

According to *Table 1*, the highest percentage corresponded to master's dissertations (64.9%) compared to Ph.D theses (35.1%). In turn, the number of academic publications centered on the ideas of N.F. Talyzina's ATL was still smaller; that is, there was a small number of publications in which this theory was the central subject of the research. Consequently, the highest percentage (93.6%) were publications in which N.F. Talyzina's ideas, although not constituting the core, were relevant in the construction of the theoretical matrices.

### *The academic publications linked to N.F. Talyzina in Brazil year by year*

In *Figure 1*, we can observe a growth trend in academic publications based on N.F. Talyzina's ideas in Brazil over the period 2003–2019.

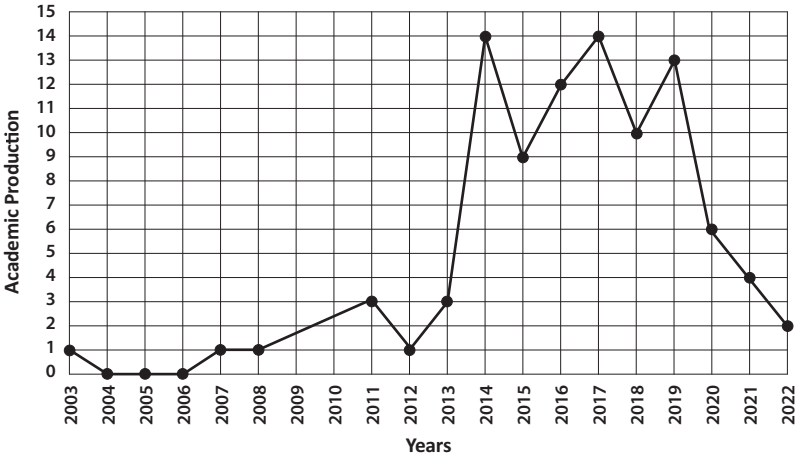


*Figure 1.* The academic publications (master's and Ph.D. levels) produced per year

The decrease from 2019 may be linked to the non-inclusion of new academic publications in the databases consulted for that period.

### *The Activity Theory of Learning in the Theoretical Foundations of Academic Publications*

The study also made it possible to identify the presence of the ATL and its relationship with other theories of the CHS in academic publications. *Table 2* shows the results of this identification, linking the theories cited to their main authors.

**Table 2**

*Main authors of academic publications*

| Author | Ph.D. level | Master's level | Total |
|---|---|---|---|
| Galperin-Talyzina | 11 | 48 | 59 |
| Vygotsky-Talyzina | 17 | 9 | 26 |
| Talyzina | 2 | 4 | 6 |
| Leontiev-Talyzina | 3 | | 3 |
| **Total** | 33 | 61 | 94 |

We can observe in *Table 2* that of the six academic publications focused on N.F. Talyzina's ATL, the greater quantity (83.3%) appear to be associated with P. Ya. Galperin's Theory. In turn, considering the total publications, the number of dissertations and theses (62.7%) that focused on P.Ya. Galperin's theory and elaborated it with N.F. Talyzina's Theory was significant; that is, there was a predominance of what has been identified in Brazil as the Galperin-Talyzina system. In other academic publications, N.F. Talyzina's Theory appeared as a complement to the theoretical configurations associated with Vygotsky's Cultural-Historical Theory and A.N. Leontiev's Activity Theory.

### *Educational levels and subjects addressed in academic publications*

The educational levels and disciplines in which research for academic publications were carried out reveal certain foci of attention in postgraduate studies that are based on the ATL of N.F. Talyzina.

As can be seen in *Table 3*, studies were carried out at all levels of education, with the main emphasis on higher education (34.0%) and high school (26.5%), and a lesser emphasis on middle (16.0%) and elementary school (13.8%). In the case of higher education, the research focused on teacher training. Regarding the subjects of the school curriculum, the area of mathematics education (35.1%) was the most popular, followed by the teaching of physics (13.8%), chemistry (12.8%), science in elementary education (9.6%), and biology (4.2%). The other areas of the school curriculum comprised 20.2% of the publications, and were distributed in small proportions among disciplines such as history, physical education, and others.

**Table 3**

*Academic publications involving different subjects and educational levels*

| Subject | PE | ES | MS | HS | HE | NA | Total |
|---|---|---|---|---|---|---|---|
| Mathematics | | 6 | 10 | 5 | 10 | 2 | 33 |
| Physics | | | | 10 | 3 | | 13 |
| Chemistry | | | | 3 | 7 | 2 | 12 |
| Sciences | 1 | 3 | 3 | 1 | 1 | | 9 |
| Portuguese | | 3 | 1 | 1 | | | 5 |
| Biology | | | | 2 | 2 | | 4 |
| Multidisciplinary | | | | | 3 | 1 | 4 |
| Not applicable | 1 | 1 | | | 2 | | 4 |
| History | | | 1 | 1 | | 1 | 3 |
| Physical Education | | | | | 1 | 1 | 2 |
| Computing | | | | 1 | | | 1 |
| English | | | | | 1 | | 1 |
| Marketing | | | | | 1 | | 1 |
| Pedagogy | | | | 1 | | | 1 |
| Educational Psychology | | | | | 1 | | 1 |
| **Total** | 2 | 13 | 15 | 25 | 32 | 7 | 94 |

*Note. PE: Primary Education; ES: Elementary School; MS: Middle School; HS: High School; HE: Higher Education; NA: Not Applicable.*

## The objects of study of the academic publications

The objects of study addressed in the academic research are presented in *Table 4*.

**Table 4**

*Objects of study addressed in the academic publications*

| Objects of study | Frequency |
|---|---|
| Skills Formation | 52 |
| Formation of Concepts | 36 |
| Problem-Solving | 27 |
| Special Education (Deaf, Hearing Impairment, Down's Syndrome, Deaf-blind, Hearing-visual Impairment, Blindness, Visual Impairment) | 7 |
| Reading and Writing | 5 |
| New ICT / Virtual Environments for Education | 4 |
| Experimental Activity | 4 |
| Creativity | 3 |
| State of Art | 2 |
| Assessment | 1 |
| Planning | 1 |
| **Total** | **142** |

There was a clear preference for three objects of study: a) skills formation (36.6%); b) formation of concepts (25.3%); and c) problem-solving (19.0%). It is important to highlight that, although they occur in a smaller proportion, other very important topics for education appear, such as: special education (4.9%), difficulties in reading and writing (3.5%), and the use of new technologies (2.8%). Finally, creativity is an object that, despite its importance, is rarely addressed in these studies.

### *Types of references cited in academic publications*

Identifying and characterizing the most frequent references in the analyzed academic publications can provide important information about which of N.F. Talyzina's ideas predominate as the basis for dissertations and dealing with the ATL. In turn, they can highlight the absence of some ideas which are important for understanding N.F. Talyzina's thought. *Table 5* shows the references to N.F. Talyzina in the publications consulted by the authors (classified into books, book chapters, and papers).

**Table 5**

*Type of references to N.F. Talyzina cited in the analyzed publications*

| Type of Reference | Citation Frequency | % |
|---|---|---|
| Book | 226 | 91.5 |
| Paper | 16 | 6.5 |
| Book Chapter | 05 | 2.0 |
| **Total** | **247** | **100** |

As the table shows, the highest frequency of references was to Talyzina's books (91.5%). In comparison, the author's papers and book chapters were rarely cited.

*Table 6* shows the most cited books and the frequencies with which they were referenced in theoretical and methodological discussions and in discussions of the results of the ATL.

**Table 6**

*The books written by N.F. Talyzina most consulted in the academic publications*

| Books | Frequency | Language |
|---|---|---|
| Psychology of learning | 70 | Spanish |
| Pedagogical psychology | 45 | Spanish |
| Activity theory applied to teaching | 31 | Spanish |
| The formation of mathematical thinking skills | 25 | Spanish |
| Lectures on the fundamentals of teaching in higher education | 24 | Spanish |
| Formation of students' cognitive activity | 13 | Spanish |

The books most used as references were: *Psychology of Learning* by Editorial Progreso, published in 1988, with a frequency of 33.6%, and *Pedagogical Psychology*, published in 2000, in Mexico, with a frequency of 21.6%, both in the Spanish language.

Although they have a low percentage of consultations, in *Table 7* we identify the main papers of Talyzina that circulate in postgraduate programs in education in Brazil.

**Table 7**

*The most consulted papers written by N.F. Talyzina in the academic publications*

| Paper | Frequency | Language |
|---|---|---|
| Talyzina, N.F., Solovieva, Y., & Quintanar, L. (2010). The approximation of the activity in psychology and its relationship with the cultural-historical approach of L.S. Vygotsky. *Revista Novedades Educativas,* 230, 4–8. | 06 | Spanish |
| Talyzina, N.F. (2008). Psychological mechanisms of generalization. *Acta Neurolology*, 24(2), 76–88. | 04 | Spanish |
| Talyzina, N.F. (1968). Analysis of Galperin's theory. *Revista Psicologia e Educación*, 5(10), 33–41. | 02 | Spanish |

These are articles that complement the theoretical discussions presented in her books, which, in a way, explain the aspects being researched, such as the question of generalization and its psychological mechanism and foundations based on the contributions of the ideas of A.N. Leontiev and P.Ya. Galperin. The only book chapter written by N.F. Talyzina cited in the analyzed academic publications was: "The principles of Soviet psychology and problems of psychodiagnostics of cognitive activity."

Núñez et al. (2020) consider it necessary to understand the ATL of N.F. Talyzina in the context of the contributions of relevant authors of the CHS. In *Table 8* these authors are presented in this aspect, differentiating between their use in the theoretical matrix, and in the subsidiary analyzes and discussions of the research results.

**Table 8**

*References to authors related to the CHS in the academic publications*

| Author | Used only in the configuration of the theoretical matrix | Used in the theoretical matrix and in the discussion of results | Total |
|---|---|---|---|
| P. Ya. Galperin | 47 | 38 | 85 |
| L. S. Vygotsky | 48 | 29 | 77 |
| A. N. Leontiev | 58 | 10 | 68 |
| V. V. Davidov | 35 | 04 | 39 |
| M. I. Majmutov | 20 | 9 | 29 |

According to *Table 8*, in general, the references to P.Ya. Galperin's theory are the most frequent (28.5%), followed by references to L.S. Vygotsky's Cultural-Historical Theory (25.9%) and A.N. Leontiev's Activity Theory (22.8%). The Theory of Developmental Teaching by V.V. Davidov (13.1%) and Problem Teaching by M.I. Majmutov (9.7%) appear in smaller proportions.

### *Types of studies based on the Activity Theory of Learning*

Another aspect analyzed in the state of the question method concerns what types of study were conducted which included Talyzina's theory in the research configuration. They are shown in *Table 9*.

**Table 9**

*Types of study in academic publications*

| Theoretical system | Empirical Study | Formative Experiment | Other | Total |
|---|---|---|---|---|
| Galperin-Talyzina | 20 | 38 | 1 | 59 |
| Talyzina | 1 | 5 | 0 | 6 |
| **Total** | 21 | 43 | 1 | 65 |

*Table 9* presents the results of the types of research related to the Galperin-Talyzina and Talyzina theories. As can be seen, there is a predominance of formative experiments (according to the authors of the academic publications) in relation to other types of empirical studies.

## Discussion

The general objective of this study was to identify and characterize the influence of N.F. Talyzina's ideas and, in particular, her ATL (Talyzina, 2023a) in academic productions at the master's and Ph.D. levels in postgraduate education in Brazil. Its importance is due to the relevance of that theory to discussions of the activity approach in Psychology, as noted by Gabay (2014), Núñez et al (2020), Semenov (2014b), and Solovieva & Quintanar (2015).

As was previously observed, from the year 2006 onwards, there was a growth in academic publications in the area of education related to the ATL. This escalated in the period from 2012 to 2019, showing an interest in the theory as it has shown its potential for shaping education that contributes to the intellectual development of students in the school context. We link the decrease observed in the period from 2019 to 2022, as explained in an article by Núñez, Pereira, Amaral, Silva and Barros (2023), to the effects of the COVID-19 pandemic, which brought about the extension of the deadline for the completion of research in postgraduate programs in Brazil.

The total number of academic publications (94), when classified into those in which Talyzina's theory was the structural foundation of the research (6), and those in which the theory was associated secondarily with other theories of the CHS (88),

can lead us to state that the number of publications of the first type in Brazilian postgraduate studies is still small. Nevertheless, the existence of theoretical configurations in research that are associated with and in dialogue with this framework (one that expands the understanding of the teaching and learning processes along the lines of the CHS) is positive, since, as Zhdan (2018) states, it is a theory with a positive potential for the practice of education.

Our results showed that N.F. Talyzina's ATL, as a reference in academic publications, appeared primarily in association with other theories, such as the P.Ya. Galperin's Theory of the Planned Formation of the Mental Actions and the Concepts, and A.N. Leontiev's Activity Theory. The ideas of N.F. Talyzina appeared in Brazil as a result of the growth of interest in authors from the CHS, in particular, L.S. Vygotsky and A.N. Leontiev, according to Longarezi (2020). In turn, there is a certain understanding of dialectical relationships in Brazil, in terms of contributions to looking at the ATL within certain didactic systems such as the Galperin-Talyzina system. The status of a didactic system which articulates the ideas of P.Ya. Galperin and N.F. Talyzina, is conceptually linked to what Davidov (1997) defines as a "pedagogical system" or "scientific-practical pedagogical." This didactic system is discussed in Brazil as the Developmental Didactic System (Núñez et al, 2020).

Our research shows that the ATL was directed at all levels of Brazilian education, with an emphasis on high school and higher education. We identified the most prioritized disciplines as mathematics and the area of the natural sciences. Although the ATL references consulted in the research were mainly oriented to teaching children, the fact that the studies addressed the learning process of adolescents and adults reveals the breadth of the theory developed by Talyzina herself and her collaborators (Talyzina, 2023b). In a way, it reinforces a research trend in the area of mathematics, where N.F. Talyzina's studies originated, as well as the development expressed in several publications. Prioritizing the area of natural sciences is linked, in a way, to the areas of research in postgraduate programs in which the academic publications were produced, which, in general, are in the areas of mathematics and science teaching.

A variety of objects of study was approached in the academic publications, especially the formation of skills and theoretical concepts and problem-solving applied to the teaching-learning process, preferably of mathematics and natural sciences. This scenario is similarly related to the experiences and training of professors who lead research groups in postgraduate programs with the largest amounts of scientific output.

The formation of concepts and skills, in addition to problem-solving, are relevant topics in N.F. Talyzina's research. When considering learning as a special type of activity in the school context, knowledge is not separated from the action through which it is acquired and applied. As Talyzina (2023a) understood, action is the psychological mechanism for forming concepts.

It is important to point out that the objects of study related to special education are less frequently presented as an area of application of the theory: for example, research with students with Downs syndrome, and visual or hearing impairment. The ATL in Brazil, together with the contributions of L.S. Vygotsky, A.N. Leontiev, and recently P.Ya. Galperin, has opened up new possibilities for debates on special

education, which has been historically guided by so-called constructivist references (Núñez et al., 2023).

Among the references to N.F. Talyzina which we consulted and used as theoretical foundations, we found six books to be among the most cited; they are translations into Spanish of classic texts by Talyzina, which express the essential aspects of organizing the teaching process under the ATL. Papers consulted in academic publications appeared in smaller numbers compared to books. Two of them discuss key issues of the ATL in relation to its theoretical foundations and relationship with the ideas of A.N. Leontiev and P.Ya. Galperin. Nevertheless, the limited number of publications by N.F. Talyzina in Brazil is evident. Translations into Spanish prevail, with the absence of Portuguese, which may influence the limited references to the ATL.

As we have shown, N.F. Talyzina's bibliographical references were associated with those of other authors from the CHS. Among these authors, P.Ya. Galperin stands out, with a frequency of 85 times. In second place appears L.S. Vygotsky, who was referenced 77 times. References to A.N. Leontiev appeared 68 times. The works of V.V. Davidov and M.I. Majmutov appeared to a lesser extent. It is essential to highlight that problem-solving, according to Talyzina (2023a), is an important way to develop students' motivation. Therefore, the publications based on the ATL proceed from this assumption in the organization of the teaching activity.

The works of L.S. Vygotsky have significantly influenced the training of researchers in the area of education, which may explain the number of times they were consulted. The next most influential is A.N. Leontiev (Leontiev, 2010). These connections between the mentioned theorists are necessary. In this direction, Solovieva & Quintanar (2021) emphasize that knowing Talyzina's contributions to Psychology requires studying and learning the ideas of L.S. Vygotsky and A.N. Leontiev (we add those of P.Ya. Galperin) without which Talyzina's texts would not be clear.

Finally, we presented important issues revealed in the analysis of the academic publications that based themselves on Talyzina's theory.

An important amount of research has been based on experimental studies, mostly of the formative experiment type, on the Galperin-Talyzina system. In these studies, a focus on the management of learning processes according to the stages of Galperin's Theory has been observed, without taking into account, in general, the qualitative parameters of the actions. Formative strategies articulate the learner's external and internal actions, in terms of subject's orientation, or orienting base. However, task systems oriented to the formation of mental actions are not created, in terms of the dimensions of orientation that support the execution and regulation of processes. The use of orienting bases, in general, of a particular type, was identified, which leads to some mistakes in the materialization of the orientation, essential in the processes of formation of mental actions. This situation shows that the studies are not considering P.Ya. Galperin's theory as a system of psychological conditions that can guarantee the study of the formation of mental actions and concepts (Galperin, 2023), as elaborated by N.F. Talyzina's ATL, as a reference for organizing and developing formative experiments.

In general, the following aspects were found, which revealed the contributions of N.F. Talyzina through the Galperin-Talyzina System to Brazilian postgraduate studies:

1. The types of student orientation towards action proposed by Talyzina are being used (Talyzina, 2023a); Talyzina expanded the ideas of orientation as the main function of the human psyche in Galperin's Theory, by showing the possibilities of not just three types, as Galperin believed, but of eight, which resulted in an understanding of student orientation in the Zone of Proximal Development (Ilyasov, 2014). In the Brazilian works, it is not possible to identify which type of orienting base was used, according to the criteria established by N.F. Talyzina and P.Ya. Galperin. There is an intention to use orientation with students in relation to the execution and regulation of the processes of forming concepts, mental actions, and specifically problem solving.
2. The discussion of motivation for learning, based on external and internal motivations, their dynamics, and how they influence the process (Talyzina, 2017, 2023b);
3. Learning control processes (Talyzina, 2019), although the qualitative parameters of actions, and in the broadest sense, the management of teaching processes, are not explored.
4. The academic publications do not reflect other contributions by Talyzina, among them the mechanisms of generalization of activity (Talyzina, 2008). Although Talyzina's theory is considered part of the Galperin-Talyzina Developmental Didactic System (Núñez et al, 2023), research has not been able to establish explicit relationships between teaching and students' psychological development under the influence of formative experiences.
5. No studies were found on structuring curriculum proposals in professional training or basic education according to Talyzina's ideas.

N.F. Talyzina criticized the curricula for training higher-level specialists for their one-sidedness, and developed new principles for training professionals with a broad profile. These studies can be interpreted in light of modern attempts to develop curricula based on general competencies of professional activity. In this sense, N.F. Talyzina's contributions in the area of university education were diverse and relevant (Núñez, Fariñas & Ramalho, 2020).

## Conclusions

The research that took N.F. Talyzina's ATL as a reference, in a way, showed that researchers are seeking to adapt and expand the ideas of L.S. Vygotsky, A.N. Leontiev, and P.Ya. Galperin in different contexts in Brazil. In these studies, the application of an important principle of N.F. Talyzina's ideas is verified: the inseparable union between knowledge and action.

The results of the study showed that the ideas of N.F. Talyzina provide a foundation for dealing with problems in organizing the management of educational processes, modeling, and the formation of various types of activities, including the development of teaching objectives, organization of learning activities, development

of concepts and skills, processes of control and regulation of learning by students, among others.

Talyzina's theory of learning is strongly related to P.Ya. Galperin's theoretical ideas, which in Brazil are considered the Galperin-Talyzina System. These studies are carried out at all levels of education, with emphasis on high school and higher education, focusing on the areas of science and mathematics teaching.

In general, academic studies in Brazil, although still specific, corroborate the advantages of the ATL in educational processes in the school context, showing its compatibility with the demands of education for all in the 21st century.

To carry out future studies, we suggest a more qualitative characterization of the research results mentioned in this paper, based on a meta-analysis, to better understand the contributions of academic publications in postgraduate studies in Brazil, in particular the singularities of the application of the Activity Theory of Learning in the context of education.

## Limitations

The categories of analysis reflect a certain subjectivity contributed by the participation of several researchers in this process. This limitation was partly reduced by training these researchers to discuss the meanings they attributed to the data, which contributed to a greater reliability of the analysis.

## Authors Contributions

The conceptualization and methodology, data curation, and analysis were done by all authors. All authors have read and agreed to the published version of the manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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DEVELOPMENTAL PSYCHOLOGY

# Voluntary Control of Cognitive Activity in Preschool Children: Age-dependent Changes from Ages 3–4 to 4–5

Marina N. Zakharova[a, b*], Regina I. Machinskaya[a]

[a] *Institute of Developmental Physiology, Moscow, Russia*
[b] *Multidiscipline Psychological Center "Territoriya Schast'ya", Moscow, Russia*

*Corresponding author. E-mail: zmn@idnps.ru

**Background.** Voluntary control of goal-directed behavior and mental activity in preschool children plays a key role in knowledge acquisition and future academic achievement. Studies of voluntary control have mainly concerned 6–8-year old children; much less is known about the ability to exercise voluntary control at early ages. Due to the high prognostic value of the level of development of voluntary control and heterogeneous development of their individual components, it seems actually useful to study age-related changes of these components in children from 3-4 to 4-5 years old.

**Objective.** To compare age-related changes in executive functions (EF) in children age 3-4 years (mean age: 3.5±0.2 yrs; n = 49; 31 boys) and 4-5 years (mean age: 4.5±0.3 yrs; n = 70; 35 boys).

**Design.** To assess the different components of EF we used: 1) a qualitative group and individual testing procedure based on the principles of Luria's theory of the dynamic localization and organization of higher mental functions; and 2) a computerized testing procedure which included the Bourdon-Wiersma cancellation test, the "Hearts and Flowers" conflict test (the Dots task), and the Corsi block-tapping test.

**Results.** The results showed that different components of voluntary control developed at different rates (heterochronically): there were significant progressive changes from 3-4 to 4-5 years for working memory, assimilation of instructions, switching between separate actions, selective concentration on a target or task, and the distribution of attention. Some other components of EF did not show significant positive dynamics during this period.

**Conclusion.** The results indicate the importance of applying the activity theory approach to the development of cognitive processes in preschool age.

***Keywords:*** executive functions (EF), working memory, voluntary control, cognitive flexibility, preschool age, neuropsychology, activity theory

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## Introduction

According to the ideas about the active nature of knowledge acquisition developed by N.F. Talyzina, the formation of concepts is a goal-directed activity, which includes the stages of orientation, execution, control, and correction. This means that not only are specific cognitive abilities (those formed on the basis of a certain subject material) important for learning, but "general activity skills" as well (Talyzina, 1988, p. 40). General activity skills include the ability to plan one's activities, "meaningful" (voluntary) memorization, and attention. However, voluntary attention isn't only responsible for developing the capacity to focus; it also enables control.

In neuropsychology and cognitive psychology, different aspects of voluntary control are combined under the umbrella term "executive functions" (EF) (Miyake et al., 2000; Diamond, 2013; Goldstein et al., 2014). Luria's neuropsychology (Luria, 1973), which is also based on activity approach, allows us to identify and study three components of executive functions: programming, selective regulation, and control.

Various neuropsychological and neurocognitive studies (Garon et al., 2008; Bull et al., 2008; Mozgovye mekhanizmy…, 2014; Alloway, T.P. & Alloway R.G., 2010; Kim et al., 2021) have shown that an important factor in academic performance is not only the effectiveness of EF in the acquisition of school knowledge, but also their maturation at preschool age. In our previously published studies of 5-to-6, and 6-to-7-year-old children, we revealed that children deemed by their teachers to be ready for school learning, were characterized by far more developed EF — including programming, selective regulation, control of mental activity, working memory, inhibitory control, cognitive flexibility, and long-term maintenance of attention — than their peers, who, according to the teachers' evaluation, could experience difficulties in adapting to school learning (Zakharova et al., 2022).

At the same time, various studies have demonstrated that the state of a child's EF at an early age is not only an important condition for the success of learning in the future, but is also already an essential factor in the progressive formation of thinking at preschool age. According to studies published by Kharitonova and Munakata (2011), cognitive flexibility (one of the components of EF) in 3-year-old children, is bound up with abstraction skills. Some longitudinal works have shown a linear improvement of voluntary control in 3-to-6 year-old children (Clark et al., 2013; Willoughby et al., 2012).

Taking into consideration the intensive heterochronic morpho-functional maturation of the prefrontal cortex in the given age period (Semenova et al., 2003) on the one hand, and the role of EF in the development of thinking and knowledge acquisition on the other, it was advisable to perform more detailed analysis of age-related changes of separate EF components in preschoolers moving from 3-4 to 4-5 years. The goal of this study was the assessment of the age-related changes in understanding and following instructions, sustained maintenance of the acquired program, and the control of execution of one's actions, as well as working memory and long-term maintenance of attention during monotonous activity.

## Methods

### *Participants*

Children age 3–4 (average age — 3.5±0.2 yrs., n = 49, boys = 31, girls = 18) and 4–5 (average age — 4,5±0.3 yrs., n = 70, boys = 35, girls = 35) participated in the current study. All the children attended junior and middle kindergarten groups in Moscow. The children had attended junior groups for at least three months, and middle groups for at least one year. Neither group included children diagnosed with any neurological or mental disorders. Moreover, we excluded five children due to their inability to follow and/or understand task instructions. Informed consent was obtained from the children's parents after the procedure was explained.

### *Procedure*

Every child underwent individual assessment, which was divided into 2–3 parts, each performed by the same neuropsychologist. The children age 3–4 were exposed to three sessions of 15–20 minutes each. The children age 4–5 were exposed to two sessions of 25–30 minutes each. If they got tired, the children could take a rest.

### *Instruments*

The neuropsychological evaluation of the development of the children's executive functions included two types of analysis. The first was a qualitative assessment of the difficulties and errors in a child's performance on various neuropsychological tests (The Bourdon–Wiersma Cancellation Test, the Spot the Difference Task, the Reciprocal Motor Programmer Test, the Graphomotor Sequences Task — Repeated Pattern Test, the Maze-tracing Task, and the Digit Symbol Coding Task).

The second involved quantitative measurement of the children's task performance (rate, accuracy number of errors) on several computerized neurocognitive tests (the Bourdon–Wiersma cancellation test, the "Hearts and Flowers" conflict test, the Dots task, and the Corsi block-tapping test (Akhutina et al., 2019)). The test battery was designed to evaluate the children's various executive functions: their abilities to follow simple and reversed instructions, to shift from one instruction to another, to maintain programs of task performance (incl. monotonous ones), to inhibit irrelevant responses, and to exercise selective attention and working memory.

### *The Data Processing*

The qualitative analysis of the neuropsychological probes was based on Luria's theory of the dynamic localization and organization of higher mental functions (1969). The results of the neuropsychological tests were analyzed by singling out four integral indexes (see *Table 1*), which reflect deficits in the following components of EF (Semenova, 2015): 1) understanding instructions or algorithms of task performance; 2) selective regulation (calculated as the mean score of four different neuropsychological parameters — deficit of overcoming immediate reactions; timely termination of the onset of an action and switching from one action to another one; difficulties in switching from one mode of action to another one, from program to program; and

difficulties in sustained maintenance of the acquired program); 3) control of execution of one's own actions; and 4) the general level of EF development (calculated as the mean score of the three previous neuropsychological indexes).

When we compared groups, we used the nonparametric Mann–Whitney U test for unrelated samples. The group differences were considered statistically significant, taking into account the Bonferroni correction, at $p < 0.05/8 = 0.006$ (the maximum number of pairwise comparisons was 8).

**Table 1**

*Neuropsychological indexes of the deficiency of executive functions*

| EF components | Deficiency manifestations |
|---|---|
| 1. Understanding instructions or algorithms | Individual features of understanding instructions or algorithms (from the first presentation, after repeated presentation, after joint execution, lack of understanding) of the different tasks: the Cancellation test, Spot the Difference task, Reciprocal Motor Programmer Test, Graphomotor Sequences Test, Maze-tracing Task, and the Digit Symbol Coding Task |
| 2. Selective regulation | |
| 2.1. Overcoming immediate reactions | 2.1. Presence of impulsive reactions during the Spot the Difference Task, Cancellation Test, Reciprocal Motor Programmer Test), Graphomotor Sequences Test, the Maze-tracing Task, and Digit Symbol Coding Task |
| 2.2. Switching from one action to another | 2.2. Interruptions during the Graphomotor Sequences, echoic reactions under choice Go/no-go task, perseveration under the Digit Symbol Coding Task |
| 2.3. Switching from one mode of action to another, from program to program | 2.3. Difficulties in switching between probes in various tasks, and between stimuli during the Reciprocal Motor Programmer Test and Digit Symbol Coding Task |
| 2.4. Sustained maintenance of the acquired program | 2.4. Mistakes in following the program (incl. stimuli omission) during the Cancellation Test, Graphomotor Sequences, the Maze-tracing Task, and Digit Symbol Coding Task; program loss during the Spot the Difference task and the Reciprocal Motor Programmer Test |
| 3. Control of execution of one's own actions | A total of the corrected and uncorrected errors found in all the tasks |

## Results

The comparison of the two preschool groups (see *Figure 1*) revealed lower levels of EF development in children age 3–4 compared to children age 4–5. Consequently, the integral neuropsychological index reflecting EF deficiency ($U = 591.0$, $p < 0.001$), and the index reflecting understanding of instructions and algorithms ($U = 437.5$, $p < 0.001$), resulted in higher values in the younger group. Selective regulation and control of execution of one's own actions did not prove to be significantly different in the two given age groups.

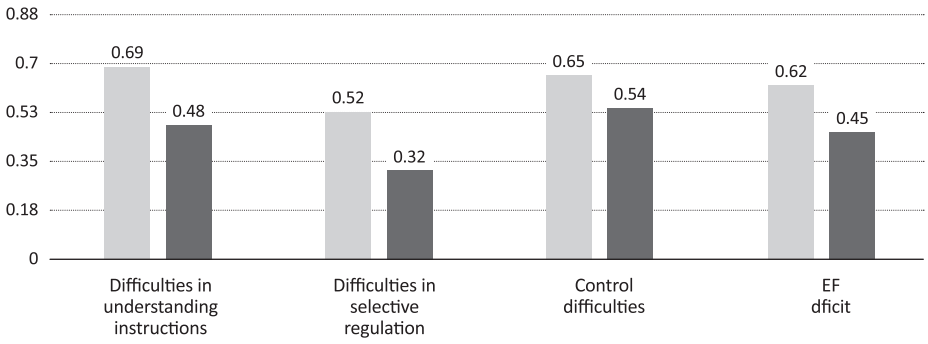


*Figure 1.* Integral neuropsychological indexes of deficiencies in EF components (higher numbers stand for lower development level)

Statistically significant differences were also found for one of the parameters included in the index of selective regulation — switching from one program element to another ($U = 726.5$, $p = 0.004$).

Computer tests showed a higher deficit in the ability to maintain a program under monotonous tasking in the younger group. The children had been given a computer version of the Cancellation Test presented in two tables. The first table required the child to cross out one target stimulus, and the second table required the child to cross out two target stimuli. It was the last table that revealed the statistically greater number of errors in the younger group ($U = 1242.5$, $p = 0.02$).

In the younger group, the computer tests also resulted in a higher score of neuropsychological indexes of deficiency in program switching compared with the older group. While the "Hearts and Flowers" conflict test was underway, intergroup differences proved to be significant for: 1) the productivity of the first (congruent) session performance ($U = 728.5$, $p < 0.0001$), as well as the second (incongruent) session performance ($U = 483.0$, $p < 0.0001$) (see *Figure 2*); and 2) errors made in the first ($U = 741.0$, $p < 0.0001$) and the second ($U = 464.5$, $p < 0.0001$) sessions. The third session, which requires switching between two programs, proved to be unsolvable for both groups.

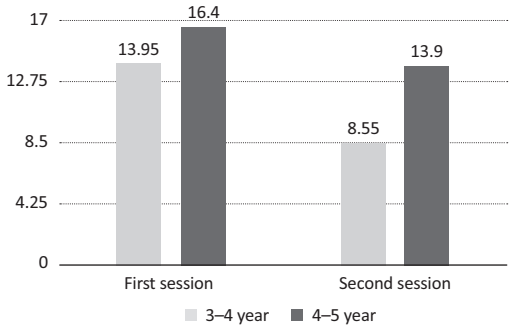


*Figure 2.* The productivity of the "Hearts and Flowers" conflict test in preschoolers

One of the most meaningful experimental probes of our study was a computer version of the Corsi block-tapping test, since it allowed us to assess visual-spatial working memory span (see *Figure 3*). Children age 3–4 were generally good at memorizing a sequence of two symbols, and children age 4–5 had the capacity to memorize three to four symbols (the symbols range was from 0 to 5, ($U = 621.0$, $p < 0.001$)).

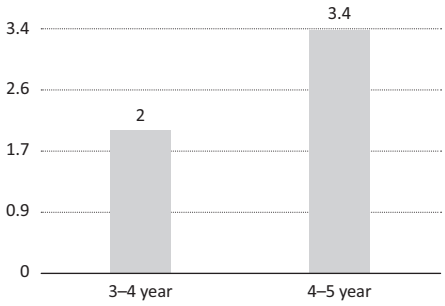


*Figure 3.* Working memory span in preschoolers

## Discussion

The results of the study showed that there was significant improvement of various components of EF during the age period from 3 to 5 years. This involved the ability to follow instructions and switch from one element of the program to another (but not yet from program to program), to increase the span and efficiency of visual-spatial working memory, and to concentrate and maintain attention when performing a monotonous task.

Our data on progressive changes in the studied components of EF by the age of 5 years are consistent with the results of Zelazo's study (Zelazo, 2006), which demonstrated pronounced difficulties in performing the DCCS (The Dimensional Change Card Sort) test for task switching (cognitive flexibility) in 3-year-old children, and the emergence of the ability to perform this test in most children of 5 years. A more recent study by Zelazo et al. (Zelazo et al., 2013) showed that the development of cognitive flexibility in children from the ages of 3 to 6 correlated with their ability stay focused when performing a flanker test. The authors attributed this result to the children's development of inhibitory control. In general, they noted an increase in the indicators of both fluid abilities and inhibitory control in children of 3-6 years as they aged, as well as a higher correlation with other indicators of cognitive development in this age group than occurs in the group of 8–15-year-old children.

Our study provided new data on the significant progressive changes in some EF functions in children 3 to 5 years old. The most prominent changes with age were found in the understanding of instructions, and the ability to switch from one element of the task program to another, as well as in the ability to maintain concentration during prolonged monotonous activity. It should be noted that all these abilities are very important for knowledge acquisition and learning. Progressive age-related shifts were also found for inhibitory control, a component of EF associated with the selective cognitive regulation of activity.

In 3-4-year-old children, we found the virtual absence of self-execution of task instructions during their performance of the neuropsychological tasks; that was an age-specific trait. However, in several tests (the Cancellation Test, Spot the Difference Task, and Digit Symbol Coding Task), cooperation with an adult helped the children cope with the task. This observation makes it prudent to include a stage of child-adult joint activity in neuropsychological tools creation for young preschoolers. Another distinguishing feature of the younger group was the pronounced individual variability in the performance of some tests: for example, some children did not master the instructions for the Digit Symbol Coding Task even after a long period of collaboration with an adult, whereas other children quickly grasped the algorithm and kept at it until the end of the task, performing it at a fast pace and without errors.

Immature voluntary control of cognitive activity in the younger group allows us to conclude that teaching 3-4-year-old children to write and read is meaningless, since it requires an appropriate level of working memory, selective and sustained attention, and the ability to program one's activity. Our results are in accordance with the viewpoint of researchers who subscribe to activity theory.

Despite their progress in EF by 4–5 years, both the younger and older groups demonstrated difficulties when performing more complex cognitive operations — for example, switching from one mode (program) of task performance to another — while there were no significant differences between age groups. Along with the results above, these data point to different rates of development (heterochrony) of various components of voluntary regulation of cognitive activity at preschool age.

It should be noted that all the children included in our study demonstrated lower levels of voluntary control than 6-7-year-old children (Zakharova et al., 2022). All the children were struggling with understanding instructions or algorithms (all the children required adult guidance for most of tasks) and had difficulties in maintaining a program which involved monotonous activity (the children were quickly exhausted due to the large number of stimuli), switching algorithms, and self-control.

Changes in age-related working memory (WM) are of particular interest, as it is exactly the retention of relevant information that is directly responsible for concept formation during learning. According to our results, 4-5-year-olds (compared to 3-4-year-olds) significantly increased their working memory span and capacity. These data complement the data on age-related transformations of WM in children age 4 to 15 years, presented in the work of Gathercole et al. (2004).

Thus, the results of our study prove the importance of applying the methodical principles of activity theory to the development of cognitive processes in preschoolers. For instance, it is of great importance to attract the attention of children and direct them to the required task (or switching between tasks), maintaining conditions that ensure the children's interest in the subject and their attention when performing joint activities. On the other hand, it is also important to teach children methods to develop task orientation and self-control. According to L. Vygotsky's concept of the *zone of proximal development* (Vygotsky, 1991*)*, active child-adult social interaction could improve voluntary forms of cognitive activity and better prepare a child for systematic education.

Our results suggest that the EF components important for the formation of concepts (general activity skills) are still immature in 3–5-year-old children. According to N.F. Talyzina, these components should be purposefully developed by means of active child-adult social interactions, including the stages of orientation, execution, control, and correction (Talyzina, 1988). In practical terms, this process could be organized as follows. The education of preschoolers should be based on their interests, leading to an increase in motivation. Adults should also help the children go through the orientation and control stages. The orientation stage is important for drawing the children's attention to the aspects underlying efficient task performance. The control stage is important for organizing the children's attention to checking their results.

According to the theory of gradual mastering of mental processes, which facilitates the activity approach to the analysis of learning processes (Galperin, 1966), teachers should move from the most expanded, element-by-element action, shared by the child and the adult, to internalized action. It is possible to offer a large number of methodological techniques (for formulating and/or organizing tasks) based on this principle. For example, you can teach a child to act according to the rules as follows. At the first stage, you must put each task (or game) in a separate box. Each box has its own number (usually from 1 to 3–4). This procedure helps the child to move sequentially from one task to another by performing physical actions (the child takes the task out of the box and puts it back after completion). At the last stage, the child uses a card with a plan, where tasks are indicated by pictograms (icons). Thus, the activity approach as a whole and the principles of the formation of cognitive activity, described in the works of N.F. Talyzina, open up great prospects for developing voluntary control in young preschoolers.

## Conclusions

1. Neuropsychological examination of preschool children revealed a heterochrony in the development of various components of voluntary control in children from 3 to 5 years of age.
2. Some executive functions — namely, the ability to assimilate instructions and switch from one element of the program to another, visual-spatial working memory, and the ability to focus and maintain attention when performing a monotonous task — exhibited significant progressive changes from 3–4 to 4–5 years. At the same time, these functions were still immature in both age groups compared to older children, and children of both age groups showed difficulties in switching from one algorithm of action to another, and insufficient voluntary control over their own activity.
3. A specific aspect of voluntary control in 3–5 year-olds is an adult-aided task acquisition, which dramatically increased the efficacy of task completion.
4. The results indicate the importance of the application of the activity theory approach to the development of cognitive processes in preschool age.

## Ethics Statement

This study was carried out in accordance with the principles of biomedical ethics formulated in the Helsinki Declaration of 1964, and these changes were approved by the committee of the Institute of Developmental Physiology of the Russian Academy of Education (Moscow).

## Informed Consent from the Participants' Legal Guardians (if the participants were minors)

Written informed consent to participate in this study was provided by the participants' legal guardians/next of kin.

## Author Contributions

Marina Zakharova developed the design and tools of the study, conducted the neuropsychological survey, and did the output processing. Regina Machinskaya provided the methodological grounding and supervised the results.

## Conflict of Interest

The authors declare no conflict of interest.

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PERSONALITY PSYCHOLOGY

# Perfectionism, the Impostor Phenomenon, Self-Esteem, and Personality Traits among Russian College Students

Marina S. Sheveleva[a*], Tatiana M. Permyakova[a], Dmitriy S. Kornienko[b]

[a] *Department of Foreign Languages, National Research University Higher School of Economics, Perm, Russia*
[b] *Institute for Social Sciences Russian Presidential Academy of National Economy & Public Administration, Moscow, Russia*

*Corresponding author. E-mail: msheveleva@hse.ru

**Background**. Perfectionism and the Impostor Phenomenon (IP) have mainly been studied in American samples, as have the associations of Perfectionism and the Impostor Phenomenon with Self-Esteem and the Big Five personality traits. However, previous studies showed that results might depend on cultural background. There is a critical lack of such research in the Russian context which might limit generalization of the previous findings to a narrow range of cultures.

**Objective**. In this study, the authors investigated how Perfectionism and the Impostor Phenomenon are related to the 5-factor model of personality, and examined the mediating role of Self-esteem between the dimensions of Perfectionism and the Impostor Phenomenon, using a Russian sample.

**Design**. The study sample comprised 372 undergraduate students age 18–23 (M = 19.07, SD = 1.05). The Impostor Phenomenon, Personality Traits, and Self-Esteem were measured by relevant questionnaires.

**Results**. The results indicated that Adaptive Perfectionism had a strong positive correlation with Extraversion, Conscientiousness, and Openness. Maladaptive Perfectionism had a strong relation to Conscientiousness and Neuroticism. Neuroticism demonstrated a strong positive correlation with impostor tendencies and was the main predictor. Self-esteem partially mediated the link between Maladaptive Perfectionism and the Impostor Phenomenon, intensifying negative feelings and Impostorism.

**Conclusion**. These results generally replicated the pattern from previous studies of the relationship between Perfectionism, the Big Five personality traits, Self-esteem, and the Impostor Phenomenon. Thus, it could be possible to conclude that the studied relationships might be regarded as universal for the Russian students in terms of culture.

***Keywords***: impostor phenomenon, perfectionism, the Big Five personality traits, mediation, self-esteem

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## Introduction

Perfectionism is considered to be a widespread phenomenon (Stoeber & Stoeber, 2009; Stricker, Buecker, Schneider, & Preckel, 2019), and is increasing as new generations as young people face more demands from society or their parents (Curran & Hill, 2019). The definition of this phenomenon is twofold. It is described as an excessive striving for excellence, combined with an overly critical attitude toward one's results (Stoeber & Otto, 2006).

Perfectionism as a multidimensional construct has been studied since the 1990s (Smith et al., 2022). Three models of multidimensional Perfectionism have generated the vast majority of the research. The first model relies on the Frost Multidimensional Perfectionism Scale (FMPS) (Frost, Marten, Lahart & Rosenblate, 1990) and includes six dimensions: concerns over mistakes, doubts about actions, personal standards, parental criticism, parental expectations, and organization. The second model, proposed by Hewitt and Flett (1991), is built around the Hewitt and Flett Multidimensional Perfectionism Scale (HFMPS). It includes three types of Perfectionism: self-oriented Perfectionism, other-oriented Perfectionism, and socially-prescribed Perfectionism. The third model was proposed by Slaney, Rice, Mobley, Trippi, and Ashby in 2001. The scale employed is the Almost Perfect Scale (APS) with its variations: Almost Perfect Scale-Revised (APS-R) and Short Almost Perfect Scale (SAPS). This scale includes two dimensions: Standards and Discrepancy. Respondents who have high scores on the Standards subscale but low scores on the Discrepancy subscale are referred to as "Adaptive Perfectionists." Respondents who have high scores on both subscales are referred to as "Maladaptive Perfectionists."

The APS measure is found to be a reliable instrument for assessing Perfectionism multidimensionally (Cokley et al., 2015) and has demonstrated good psychometric properties in adaptations to other languages. It has been used to study Perfectionism in different countries: Holland (Van Yperen & Hagedoorn, 2008); Japan (Nakano, 2009); Korea (Park, 2009); Turkey (Öngen, 2009); and Russia (Wang, Permyakova, & Sheveleva, 2016). In this study, we followed the third model of Perfectionism, due to its proven track record for research in a range of countries (Rice, Loscalzo, Giannini & Rice, 2018).

In order to streamline the research on Perfectionism, Stoeber and Otto (2006) operationalized two dimensions of Perfectionism in the three models described above. The first dimension is called "perfectionistic concerns," or "Maladaptive Perfectionism," and includes the following subscales: concerns over mistakes; doubts about actions (Frost et al., 1990); socially prescribed perfectionism (Hewitt et al., 1991); and discrepancy (Slaney et al., 2001). The second dimension is called "perfectionistic strivings," or "Positive Perfectionism," and includes personal standards, parental expectations, and organization (Frost et al., 1990), self-oriented Perfectionism (Hewitt et al., 1991), and high standards (Slaney et al., 2001).

The construct of Impostorism has received significant attention in the literature over the past decades. A systematic literature review has revealed over 1,200 studies of the Impostor Phenomenon with 80% being published in this millennium (Mak, Kleitman, & Abbott, 2019). The Impostor Phenomenon, or Impostorism, can be defined as the inclination to think that one has reached a professional success because of luck, continuous effort, or some kind of mistake – but not due to one's intellectual

abilities (Clance, 1985; Pannhausen, Klug & Rohrmann, 2020). Employees with Impostorism fear that they will be exposed as "frauds" and are often prone to anxiety, low self-confidence, depression, and frustration (Clance & Imes, 1978; Stone-Sabali, Bernard, Mills, & Osborn, 2023).

The studies of the Impostor Phenomenon could be grouped into three fields: organizational and environmental settings typical for this phenomenon (Bernard & Neblett, 2018; Chakraverty, 2020; Neureiter & Traut-Mattausch, 2017; Parkman, 2016; Sharma, 2018); its links with other personality dispositions (Ferrari & Thompson, 2006; McGregor, Gee, & Posey, 2008; Schubert & Bowker, 2019; Yaffe, 2020); and psychometric properties of the Impostor Scale (Chrisman, Pieper, Clance, Holland & Glickauf-Hughes, 1995; French, Ullrich-French, & Follman, 2008; Simon & Choi, 2018), and its adaptations to other languages (Brauer & Wolf, 2016; Chae, Piedmont, Estadt & Wickset, 1995).

### *Perfectionism and the Big Five personality traits*

The number of studies examining Perfectionism and the Big Five personality traits is quite extensive, and represents 25 years of research. The interest of researchers in this topic is explained by the need to place Perfectionism and its dimensions into a broader personality framework. The widely-used personality model includes Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness (John, & Srivastava, 1999). Neuroticism exhibits an emotional mood and excitability. Extraversion is expressed by characteristics of sociality and mobility. Openness relates to imagination, acceptance of new ideas, and mental curiosity. Agreeableness indicates trustworthiness and altruism. Conscientiousness reflects self-discipline and a tendency to be responsible. (McCrae & Costa (2008). Two recent meta-analytic articles (Smith et al., 2019; Stricker et al, 2019) report over 75 independent studies of Perfectionism and the five-factor model of personality. The key finding was that regardless of the chosen Perfectionism model, in most studies perfectionistic concerns are correlated with neuroticism, low agreeableness, and low extraversion, while perfectionistic strivings are correlated with conscientiousness. At the same time, many inconsistencies in research were noted, largely resulting from the chosen Perfectionism scale and the sample size (Smith et al., 2019).

Due to the studies of Smith et al. (2019) and Stricker et al. (2019), the populations that were underrepresented in areas research could be clearly identified. Firstly, 85% out of 77 reported studies were based on American, Canadian, Australian, and British samples, while only the remaining 15% of studies included speakers of languages other than English. Respondents in these separate studies were from Turkey, Belgium, Germany, and China. Secondly, 54 studies followed Hewitt and Flett's instrumental understanding of Perfectionism and employed the Hewitt and Flett Multidimensional Perfectionism Scale (HFMPS), and 29 studies applied Frost's Perfectionism model, employing the Frost Multidimensional Perfectionism Scale (FMPS). Only 15 studies followed a different Perfectionism model proposed by Slaney et al. (2001) and employed a well-established Almost Perfect Scale, and its forms, namely Almost Perfect Scale-Revised (APS-R) or Short Almost Perfect Scale (SAPS). Many studies employed several scales in one article, which inflated the results, producing a total greater than 77.

If we analyze the studies with different forms of the Almost Perfect Scale, two out of those 15 studies included psychiatric and medical patients samples (Békés et al., 2015; Chang, 2009), while 13 studies employed non-clinical samples, and will be of particular relevance to our research. In order to provide reliable findings in cross-sectional studies, the sample size is required to be larger than 250 participants (Schönbrodt & Perugini, 2013). The sample size in the 13 studies under analysis varied from 84 to 1,465 respondents. However, only in four studies was the sample size larger than 250 participants (Clark, Lelchook, & Taylor, 2010; Dunkley, Blankstein, & Berg, 2012; Rice, Richardson, & Tueller, 2014; Ulu, & Tezer, 2010). It is also worth noting that in terms of participants' origin, the population sample was again narrowed. In the 13 studies reviewed, the sampled populations were mainly of American, Canadian, and Australian origin. Only three studies included respondents from non-English-language backgrounds (Ozbilir, 2011; Ozbilir, Day, & Catano, 2015; Ulu & Tezer, 2010).

In Turkey, Ulu & Tezer (2010) used a sample of 604 undergraduate students. The results showed that high Standards were positively correlated with Extraversion, Conscientiousness, and Openness, while Discrepancy was negatively correlated with Extraversion and positively with Neuroticism. These results followed the same pattern as the results of Rice et al. (2014) with one exception. In the latter study, Discrepancy also had a strong negative correlation with Conscientiousness. Clark et al. (2010) conducted a similar study on the sample of 323 working university students from one American university. Their findings showed that high Standards were significantly positively related to Extraversion, Agreeableness, Conscientiousness, and Openness, while Discrepancy was significantly negatively related to Agreeableness, Conscientiousness, and Neuroticism. Dunkley et al. (2012) do not report the intercorrelations between the study variables. The summary of variables' intercorrelations in the research overview is provided in *Table 1.*

**Table 1**

*Intercorrelations between Discrepancy, Standards and the Five Factor Model Dimensions*

| Study | | | Intercorrelations with Big 5 | | | | |
|---|---|---|---|---|---|---|---|
| **Authors and year** | **Sample size and origin** | **Subscales** | **Extra-version** | **Agreeable** | **Conscien-tiousness** | **Neuro-ticism** | **Openness to experience** |
| Ulu & Tezer, 2010 | 604 university students, Turkey | Standards | .19* | .05 | .41* | .20 | .32* |
| | | Discrepancy | –.16* | –.05 | –.03 | .40* | –.09 |
| Clark, Lelchook, & Taylor, 2010 | 323 university students, USA | Standards | .22** | .47** | .49** | –.10 | .52** |
| | | Discrepancy | –.08 | –.18** | –.24** | –.40** | –.09 |
| Rice, Richardson, & Tueller, 2014 | 340 university students, USA | Standards | .23** | .09 | .46** | –.05 | 0,37** |
| | | Discrepancy | –.32** | .11 | –.22** | .59** | .09 |

Regression analysis demonstrated that Conscientiousness, Openness, and Extraversion were the main predictors for Adaptive Perfectionism, while Maladaptive Perfectionism was predicted by Neuroticism to a large extent (Ulu & Tezer, 2010).

The goal of the present research is to build on these four studies by providing a different cultural context and addressing the inconsistencies present in the previous works.

### *Impostorism and the Big Five personality traits*

A number of articles have explored the relationship of the Impostor Phenomenon (IP) to other personality constructs (e.g., Fried-Buchalter, 1992; King & Cooley, 1995). Within this research context, the IP is connected to a range of traits including the Big Five Personality Model (Watson, 2012; Vergauwe, Wille, Feys, De Fruyt, & Anseel, 2015). However, the number of studies exploring the relatedness of the IP to the Five-Factor Model of personality is limited. To the best of our knowledge, there have been only four studies based on a range of samples in terms of their origin: Korean (Chae et al., 1995); American (Ross, Stewart, Mugge, & Fultz, 2001, and Bernard, Dollinger & Ramaniah, 2002); and Belgian (Vergauwe et al., 2015).

A strong positive relationship between the IP scales and Neuroticism and a strong negative relationship between the IP scales and Conscientiousness were observed in all four studies (Chae et al., 1995; Ross et al., 2001; Bernard et al., 2002; Vergauwe et al., 2015).

However, findings based on other traits of the Big Five taxonomy were inconsistent. Extraversion had significant, but low, negative correlations with the Clance Impostor Phenomenon Scale (CIPS) in some studies (Chae et al., 1995, Ross et al., 2001, Vergauwe et al., 2015), but not in others (Bernard et al., 2002). Meaningful low correlation with Agreeableness was shown only by Chae et al., 1995.

The inconsistencies mentioned above could be explained by a number of factors, including the sample size (from 129 in Ross et al., 2001, to 654 in Chae et al., 1995); sample type – consisting of working adults (Chae et al., 1995; Vergauwe et al., 2015) as opposed to college students (Bernard et al., 2002; Ross et al., 2001); scales used to measure the IP and the Big Five; and the sample origin.

Given the inconsistencies described above, and the possibility that Impostorism might depend on cultural background (Chae et al., 1995), the replication of the results with a Russian sample could contribute to our existing knowledge.

### *The link between Perfectionism and the Impostor Phenomenon*

Many studies mention the connection between Perfectionism and the Impostor Phenomenon, as both share a number of symptoms such as setting unattainable high standards, fear of failure, self-criticism, absence of satisfaction with good performance, procrastination, and low Self-esteem (Hill et al., 2004; Cokley et al., 2015; Lane, 2015; Pannhausen, Klug, & Rohrmann, 2020). However, there is scant research in this area. Thompson, Foreman, and Martin (2000) showed a strong link between impostor fears and perfectionistic concerns over mistakes, as well as the role of Perfectionism in predicting and maintaining the Impostor Phenomenon. In more recent

studies, it has been shown that Maladaptive Perfectionism or perfectionistic concerns (and not Adaptive Perfectionism or perfectionistic strivings) predict the development of the Impostor Phenomenon (Dudău, 2014; Pannhausen et al., 2020). These findings were deepened by Wang, Sheveleva, & Permyakova (2019), who showed that the Impostor Phenomenon is the key link between perfectionistic discrepancy and negative mental health outcomes such as depression and anxiety.

Despite the well-studied association between Impostorism and Perfectionism, the mechanism behind this relationship remains unknown. Self-esteem has been found to mediate the relationship between Perfectionism and other characteristics. For instance, Self-esteem mediates the relationship between Adaptive Perfectionism and work-family conflict (Deuling & Burns, 2017). Prior research on the relationship between the Impostor Phenomenon and Self-esteem has yielded rather varied results. Schubert and Bowker (2017) demonstrated the crucial role of Self-esteem and Self-esteem instability in the Impostor Phenomenon. Some studies have discovered the mediating role of Self-esteem in relation to Impostorism and racial identity (Lige et al., 2017), impostor sentiments, and parenting styles (Yaffe, 2020).

Only one study addresses the nature of the relationship between Perfectionism and the Impostor Phenomenon (Cokley et al., 2018). The authors hypothesized that Self-esteem might be the link between the Impostor Phenomenon and Perfectionism. They demonstrated that Self-esteem was a partial mediator for the link between Perfectionism and the Impostor Phenomenon. The authors stated that this study needs to be replicated due to its limitations such as the sample origin (American in this case). These findings and limitations motivated us to reproduce the study in a different cultural setting.

Thus, the preliminary, inconsistent results (Stricker et al., 2019), limited samples (Smith et al., 2019), predominantly English-speaking respondents from the United States, the United Kingdom, and Canada (Methikalam, Wang, Slaney, & Yeung, 2015), and the existence of cross-cultural differences (Chae et al., 1995), substantiate the need for study of the following research questions:

RQ1: How do the Discrepancy and Standards subscales relate to the Big Five personality model in a Russian sample?

RQ2: How does the Impostor Phenomenon relate to the Big Five personality model in a Russian sample?

RQ3: Does Self-esteem mediate the relationships between Perfectionism and Impostorism in a Russian sample?

## Methods

### *Participants*

The participants were 372 undergraduate students (277 female — 74.5%) between 18 and 23 years of age (M = 19.07, SD = 1.05) from Russian universities. The respondents majored in a range of subjects: Chemistry, Economics, Engineering, IT, Math, Management, Law, and Psychology. There were non-significant differences in age (t = –.695, ns.) between men (M = 19.02, SD = .09) and women (M = 19.09, SD = .07).

### *Procedure*

The subjects were tested in a group session during regular class hours. They received a brief introductory talk about the study's aims, completed online questionnaires, and provided their demographic details. They were instructed to take as long as needed to complete the questionnaires, and it took participants an average of 20 minutes to complete them. The questionnaires were filled out in the presence of the researcher. Upon completion, the participants were debriefed and thanked. Their participation was voluntary, and no compensation was paid. The respondents received course credit as an incentive to participate in research.

The questionnaires were filled out in Russian, as all of them were either developed in Russian (*Short Portrait Big Five Questionnaire* (Egorova & Parshikova, 2016) or adapted to the Russian language in previous studies (please see Sheveleva et al., 2021; Wang et al., 2016; Zolotareva, 2020, for reference). The study's procedures complied with the ethical code for research of the institutions from which the participants were recruited.

### *Materials*

*The Clance Impostor Phenomenon Scale* (CIPS; Clance, 1985; Sheveleva et al., 2021*)* was used to assess Impostorism, a fear of being evaluated and failing to reproduce achievements, and the tendency to underestimate oneself. Items were anchored on a 1–5 Likert-type scale (1 = strongly disagree; 5 = strongly agree). The CIPS has strong reliability and validity (French et al., 2008; Mak et al., 2019). In this sample, Cronbach's alpha was .89.

*The Rosenberg Self-esteem Scale* (RSES; Rosenberg, 1965; Zolotareva, 2020*)* is a unidimensional instrument elaborated from a phenomenological conception of Self-esteem that captures subjects' global perception of their worth through a 10-item scale, rated on a 4-point Likert-type scale, ranging from 1 (strongly disagree) to 4 (strongly agree). Rosenberg (1965) reported Cronbach alphas from .85 to 0.88 for the samples of college students. Cronbach's alpha for this study is .88.

*The Short Portrait Big Five Questionnaire* (BF-10; Egorova & Parshikova, 2016) is a 10-item domain-level personality scale designed to assess the Big-Five personality dimensions: Agreeableness, Conscientiousness, Openness, Extraversion, and Emotional Stability. Each item presents a description of a person with whom the respondents compare themselves using the 6-point Likert scale from 1 (this person is completely different from me) to 6 (this person is very much like me). The average internal consistency for all traits is .58. The average Cronbach's alpha for this study is .51, which corresponds with other studies of the Big Five (*e.g.,* Romero, Villar, Gómez-Fraguela & López-Romero, 2012)

*The Short Almost Perfect Scale* (SAPS) is a brief, established measure of the Almost Perfect Scale-Revised (Slaney et al., 2001; Wang et al., 2016). The SAPS consists of two subscales: Standards and Discrepancy. The Standards subscale measures the level of perfectionistic striving by assessing one's setting of high expectations. The Discrepancy subscale measures the level of perfectionistic concerns by assessing each participant's tendency to perceive a gap between their standards and performance. Respondents were asked to rate each item on a seven-point Likert scale where 1 was

"strongly disagree" and 7 was "strongly agree." The Cronbach alphas ranged from .85 to .87 for Standards and .84 to .87 for Discrepancy (Rice et al., 2014). In the present study, the Cronbach alphas of Standards and Discrepancy scores were .82 and .79, respectively.

*Data analysis.* Pearson's correlation and mediation analyses were carried out. The mediation analysis was conducted with PROCESS and the plugin for SPSS, based on the bootstrapping technique developed by Preacher and Hayes (2004). Bootstrapping is not based on a normal distribution; that is why a total of 5000 bootstrap samples were used to obtain 95% CIs (confidence interval) and test the significance of the indirect effect. The significance of the indirect effect was indicated if the 95% CI did not include zero.

## Results

Descriptive statistics including means, standard deviations, and correlations between all scales are presented in *Table 2.*

**Table 2**

*Descriptive statistics and correlations of variables.*

| Variable | M | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Impostor Phenomenon | 49.36 | 10.88 | | | | | | | | | |
| 2. Standards | 21.22 | 4.69 | –.031 | | | | | | | | |
| 3. Dscrepancy | 16.48 | 5.96 | .528** | .164** | | | | | | | |
| 4. Self-esteem | 29.78 | 5.66 | –.680** | .237** | -.540** | | | | | | |
| 5. Extraversion | 8.02 | 2.61 | –.252** | .221** | –.106* | .308** | | | | | |
| 6. Agreeableness | 8.97 | 2.07 | –.152** | –.053 | –.199** | .200** | .075 | | | | |
| 7. Conscientiousness | 8.75 | 2.35 | –.165** | .192** | –.162** | .207** | –.031 | .248** | | | |
| 8. Neuroticism | 6.55 | 2.32 | .468** | .035 | .311** | –.474** | .002 | –.283** | –.148** | | |
| 9. Openness | 8.72 | 2.03 | –.373** | .371** | –.172** | .475** | .552** | .085 | .045 | –.207** | |

*Note. * — p<.05; ** — p<.001.*

### *Research question 1. Perfectionism and the Big Five personality traits*

The Pearsons' correlations were conducted to examine the relations between personality traits and Perfectionism variables. Standards positively correlated with Conscientiousness (r = .192; p<.01), Openness (r = .371; p<.01), Extraversion (r = .221; p<.01), and Discrepancy negatively associated with Agreeableness (r = –.199; p<.01), Conscientiousness (r = –.162; p<.01), Openness (r = –.172; p<.01), Extraversion (r = –.106; p<.01). Moreover, Discrepancy positively correlated with Neuroticism (r = .311; p<.01).

The multiple regression results showed that three Big Five traits accounted for a significant amount of the variance in high Standards ($R2 = .18$, $F(5, 392) = 17.25$, $p<.001$). Agreeableness ($\beta = -.100$; $p<.05$), Conscientiousness ($\beta = .220$; $p<.001$), Openness ($\beta = .351$; $p<.001$) revealed as a significant predictors for high Standards. Concerning the Big five predictors for Discrepancy Conscientiousness ($\beta = -.12$, $p<.01$), and Neuroticism ($\beta = .237$, $p<.001$) had a significant impact with 14% of the total amount of variance ($R2 = .14$, $F(5, 392) = 12.26$, $p<.001$).

***Research question 2. Impostorism and the Big Five personality traits***

With regard to the mean Impostor tendencies shown in *Table 2*, a one-way ANOVA indicated no significant sex differences in mean Impostor tendencies $F(1, 370) = 8.16$, $p<.01$. There was no association between the Impostor Phenomenon and age.

To examine the relation between Impostorism and personality traits, we calculated Pearson correlation coefficients. The intercorrelations of the variables are given in *Table 2*.

At the level of the zero-order correlations, it was found that Impostorism positively correlated with Neuroticism ($r = .486$; $p<.01$) and negatively with the other traits: Agreeableness ($r = -.152$; $p<.01$), Conscientiousness ($r = -.165$; $p<.01$), Openness ($r = -.373$; $p<.01$), Extraversion ($r = -.252$; $p<.01$).

Next, we conducted the multiple regression where the Big Five traits were entered as predictors for the Impostor, $R2 = .32$, $F(5, 392) = 37.1\ 4$, $p<.001$. When controlling for shared variance among the Big Five traits, Extraversion ($\beta = -.13$, $p<.01$), Conscientiousness ($\beta = -.11$, $p<.01$), Neuroticism ($\beta = .40$, $p<.001$), and Openness ($\beta = -.22$, $p<.001$) were still associated with impostor tendencies.

***Research question 3. Perfectionism and the Impostor Phenomenon***

The correlations between the Impostor Phenomenon and Self-esteem showed a significant negative relationship ($r = -.680$; $p<.01$). Discrepancy was negatively correlated with Self-esteem ($r = -.540$, $p<.01$), and positively correlated with Impostorism ($r = .528$, $p<.01$). Standards were positively associated with Self-esteem ($r = .237$, $p<.01$) and insignificantly correlated with the IP.

***Mediation analyses***

Following Cokley's procedures (2018), two different mediation analyses with Self-esteem as a mediator between Perfectionism (Discrepancy and Standards) and Self-esteem were performed. The result of regression of Discrepancy on Impostorism was significant ($b = .527$, $SE = .019$, $p<.001$), and the subsequent regression of Discrepancy on Self-esteem was also significant ($b = -.545$, $SE = .016$, $p<.001$). Next, while controlling for Discrepancy, the regression of Self-esteem on Impostorism was found significant ($b = -.548$, $SE = .016$, $p<.001$). After controlling for Self-esteem, Discrepancy continued to be a significant predictor of Impostorism ($b = .229$, $SE = .019$, $p<.001$). Discrepancy and Self-esteem explained 48.8% of the variance of Impostorism (*Figure 1*). Therefore, we concluded that Self-esteem was a partial mediator between Discrepancy and Impostorism.

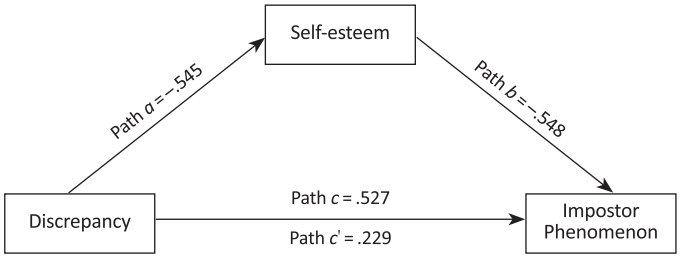


*Figure 1.* Mediation model of the indirect effect of discrepancy on the Impostor Phenomenon through Self-esteem

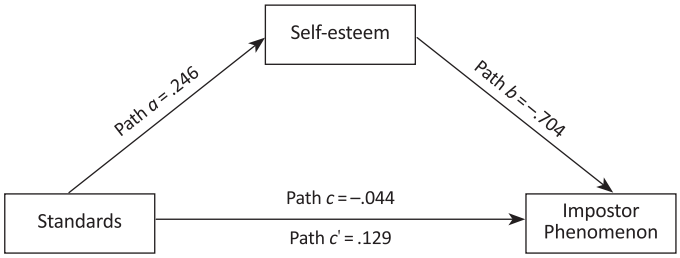


*Figure 2.* Mediation model of the indirect effect of standards on the Impostor Phenomenon through Self-esteem

The analytical procedure was repeated to test the direct effect of Standards and the indirect effect of Self-esteem on Impostorism. The regression of Standards on Impostorism was insignificant (b = –.044, SE = .028, p<.383); the regression of Standards on Self-esteem was significant (b = .246, SE = .024, p<.001). While controlling for Standards, the regression of Self-esteem on Impostorism was also significant (b = –.704, SE=.043, p<.001). Next, while controlling for Self-esteem, Standards appear to be the significant predictor for Impostorism (b = .129, SE = .021, p<.001). Standards and Self-esteem accounted for 46.7% of the variance of Impostorism (*Figure 2*). The indirect effect of Standards on Impostorism was significant ( …. ) *b* = –.173, SE = .038, CI = –.246, –.098 ( …. )

### *Assessment of mediation*

The indirect effect of Discrepancy on Impostorism was significant ( …. ) *b* = .298, SE = .029, CI = .237, .355 ( …. )

## Discussion

The aim of this research was to examine the relationships between Perfectionism, the Impostor Phenomenon, and the Big Five personality traits with a Russian sample, as well as the mediating role of Self-esteem between Perfectionism and the Impostor Phenomenon.

### *Perfectionism and the Big Five personality traits*

The results of the present study are in line with previous research (Ulu & Tezer, 2010; Rice et al., 2014). In this study, Standards had a strong positive correlation with Extraversion, Conscientiousness, and Openness. The Standards subscale followed a consistent correlational pattern with previous studies showing that more social-oriented, open-minded, responsible, and self-controlled people pose higher standards for themselves in terms of performance results. People with high Standards tend to do their best and achieve competence in what they are doing. This fact is rooted in their personality traits.

Discrepancy does not show consistent correlations as different results are reported in a range of studies. However, the most replicable link is with Neuroticism. Our results correspond with Ulu & Tezer (2010) and Rice et al. (2014) that Conscientiousness and Neuroticism have a strong relationship with Discrepancy. Concerning the role of Extraversion in Discrepancy at the correlation level, we found the same results as Ulu & Tezer (2010), but Extraversion did not appear in the predictors model in this study.

The reasons why the Standards subscale showed a more stable pattern than Discrepancy could be based on the cultural origin of the respondents and a range of scales used to measure the Five Factor Personality Model. Moreover, any person could set standards while the Discrepancy scale shows the relationship between Standards and performance. It stems from the fact that personality traits could hinder the performance and achievements.

Overall, our study, in line with previous research, demonstrated that Adaptive Perfectionism (measured by the Standards subscale) was mainly linked with positive personality traits such as Conscientiousness and Openness, while Maladaptive Perfectionism (measured by the Discrepancy subscale) was connected with Neuroticism to a larger extent.

### *Impostorism and the Big Five personality traits*

To identify people with the highest Impostorism scores with the CIPS, the cutoff values from previous studies were used (Holmes, Kertay, Adamson, Holland, & Clance, 1993; Chae et al., 1995). Using the values of 58 and 62 it was found that only 20% and 13% of our sample could be regarded as Impostors. Such percentages are half as much as in the Korean sample, and crucially smaller than the American sample (Clance, 1985; Harvey & Katz, 1985). Even though these differences need to be studied more precisely, we may postulate (according to Chae et al., 1995) that cultural differences may influence Impostorism.

Our findings of Impostor and Neuroticism relations support the previous studies (Ross et al. 2001; Bernard et al., 2002; Vergauwe et al., 2015). Neuroticism demonstrates a strong positive correlation with Impostor tendencies and acts as the main predictor. The results of the relationship between Impostor and Agreeableness, Conscientiousness, and Extraversion cohere with studies of Chae et al. (1995), as we also found low but significant associations between Impostor and the mentioned personality traits. Based on the previous studies and our results, we support the idea that Neuroticism is the primary personality trait in relationships with the Impos-

tor Phenomenon, whereas the other traits play a complementary role in predicting impostor tendencies. We may speculate that more emotionally unstable individuals could demonstrate more impostor tendencies such as experiencing anxiety, low self-confidence, and proneness to psychological distress.

### *Perfectionism and the Impostor Phenomenon*

The results of this study replicate Cokley et al. (2018) both in terms of correlations, regressions, and mediation analysis. The Discrepancy subscale had significant, positive correlations with the Impostor phenomenon. The Standards subscale was non-significantly, negatively correlated with the Impostor Phenomenon. Despite the expected cultural dependency of the results, current research on the relationship between Impostor and Perfectionism aligns with the findings from European and American samples (Wang et al., 2019).

The mediating effect of Self-esteem was the highest for Discrepancy. As Self-esteem mediates the link between Maladaptive Perfectionism and the Impostor Phenomenon, it intensifies negative feelings and Impostorism. It means that Maladaptive Perfectionists who have low scores on Self-esteem are prone to Impostorism. They worry about the gap between their high goals and real-life results and negatively evaluate themselves. This results in experiencing intellectual fraudulence, being highly self-critical, and attributing success to external factors, as well as higher anxiety, depression, and other negative mental health outcomes.

This discussion leads to two conclusions. First, low Self-esteem is clearly seen as a factor intensifying Impostorism. Thus, low Self-esteem should be the point of intervention during counselling work with clients suffering from Maladaptive Perfectionism and Impostorism. Secondly, the link between Perfectionism, Self-esteem, and Impostorism could be regarded as universal in terms of culture.

## Conclusion

This study leads to a better understanding of the links between Perfectionism, Impostorism, and the Big Five as well as Perfectionism and Impostorism with each other. Extraversion, Conscientiousness, and Openness had positive correlations with Standards. Conscientiousness had negative and Neuroticism positive relations with Discrepancy. Neuroticism was the primary personality trait in relationship with the Impostor Phenomenon. Self-esteem mediated the link between Maladaptive Perfectionism and the Impostor Phenomenon.

Comparing the results of this study with previous studies, we can state that the strongest patterns were replicated. This result could lead to the conclusion that these relationships exist notwithstanding the cultural background of the respondents, and might be regarded as universal in terms of culture.

This study generally replicated the result pattern from previous studies of the relationship between Perfectionism, the Big Five personality traits, Self-esteem, and the Impostor Phenomenon.

Practical implications of this study could be connected with providing counselling support to students in higher educational establishments in Russia. As students

high on Maladaptive Perfectionism and Impostorism tend to drop out more often, understanding the point of intervention while providing counselling sessions might yield better results.

## Limitations

This study has some limitations. First, the convenience sample limits the generalizability. There were more women than men in the sample. Second, only self-reported measures were used. Third, a cross-sectional design is a limitation in itself.

Several paths for further research could be suggested. First, there might be cross-cultural studies on IP and Perfectionism and their trait-relatedness, controlling for other sample characteristics and measurements. Second, perspective studies may try to find other mediators between Perfectionism and Impostorism. Third, qualitative studies could provide a better understanding of the psychological nature of Perfectionism and Impostorism.

## Ethics Statement

The procedures of measurement met the ethical standards adopted at the Russian Presidential Academy of National Economy & Public Administration and National Research University Higher School of Economics. The participants took part in the research voluntarily and gave written consent to participate in the study.

## Author Contributions

M.Sh. and D.K. came up with the research idea and study design, T.P. developed the theory, D.K. carried out the statistical analysis of the data, and M.Sh. drafted the manuscript. All authors discussed the results, revised the manuscript, and approved the submitted version.

## Conflict of Interest

The authors declare that the research was conducted absent any commercial or financial relationships that could be construed as a potential conflict of interest.

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# The Role of Psychological Time in Late Socialization. A SEM Analysis

Ekaterina V. Zabelina[a*], Olga S. Deyneka[b], Yulia V. Chestyunina[c], Ekaterina V. Vedeneeva[a]

[a] *Chelyabinsk State University, Russia*
[b] *Saint-Petersburg State University, Russia*
[c] *Rostov State Technical University, Russia*

*Corresponding author. E-mail: katya_k@mail.ru

**Background**. Psychological time, a subjective reflection of the objective passage of time, has age specific characteristics and can be considered a resource for adaptation to difficult life situations (Pultz, & Hviid, 2016). We assume that the components of psychological time are also a resource for adaptation to retirement, smoothing out undesirable social and biological changes in retirees' lives.

**Objective**. This study explores this hypothesis by identifying the contribution of the cognitive component of psychological time — temporal focus and subjective age — to the effectiveness of late socialization.

**Design**. The developed theoretical model was verified by the SEM method on the sample of retirees from Chelyabinsk, Russia (N = 291). To collect the empirical data we used the Temporal Focus Scale (Shipp et al., 2009), the Age of Me (Barak, 2009), the Life Satisfaction Scale (Diener & Lucas, 1999), the Income Satisfaction Scale (Deyneka, 2000), and questionnaire variables.

**Results**. Temporal focus and subjective age mediated the influence of biological and social variables on the retirees' subjective well-being. A younger subjective age smoothed the contribution of educational level, working status, and disability, whilst the current and future focuses mediated the association between religiosity and various parameters of satisfaction.

**Conclusion**. The results of the study broaden the understanding of psychological time in the late socialization process. A pronounced focus on the present, along with younger subjective age, can be seen as psychological resources, allowing for better adaptation to the social status of a retiree; that is, increasing the effectiveness of late socialization.

***Keywords***:
aging society, late socialization, psychological time, temporal focus, subjective age, subjective well-being, life satisfaction, retirees

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## Introduction

The problem of an aging society and its consequences has until recently only been a concern of individuals, but since the second half of the twentieth century, the whole world community has become concerned about this process (Herath, 2017; Teixeira, Nagarajan, & Silva, 2017; Vogel, Ludwig, & Borsch-Supan, 2017). The contradiction between a person's increased life expectancy, on the one hand, and the not always high social productivity and personal happiness experienced in retirement, on the other, is unresolved. Nevertheless, despite the joint efforts of scientists, politicians, and public figures in this field (https://www.garant.ru/news/1221705/), this problem is still not solved in Russia, and the means for its solution are not obvious.

One promising approach to the study of an aging society involves seeing it through the prism of late socialization (Zabelina, & Chestyunina, 2022), because that approach allows retirement to be seen as an opportunity for effective adaptation to a new way of life and self-realization in a new social environment. In social psychology socialization is viewed as a two-way process of individual absorption of social experience, a system of social ties and relationships, norms of behavior, social roles, and values which enable individuals to function successfully in society and achieve self-realization (in a social environment) (Andreeva, 1980). It is customary to distinguish between primary (early) and secondary (adult) types of socialization (Yantzen, 2015). Late socialization is understood as a type of secondary socialization (Drobysheva, & Zhuravlev, 2016), the process and result of a person's rethinking his or her life and the surrounding reality, while adapting to a new social status (retiree), accompanied by changes in consciousness and behavior.

Psychological factors are important in late socialization, as they allow a person to use his own resources to adapt to the changes which accompany older ages (Sergienko, & Kharlamenkova, 2018), and help to dispel negative social stereotypes of older persons. For example, it was found that the older generation of Russian residents not only actively uses Internet gadgets, but do it more ethically compared to younger people (Maksimenko, Deyneka, & Dukhanina, 2022).

One of the non-obvious psychological factors influencing the adaptation to retirement is psychological time and its components (the perception and experience of time, attitude toward time, etc.). Since the passage of time is not perceived in the same way at different ages (Sircova et al., 2014), it can be assumed that its late-onset features may affect the success of adaptation to retirement. Since psychological time is a subjective reflection of the objective passage of time in the psyche, it is clearly amenable to correction by psychotherapeutic methods: that is, there is an opportunity to make retirement happier.

In spite of this fact, the role of psychological time in the process of adaptation to retirement has not been sufficiently studied. The question of how the perception of time and self-image in this period of life affects a person's identity upon acquiring the status of pensioner is ambiguous. Moreover, research on psychological time in old age, including its cognitive component, generally focuses on clinical cases (*e.g.*, Balashova, 2016; Mikeladze, 2014) and does not always take into account the parameters of the norm. Thus, the purpose of our study was to identify the role of psychological time, namely its cognitive component, in the process of late socialization.

## Theoretical review

### *Late socialization: criteria and factors*

The socialization of older persons (late socialization) refers to the development of knowledge and skills, the adoption of new behaviors, and changes in values, all of which should ensure adequate adaptation to one's age and appropriate participation in interaction with society (Dubynina, 2019). Related concepts include active aging (Cao, 2022; Zheng et al., 2023); successful aging (Martinson, & Berridge, 2015; Zhang et al., 2018); healthy aging (Scult et al., 2015; Arroyo-Quiroz et al., 2020); effective aging (Strizhitskaya, 2017); favorable aging (Sergienko, & Kharlamenkova, 2018); social adaptation/disadaptation (Prokhorova, 2022); desocialization (Belikov, 2019); and resocialization (Perinskaya, 2005; Serdakova et al., 2020). These concepts try to describe the effectiveness of socialization at a late age: how successfully a person can adapt in society when changing his or her lifestyle (retirement).

However, despite the variety of terms used to refer to late socialization, the research focus has been on objective criteria of socialization, such as activity and productivity in society (Pinto, & Neri, 2017), independence (Galinha, Pinal, & Lima, 2021), participation in work and social life (Pavlova, Gumennikov, Monastyrny, 2017), life quality (Yantzen, 2015; Galinha, Pinal, & Lima, 2021), level of material security (Drobysheva, & Zhuravlev, 2016), health (Pinto, & Neri, 2017; Westerhof, Miche, & Brothers, 2014), favorable environment (Belikov, 2019; Yantzen, 2015), and the like.

In contrast, our study focused on subjective criteria like life satisfaction and happiness (Pavlova, Gumennikov, & Monastyrny, 2017). We proposed considering various aspects of subjective well-being as criteria for effective late socialization, — namely, life satisfaction in general (Diener & Lucas, 1999), economic satisfaction (Deyneka, 2000), health satisfaction, and the modality of perception of life in retirement.

To date, a large number of factors (biological, social, psychological) influencing the process of late socialization have been studied (*e.g.*, Melekhin, 2016; Yantzen, 2015). While we understand the conventionality of this division of factors into groups, we used it to make the theoretical model as clear and transparent as possible. One obvious factor is health. There are objective reasons to highlight this factor, because some diseases (ischemic heart disease, hypertension, diabetes mellitus, respiratory and digestive diseases, diseases of visual and hearing organs, diseases of the central nervous system, and oncological diseases) are the companions of old age for most retirees (Vaganova-Naĭmushina, 2017). In this study, the presence or absence of disability status was chosen as a factor of late socialization reflecting objective health problems.

In a number of studies, the level of physical activity in old age is considered a factor influencing physical health (VOZ, 2010; Nicholson, 2004; Paterson, & Warburton, 2010) and late socialization as a whole (VOZ, 2010). However, according to research on the Russian sample, retirees' physical activity is not realized through playing sports, but mainly through performing various types of work (paid work, gardening, childcare, fishing, hunting, etc.) (Zasimova, & Sheluntcova, 2014). Therefore, not only the state of health but also the indicator of working status was taken as a factor of late socialization in this study. In the scientific literature there is a lot of evidence of the positive impact of employment on the assessment of emotional state and psychological well-being of retirees (Konoplev, & Konopleva, 2016; Prokopets, 2017). The attitude toward online work of older employees is also being studied (Toscano et al., 2022).

Closely related to the possibility of continuing to work is the issue of the retirees' level of education (Shakhmatova, 2021; Sergeeva, & Borisov, 2020), which can also be considered one of the factors contributing to life satisfaction in this period (Andreenkova, & Andreenkova, 2019). The presence or absence of a family (Bukhalova, 2011; Iakimakha, 2002) can also be one of the factors determining the process and the result of late socialization, and can lead to the development of the problem of loneliness at an older age (Naumova, & Glozman, 2021; Gekht, 2001).

A number of studies on gerontopsychology suggest that there is an increasing interest in religion as people age (Shangareeva, & Kozyrev, 2016; Kofanova, & Mchedlova, 2010). Increasing religiosity in old age gives strength, helps people to cope with the fear of death, and helps to foster humility in difficult life situations. Thus, religiosity can also be seen as a factor of late socialization in this study.

### *Psychological time and its cognitive component*

Psychological time as a subjective reflection of the passage of time in the human psyche has not yet been specifically studied in the process of later socialization; however, the prerequisites for this study exist. According to Kovalev (1988), psychological time is a "person's perception and experience of his or her objective time of life, a concept of time conditioned by both personal experience of individual and group life, by one's social, historical, and cultural experience, and by the person's awareness of the passage of time, personal relationship to time, and psychological organization and regulation of vital time" (p. 217). The international scientific community presents a wide variety of terms to describe psychological time: temporal orientation (Holman & Silver, 1998); time attitude (Nuttin, 1980; Nestik, 2011, 2015); polychronicity (Bluedorn, 2000); temporal depth (Bluedorn, 2002); time perspective (Boniwell, & Zimbardo, 2004; Zimbardo, & Boyd, 1999); temporal focus (Shipp et al., 2009); MindTime (Zabelina & Fortunato, 2019); subjective age (Barak, 2009); time experience (Golovakha, & Kronik, 1984), and others.

According to Nestik's (2015) model of attitudes toward time, psychological time has four components: 1) value-motivational (subjective value of time as an irreplaceable resource); 2) cognitive (temporal perspective, temporal aspects of identity); 3) affective-evaluative (the emotional relationship of personality to time); and 4) conjectural (preferred ways of organizing time) (p. 100). In our study, we focused on the cognitive component of retirees' psychological time — subjective age and time focus — as the least studied and giving contradictory data.

A review of the theoretical frameworks used to study the problem of psychological time in old age as a factor of late socialization revealed differences in the approaches of foreign and Russian authors researching this issue (Danilova, & Zabelina, 2022). The latter tend to consider psychological time of the elderly from a clinical-psychological standpoint, analyzing its cognitive deviations (Balashova, 2016; Mikeladze, 2014; Bragina, 2013; Melyohin, & Kireeva, 2016; Metsler, 2015). The research by foreign authors follows three main directions: 1) a future time perspective (Demiray, & Bluck, 2014; Daly, Hall, & Allan, 2019; Korff, Biemann, et al., 2020); 2) subjective age (Blöchl, Nestler, & Weiss, 2021); and 3) perspective on the past (Holman, & Silver, 2016; Mello, Barber, & Vasilenko, 2022). However, there is plenty of contradictory data within the domains of psychological time research on old age, both in Russia

and abroad. Some phenomena, such as the temporal focus of older people, have been left out of the international research. This confirms the need for further study of psychological time, especially its cognitive component, on the Russian sample of mentally healthy elderly people in retirement.

Temporal focus is a person's degree of attention to various aspects of life, which can concentrate on their past, present, or future (Shipp et al., 2009). While it is a stable feature, temporal focus nevertheless is still subject to fluctuations during one's life. As a person ages, he or she realizes that life is finite, and focuses less and less on the future (Carstensen et al., 1999). In addition to natural adulthood, there may be significant events (Shipp, Aeon, 2019) that affect temporal focus, and retirement may be one of them.

A person's subjective age is the self-perception of one's own age (Sergienko, 2020). Research on the relationship between subjective age and subjective well-being in old age results in contradictory data. Most scholars conclude that feeling younger (younger subjective age) has a positive effect on life satisfaction in old age (Blöchl; Nestler, & Weiss, 2021). However, some studies (Veenstra, Daatland, & Aartsen, 2021) have found that the desire to be younger is often related to dissatisfaction with life and poor physical health. These data deficits and inconsistencies have led to the inclusion of temporal focus and subjective age as cognitive components of psychological time as factors of late socialization by Nestik (2015) in his theoretical model.

### *A priori model*

Theoretical analysis allowed us to construct a model of the contribution of psychological time to late socialization (*Figure 1*).

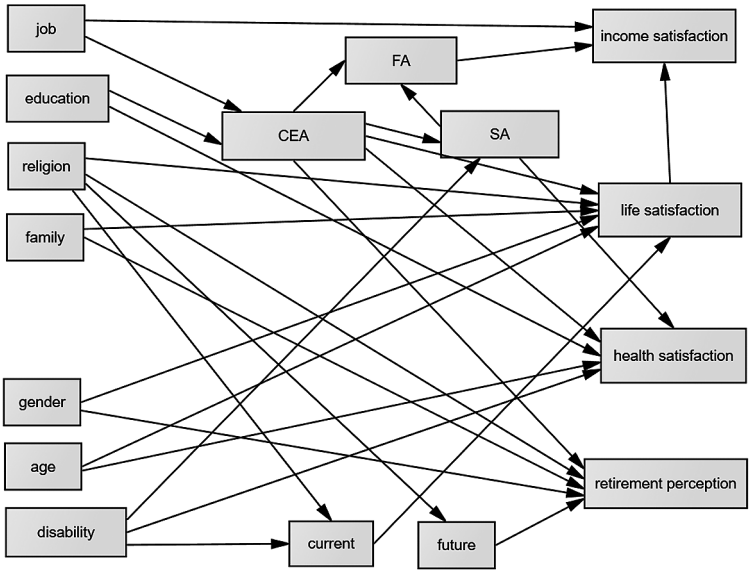



*Figure 1.* A priori model of contribution of psychological time to late socialization

*Notes: CEA = cognitive-emotional age; SA = social age; FA = physical age; current = current focus; future = future focus. Biological factors: gender, age, disability. Social factors: job, education, religion, family.*

The model we developed consists of several components (factors and criteria of late socialization), wherein psychological time serves as the mediator of the relationship between the factors of socialization (biological and social) and the criteria of its effectiveness (subjective well-being). By the effectiveness of late socialization, we mean the degree to which an older person is able to adapt to the new social status of a retiree. Within the framework of this model, we use only the internal (subjective) criteria of efficiency, because today more and more weight is given to subjective assessments of the human condition compared to the objective (*e.g.*, Westerhof, Miche, & Brothers, 2014).

For example, in medicine, a person's perception of their disease is considered more relevant than the objective indicators of disease (Vasserman, Chugunov, & Shchelkova, 2019). It is believed that only the person knows best what is good or bad for him. Besides, according to some research (Dubynina, 2019), while other stages of socialization are associated with such solemn rituals as the graduation ceremony, wedding, etc., in old age, life itself comes to the forefront of a person's inner sense of identity.

Biological and social factors (conditional separation) within this model are considered as independent variables, because they are effectively given to the person from the outside, — that is, defined objectively, they are difficult to influence by one's desire. Social factors in this case are the factors that trigger change and the need to socialize anew. For example, retirement often involves the termination of a professional career, the destruction of some social (working) ties, etc.

Psychological time acts as a subjective factor, because by mediating external (objective) events, psychic perception can change a person's interpretation and attitude toward them. That is why we assume its mediating role in the model.

Finally, subjective well-being in retirement seems to be an even more subjective factor that is likely to change in response to changes in external social conditions, taking into account the individual's perception. Subjective well-being, or satisfaction with various aspects of life, is most susceptible to change in response to changes in the retiree's environment (*e.g.,* Shchukina, & Shirman, 2022); thus, we consider it as a dependent variable. The a priori model was then verified in our empirical study.

## Methods

Our research methods included questionnaires to collect data on social and biological factors of late socialization. The biological factors identified were the gender of the respondents (1 = male, 2 = female), their chronological age, and whether they had a disability (1 = yes, 2 = no).

The following were identified as social factors: a) level of education (1 = primary, 2 = general secondary (school), 3 = secondary vocational, 4 = higher); b) family (1 = married, 2 = single, 3 = divorced, 4 = widowed); c) working status (1 = working, 2 = not working); and d) the level of religiosity (1 = atheist, 2 = indifferent to religion, 3 = admit the existence of the Higher Forces, 4 = I am a believer, 5 = I believe and try to observe the rites of my religion).

For diagnostics of temporal focus we used the Russian version of the Temporal Focus Scale (Shipp et al., 2009). The technique is a simple tool which includes 12 statements and 3 subscales: 1) focus on the past (M = 5.21, SD = 1.46); focus on current events (M = 5.17, SD = 1.17; and focus on the future (M = 4.44, SD = 1.57). The scale showed a high level of reliability on the Russian sample (α = 0.879).

To explore subjective age, the Age-of-Me scale was applied (Barak, 2009) (α = 0.913). The questionnaire consists of four statements with missing values, in which a digit must be entered: 1) I feel __ years old; 2) I think I look ___ years old; 3) In my opinion, I act like a person of __ years; and 4) My interests mainly correspond to the interests of a person __ years old. The first statement characterizes the cognitive-emotional age (feeling-age), the one at which a person "feels oneself" (M = 54.6, SD = 15.38). The second statement reflects the biological (physical) age (look-age) — "the age that a person looks like" (M = 57.9, SD = 12.57). The third statement conveys social age (do-age) — "the age at which a person acts" (M = 56.7, SD = 12.51). The fourth statement describes the intellectual age of a person (interest-age); this is "the age at which a person shows his or her interests" (M = 56.87, SD = 11.79).

The results were counted in two ways. First, the figures (age) given by the respondents in the survey (on four scales) were the primary data. Second, the difference between the age indicated in the statements by the respondents and the person's actual chronological age was calculated. In the second case, the higher the indicator, the younger the subjective age is diagnosed.

The main criterion for late socialization — the subjective well-being of the retirees — was diagnosed with several indicators: 1) Life satisfaction as a component of subjective well-being (Diener & Lucas, 1999); 2) Subjective assessment of income as an indicator of subjective economic well-being (Deyneka, 2000); 3) Subjective assessment of physical condition as health satisfaction; and 4) General perception and attitude toward retirement as a qualitative indicator of the satisfaction of life in retirement.

The level of happiness and subjective well-being was investigated with the help of the questionnaire by Diener and Lucas (1999). The Subjective Happiness Scale (M = 4.05, SD = 1.49) measures the emotional experience of an individual's life as a whole, reflecting the overall level of psychological well-being. The main advantage of this method is its compactness, as well as its validity and reliability (α =0.874), thanks to a simple and unambiguous internal structure.

For the diagnosis of subjective economic well-being, the study used Furnham's scale of subjective income level as adapted by Deyneka (2000). Respondents were asked to rate their income on a 7-point scale, with 1 being making ends meet and 7 being very high. This method (M = 3.56, SD = 0.96) is widely used in studies of economic psychology as an indirect indicator of a person's subjective economic well-being.

Subjective assessment of the level of health was carried out using the authors' scale of assessment of the physical condition of the respondents (M = 3.12, SD = 0.73). The evaluation was conducted using a 5-point Likert scale when answering the question "Assess your physical condition" (1 = very bad, 2 = bad, 3 = satisfactory, 4 = good, 5 = excellent). Thus, the higher value of this indicator in the model corresponds to a higher level of satisfaction with one's health.

The diagnosis of general perception and attitude towards retirement was carried out using the method of open questions. Respondents were asked to complete the sentence: "Life in the retirement is...". Their answers were subject to a thematic analysis (Braun, & Clarke, 2006), which allowed us to distinguish three semantic categories: 1) negative perception of retirement (*e.g.,* "sadness," "idleness," "death"); 2) neutral attitude to retirement life (*e.g.,* "another life," "another stage in life," "continuation of the path"), and 3) positive perception of retirement (for example, "dream," "rest," "live for yourself," "freedom," etc.). That is, the higher value of this indicator in the model corresponds to greater satisfaction of life in retirement.

The main mathematical method was structural equations modeling — SEM (Byrne, 2016). Data processing was carried out using the statistical package IBM SPSS Statistics Rus. 24.0, including the AMOS module. To measure the model's compliance with the original data, the method of structural equations modeling was used with recommended values of criteria: p — criterion significance level, $\chi^2 > .05$, CFI > .95, RMSEA < .05, GFI > .9, PCLOSE = .5.

### *Participants*

The sample was randomly drawn from retirees living in Chelyabinsk (Chelyabinsk region, Russia) and included people with various living conditions (living separately, in families, in nursing homes, etc.), types of occupations, education levels, family relationships, and working status. The Chelyabinsk region is one of the largest economic units of the Russian Federation. The region's industrial development is determined by the metallurgical, engineering, fuel and energy, construction, and agro-industrial sectors. The steel sector leads the economy, with more than 60% of the area's industrial production. Since the majority of the population is employed in the metallurgical sector, many are likely to have health problems and to retire immediately after reaching the relevant age, except for employers and managers. There are some institutions of late socialization in Chelyabinsk, such as retiree clubs, libraries for the elderly, volunteer programs, etc. (http://chelib.ru/sitemap/to-readers/clubs/for-elders/). Many retirees have private plots of agricultural land.

A total of 291 retirees were surveyed (*Table 1*). The criterion for inclusion in the sample was having had the status of the retiree for at least one year, as well as the absence of a psychiatric diagnosis (clinical norm). Accordingly, the criterion for exclusion from the sample was non-achievement of retirement age, and not having the status of retiree.

The number of women in the study sample is much higher than the number of men, because, according to ROSSTAT (https://rosstat.gov.ru/storage/mediabank/Bul_chislen_nasel-pv_01-01-2022.pdf), women live longer than men in general. Employed (N = 134) and unemployed (N = 157) retirees were represented in approximately equal proportions. Thirty-four percent (34%) of the total sample had a disability (n = 75), which is also natural, since the number of chronic diseases and other health problems resulting in disability increases with age. Also. the sample contained approximately the same number of single (n = 135) and married retirees (n = 156). Thus, it can be concluded that the sample is representative and reflects the general population as far as the main indicators are concerned.

**Table 1**

*Sample characteristics*

| № | Respondents | Gender | | N |
|---|---|---|---|---|
| | | Male | Female | |
| 1 | Total | 75 | 216 | 291 |
| 2 | Employed | 42 | 92 | 134 |
| 3 | Unemployed | 33 | 124 | 157 |
| 4 | Disabled | 15 | 60 | 75 |
| 5 | Without disability | 26 | 190 | 216 |
| 6 | Married | 50 | 106 | 156 |
| 7 | Single | 25 | 110 | 135 |

Because older respondents may lose cognitive function (*e.g.*, loss of attention), the questionnaires were offered in paper form, and completed individually under the supervision of the researcher.

## Results

First, we tested the model to include all the variables that were being diagnosed (Byrne, 2016). In this case, we found some of the factors had no significant associations: gender ($p = .094$), age ($p = .889$), and family status ($p = .129$). The model's fit was also far from acceptable: CMIN = 320.062, df = 95, $p = .000$; GFI = .878; CFI = .716; RMSEA = .090; Pclose = 0.000. Therefore, we decided to remove a range of indicators from the final model as not having sufficient weight to explain its content. After the removal of gender, chronological age, and family status, the model's parameters improved significantly: CMIN = 114.127, df = 56, $p = .000$; GFI = .929; CFI = .865; RMSEA = .074; Pclose = .005.

In order to further improve the model's suitability, we combined the errors of the variables of working status and education level, current and future focus, and three satisfaction indicators. The final model showed satisfactory correspondence indexes of the empirical data with the theoretical model (CMIN = 65.740, df = 52, $p = .095$; GFI = .967; CFI = .979; RMSEA = .030; Pclose = .944) (see *Figure 2*). All model elements showed significant associations (*Table 2*).

The analysis of the posteriori model generally confirmed the basic assumption: the level of subjective well-being in retirement age is influenced by biological and social factors, while psychological time (its cognitive component) mediates this effect.

The presence or absence of disability was the only biological factor that showed a link with the criteria of late socialization. Disability had a moderate influence on the retiree's subjective assessment of her health, both directly and through subjective (social) age, which mediates this impact. The absence of disability in old age increased the probability of assessing oneself as a healthier person, contributed to the shaping of interests of "younger age," and allowed the retiree to feel included in a social group of younger people, which in turn reduced the risk of poor health scores. In addition, the lack of disability status contributed to overall retirement satisfaction indirectly through a focus on the present.

**Table 2**

*Regression coefficients in the model*

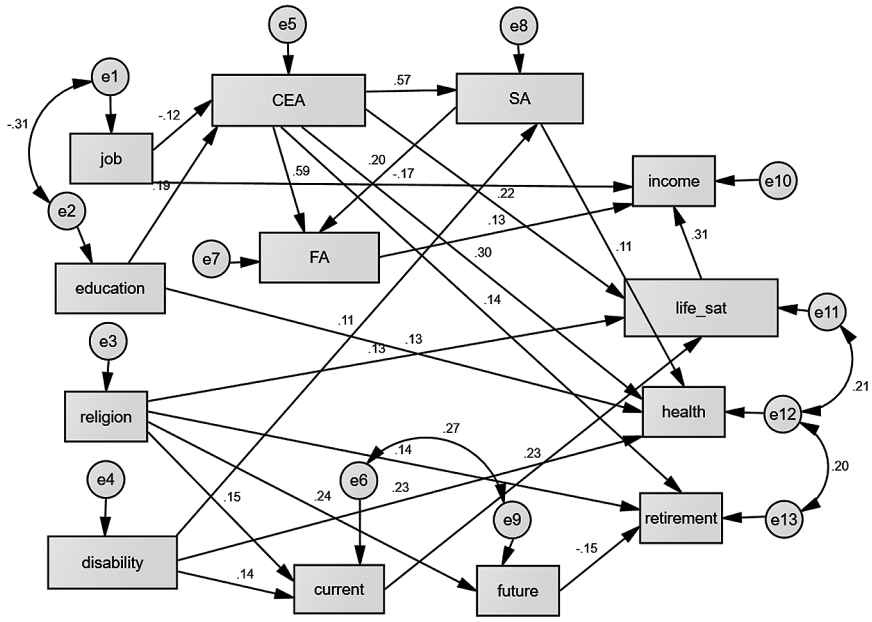
| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| CEA | <--- | job | –.895 | .433 | –2.064 | .039 |
| CEA | <--- | education | 3.579 | 1.143 | 3.131 | .002 |
| current | <--- | religion | .179 | .069 | 2.585 | .010 |
| current | <--- | disability | .461 | .186 | 2.483 | .013 |
| SA | <--- | CEA | .430 | .036 | 12.009 | *** |
| SA | <--- | disability | 3.139 | 1.362 | 2.305 | .021 |
| life_sat | <--- | current | .297 | .069 | 4.306 | *** |
| future | <--- | religion | .384 | .093 | 4.147 | *** |
| life_sat | <--- | CEA | .024 | .006 | 3.934 | *** |
| life_sat | <--- | religion | .200 | .083 | 2.401 | .016 |
| FA | <--- | CEA | .443 | .038 | 11.801 | *** |
| FA | <--- | SA | .197 | .050 | 3.931 | *** |
| income | <--- | job | –.087 | .028 | –3.092 | .002 |
| health | <--- | education | .138 | .052 | 2.662 | .008 |
| health | <--- | SA | .008 | .004 | 1.885 | .059 |
| retirement | <--- | future | –.078 | .030 | –2.584 | .010 |
| income | <--- | life_sat | .198 | .035 | 5.673 | *** |
| health | <--- | CEA | .016 | .003 | 4.753 | *** |
| retirement | <--- | CEA | .008 | .004 | 2.361 | .018 |
| retirement | <--- | religion | .121 | .049 | 2.460 | .014 |
| income | <--- | FA | .013 | .005 | 2.438 | .015 |
| health | <--- | disability | .475 | .101 | 4.685 | *** |

*Notes: CEA = cognitive-emotional age; SA = social age; FA = physical age; current = current focus; future = future focus; retirement = perception of the retirement; life_sat = life satisfaction.*

At the same time, the focus on current events and interest in them contributed to increasing life satisfaction. Thus, the analysis of the model revealed a significant influence of the biological factor — disability — on the effectiveness of late socialization, both directly and indirectly, mediated by social age and current focus.

Several social factors were important for the effectiveness of the late socialization process: the continuation of a professional career (working status), the level of education, and the level of religiosity. Although the contribution of each of these indicators was less than that of the biological factor of disability, collectively they were serious predictors of subjective well-being in retirement. In this case, elements of psychological time (temporal focus and subjective age) could adjust the influence of these factors.

Thus, the working status of a retiree may increase or decrease his or her satisfaction with their income (subjective economic well-being), depending on whether this




CMIN = 65.740, df = 52, p = .095; GFI = .967; CFI = .979; RMSEA = .030; Pclose = .944

*Figure 2.* Posteriori model of the contribution of psychological time to late socialization

*Notes: CEA = cognitive-emotional age; SA = social age; FA = physical age; current = current focus; future = future focus; retirement = perception of retirement; life_sat = life satisfaction.*

influence is mediated by subjective age. In general, non-working retirees were more likely to experience lower income satisfaction, but for those who felt younger (cognitive-emotional and physical age), on the contrary, income satisfaction increased. It is likely that people of retirement age who perceive themselves to be younger than their age, have a positive attitude toward their age, maintain themselves in good physical and mental form, and extend this positive attitude to the assessment of their material condition. On the other hand, it is possible that older persons who invest in their physical and emotional well-being may feel more financially wealthy, regardless of their working status.

A similar pattern can be observed with regard to education. High educational level by itself did not directly affect income satisfaction, but, combined with younger subjective age (cognitive-emotional and physical one), contributed to greater subjective economic well-being. In addition, the feeling of being younger than one's age contributed to a positive (optimistic) perception of life in retirement, increased self-esteem in health, and overall life satisfaction. That is, a younger subjective age served as a mediator to enhance the social factors of late socialization.

In addition, higher levels of education alone made a small contribution to the assessment of physical well-being in retirement (health), which can be attributed to greater knowledge about health and medicine, and a clearer understanding of where to fill knowledge gaps in this field. Education and the habit of constant learning can create a mindset of individual awareness, including in relation to one's own health,

which implies a more attentive approach to one's physical condition and timely prevention of illness.

The level of religiosity of an elderly person, one's faith in God and religious rituals, contributed to effective late socialization (satisfaction with life and the positive perception of life in retirement), both directly and indirectly — through the retiree's temporal focus. Involvement in the events of the present (current focus) significantly increased this influence, while thoughts and worries about the future (future focus), on the contrary, negated this influence, worsening expectations about life in retirement (such as the time of death, boredom, loneliness, etc.). That is, despite the belief in higher forces, a focus on the future in retirement age may reduce the effectiveness of the process of late socialization.

## Discussion

The model we developed clarifies the role of psychological time (specifically, its cognitive component) in the process of late socialization by matching and complementing previous data. The impact of a focus on the present on life satisfaction has been confirmed by a number of studies (Shipp et al., 2009). However, in our study we have established the status of a current focus as the mediator between biological (disability) and social (religiosity) predictors of late socialization. Involvement in current events, interest in them, and motivation to actively participate in them, even despite objective health constraints, seems to be a recipe for happy old age.

It seems to be important to identify the fact that a pronounced future focus in retirement age may reduce the effectiveness of late socialization through the negative perception of the retirement lifestyle. Despite the novelty of the data obtained, they are generally consistent with Carstenen's concept of a shorter time horizon for the future in old age (Carstensen et al., 1999). Most likely, anxiety about retirement, especially in the later period, leads people to look into the future more often, presenting it in negative terms.

Younger subjective age contributed to an increase in all diagnosed indicators of effective late socialization, as confirmed by other studies (Blöchl, Nestler, & Weiss, 2021; Sergienko, 2020). At the same time, the understanding that certain subjective ages may mediate (increase or decrease) the influence of other factors (*e.g.*, educational level, working status) broadens our understanding of the role of this phenomenon in the process of late socialization. Age perception seems to be the result of a complex interaction of various factors, objective and subjective, which needs further research. Moreover, the discovery of the role of different types of subjective age (physical, cognitive-emotional, and social) can be considered an outcome of the study, which could start a new line of research.

The role of objective health and disability in shaping the subjective well-being of the retirees, as noted in a number of studies (VOZ, 2010; Nicholson, 2004; Paterson, & Warburton, 2010), has also been confirmed in this model. The results of the study clarify the mechanism of this influence, which can be mitigated by social age and focus on current events. It can be assumed that retirees' interest in modern trends, which can be realized thanks to IT technologies, allows older people to compensate for objective health problems and thus increases their subjective well-being.

In general, the model of psychological time as a factor shaping late socialization fits well with modern models of successful aging (Shchukina, & Shirman, 2022). To ensure the continuity of the personal development of older persons, it is necessary for them to continue to lead an active creative and social life, to reflect on their life experience, to rethink it creatively, and to use it in their current life situation.

## Limitations

The main limitation of the study was its narrow approach to socialization and its criteria as purely subjective (psychological). External criteria of socialization, such as the ability to function independently, productivity as a member of society and others, were not considered. On the other hand, the introduction of additional criteria would have complicated the already loaded model, causing possible computational difficulties. In addition, the research is impoverished by the fact that it did not consider the process of socialization, but only its outcome, and that only in a subjective way.

The study identified the role of only two cognitive components of psychological time. In further studies it is proposed to test the assumption about the role of nostalgia, time attitude, and time perspective in the process of late socialization. The study involved retirees living in one city with a strong industrial profile, which could have skewed the results. In the future, it is planned to expand the sample to include representatives from cities and towns in Russia with different urban orientations.

In addition, the study was limited in its methods of data collection. For example, the measure of disability can be more variable, including various degrees and nosologies that can determine a person's satisfaction to some extent. In this study, we only accepted the diagnosis of disability without specifying the criteria, which makes the measurement quite crude. Moreover, some important biological and social indicators — namely, gender, age, and family status — may have a significant impact on how people live in old age but are not reflected in the empirical model. We explain this with a large number of variables in the model, where it is possible to "displace" less significant factors. A confirmation of this assumption can be found in other studies where the relationship of life satisfaction to the individual's family situation is not determinative (*e.g.,* Shchukina, & Shirman, 2022). Further research with other design options is needed to clarify this finding.

Our model explains the causal relationships between factors and results of late socialization unilaterally. But it must be understood that psychic reality is always more complex than a theoretical model. Probably, in reality, the associations of the model elements are bidirectional; that is, they are mutually deterministic. For example, feeling younger than one's chronological age (a younger subjective age) can increase subjective satisfaction with life. At the same time, it is possible that improved physical indicators due to rest or treatment may cause one to feel younger.

## Conclusion

Thus, the study succeeded in developing and verifying a model of the contribution of psychological time (its cognitive component) to late socialization. It was shown

that temporal focus and subjective age are the factors that mediate the association between biological and social variables, and the subjective well-being of the retirees. In particular, it has been established that a younger subjective age serves as a mediator that strengthens the social factors of late socialization (level of education, working status), along with biological factors (presence of disability). The temporal focus mediates the contribution of religiosity to the effectiveness of late socialization: involvement in current events (current focus) greatly enhances the subjective well-being of retirees, while thoughts and worries about the future (future focus), on the contrary, offset this influence, worsening expectations for retirement.

Our results broaden the understanding of the late socialization phenomenon, determining time-cognitive predictors of its success. New evidence about the role of cognitive elements of psychological time in the process of late socialization provides the basis for the development of special training and counselling programs on the prevention of fear of aging, helping retirees acquire the ability to adapt to their age and increase satisfaction with later life. It is recommended that individuals, family systems, and community organizations all work to maintain older persons' interests, stress their importance, and offer them an active role during retirement.

A separate niche in psychological practice with retired clients can be a discussion of their image of the future and perception of their own age. It is likely that changing their picture of the future and creating a more positive perception of themselves in it, as well as enrichment with modern interests, will make it easier for retirees to adapt to their new status and make this period of life happier, reducing the fear of aging and loneliness. We also recommend that preventive work be initiated before retirement age in preparation for late socialization. The study contributes to science by demonstrating the role of psychological time in enhancing the effectiveness of late socialization, suggesting a cognitive-therapeutic approach to overcoming the negative consequences of an aging society.

## Author Contributions

E. Zabelina and Yu. Chestyunina conceived of the idea. Yu. Chestyunina and E. Vedeneeva developed the theory and performed the computations. E. Zabelina and Yu. Chestyunina verified the analytical methods. O. Deyneka encouraged Yu. Chestyunina to investigate temporal focus in the model of late socialization and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

## Ethics Statement

The study and consent procedures were approved by the Ethics committee of the Department of Psychology at Chelyabinsk State University

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EDUCATIONAL PSYCHOLOGY

# Conscious Self-Regulation as a Meta-Resource of Academic Achievement and Psychological Well-Being of Young Adolescents

Varvara I. Morosanova[a], Tatiana G. Fomina[a*], Irina N. Bondarenko[a]

[a] *Psychological Institute of the Russian Academy of Education, Moscow, Russia*

*Corresponding author. E-mail: tanafomina@mail.ru

**Background.** The role of conscious self-regulation in determining students' psychological well-being and academic performance is considered in the context of the fundamental problem of the regularities of young adolescents' development.

**Objective.** To reveal the role of meta-resources of conscious self-regulation in determining young adolescents' psychological well-being and academic performance.

**Design.** Sample: 500 students in 4th- to 6th grade (10–12) in general schools, 149 of whom participated in a three-year longitudinal study. The Self-Regulation Profile of Learning Activity and the Well-Being Manifestation scales were used.

**Results.** Conscious self-regulation and academic performance increase significantly in fifth grade and decrease in sixth grade. On the contrary, psychological well-being is characterized by a systemic positive dynamic. A typological analysis identified the levels of psychological well-being of students growing, stable, and declining during the transition period. It was found that the general level of conscious self-regulation made a significant positive contribution and is a universal resource for students' psychological well-being and academic performance. Special regulatory resources for academic performance are described, depending on the trajectory of changes in psychological well-being. Increased well-being is determined by the regulatory competencies of Planning and Evaluation of results and its stability by Planning, Modelling, Flexibility, and Responsibility. The general level of self-regulation, regulatory competencies, Planning, Programming and Responsibility mediate in the relationship between student psychological well-being and academic performance. A longitudinal study found that self-regulation has a long-term positive effect on student psychological well-being and academic performance.

***Keywords:*** conscious self-regulation, psychological well-being, resource approach, meta-resource, longitudinal study, adolescence, transition from primary to secondary school

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**Conclusion.** Conscious self-regulation is a meta-resource that makes a significant contribution to both the psychological well-being and academic performance. Mediator and prognostic effects of self-regulation on these properties create a psychological basis for practical work.

## Introduction

The scientific problem of the regularities of psychological development of young adolescents in grades 4–6 (ages 10–12) at a general education school has recently attracted the attention of researchers (Fomina & Morosanova, 2019; Ng, Huebner, & Hills, 2015; van Genugten, Dusseldorp, Massey, & van Empelen, 2017). This period covers the transition from primary to secondary school, takes three years, and is accompanied by a number of quantitative and qualitative changes in the adolescents' psyche. The questions of what psychological resources are necessary for solving age-related tasks of realizing one's own behavior, understanding one's individual characteristics, mastering the ability to build relationships, and developing social activity continue to be relevant. Identification of these resources to maintain psychological well-being and academic performance under changing learning conditions in transitional periods remains a significant and not yet solved task.

In spite of the fact that there has been considerable research on the cognitive and personal development of young adolescents, theoretical studies of age-related changes in the regulatory sphere are fragmentary and available empirical data are often contradictory. And while the personal (Potanina & Morosanova, 2022) and motivational (Gordeeva, Sychov, & Stepanova, 2022) spheres in relation to school success and psychological well-being have been fairly well studied (Gordeeva et al., 2022; Tikhomirova et al., 2020; Veraksa et al., 2022), the contribution of conscious self-regulation (Morosanova & Fomina, 2016) to achieving academic success without sacrificing psychological well-being has been poorly studied and is the subject of the present article.

### *Conscious Self-Regulation in Achieving Educational Goals*

The relevance of studying conscious self-regulation in the field of education has been often emphasized by Russian and foreign researchers (Gestsdottir et al., 2017; Morosanova, 2021; Veraksa et al., 2021). Regulatory resources are the psychological basis for the formation of universal learning competences and the achievement of meta-outcomes of education (agentive, regulatory, and personal), which are indicated in the Russian State Educational Standards (FSES OOO) as the goals to be achieved at all the levels of study. Data on the age-related characteristics of conscious self-regulation are in demand not only in psychological science, but also in pedagogical support for the achievement of educational meta-results.

### *A Resource Approach to the Study of Conscious Self-Regulation (SR)*

The position of adolescents as subjects of education at a new level of studies raises the issue of developing their conscious self-regulation in order to set new goals, successfully achieve them, and maintain an optimal level of psychological well-being.

The present study was carried out on the basis of a resource approach to conscious self-regulation (Morosanova, 2016, 2017, 2021). We consider conscious SR to be the control level of an integral system of human psychic self-regulation. This level is realized by a person's universal and special regulatory competencies, allowing him or her to consciously and independently set goals and manage their achievement. Our empirical studies of recent years have shown that these competencies make a direct contribution to successful activities and also serve as a psychological means for mobilizing, integrating, and mediating the influence on a person's behavior of various subsystems of cognitive, personal, and psychophysiological resources and human reserves. In this sense, conscious self-regulation is a controlling meta-resource for successful solution of a person's life tasks.

This meta-resource is implemented by two groups of regulatory competencies. The cognitive ones are consistently manifested in various types of activity and provide for planning one's goals, modeling significant conditions for their achievement, programming, evaluating results, and correcting actions. Intrapersonal competencies are the ways of regulating behavior and relations with the outside world (flexibility, reliability, independence, initiative, etc.). The regulatory meta-resource has a hierarchical structure and is implemented through universal and special resources, which differ according to the scale of the tasks being addressed.

The heuristic value of the resource approach to the study of conscious SR is demonstrated by results obtained in the fields of professional activities (Kondratyuk & Morosanova, 2022; Morosanova et al., 2020b), psychological health and stress resistance (Morosanova et al., 2021b), and educational activities (Morosanova & Fomina, 2016). Surveys of schoolchildren have made it possible to empirically verify the theoretically substantiated idea that conscious self-regulation is a meta-resource for achieving educational goals, which contributes to the productive aspects of achieving these goals and serves as a mechanism for coordinating, mediating, and accumulating the entire palette of individual psychological properties used by students to solve various problems, including learning, self-education, and professional self-determination. Thus, on a sample of students in grades 7–11, it was shown that the general level of SR, along with non-verbal intelligence, acts as a universal resource for academic achievement (Morosanova & Fomina, 2016) and project activities (Morosanova & Filippova, 2021). The same is true for high achievement on the Unified State Exams (USE), in combination with SR reliability as a special resource for academic success under stressful testing conditions (Morosanova & Filippova, 2019). The regulatory competence of modeling significant conditions turned out to be a special resource for success in mathematics at school (Fomina & Morosanova, 2019). For the first time, similar patterns were replicated for success in learning one's native language (Russian) (Morosanova et al., 2021a). An important result in terms of maintaining students' health and well-being was obtained in relation to SR and school anxiety: regulatory competencies act as mediators reducing the risk of developing high levels of test anxiety (Morosanova & Fomina, 2017).

### *Psychological Well-Being (PWB) of Young Adolescents*

Studies in the field of educational psychology show that the academic performance of students with a high level of PWB is significantly higher than that of their peers with

low PWB. The same is true for school engagement, self-efficacy, social adaptation, and test anxiety level (Bondarenko et al., 2020; Fomina et al., 2021; Morosanova et al., 2020a). We define psychological well-being as a construct that ensures the functional state of a student and includes a number of components. Some of them are associated with experience of satisfaction, and others with realization of the needs, meanings, and goals of the personality (Morosanova et al., 2018).

During the transitions from 4th to 5th grade and from 5th to 6th grade, the academic performance and PWB of some students stays at a fairly high level and does not undergo significant changes, while other students demonstrate an increase or decrease of these characteristics. A decline in well-being cannot but cause concern. Studies have shown the significance of life satisfaction among adolescents for the general trajectories of their age-related development and positive functioning in the future (Blakemore & Mills, 2014; Calmeiro et al., 2018; Caprara et al., 2017; Orben, et al., 2020). In this regard, longitudinal studies are of particular scientific importance, as they permit more substantiated conclusions about the factors influencing PWB dynamics. It has been repeatedly demonstrated that conscious self-regulation is one such factor (Morosanova et al., 2018; Pandey et al., 2018). In particular, regulatory competences mediate the risk of developing a high level of assessment anxiety (Martin & Steinbeck, (2017). According to a meta-analysis, this can predict a wide range of significant manifestations of PWB in children and adolescents, such as the quality of interpersonal interaction and mental health (Robson, Allen, & Howard, 2020). Moreover, more and more researchers emphasize the importance of including practical methods for developing self-regulation in programs for improving the PWB of adolescents in order to increase their satisfaction with life (van Genugten et al., 2017).

### *The Relationship Among Self-Regulation, Psychological Well-Being, and Academic Achievement*

The relationship among PWB, SR, and academic performance during the transition from elementary to secondary school is changing. It has been shown that young adolescents are characterized by a drop in academic motivation, which inevitably leads to a decrease in academic achievement, and this negatively affects their subjective well-being (Martin & Steinbeck, 2017). In parallel, a weakening is observed in the relationship between academic achievement and students' PWB (Yang et al., 2019). In contrast to these trends, SR is a reliable predictor of both academic achievement and well-being of adolescents, which argues in favor of understanding SR as a meta-resource for solving various life problems, such as overcoming academic failure and academic stress, and achieving professional self-determination, etc. (Fomina & Morosanova, 2019; Gestsdottir & Lerner, 2008; Morosanova, 2017, 2022).

The age period under study has not been investigated sufficiently due to the weak ability of young adolescents to reflect and the non-linear nature of the ongoing psychological processes. The great variability of individual characteristics in the development and formation of the studied parameters led to designing various strategies for organizing empirical research and data processing to solve the problem.

### *Current Study*

The main hypothesis of this study is that self-regulation, as the controlling meta-level of the system of universal and special regulatory resources for achieving educational goals: directly affects academic success, and mediates the influence of other individual reserves on it, in particular, that of psychological well-being.

The study's purpose is to reveal the meta-resource role of conscious self-regulation in determining the psychological well-being and academic performance of young adolescents.

To achieve this goal, the following research tasks were set:

1) to determine the dynamics of conscious self-regulation, psychological well-being, and academic achievement of students based on the data of a three-year longitudinal study;
2) to identify universal and special regulatory resources of academic achievement for students with different dynamics of PWB;
3) to assess the mediator effects of conscious SR (as well as of certain regulatory competencies) in the relationship between the students' psychological well-being and academic achievement;
4) to substantiate the long-term effects of self-regulation on the psychological well-being and academic performance of students.

## Methodology

### *Participants*

The sample was formed from 4th- to 6th-grade students of Russian general education schools in Moscow and Kaluga. More than 500 schoolchildren took part in the study at its various stages. The sample of fourth graders consisted of 402 people (53% boys, mean age 10.20, standard deviation 0.50). The sample of students involved in the study in both the 4th and 5th grades was 239 people (48% boys). The sample of 6th-grade students included 185 people (50% boys, mean age 11.95, standard deviation 0.50). The total sample of the longitudinal study from grades 4–6 (children who took part in three measurements) was 149 people (50% boys).

### *Methods*

The main research instruments included "Self-Regulation Profile of Learning Activity Questionnaire, SRPLAQ-M" (Morosanova & Bondarenko, 2017) and "Well-Being Manifestations Measure Scale" (Morosanova et al., 2018). As an additional instrument, the study used "Big Five - Children's Version", adapted in Russian (Malykh et al., 2015). We also collected data on academic achievement across all age groups and calculated the average score of the final grades in the main academic subjects.

### *Procedure*

Depending on the problems being solved, these studies implemented either a cross-sectional or a longitudinal design. The cross-sectional data were used to identify a significant relationship among conscious SR, PWB, and academic achievement (includ-

ing mediating effects), while the longitudinal data were used to reveal their dynamics and prognostic effects. For statistical data analysis, the study used IBM SPSS Statistics, version 26: primary statistics (mean values, standard deviations, etc.), correlation analysis, cluster analysis, and Wilcoxon test. The resource nature of conscious SR was studied by means of the Stepwise Regression method, which allowed us to assess the SR contribution to academic achievement and PWB. An integrative indicator of SR development (general SR level) was used to test the assumption of the universality of the regulatory resources for achieving educational goals, and particular cognitive and personal regulatory indicators were used to assess the contribution of special resources. Cross-longitudinal structural modeling was performed by means of the AMOS 23 program. To reveal the mediating role of self-regulation, mediator analysis was used in accordance with the classical scheme, as well as the Sobel test.

## Results

Dynamics of Psychological Well-Being, Conscious Self-Regulation, and Academic Achievement: Individual Typological Trajectories

The first research task was aimed at identifying the dynamics of conscious self-regulation, psychological well-being, and academic performance of the students. A longitudinal study of students from grades 4 to 6 made it possible to establish a number of regularities. *Figure 1* shows averaged data characterizing the revealed dynamics.

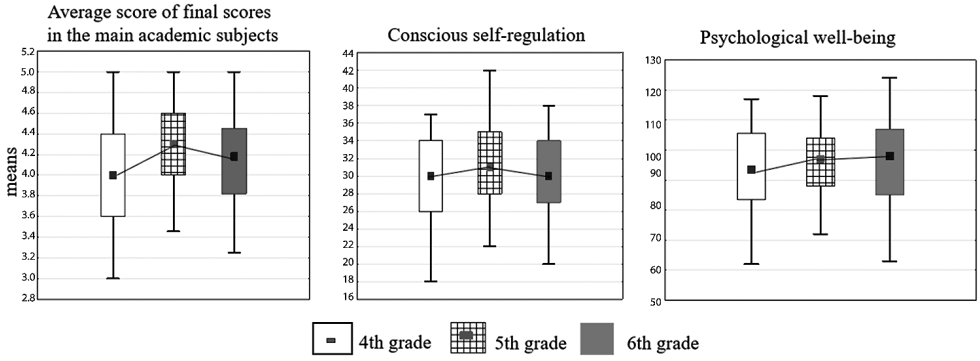


*Figure.1.* Dynamics of students' PWB, academic achievement, and self-regulation during their transition from primary to secondary school (three longitudinal points), means and variances

*Note. Conscious self-regulation — integrative indicator calculated as sum of values for all SR features; Psychological well-being — integrative indicator calculated as sum of values for all PWB components*

In the period under study, the students' PWB is gradually increasing, while a significant improvement in academic performance and SR, which occurs during the transition from primary to secondary school, is replaced from the 5th to the 6th grade by a slight deterioration. The dynamics, therefore, show that the contradiction between activity that develops the cognitive sphere (learning), and activity aimed at understanding the relationship between people (communication), is resolved in

6th grade in favor of communication, which is manifested in a decrease in academic achievement. Indeed, according to D.B. Elkonin's age periodization of psychic development, the outstripping development of the intellectual-cognitive sphere of the psyche in this period is replaced by development of the need-motivational sphere. Accordingly, such neoplasms as deliberateness, an internal plan of action, self-control, and reflection give way to the desire for "adulthood", the formation of self-esteem, and submission to the norms of social life.

The SR dynamics are similar to those for achievement. Here it is important to keep in mind that, being a self-assessment indicator, conscious SR may reflect another trend of the period under study. The end of 5th grade corresponds to the transition from the first stage of adolescent development (10–11 years) to the second one (12–13 years). If at the first stage adolescents "accept" themselves, being able to identify negative traits, then at the second stage they are characterized by situationally negative self-esteem, which can be expressed in a decrease in their SR subjective assessment in 6th grade.

The rise in academic achievement, PWB, and SR during the transition from 4th to 5th grade undoubtedly requires a more careful and detailed investigation of the psychological resources providing this improvement. Particularly interesting in this regard is the continuous growth of PWB despite the crises of this age.

The rise in PWB does not negate the fact that, moving from 4th to 5th grade, some students simply maintain the previously achieved level of PWB, while others do not have enough resources to do so.

Therefore, we tested the assumption that the trajectories of PWB and academic performance are determined, first of all, by the regulatory resource. Since academic performance is also determined by personal and motivational features, these were also taken into account when building regression models.

### *Universal and Special Regulatory Resources of Students with Different Trajectories of Change in Psychological Well-Being and Academic Achievement*

To solve the second research task, we used regression analysis. Studies show that general SR level is a universal resource for PWB, regardless of the PWB trajectory, whereas special regulatory resources for PWB require more detailed consideration. To this end, the sample was divided into groups with different PWB dynamics: decreasing, stable, and increasing PWB.

With regard to the special regulatory resources of PWB, the following data were obtained. The increase in PWB is determined by such SR features as Planning and Result Evaluation; the stability of PWB by Planning, Modeling, Flexibility, and Responsibility. The PWB resource in the group with reduced well-being is Result Evaluation. It is worth noting the importance of objective feedback on the results achieved by the student, regardless of group affiliation. This could be the assessment of learning activities by adults as an opportunity to earn respect of the teacher and parents, or comparison with classmates' results, which allows one to take a worthy place among peers, as well as the self-esteem which starts to form.

**Table 1**

*Specific regulatory resources of academic achievement during transition from primary to secondary school in groups with different dynamics of psychological well-being*

| 4th grade | | | 5th grade | | | 6th grade | | |
|---|---|---|---|---|---|---|---|---|
| | **Beta** | ***p*-level** | | **Beta** | ***p*-level** | | **Beta** | ***p*-level** |
| **Decreased PWB** | | | | | | | | |
| R2 = 0.32, F(8, 20) = 2.61, $p < 0.03$ | | | R2 = 0.29, F(4, 103) = 11.83, $p<0.00$ | | | R2 = 0.46, F(10, 28) = 4.19, $p<0.001$ | | |
| Planning | 0.65 | 0.01 | Modeling | 0.86 | 0.04 | Achievement motivation | 0.64 | 0.00 |
| Modeling | 0.45 | 0.03 | Responsibility | –0.60 | 0.01 | External motivation | –0.62 | 0.00 |
| | | | Anxiety | 0.86 | 0.01 | Cognitive motivation | 0.38 | 0.03 |
| | | | Achievement motivation | 0.69 | 0.02 | Neuroticism | 0.33 | 0.02 |
| | | | | | | Flexibility | 0.27 | 0.05 |
| **Stable PWB** | | | | | | | | |
| R2 = 0.31, F(6, 17) = 13.83, $p < 0.00$ | | | R2 = 0.27, F (9, 115) = 6.22, $p < 0.00$ | | | R2 = 0.59, F(13, 46) = 7.68, $p < 0.000$ | | |
| Planning | 0.31 | 0.00 | Planning | 0.21 | 0.04 | Openness | 0.69 | 0.00 |
| Flexibility | –0.18 | 0.01 | Achievement motivation | 0.42 | 0.00 | Parents' Respect motivation | –0,27 | 0.01 |
| | | | Anxiety | –0.26 | 0.01 | Planning | 0.25 | 0.03 |
| | | | Openness | 0.62 | 0.00 | Conciseness | –0.58 | 0.01 |
| | | | | | | Achievement motivation | 0.28 | 0.02 |
| | | | | | | Anger | –0.27 | 0.03 |
| | | | | | | Modeling | 0.21 | 0.07 |
| **Increased PWB** | | | | | | | | |
| R2 = 0.47, F (6, 19) = 4.65, $p < 0.00$ | | | R2 = 0.79, F (10. 11) = 8.87, $p < 0.00$ | | | R2 = 0.63, F (11. 32) = 7.69, $p < 0.00$ | | |
| Programming | 0.53 | 0.01 | Planning | 0.49 | 0.01 | Openness | 0.60 | 0.00 |
| Modeling | 0.50 | 0.01 | Responsibility | 0.64 | 0.00 | Flexibility | 0.34 | 0.00 |
| Neuroticism | 0.50 | 0.01 | Independence | 0.31 | 0.02 | Programming | –0.38 | 0.01 |
| Openness | 0.27 | 0.00 | Anger | –0.82 | 0.00 | Parents' Respect motivation | 0.26 | 0.01 |
| | | | Extraversion | –1.64 | 0.00 | Extraversion | –0.47 | 0.05 |
| | | | Agreeableness | 1.83 | 0.00 | Responsibility | 0.35 | 0.01 |
| | | | | | | Anxiety | –0.36 | 0.00 |

With respect to specific regulatory resources for academic achievement, the contribution of self-regulation was assessed for the groups with different well-being dynamics.

We confirmed the assumption that students with a decrease in PWB show a negative tendency in academic performance when they move to secondary school.

The identified regulatory predictors of academic achievement in the groups with different PWB dynamics make it possible to assess the regulatory resources allowing students to overcome the difficulties of the transition period. Numerous studies of the SR contribution to the achievement of learning goals demonstrate that it varies from 20 to 35% in different samples. In this case, we can talk about a universal regulatory resource. When evaluating the SR contribution to the achievement of specific learning goals, it is preferable to identify regulatory cognitive and intrapersonal features that make up the student's special resources in relation to these goals (*Table 1*).

Table 1 shows how the special regulatory resources of academic achievement change in the groups with different PWB dynamics at the stage of transition from primary to secondary school, following a change in the character of learning tasks. The table shows that by 6th grade, the system of predictors of academic achievement becomes more complicated. While in 4th grade it is self-regulation and personality features, in the 5th grade achievement motivation and anxiety are added, and in 6th grade it is a complex system of regulatory, motivational, personal, and emotional properties.

Thus, in 4th grade, for the group with a decrease in PWB, such resources are the competencies of Planning and Modeling, which indicates the efforts consciously made by students to achieve better results. Progress in the group with stable PWB is determined by the level of Planning and Regulatory Flexibility (with the negative sign), as well as the pronounced personal disposition Openness to new experience. The positive contributions of Planning and Openness indicate that not only volitional processes of self-organization have a positive effect on the progress of schoolchildren; equally important here is their interest in learning new things, the desire to expand their knowledge in the subjects of the curriculum. Reduced Flexibility is likely to keep the student's attention on the discipline being studied. Progress in all significant subjects in the group with an increase in PWB is also determined by self-regulation and personal dispositions. This group included students who are able to build and organize stable, step-by-step progress towards a goal, using all the factors contributing to its achievement (the positive contribution of Programming and Modeling).

Presenting the analysis of resources and predictors of academic performance in 5th grade, we will focus only on the regulatory competencies. In the group with a decrease in PWB, the main resource for academic success is the students' ability to identify the factors significant for achieving a goal (Modeling). The decrease in regulatory Flexibility and Responsibility leads to a decrease in academic achievement. In the stable PWB group, academic success is determined by the ability to set learning goals (Planning). In the group with an increase in PWB, Responsibility, Planning, and Independence make a positive contribution to the students' performance.

Summarizing the results, we note that a distinctive feature of students with high PWB and high academic achievement is the regulatory property of Responsibility, reduced Extraversion, and a high level of positive emotions in relation to both the learning process and its participants (high Agreeableness). It is important to emphasize that the fundamental difference between a universal resource and a special one is the greater connection of the latter with a differential psychological basis (cognitive and personal) of the individual, as well as the regulatory skills accumulated in the individual's experience of achieving various goals. It is this regularity that the resulting equations have demonstrated. A special regulatory resource corresponds only to a certain class of goals or even to one specific task. Its content and degree of development bears the imprint of specific actions necessary to achieve a particular goal.

In 6th grade, along with a general decline in both self-regulation and academic performance (*Figure1*), we note that in the group with negative PWB dynamics the only special regulatory resource is Flexibility. Obviously, the failure to set learning goals and to take steps to achieve them, the refusal to be responsible for the results, are the cause of both reduced well-being and reduced academic performance, compared to 5th grade. In the stable PWB group, performance is determined primarily by Openness to new experience and regulatory competencies in Planning and Modeling. The only thing that does not allow the students of this group to achieve high results is their reduced conscientiousness. And, finally, students in the group with growing PWB achieve high performance through their high responsibility and flexibility. We note the negative contribution of Programming to academic performance, which may not be a general pattern and requires further research.

### *The Mediating Role of Regulatory Resources in the Relationship Between Psychological Well-Being and Academic Achievement of Young Adolescents*

The research task of assessing the mediating effects of conscious SR in the relationship between psychological well-being and academic achievement was addressed by means of mediator analysis. The basis for setting this task was the obtained results on the significant relationship of the level of SR development with both PWB and academic performance.

To test the assumption about the mediating contribution of various regulatory competencies to the relationship between psychological well-being and academic performance in young adolescents, a mediator analysis was performed in accordance with the classical scheme and the Sobel test. We relied on a confirmed reciprocal relationship between the academic achievements of the adolescents and their well-being (not only psychological, but also its other form — subjective well-being). However, we took into account that the direction of the causal relationship between PWB and academic performance in different periods of study remains debatable.

To answer the question of whether self-regulation (as well as certain regulatory competencies) is a mediator of the relationship between PWB and student achievement, we used a statistical analysis of mediation as one of the forms of structural

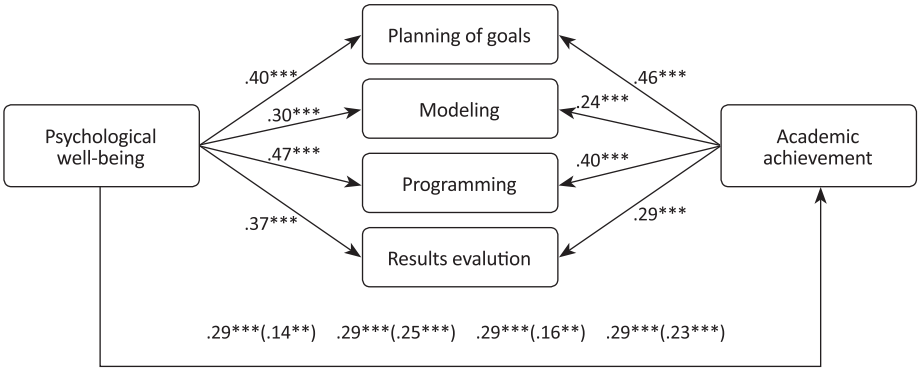


*Figure 2.* Effect of psychological well-being on academic achievement, mediated by specific regulatory resources

*Note. Standardized regression coefficients and direct effect coefficients are shown. The total indirect effect coefficient of psychological well-being on academic achievement is shown in parentheses. **p < .01, ***p < .001.*

modeling. To test the research hypothesis, we analyzed several mediator models, which successively included individual cognitive regulatory competencies as mediators (*Figure 2*), as well as an integral indicator of the general SR level (*Figure 3*). The dependent variable was academic achievement; the independent variable was students' PWB.

The most significant and high mediator effect was found for the Planning and Programming competencies (*Figure 2*). The highest mediator effect was demonstrated by the general SR level. Thus, the study confirmed the hypothesis that the development of conscious self-regulation is a universal resource for psychological well-being and academic achievement, which can affect academic performance both directly and through the relationship with special regulatory resources for the PWB of students.

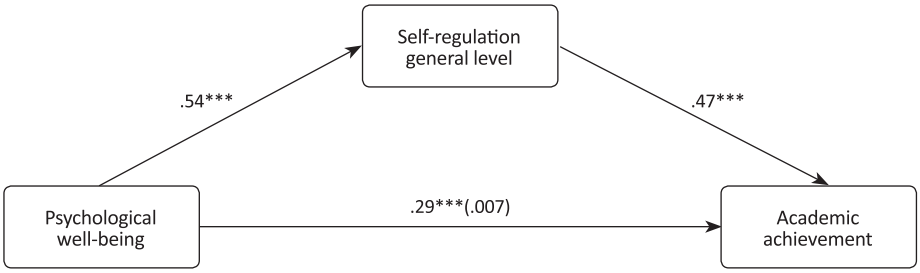


*Figure 3.* Effect of psychological well-being on academic achievement, mediated by general level of self-regulation (universal resource)

*Note. Standardized regression coefficients and direct effect coefficients are shown. The total indirect effect coefficient of psychological well-being on academic achievement is shown in parentheses. ***p < .001.*

### *Predictive Effects of Conscious SR Influence on Academic Success and PWB of Students During Their Transition from 4th to 5th and 6th Grades*

The task of substantiating the long-term effects of conscious SR on the students' PWB and academic performance was addressed by means of a cross-longitudinal analysis. This allowed us to assess the stability of the studied features over time, through analysis of simultaneous relationships and the overall variation of variables within each of the measurements, as well as to reveal causal relationships, showing how much the variation in the previous measurement of one feature explains the variation in the subsequent measurement of another feature. *Figures 4* and *5* present the final models, including only significant relationships.

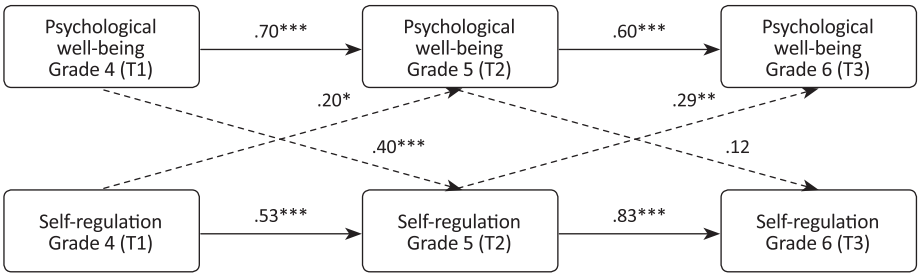


*Figure 4.* A three-wave cross-lagged panel model of Self-Regulation and Psychological Well-Being

*Note. Standardized coefficients are presented. ***p < .001, **p < .01, *p < .05*

The results confirmed the role of conscious self-regulation of primary school students as a significant predictive resource for PWB and achievement during their transition to secondary school and further education. These results have been verified in several studies on different samples, using methods for diagnostics of not only psychological but also subjective well-being.

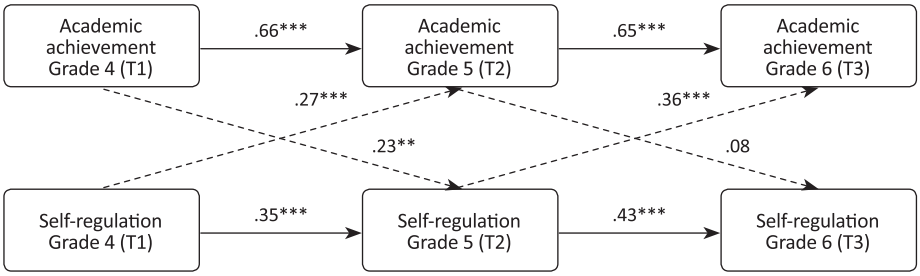


*Figure 5.* A three-wave cross-lagged panel model of Self-Regulation and Academic Achievement

*Note. Standardized coefficients are presented. ***p < .001, **p < .01, *p < .05*

Comparative analysis of the regression coefficients of the model presented in *Figure 4* made it possible to reveal the role of students' PWB in overcoming difficulties of the transition period and ensuring further academic success. Not only the level of

conscious SR achieved at the end of primary school, but also the high level of PWB, serve as the foundation for further SR development. Indeed, 5th grade, with its transition to radically new learning conditions, requires a higher development of regulatory competencies. At the stage of adaptation to these conditions, conscious SR becomes a key resource that contributes to the academic performance and PWB of adolescents.

Comparison of the significance and magnitude of the regression coefficients in the model presented in *Figure 5* allow us to state that the level of students' academic achievement in 4th grade predicts the development of their self-regulation in 5th grade. However, upon transition to 6th grade, it is conscious self-regulation that predicts academic performance. If we compare these results with the dynamics of SR development, it can be noted that transition from 4th to 5th grade is associated with significant changes in the self-regulation of students' learning activity. These changes become an effective resource for maintaining academic performance in secondary school. Our research allowed to identify and describe this effect.

## Discussion

The study tested the hypothesis that self-regulation, being the controlling meta-level of the system of universal and special regulatory resources for achieving educational goals, a) directly affects academic success, and b) mediates the influence of other individual reserves on it, especially that of psychological well-being. The results expand the scientific understanding of the age-related dynamics of conscious self-regulation and psychological well-being as psychological resources for the academic performance of young adolescents.

In particular, we have shown that during the transition from primary to secondary school, along with gradually growing well-being, there is an improvement in academic performance and self-regulation in 5th grade, and a temporary deterioration in 6th grade. Previously, it was believed that difficulties for students arise precisely in 5th grade, which probably predetermined the increased attention of teachers and parents to this period and provided timely assistance to fifth-graders.

We showed that, contrary to popular belief about the difficulties of the transition from primary to secondary school (with the threat of declining PWB), the number of students with negative PWB dynamics (12% of the sample) turned out to be significantly lower than the number of students with positive (22%) and stable PWB dynamics (67%) (Morosanova et al., 2019). This empirical result allows to conclude that the majority of schoolchildren are able to actualize their psychological resources for overcoming the difficulties of the transition period. On the one hand, fifth-graders receive significant social support from parents and teachers, and, on the other, being in a new situation, they gain new experience in self-organization of their activities and social interaction, becoming more independent and autonomous in solving educational problems. This life experience becomes the basis for a positive attitude towards oneself and contributes to the formation of high self-esteem. But the lack of real experience of independence leads to the fact that they now face the difficulties of independence in the 6th grade.

It is important to note that PWB dynamics during transitions rarely attract the attention of researchers due to their instability. Thus, students who had the highest

level of PWB in 4th grade have a lower level in 5th grade, and vice versa, students who initially had the lowest PWB demonstrate its significant increase in 5th grade (Morosanova et al., 2019). The few longitudinal studies of PWB dynamics in adolescents show somewhat conflicting results. Thus, Herke and colleagues (Herke, Rathmann & Richter, 2019) found a decrease in well-being from grade 5 to grade 12; Yang and colleagues from grade 9 (Yang, Tian, Huebner & Zhu, 2019). Very few studies have proposed heterogeneous models of the students' PWB dynamics. One of them, conducted on a sample of 687 students, covered the educational transition in middle and late adolescence in four waves, describing three subgroups of life satisfaction trajectories: stable-high, high-decreasing, and low-increasing (Pande et al., 2018). These results are supported by the study of Tikhomirova et al., who described three trajectories of life satisfaction in adolescents: high-stable, declining, and improving (Tikhomirova, Malykh, & Malykh, 2020).

Analysis of non-cognitive predictors of academic performance in groups with different PWB dynamics has demonstrated its scientific promise. As shown in our study of academic performance in the group with increasing PWB, its high level is ensured by the development of Planning and Responsibility competencies. In the stable PWB group, the determinants of academic achievement – regulatory Flexibility and Modeling – have an instrumental function and are able to provide only the already achieved level of academic success, whereas low academic performance in the group with decreasing PWB can be explained by the lack of regulatory competencies. Thus, identifying the resource role of self-regulation in relation to PWB and academic achievement allows for a fresh look at SR, taking into account the fact that resources can both accumulate and be depleted. A similar view of self-regulation as a depletable resource can be found in the works of R. Baumeister on ego-depletion (Baumeister et al., 2018).

Previous studies have shown that as children grow older, the determination of their academic performance and well-being changes. At the beginning of secondary school, each non-cognitive predictor makes a separate direct contribution to academic performance and then, by the time of transition to high school, these relationships "fold up", with only those remaining that reliably ensure the achievement of results. This applies primarily to conscious self-regulation (Morosanova et al., 2018). Therefore, it is important to identify and evaluate mediating links. The general level of conscious self-regulation demonstrates the highest effect in the relationship between PWB and academic performance. Of the regulatory competencies, we especially note Planning and Programming, which are important abilities for the beginning of secondary school. The ability to set a goal and build specific steps to achieve it will subsequently form the basis of many positive characteristics, such as responsibility, initiative, a high level of achievement motivation, and high results in educational and professional activities. Thus, our study confirmed the hypothesis that conscious self-regulation is a universal resource for psychological well-being and academic achievement, which can affect academic performance both directly and through the relationship of special regulatory resources for the students' psychological well-being.

A similar result was obtained by other researchers (Calmeiro, Camacho, & de Matos, 2018). These data indicate that adolescence can be an important period both for the development of self-regulation and for the actualization of its meta-resource role.

A theory's value depends upon its predictive power. One result of our study was its predictive models that answer the question: does the level of SR development predict psychological well-being and academic performance in the long term? The analysis of the longitudinal relationship between conscious SR, PWB, and academic achievement made it possible to reveal the mechanisms of their mutual determination. The transition from primary to secondary school is the unique schooling period where we can observe the reciprocity of the relationship between PWB and SR. In the future, such reciprocity manifests itself in the relationship between SR and academic performance, SR and school engagement (see Fomina, Filippova, & Zhemerikina, 2022; Morosanova, Bondarenko, & Kondratyuk, 2021). Both models demonstrate that 5th grade is a significant stage in the development and formation of conscious self-regulation, as well as its actualization as a meta-resource for academic achievement and well-being of adolescents. Many studies have appeared in which self-regulation is considered a significant mechanism for maintaining the psychological well-being of adolescents. One of them identified the relationships between positive development and self-regulation (Gestsdottir & Lerner, 2008); it has also been shown that the skills of self-control and self-regulation in adolescents provide higher levels of subjective well-being and life satisfaction (Chang et al., 2020); another study revealed the role of self-regulation as a meta-resource preventing the formation of problem behavior in adolescence (Galton, Morrison, & Pell, 2000). The results of our study are consistent with those of other researchers. Thus, stable linear positive relationships were obtained: high academic performance is associated with a higher level of subjective well-being of students (e.g., Converse et al., 2018; Salmela-Aro & Tynkkynen, 2010). At the same time, longitudinal studies have found that the relationship between academic achievement and PWB can be reciprocal: a high level of PWB can be both a precursor and a consequence of academic achievement (Robson, Allen, & Howard, 2020). Researchers insist that practical work on the development of self-regulation (in its various manifestations) has great potential for increasing life satisfaction among adolescents (Tolan & Larsen, 2014). All this also emphasizes its role as a managing meta-resource not only for academic success, but also for solving various age-related problems.

From a theoretical point of view, our results convincingly show the meta-resource nature of SR, since without it, neither PWB nor academic achievement have a reliable psychological basis that ensures their stable development. In addition, the analysis of the trajectories of SR, PWB, and academic achievement is of high practical importance for the early identification of "problem" areas in adolescents' development and helps to effectively allocate resources in the designing of psychological interventions (Herke, Rathmann, & Richter, 2019).

## Conclusion

The study provides new evidence for the resource role of conscious self-regulation in predicting the levels of PWB and academic success of students during their transition from primary to secondary school.

The data analysis establishes heterochronous changes in the SR general level and academic achievement of students during the transition period. The significant rise of

these indicators, recorded upon transition to 5th grade, is replaced by a decline upon transition to 6th grade. The psychological well-being of schoolchildren in this period is, on average, characterized by systematic positive dynamics, but it is advisable to consider groups of students with increasing, stable, and decreasing PWB levels.

We have shown that conscious self-regulation is a universal resource for both academic performance and psychological well-being of students. The study also revealed some special resources for academic achievement and students' well-being, depending on the trajectory of changes in their PWB. Improved well-being is determined by the regulatory competencies of Planning and Results Evaluation, while its stability is determined by Planning, Modeling, Flexibility, and Responsibility.

The data analysis revealed and described the mediator effects of conscious SR on the relationship between psychological well-being and academic success of young adolescents. The most pronounced mediator effect is typical for the regulatory-cognitive competences of Planning and Programming, the regulatory-personal feature of Responsibility, as well as the general level of conscious self-regulation.

The study established significant long-term effects of the positive impact of self-regulation on the psychological well-being and academic performance of students. Prognostic effects are demonstrated not only for the general SR level, but also for certain regulatory components.

The data on various trajectories of PWB and SR dynamics make it possible to set new priorities for the age development of young adolescents, directing the efforts of teachers, psychologists, and parents towards developing the students' self-regulation in 5th grade and maintaining their well-being in 4th grade.

## Limitations

The present study did not analyze gender differences in students' psychological well-being, nor did it assess school satisfaction among the adolescents. Investigating these variables in future studies will take into account their contextual impact.

## Ethics Statement

Ethical agreement and consent for access to the schools were provided by the Ethics Committee of the Psychological Institute of the Russian Academy of Education (approval number 2017/1-128).

## Informed Consent from the Participants' Legal Guardians (if the participants were minors)

Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

## Author Contributions

Conceptualization, V.M and T.F.; verification of the analytical methods, T.F. and I.B; investigation, T.F.; data curation, T.F and I.B.; writing-review, and editing, V.M, T.F., I.B.; supervision, V.M.; project administration, T.F. All authors discussed the results and contributed to the final manuscript.

## Conflict of Interest

The authors declare no conflict of interest

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PSYCHOMETRICS

# Cross-Language Validation and the Factor Structure of the Social-Emotional Competence Questionnaire for Pakistani Adolescents

Tahira Jabeen[a*], Aneela Maqsood[a]

[a]*Fatima Jinnah Women University, Rawalpindi, Pakistan*

*Corresponding author. E-mail: tahira@live.com

**Background**. For the last few years, in the field of school education, social-emotional competencies have been gaining in importance because they result in positive attitudes and adaptation to school (Mella et al., 2021).

**Objective**. The current study was designed to conduct Urdu translation, cross-language validation, and confirmatory factor analysis of the Social-Emotional Competence Questionnaire (SECQ) for Pakistani adolescents.

**Design**. Urdu translation was done using the standard back-translation method. The data for the main study was collected using a non-random sampling method for 910 adolescents who were between 10 to 19 years old.

**Results**. The findings of the pilot study (n = 64) show that the Social-Emotional Competence Questionnaire is a reliable questionnaire, as Cronbach's alpha reliabilities of both versions (English and Urdu) were acceptable (Version 1 $\alpha = 0.77$; Version 2 $\alpha = 0.77$). After 15 days, the Pearson product-moment correlation was checked to meet the objective of cross-language validation, which resulted in a high correlation between the two forms ($r = 0.88$). The original author of the questionnaire had proposed a factor structure consisting of five factors, namely: self-awareness, social awareness, self-management, relationship management, and responsible decision-making. Results of the confirmatory factor analysis (CFA) in the present study also confirmed and supported the five-factor structure in comparison to other models for the Urdu version.

**Conclusion**. The Social-Emotional Competence Questionnaire is a reliable and culturally-validated tool for adolescents attending school, which can be used in future research for measuring social-emotional competencies.

***Keywords:***
social-emotional competencies, reliability, validity, factor structure, psychometric characteristics, cross-language study

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## Introduction

Social-emotional competencies are important for people of all ages, including young children, adolescents, and older adults. These skills particularly help children in managing problematic behaviors, thereby increasing interest and commitment toward their school. These are the basic advantages of these competencies. They also indirectly help to increase cooperation and problem-solving abilities among individuals, which improves family relationships and increases a healthy commitment towards society (Gokel & Dagli, 2017).

Since 1900, social-emotional competencies have been studied widely around the world, and intervention programs have been aimed at increasing these skills at various levels of education (Cristovao et al., 2020; Osher et al., 2016). These interventions are effective in improving skills of social-emotional learning, social behavior, and academic performance, as well as in decreasing problematic behaviors and psychological distress (Durlak et al., 2011). These skills are greatly influenced by culture, gender, and peer relationships. Males are less interested in, and less able to control, their emotions. So, males appear insensitive, non-cooperative, less emotional, and more aggressive (Chaplin & Aldao, 2013; Curby, et al, 2015). But females are more expressive than males, and can control their feelings in a constructive way, which enables them to better understand a variety of emotions, and their causes and consequences (Garner, et al, 2014).

As interest in the social-emotional domain has increased globally in the context of educational settings, this has increased the need to promote feelings of interpersonal skills of being accepted and recognized (Zhang et al., 2014). The social behavior of adolescents plays a vital role for students (Gómez-Ortiz et al., 2017), which favors school success (Cappadocia & Weiss, 2011).

It is widely-accepted that social competence is a comprehensive, empirical, and multi-faceted phenomena, which cannot be understood on its own, as it can include emotional regulation, prosocial behavior, the ability to adapt normatively, social adjustment, and perceived effectiveness in social interactions (Dirks et al., 2007; Losada, 2018; Santos et al., 2014). Gómez-Ortiz et al. (2017) state that social competence is the efficacy of social interaction, which stems from usage of socio-emotional skills in order to attain personal aims across diverse circumstances, and at different time periods. In this manner, social competence includes the cognitive and social-emotional capabilities of each individual to succeed under different circumstances, in forming healthy relationships among different people (Del Prette & Del Prette, 2005).

Hence, social competence means adjustment to changing demands in the school environment, in interpersonal relationships, emotional health, and acceptance among classmates (Losada et al., 2018). In addition, especially for adolescents, it is appropriate to study and evaluate interventions, to see their effect on social competence in educational settings (Gómez-Ortiz et al., 2017; Losada et al., 2017), because it is an important developmental period of maturation, and of subtle adaptation (as distinctive changes occur in this phase) in individuals (Bessa et al., 2019; Gómez-Ortiz et al., 2017).

The perception of what is appropriate social-emotional behavior changes from one context to another among different cultural groups (Kwong et al., 2018; Broekhuizen et al., 2017), and it is known as a unique aspect of childhood development. Country-level norms and values guide the appropriateness of social behavior and emotional expressivity (Wang & Zhang, 2020). When Asian people are com-

municating and interacting in public, they show limited expression of emotions and feelings. But group cohesiveness and feeling of belongingness are the most prominent features of some parts of Asian culture, i.e., East Asian culture (Liew & Zhou, 2022). If a focus is placed on research about social-emotional development, then evidence mostly pops up from regions such as Northern America, Europe, Great Britain, and Australia (Ren, et al., 2020; Ren & Pope Edwards, 2016).

For the past few years, those associated with the lives of children and adolescents, such as parents, teachers, researchers, and policy makers, have acknowledged the importance of social-emotional development for children and adolescents; this then has pushed people from Asia to study the cultural differences in social-emotional development (Chung et al., 2020). Even the most recent systematic review by Yong et al. (2023), found that most studies have come from the Asian continent – particularly from countries such as China and Hong Kong. Samples of these studies share Chinese ethnicity, which restricts their generalizability. There is a scarcity of social-emotional development studies from Southeast, North, West, and Central Asia. Previous literature on social-emotional development indicated a clear need for scales to measure these competencies that are psychometrically rigorous and which have practical use in schools (Mantz et al., 2016).

## Objectives of the study

In the following paper, an effort was made to examine cross-language translation (to Urdu), and to carry out a confirmatory factor analysis of the Social-Emotional Competence Questionnaire, so that it can be used for evaluating the competencies among students, in light of the need for a reliable and valid questionnaire regarding social competencies in Pakistan.

## Method

Through non-random sampling, adolescents who were currently enrolled in school were selected to take part in the study.

### *Participants*

The pilot study consisted of 33 males and 31 females of classes 9 or 10. Their age ranged from 13–17 years (M = 14.86 & SD = 0.97). The main phase of the study included 910 adolescents attending public schools, of classes 6 to 10. Of these, 454 were males, and 456 were females, with an age range 10 to 19 years (M = 13.45, SD = 1.63). If the students reported physical or psychological issues, or a history of traumatic events or surgery in the past six months, they were excluded from the study. In order to calculate a sample in any study for analyzing CFA, it is suggested to minimally include five to 10 individuals per item for that scale (Choudhry et al. 2018; Shuja et al., 2020).

### *Parts of the study*

The current study can be divided in two phases: the first phase in which the pilot study was based on Urdu translation and cross validation, and the second phase in which item-total correlation and various factor structures were computed as part of the main study.

### *Process of Urdu Translation of the SECQ*

For Urdu translation, the forward-backward method was used in the study (Anderson & Brislin, 1976; Hambleton, 1994), The details of each step of the translation process are given below.

a) In Step 1, the English SECQ was given to five professionals to translate it into Urdu as accurately as possible, by keeping the construct of each item in mind. These professionals had a minimum of a Masters degree in different domains of the social sciences. They were experts in both the English and Urdu languages (Hambleton & Patsula, 1999). At the end of this phase, five independent Urdu translations were received by the researcher.
b) In Step 2, the five translations were assembled up in a word.docx document. In order to check the Urdu translations, five different professionals were selected; their main task was to check the grammar, content, and construction of words and sentences. They were requested to propose new words or sentences if they found the content to be mistranslated, incorrect, or unclear, in order to obtain translations as close as possible to the meaning of the original version.
c) In Step 3, five more professionals were hired who did not know about the questionnaire, to do five back-translations.
d) In Step 4, the same five bilingual professionals as in Step 2, reviewed and evaluated the back translations, in order to obtain accurate and precise items for the final Urdu SECQ version.
e) In Step 5, the final Urdu and English SECQ versions were administered to male and female students in two groups at two time periods. These students were bilinguals and they could understand both languages. After an interval of fifteen days, the same procedure was repeated with the same participants, in order to achieve cross-language validity for evaluating the structure and empirical equivalence for the Urdu and English SECQ.

### *Procedure*

This study was approved by the Ethical Committee of Fatima Jinnah Women University, Rawalpindi. After that approval, the SECQ author's approval to use a questionnaire in the study was obtained. After the SECQ author's approval, approval for data collection was obtained from the directorate of Federal Government Education Institutions. In the end, principals, school teachers, and students were informed about the study, its aim, significance, the right to withdraw at any time, and the matter of confidentiality. In total, the students spent 10 to 15 minutes completing the questionnaire, during which their questions were also addressed.

### *Study Instrument*

Individual descriptors for the students included age, gender, and their school class. The social competence of adolescents was assessed by the Social-Emotional Competence Questionnaire (SECQ).

### *The Social-Emotional Competence Questionnaire (SECQ)*

The Social-Emotional Competence Questionnaire (SECQ) was developed by Zhou and Ee in 2012. The SECQ is comprised of five subscales based on 25 items; these subscales are self-awareness, social awareness, self-management, relationship management, and responsible decision-making. The Collaborative for Academic, Social, and Emotional Learning (CASEL) grouped these competencies into *intrapersonal* (self-awareness, self-management), and *interpersonal* competencies (social awareness, relationship skills, and responsible decision-making) (Taylor et al., 2018). These social competencies are the means of adjustment to the changing demands of the school environment, interpersonal relationships, emotional health, and acceptance among classmates (Losada et al., 2018).

Questions of SECQ are scored on a six-point Likert scale which ranges from response options such as "not at all true of me" to "very true of me." Overall, the authors reported reliability of 0.86 for the SECQ (Zhou & Ee, 2012). Resurrección et al. (2021) chose 221 primary education students, ages from 8 to 11 years, and for them they reported Cronbach's alpha for each subscale: self-awareness = 0.64; social awareness = 0.72; self-management = 0.73; relationship management = 0.69; and responsible decision-making = 0.76. In the same way, Aguilar et al. (2019) selected 1494 participants from twelve schools with ages between 7 and 16 years old, and they reported reliability for the subscales of the SECQ as: self-awareness $\alpha = 0.72$, social awareness $\alpha = 0.76$, self-management $\alpha = 0.80$, relationship management $\alpha = 0.72$, and responsible decision-making $\alpha = 0.82$. Sample items of the questionnaire are: *1) I understand my moods and feelings; 2) If a friend is upset, I have a pretty good idea why;* and. *3) I always try and comfort my friends when they are sad.*

## Results

Data was analyzed using the Statistical Package for Social Sciences (SPSS version 23, IBM Corp., Armonk, NY, USA), and the Analysis of Moment Structure (AMOS 22). In the first step, the mean, standard deviation, and alpha reliabilities of the English and Urdu versions, and the Pearson correlation, were calculated. In step 2, item-total correlation and different factor structures of the questionnaire were tested.

**Table 1**

*Pearson product-moment correlation coefficient, test-retest reliability of Urdu and English versions of the Social-Emotional Competence Questionnaire (SECQ) n = 64)*

| SECQ | Mean | Standard Deviation | Range | Cronbach Reliabilities | Correlation Coefficients | Significance Level |
|---|---|---|---|---|---|---|
| Urdu SECQ | 89.17 | 11.49 | 53 | 0.77 | 0.88 | 0.000 |
| English SECQ | 88.28 | 11.67 | 55 | 0.77 | | |

*Correlation is significant at 0.01 level (2 tailed)*

*Table 1* shows that alpha reliability coefficients were 0.77 for both forms, with correlation r = 0.88. This indicates that the Urdu SECQ had a good internal consis-

tency and test-retest reliability, over the interval of 15 days in a small sample of 64 students.

*Table 2* shows the corrected item-total correlation of the main study of the Social-Emotional Competence Questionnaire. Most of the items had an above .20 value for the corrected item-total correlation, which was acceptable (Abubakar et al., 2020; Piedmont, 2014).

**Table 2**

*Corrected item-total correlation of Social-Emotional Competence Questionnaire (SECQ) (N = 910)*

| SECQ | **Items** | **Item-Total Correlation** |
|---|---|---|
| Self-Awareness | SAQ1 | .571 |
| | SAQ2 | .575 |
| | SAQ3 | .564 |
| | SAQ4 | .589 |
| | SAQ5 | .524 |
| Social Awareness | SOCAQ1 | .558 |
| | SOCAQ2 | .482 |
| | SOCAQ3 | .463 |
| | SOCAQ4 | .484 |
| | SOCAQ5 | .554 |
| Self-Management | SMQ1 | .406 |
| | SMQ2 | .548 |
| | SMQ3 | .302 |
| | SMQ4 | .465 |
| | SMQ5 | .502 |
| Relationship Management | RMQ1 | .566 |
| | RMQ2 | .589 |
| | RMQ3 | .469 |
| | RMQ4 | .563 |
| | RMQ5 | .481 |
| Responsible Decision Making | DMQ1 | .637 |
| | DMQ2 | .670 |
| | DMQ3 | .654 |
| | DMQ4 | .625 |
| | DMQ5 | .634 |

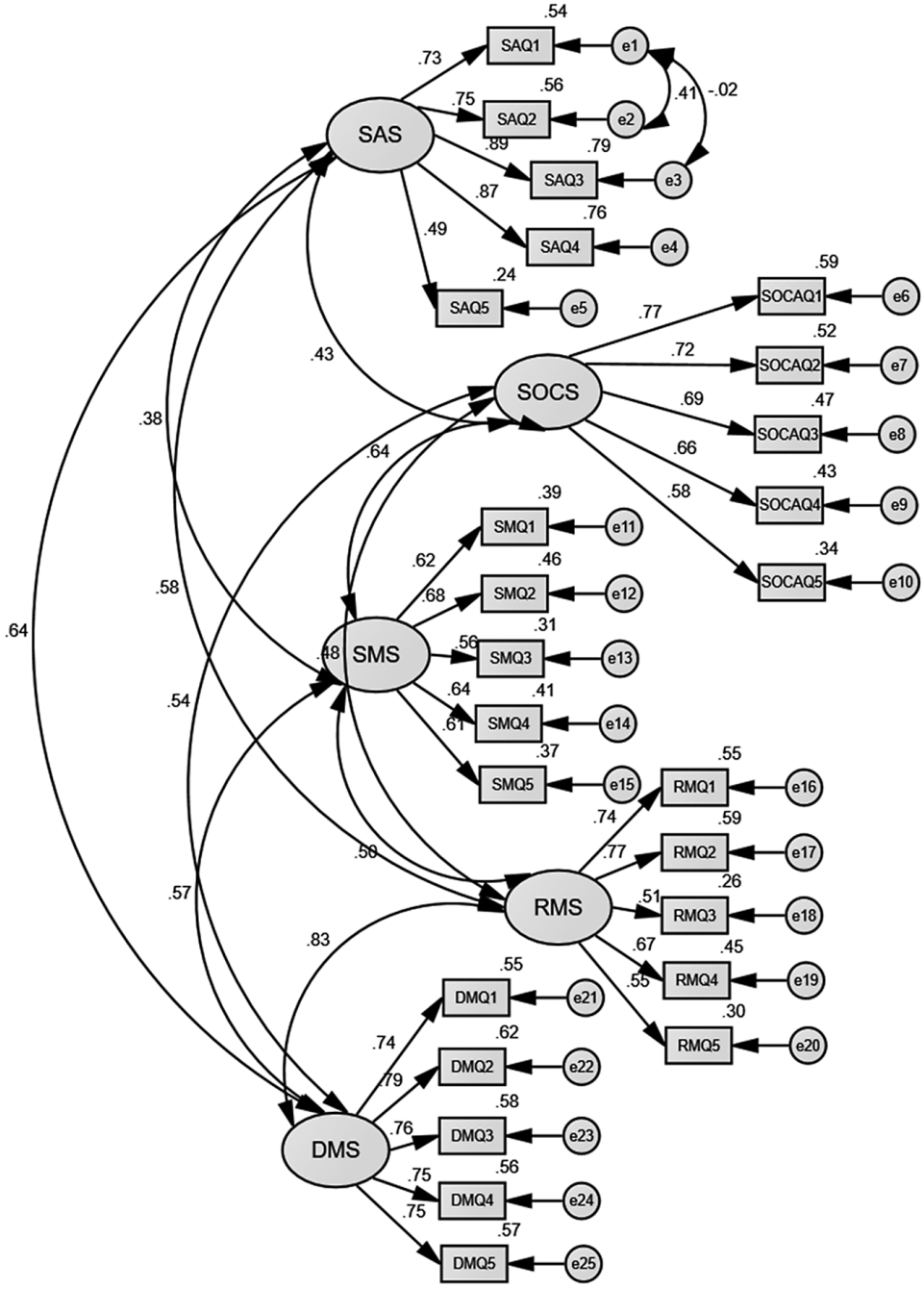


*Figure 1.* CFA five factors model for Social-Emotional Competence Questionnaire

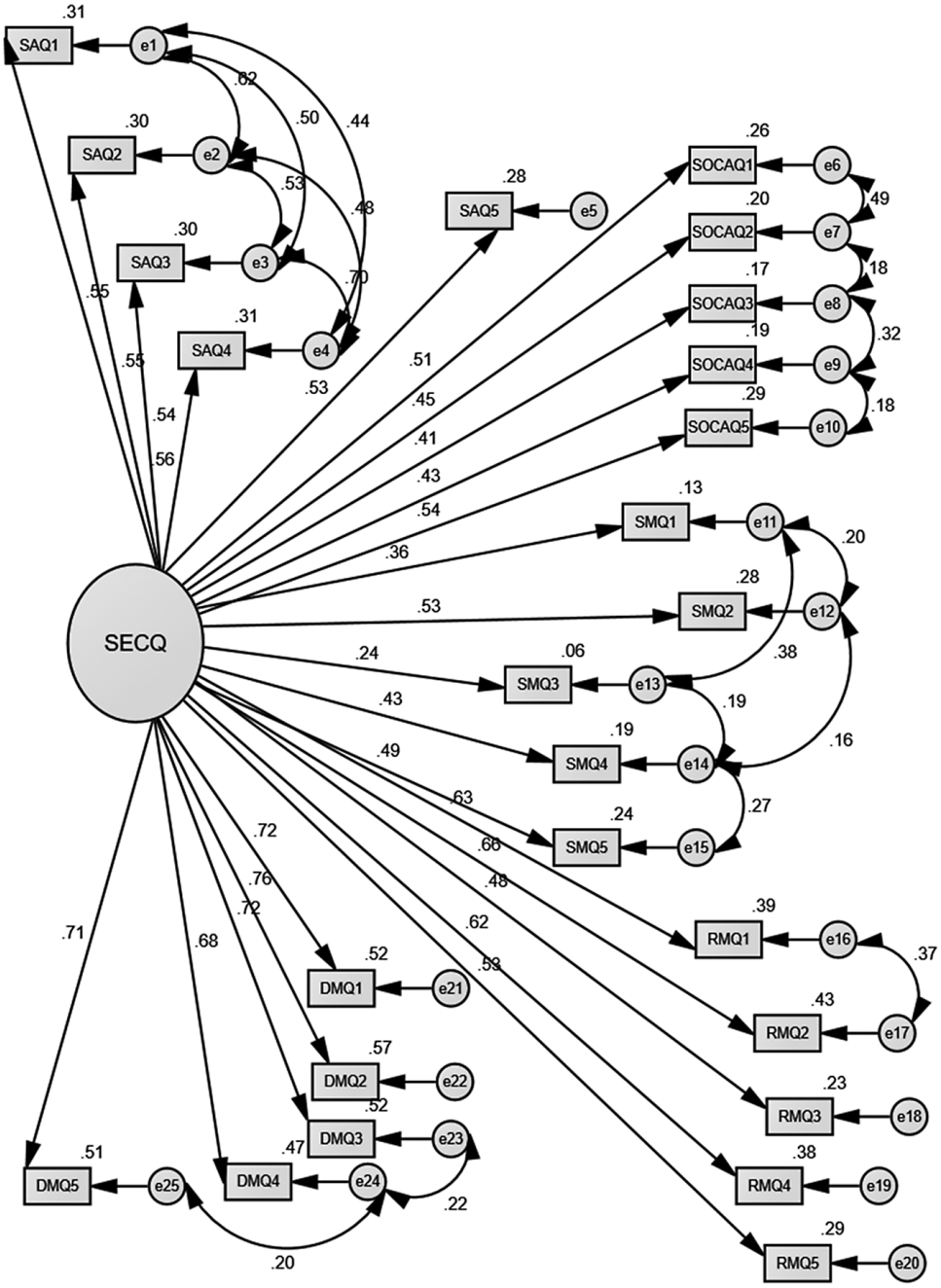


*Figure 2.* CFA model for uni-dimensional Social-Emotional Competence Questionnaire

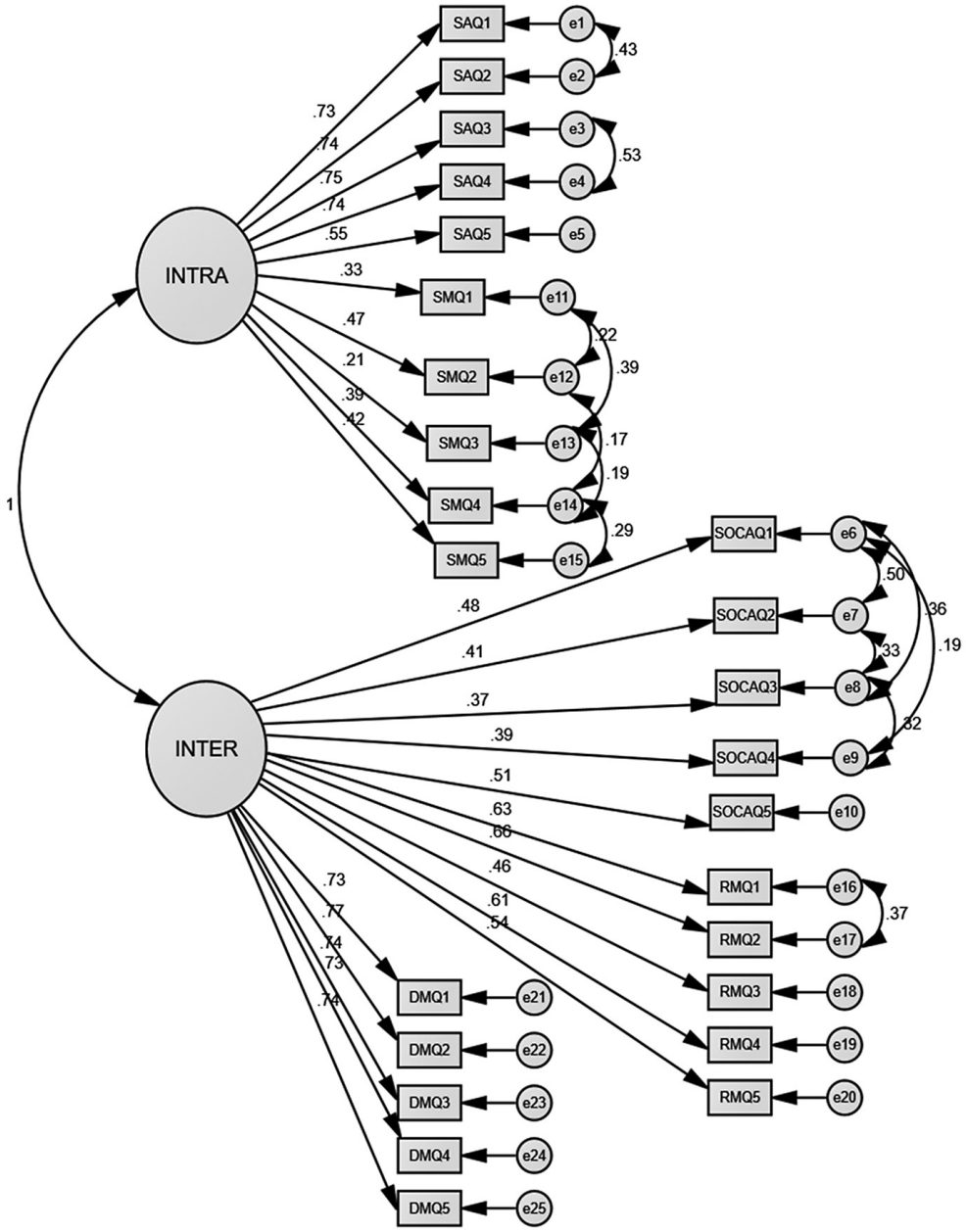


*Figure 3.* CFA model for two global factors Social-Emotional Competence Questionnaire

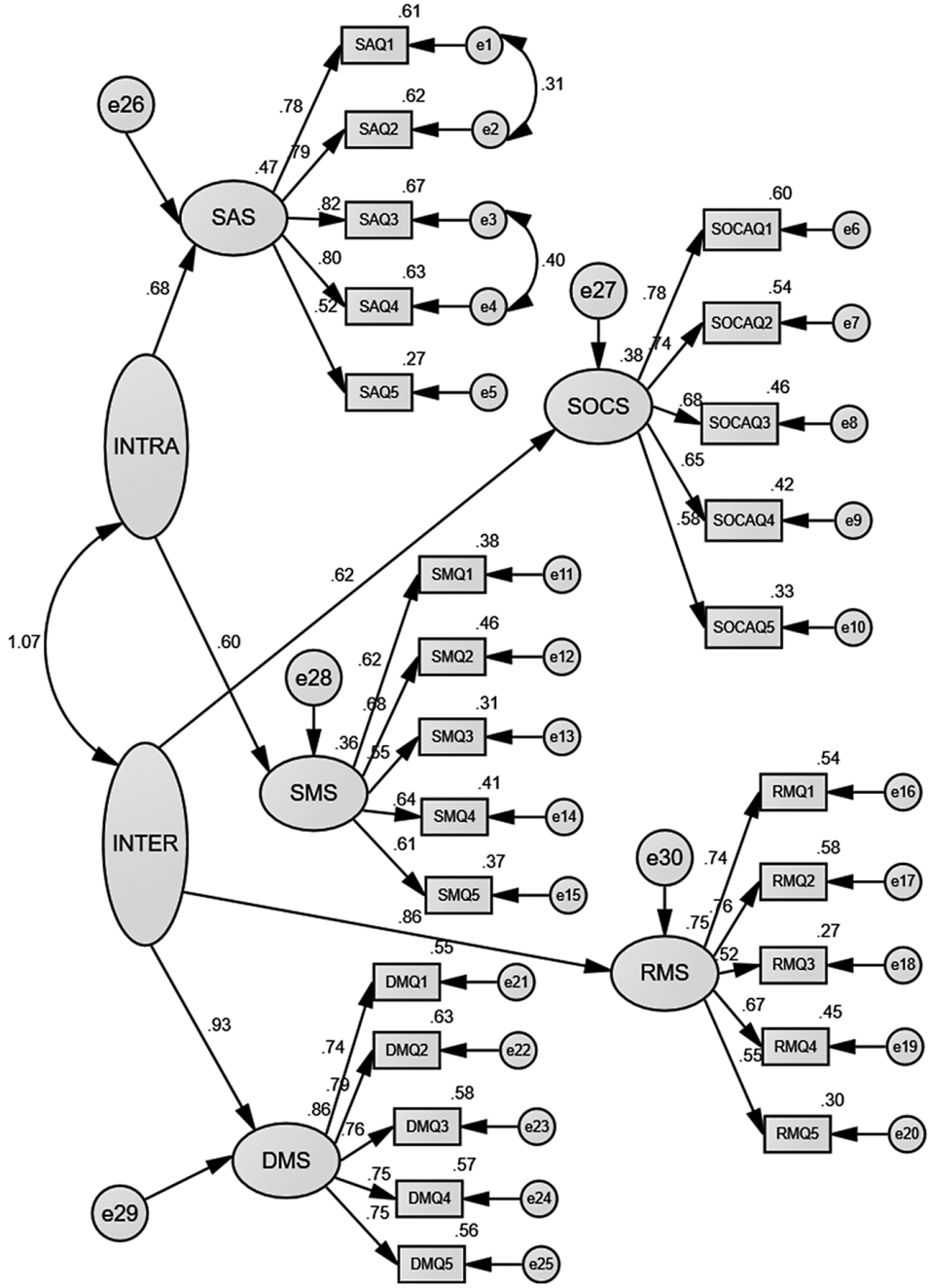


*Figure 4.* CFA model for five factors + two higher-order factors of Social-Emotional Competence Questionnaire

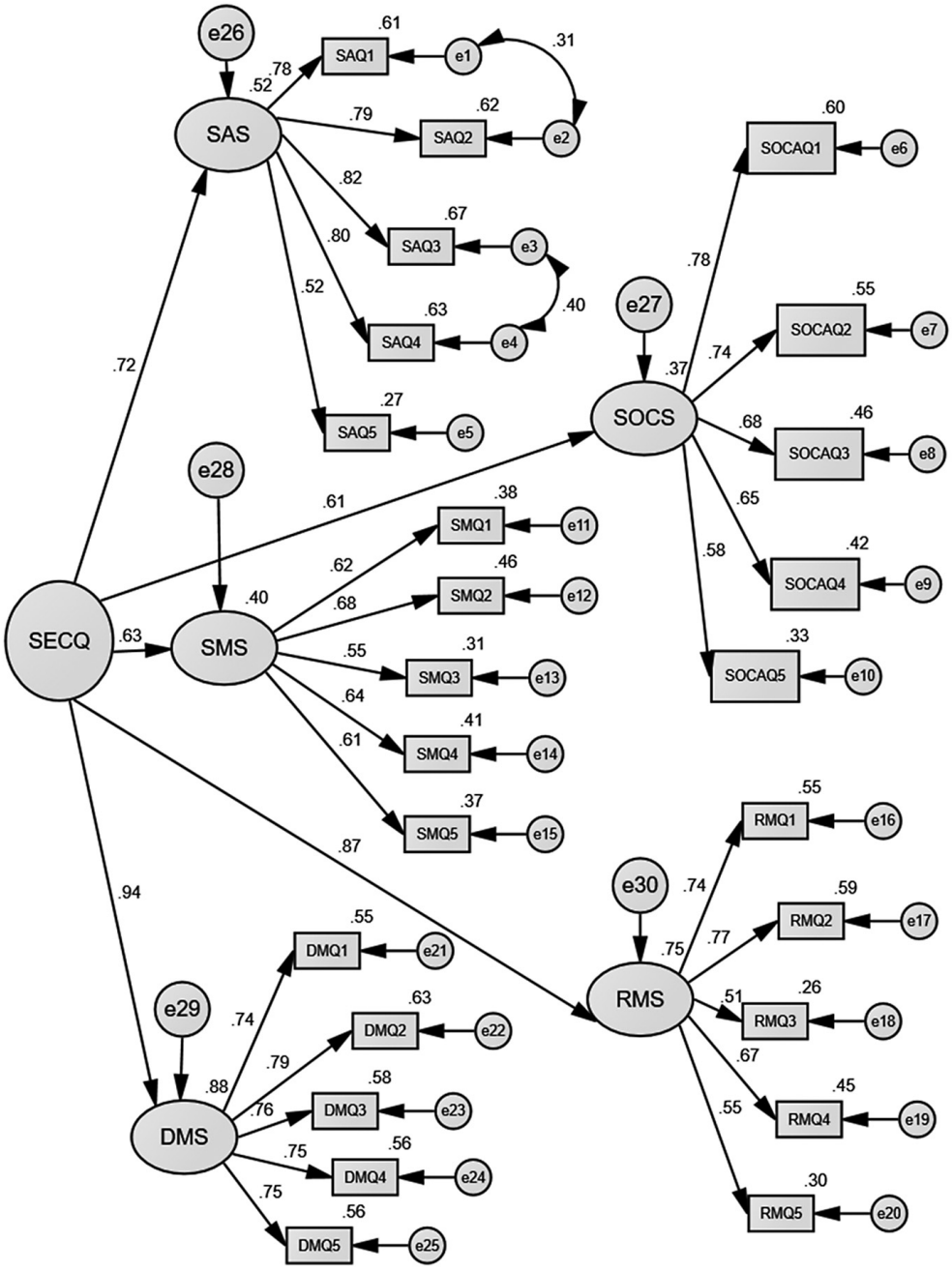


*Figure 5.* CFA model for five factors + one higher-order factor of Social-Emotional Competence Questionnaire

*Table 3* represents the variety of Model Fit Indices for the Urdu version of the Social-Emotional Competence Questionnaire. These models are: five factors, uni-dimensional, two global factors, five factors plus two, and one higher order factor. (Brown, 2015; Hooper et al., 2008).

**Table 3**

*Model-fit Indexes for the Urdu Version of the Social-Emotional Competence Questionnaire (SECQ) (N=910)*

| | $\chi^2$ (df) | NFI | IFI | TLI | CFI | RMSEA |
|---|---|---|---|---|---|---|
| Five factors | 1016.334 (263) | .904 | .927 | .917 | .927 | .056 |
| Uni-dimensional | 1252.518 (257) | .882 | .904 | .887 | .903 | .065 |
| Two global factors | 1470.249 (261) | .861 | .883 | .865 | .883 | .071 |
| Five factors + two higher-order factor | 1063.271 (267) | .900 | .923 | .913 | .923 | .057 |
| Five factors + one higher-order factor | 1067.551 (268) | .899 | .923 | .913 | .922 | .057 |

*Note. $\chi^2$ = chi-square; df = degree of freedom; RMSEA = root mean square error of approximation; IFI = incremental fit index; NFI = normed fit index; CFI=comparative fit index; TLI =Tucker–Lewis index.*

## Discussion

The current study was conducted to determine the reliability, cross-language validity, and confirmatory factor analysis of the Social-Emotional Competence Questionnaire. It is one of the studies that aims to study the acceptability of fit and the inherent structure of the scale for the Pakistani population. Cross-language validation was done in a pilot study by administering both Urdu and English versions, with a 15-day interval in between, to 64 adolescent students. The results revealed that the Urdu and English versions of the questionnaire had a good level of reliability (Version 1 and Version 2 $\alpha = 0.77$).

The findings of the present study regarding the reliability of the scale, are in line with most recently-conducted studies such as the ones by Kim (2021) and Portela-Pino et al. (2021), which have reported an average reliability of the SECQ as 0.88 and 0.91. Aguilar et al. (2019) and Resurrección et al. (2021) found a reliability of: self-awareness = 0.72, 0.64; social awareness = 0.76, 0.72; self-management = 0.80, 0.73; relationship management = 0.72, 0.69; and responsible decision-making = 0.82, 0.76, respectively.

After Cronbach's alpha reliability met the criteria of satisfaction, then item-total correlation was computed, and the correlation value ranged from .30 to .67. These two values are same as previous studies (Abubakar et al., 2020; Piedmont, 2014). Apart from item-total correlation, factor loading of all items was checked, and all of these were higher than 0.30. All 25 items of the SECQ had a factor loading of a minimum of 0.30 and a maximum of 0.67, which had been recommended in a previous study (Jiménez, et al., 2018).

The present study also computed a factor structure based on five factors, uni-dimensional, two global factors, five factors + two higher order factors, and five factors

+ one higher order factor, of the Social-Emotional Competence Questionnaire. For testing acceptability of the proposed models, values of chi-square, degree of freedom, NFI, IFI, TLI, CFI, and RMSEA were checked. All proposed models of SECQ showed that the best-fit models for the scale such as chi-square and degree of freedom for five factor SECQ was 1016.334 (263), and the values of other indexes were: NFI = .904, IFI = .927, TLI = .917, CFI = .927, and RMSEA = .056.

The Chi-square and degree of freedom for uni-dimensional SECQ was 1252.518 (257), and the values of other indexes were: NFI = .882, IFI = .904, TLI = .887, CFI = .903, and RMSEA = .065. The Chi-square and degree of freedom for two global factor SECQ was 1470.249 (261), and the values of other indexes were: NFI = .861, IFI = .883, TLI = .865, CFI = .883, and RMSEA = .071. The Chi-square and degree of freedom for five factors plus two higher-order factor SECQ was 1063.271 (267). In addition, the values of other indexes were NFI=.900; IFI=.923; TLI=.913, CFI=.923 and RMSEA=.057. Lastly, the chi-square and degree of freedom for five factors plus one higher-order factor SECQ was 1067.551 (268), and the values of the other indexes were NFI = .899, IFI = .923, TLI = .913, CFI = .922, and RMSEA=.057.

Nearly all these five models of the SECQ supported the data efficiently. Among all these models, the five-factor model was the best-suited model for the SECQ, and this finding of CFA was the same as for the original study of the SECQ. In that study, authors initially indicated a marginal acceptable fit: $\chi^2 = 539.98$ (df = 265, p<.001), $\chi^2/df = 2.04$; RMSEA = .048; CFI = .89; and IFI = .89; but later on, for a sample of secondary school children, the CFA values of model fit were suitable: $\chi^2 = 712.20$ (df = 265, p<.001), $\chi 2/df = 2.69$; RMSEA = .069; CFI = .86; and IFI = .86 (Zhou & Ee, 2012).

In another study, Petric and Szamoskozi (2018) tested the five-factor structure on the sample of 546 in Hungary, in which results also showed a borderline acceptable fit of the CFA model as: $\chi^2 = 733.957$ (df = 265, p<.001); $\chi^2/df = 2.77$; RMSEA = .056; CFI = .89; and IFI = .89.

The latest study of the SECQ by Dinh et al. (2021) tested the number of CFAs for the SECQ such as five factors, two global factor, five factors plus two and one higher order factor. Out of these four models, three showed a fitness of acceptable, except two global factors such as normed $\chi^2$ on five factors: CFI = 2.43, RMSEA = .901, SRMR = .034, AIC = 99977.209, and BIC = 100410.227; normed $\chi^2$ on five factors + one higher-order factor: CFI = 2.42, RMSEA = .901, SRMR = .039, AIC = 99974.101, and BIC = 100387.681; normed $\chi^2$ on five factors + two higher-order factor: CFI = 2.43, RMSEA = .900, SRMR = .039, AIC = 99978.752, BIC=100391.355; and normed $\chi^2$ on the two global factor model: CFI = 4.11, RMSEA = .779, SRMR = .050, AIC = 100583.624, and BIC = 100973.572.

The findings of present study are the same as the aforementioned study, except for the two global factor SECQ models, which were not supported by Vietnamese culture. This also supports the notion that the culture of each country is unique, and can cause changes in the expression of social competence among its people (Kwong et al., 2018; Broekhuizen et al., 2017). The results of the present research are in line with the predefined objectives that are supported by previous research. In the recent years, the SECQ has been translated and culturally-validated for residents of Hungary and Vietnam.

The findings of the present study further provided evidence of cross-language validity from Pakistan by testing a variety of SECQ models. Practitioners who are working with adolescents might use the validated SECQ instrument in both clinical and non-clinical settings. The SECQ is a short, straightforward, and easily comprehensible questionnaire, which provides an opportunity to administer it more than one time to evaluate the level of social competence of adolescents. Future studies can also use other measures with the SECQ in order to establish convergent and discriminant validity among different scales. By applying the standards of evidence-based practice, the psychometric qualities of the SECQ can be explored in other Asian countries.

## Conclusion

Among models of the SECQ such as the five-factor model, uni-dimensional, two global factor, five factors plus two and one higher order factors, the five-factor model emerged as a promising factor, and the SECQ was culturally-validated scale for determining social competence on the sample of adolescent students in Pakistan. Hence, future researchers should use the mean of the five-dimensions model for social competence.

## Ethics Statement

This study was approved by the Ethical Committee of Fatima Jinnah Women University (FJWU/EC/2021/33).

## Informed Consent from the participants

Informed consent to be part of the study was provided by the participants.

## Author Contributions

T.J. contributed to the conception, data collection, and the writing of the manuscript. A.M. supervised and critically reviewed the manuscript.

## Conflict of Interest

Authors declare no conflict of interest in the study.

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# An Independent Evaluation of the Psychometric Properties of the Russian Version of the Pediatric Daytime Sleepiness Scale (PDSS)

Ilya M. Zakharov[a], Victoria I. Ismatullina[b], Pavel V. Kolyasnikov[a], Julia A. Marakshina[b], Artem S. Malykh[a], Anna O. Tabueva[a], Timofey V. Adamovich[b], Marina M. Lobaskova[a], Sergey B. Malykh[b, c]

[a] *Ural Federal University named after the first President of Russia B.N. Yeltsin, Yekaterinburg, Russia*
[b] *Psychological Institute of Russian Academy of Education, Moscow, Russia*
[c] *Lomonosov Moscow State University, Russia*

*Corresponding author: malykhsb@mail.ru

**Background**. The quality of sleep significantly impacts children's day-to-day performance, with at least 20% reporting issues with sleepiness. Valid tools for assessing the quality of sleep are needed.

**Objective**. In this study, we assessed the psychometric properties of the Russian version of the Pediatric Daytime Sleepiness Scale (PDSS). The initial adaptation of the PDSS was conducted on a sample from the Arctic regions of Russia. This location may have influenced the scale's generalizability due to variations in natural daylight across different areas of the country.

**Design**. To rectify this, we gathered a comprehensive, geographically diverse sample from Russia. This combined dataset comprised 3772 participants between 10 to 18 years of age, from nine different regions of Russia.

**Results**. We confirmed the unifactorial structure of the PDSS, which showed no regional effects. The psychometric analysis indicated that one item from the 8-item PDSS could be removed, thereby improving the scale's model fit. We also observed gender and age impacts on sleep quality: boys reported fewer sleep-related issues than girls, and younger children reported fewer problems than older children.

**Conclusion**. This study validates the usefulness and reliability of the Russian version of the PDSS, thereby enhancing its general applicability. Furthermore, we replicated previously reported age and sex effects on the sleep quality of school-aged children.

***Keywords:*** daytime sleepiness, adolescents, sleep-related problems, sleep duration, psychometric analysis

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## Introduction

Numerous factors contribute to individual differences in educational achievements, including cognitive attributes, socioeconomic status, and even physical activity levels. However, a frequently overlooked factor is problems with sleep quality, such as sleep deprivation or excessive daytime sleepiness. Prior studies have linked these issues to significant impairments in cognitive performance and learning abilities (Dimitrova & Genov, 2020; Dijk et al., 2012; Liu et al., 2012; Fakier & Wild, 2011). These effects are more pronounced in children and adolescents compared to adults. For instance, in the United States, a minimum of 20% of adolescents report daily sleepiness problems, such as falling asleep at school or while doing homework, excessive tiredness, or issues resulting from oversleeping (National Sleep Foundation, 2006). Student sleepiness has been negatively correlated with academic outcomes in multiple studies (Turner et al., 2019; Jalali et al., 2020; Gallego-Gomez, 2021).

Alongside its cognitive effects, sleep deprivation heightens feelings of anger toward oneself and others (Kamphius et al., 2012; Krizan & Hisler, 2019) and leads to more frequent illness (Orzech et al., 2013). Moreover, excessive daytime sleepiness is often exhibited by children and adolescents (Dorofaeff & Denny, 2006). Significant age effects are also observed within adolescent groups: studies show a twofold decrease (from 50% to 24%) in getting sufficient sleep time when comparing 8th graders to 6th graders (Volmer et al., 2012; Porcheret et al., 2018). This increase in sleepiness is associated with behavioral factors, such as the "eveningness" chronotype found in adolescents residing in brightly lit urban areas (Vollmer et al., 2012). These factors, combined with early school start times, result in a significant sleep deficit with potentially serious implications for student learning quality (Porcheret et al., 2018).

A multi-site study involving 9,000 students from eight public high schools in a three-year project underscored the significant impact of improved sleep (Wahlstrom et al., 2014). The study found that when high schools began at 8:30 AM or later (as compared to the average start time of between 7:45 AM and 8:15 AM), more than 60% of students managed to get at least eight hours of sleep per school night. This led to enhancements in both their health status and academic performance. Teens reporting less than eight hours of sleep had a significantly higher risk of poor decision-making relating to substance use and displayed more symptoms of depression. Conversely, school attendance rates, grades in core subjects such as math, English, science, and social studies, and performance on state and national achievement tests improved with later school day start times. Interestingly, the shift in school start times also had indirect effects, such as a 70% reduction in car crashes for teen drivers 16 to 18 years old.

Given the significance of sleep quality for school children, a reliable tool for measuring it is essential. Timely screening for sleep problems can mitigate severe repercussions and assist in identifying at-risk children. Prior studies have indicated that quick, inexpensive, and robust screening is feasible using subjective measures of sleepiness. Among the available self-rating sleep scales, the Pediatric Daytime Sleepiness Scale (PDSS) has demonstrated the highest validity and reliability (Canto et al., 2014). The PDSS, designed for children ages 11 to 15, comprises eight sleep-related

behavior questions and is used to assess sleep-related problems and confirm sleeping habits (Pereira et al., 2010). Successful adaptations of the PDSS exist in German, Brazilian, Turkish, Chinese, Korean, and Japanese versions (Schneider & Randler, 2009; Felden et al., 2016; Bektas et al., 2016; Yang et al., 2010; Rhie et al., 2011; Komada et al., 2016).

The PDSS was previously translated into Russian by Randler and colleagues (Randler et al., 2019) and exhibited satisfactory factor structure, as supported by confirmatory factor analysis (CFA) and reliability (intraclass coefficient = 0.70). However, a unique aspect of that study was that it was conducted in Russian Arctic cities, specifically the Karelia and Murmansk regions, where daylight varies drastically throughout the year. For instance, in Murmansk, the sun remains continuously above the horizon (a phenomenon known as the midnight sun) for over two months. This significant variation in natural light has been shown to influence both mood and sleep patterns, although the results have been inconsistent (see Overland et al., 2020). Notably, most studies examining the effect of daylight variation have focused on adults. Given the results of the "Minnesota sleep study," it is highly probable that daylight variation across different geographical regions may significantly impact schoolchildren's academic performance. Collectively, the special characteristics of these studies underscore the need to directly compare sleep quality and its association with academic performance among adolescents.

The objective of the current study was to explore the factors that may affect the sleep quality of Russian schoolchildren. To achieve this, we planned to 1) assess the psychometric properties of the PDSS using a large-scale, geographically diverse Russian sample; 2) analyze potential regional differences in PDSS scores; and 3) examine potential age and gender differences in the sleep quality of Russian schoolchildren. Initially, the PDSS questionnaire was designed for early adolescents 10-15 years old. The additional objective of our study was to test whether this age range could be extended up to 18 years old.

## Methods

### *Participants*

Our study was carried out during 2020-2021. The combined dataset included 3772 participants; after deleting incomplete data, 3583 participants remained. The gender identity was based on self-reports with the options "Male," "Female," and "Don't want to answer this question." In the whole sample, 1661 participants identified themselves as boys and 1912 as girls, with 10 participants refusing to identify their gender. The participants' ages ranged from 10 to 18 years.

Schools from 10 different geographical Russian regions participated in the study. In each school, there were two different days when the data was collected with the difference between days less than a week. The region with the highest daylight variation was Murmansk (68° 58′ 45.01" N; its daylight variation includes more than two months of polar day and one month of the polar night). The region with the least daylight variation was Rostov-on-Don (47°13′ 29.50′ N), which has daylight variation of 8 to 15.5 hours from winter to summer). The number of participants from each region is presented in *Table 1.*

**Table 1**

*The distribution of the participants among Russian regions*

| Region | Collection dates | N |
|---|---|---|
| Khabarovsk region | 24 November, 2020<br>2 December, 2020 | 559 |
| Krasnoyarsk region | 24 November, 2020<br>3 December, 2020 | 326 |
| Murmansk region | 24 November, 2020<br>2 December, 2020 | 145 |
| Novosibirsk region | 24, 26 November, 2020<br>7, 9 December, 2020 | 424 |
| Omsk region | 30 November, 2020<br>10 December, 2020 | 260 |
| Perm region | 24 November, 2020<br>2 December, 2020 | 86 |
| Rostov region | 24 November, 2020<br>9, 10 December, 2020 | 767 |
| Tyumen region | 16 February, 2021 | 549 |
| Yaroslavl region | 24 November, 2020<br>2 December, 2020 | 229 |

The data were collected during the COVID-2019 pandemic, which may have affected the study results. In two out of the nine regions, the COVID-related limitations included schools and other educational institutions directly. Preliminary analysis showed that the inclusion of these two regions did not affect the study results, so the present analysis was performed on the full sample.

The study received approval from the Ethics Committee of the Psychological Institute of the Russian Academy of Education (approval №2020/4-1). The participants were minors and so informed consent was obtained for each participant from parents or legal guardians.

### *Procedure*

The questionnaire was presented digitally from either the students' personal computers or in school computer classes.

*PDSS Questionnaire.*

The PDSS is an 8-item questionnaire that was developed to assess extreme daytime sleepiness in schoolchildren. It was previously translated into Russian and tested for comprehension by Randler and colleagues (2019). The interviewee rates the frequency of the behaviors itemized below on a 5-point Likert scale, which ranges from 0 (never) to 4 (always). Rankings on all the items are totaled to obtain a total score,

which could amount to anything from 0 to 32. A higher score indicates greater daytime sleepiness. The start time of filling in the questionnaire was also added as a separate measure.

The original and translated items are presented in *Table 2*.

**Table 2**

*Original and translated versions of the PDSS*

| № | Item in English | Item in Russian |
|---|---|---|
| 1 | How often do you fall asleep or get drowsy during class periods? | Как часто ты засыпаешь или чувствуешь сонливость во время занятий? |
| 2 | How often do you get sleepy or drowsy while doing your homework? | Как часто ты засыпаешь или чувствуешь сонливость во время выполнения домашнего задания? |
| 3 | Are you usually alert most of the day? | Бодр(а) ли ты обычно большую часть дня? |
| 4 | How often are you ever tired and grumpy during the day? | Как часто ты чувствуешь себя уставшим(ей) и раздражительным(ой) в течение дня? |
| 5 | How often do you have trouble getting out of bed in the morning? | Как часто ты испытываешь трудности пробуждения по утрам? |
| 6 | How often do you fall back to sleep after being awakened in the morning? | Как часто ты снова засыпаешь после того как проснешься утром? |
| 7 | How often do you need someone to awaken you in the morning? | Как часто тебе нужна посторонняя помощь, чтобы проснуться утром? |
| 8 | How often do you think that you need more sleep? | Как часто ты думаешь, что тебе не хватает сна? |

### *Statistical approach*

Construct validity was examined through CFA with the following adjustment indicators used as criteria: comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) (Brown, 2014). We also analyzed the psychometric properties of the PDSS according to the IRT approach. Cronbach's α and McDonald's ω (McDonald, 1999) were calculated to estimate the reliability of the PDSS. Regression and correlation analyses were used to investigate the relationship of the PDSS scores with other variables. All analyses were performed in the R language for statistical programming with the packages 'mirt', 'lavaan', and 'psych'.

## Results

*Psychometric properties of the Russian version of the PDSS*

The first step of the analysis was to analyze the factor structure of the questionnaire. To do that, we randomly split our sample into two parts. We first performed an exploratory factor analysis (EFA) on the first part of the sample and then a confirma-

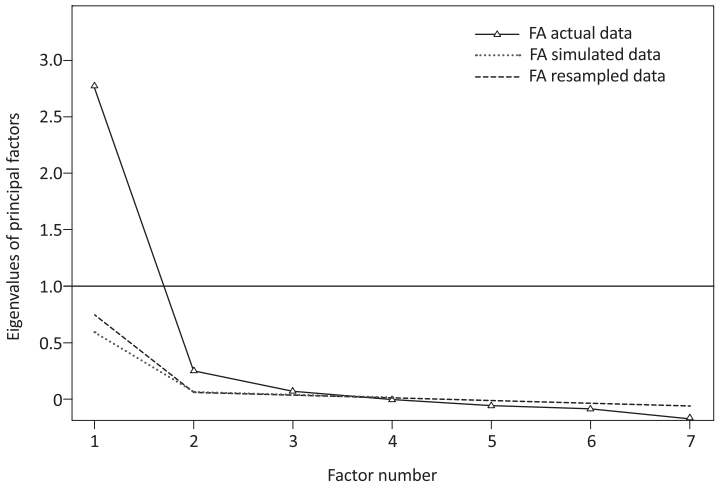


*Figure 1*. The results of the exploratory factor analysis

*Note. Both scree plot and the fact that there is only one eigenvalue higher than 1 point to a one-factor solution.*

tory factor analysis (CFA) on the second part. The EFA results pointed to the one-factor solution (*Figure 1*).

The next step of the analysis was to show that the one-factor solution had an adequate fit on the second part of the data. To do that, we fitted a graded response model (the recommended model for ordered polytomous response data) on the whole dataset, using a full-information maximum likelihood fitting function. In addition, we assessed model fit using an index, M2, specifically designed to assess the fit of item response models for ordinal data. We used the M2-based root mean square approximation (RMSEA) error as the primary fit index. We also used the standardized root mean square residual (SRMSR) and comparative fit index (CFI) to assess the adequacy of model fit.

The RMSEA value we obtained (RMSEA = 0.09; 95% CI [0.10; 0.12]) was higher than the cutoff value (RMSEA <= 0.06), and the SRMSR value (SRMSR = 0.069) was within the normative value (SRMSR <= 0.08). The CFI (CFI = 0.949) was below the recommended 0.95 threshold. To improve the quality of the model, we used the IRT model to analyze each item's parameters separately. The results of the IRT analysis are presented in *Table 3*.

The values of the slope (a-parameters) ranged from 0.80 to 2.40. A slope parameter measures how well an item differentiates respondents with different levels of a latent trait. Item 1 was the most discriminating item, and Item 7 was the least discriminating. This result can also be visualized with the category characteristic plot (*Figure 1*). Three location parameters (b-parameters) are also listed for each item. Location parameters are interpreted as the value of theta corresponding to a .5 probability of responding at or above that location on an item. There are m-1 location parameters, where m refers to the number of response categories on the response scale. The location parameters indicate that the responses covered a wide range of latent traits.

**Table 3**

*The slope values (a-parameter) and the location parameters (b-parameters) of the items according to the IRT analysis*

| Item | a | b1 | b2 | b3 | b4 |
|---|---|---|---|---|---|
| 1. Fall asleep/drowsy during class | 2.40 | –1.65 | –0.51 | 0.55 | 1.69 |
| 2. Drowsy/asleep during homework | 1.82 | –1.23 | –0.13 | 0.90 | 1.96 |
| 3. Usually alert during the day (reverse coded) | 1.32 | –1.07 | 0.80 | 1.93 | 3.60 |
| 4. Tired and grumpy during the day | 1.79 | –2.24 | –0.39 | 0.82 | 2.13 |
| 5. Trouble getting out of bed in the morning | 1.56 | –1.93 | –0.75 | 0.21 | 1.18 |
| 6. Fall back to sleep after being awakened | 1.18 | –1.48 | 0.01 | 1.00 | 2.31 |
| 7. Need someone to awaken you | 0.80 | –0.79 | 0.57 | 1.72 | 3.00 |
| 8. How often do you think you need more sleep? | 1.96 | –1.48 | –0.53 | 0.23 | 0.98 |

Altogether, the IRT analysis shows that Item 7 ("How often do you need someone to awaken you in the morning?") does not add to identifying individual differences in sleep quality and can be omitted. The model fit improves after deleting this item, with RMSEA equaling 0.09 (95% CI[0.09; 0.10]), SRMSR equaling 0.05, and CFI = 0.96. The difference between the distributions of the original and recalculated (corrected) PDSS total scores are presented in *Figure 2*.

The comparison of the factor analysis and reliability measures (Cronbach's α and McDonald's ω) of the original and edited versions of the scale is presented in *Table 4*.

**Table 4**

*The factor analysis and reliability measures of the original and edited PDSS*

| Item | F1 original | h2 original | F1 edited | h2 edited |
|---|---|---|---|---|
| Fall asleep/drowsy during class | 0.816 | 0.666 | 0.829 | 0.687 |
| Drowsy/asleep during homework | 0.73 | 0.533 | 0.738 | 0.544 |
| Usually alert during the day (reverse coded) | 0.613 | 0.376 | 0.62 | 0.385 |
| Tired and grumpy during the day | 0.724 | 0.525 | 0.731 | 0.534 |
| Trouble getting out of bed in the morning | 0.675 | 0.456 | 0.652 | 0.425 |
| Fall back to sleep after being awakened | 0.569 | 0.324 | 0.547 | 0.299 |
| Need someone to awaken you | 0.424 | 0.18 | | |
| How often do you think you need more sleep? | 0.755 | 0.57 | 0.751 | 0.564 |
| SS loadings | 3.631 | | 3.439 | |
| Proportion Var | 0.454 | | 0.491 | |
| Cronbach's α | 0.82 | | 0.82 | |
| McDonald's ω | 0.82 | | 0.83 | |
| | Average variance extracted — 37% | | Average variance extracted — 41% | |

*Note. F1 = unrotated standardized loadings on a factor. h2 is factor communality estimates.*
*The regional, sex, and age effects on the PDSS total score.*

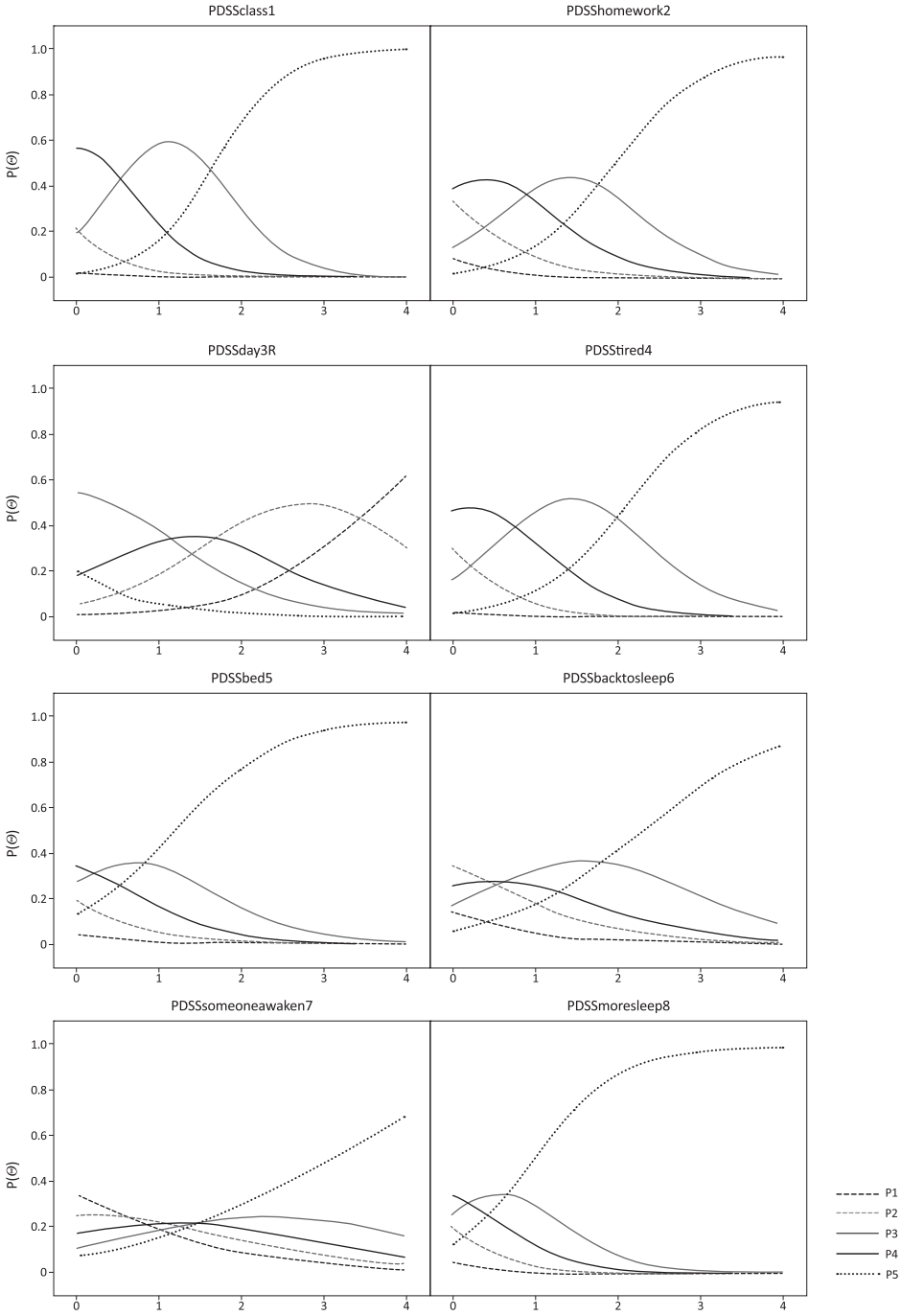


*Figure 2.* The category characteristic plot for the IRT parameters

*Note. P1-P5 = response options (5-point Likert scale, P1 = "Never", P5 = "Always"). P(θ) shows the probability of choosing each type of the answer to the questionnaire item.*

***The answers options were on a 5-point Likert scale from 0 (never) to 4 (always)***

The data in our study were collected across multiple data collection sites from different geographical regions in Russia. The descriptive statistics for different regions are presented in *Table 5*.

**Table 5**

*Descriptive statistics for different regions of data collection*

| Region | Variable | n | mean | sd | median |
|---|---|---|---|---|---|
| Khabarovsk | Sex | 559 | 1.56 | 0.5 | 2 |
| | Age | 559 | 13.55 | 1.47 | 13 |
| | PDSS | 559 | 14.35 | 5.7 | 14 |
| Krasnoyarsk | Sex | 326 | 1.6 | 0.49 | 2 |
| | Age | 326 | 15.07 | 1.33 | 15 |
| | PDSS | 326 | 12.78 | 5.04 | 13 |
| Murmansk | Sex | 145 | 1.5 | 0.5 | 1 |
| | Age | 145 | 14.63 | 1.31 | 14 |
| | PDSS | 145 | 13.23 | 6.12 | 13 |
| Novosibirsk | Sex | 424 | 1.53 | 0,5 | 2 |
| | Age | 424 | 14.4 | 1.42 | 14 |
| | PDSS | 424 | 12.64 | 5.59 | 12 |
| Omsk | Sex | 260 | 1.52 | 0.52 | 2 |
| | Age | 260 | 13.57 | 1.91 | 13 |
| | PDSS | 260 | 12.28 | 5.51 | 12 |
| Perm’ | Sex | 86 | 1.58 | 0.5 | 2 |
| | Age | 86 | 15.21 | 1.59 | 15 |
| | PDSS | 86 | 11.6 | 5.54 | 11.5 |
| Rostov-on-Don | Sex | 767 | 1.52 | 0.5 | 2 |
| | Age | 767 | 14.98 | 1.41 | 15 |
| | PDSS | 767 | 12.62 | 5.89 | 12 |
| Tatarstan | Sex | 236 | 1.46 | 0.5 | 1 |
| | Age | 238 | 15.3 | 1.18 | 15 |
| | PDSS | 235 | 12.27 | 5.4 | 12 |
| Tyumen’ | Sex | 549 | 1.55 | 0.53 | 2 |
| | Age | 549 | 14.23 | 2.01 | 14 |
| | PDSS | 549 | 11.97 | 5.68 | 12 |
| Yaroslavl | Sex | 229 | 1.57 | 0.5 | 2 |
| | Age | 229 | 15.44 | 1.23 | 16 |
| | PDSS | 229 | 13.31 | 5.54 | 13 |

We investigated whether the region of data collection affected the PDSS total score by applying multinomial logistic regression. The results of the multinomial lo-

gistic regression analysis are presented in *Table 6*. For multinomial logistic regression, the baseline variable should be set to compare different levels of nominal data. We used the Tyumen collection site as the baseline level. The relative ratio for a one-unit increase in the PDSS scores depending on the collection site ranged from 0.99 to 1.13 (a value of 1 means that there is no change, *Table 6*). The prediction accuracy of the regression model was 21.82%, indicating overall minor regional differences in PDSS scores.

**Table 6**

*The results of multinomial logistic regression analysis*

| Region | (Intercept) | PDSS Score Corrected Odds Ratio | p-value |
|---|---|---|---|
| | 0.000878 | 1.136154 | 0.308 |
| Khabarovsk | 0.360339 | 1.082254 | 0.1 |
| Krasnoyarsk | 0.385376 | 1.035529 | 0.19 |
| Murmansk | 0.175535 | 1.033744 | 0.093 |
| Novosibirsk | 0.537805 | 1.029662 | 0.34 |
| Omsk | 0.457738 | 1.002706 | 0.867 |
| Perm' | 0.2236 | 0.970294 | 0.232 |
| Rostov-on-Don | 1.002613 | 1.027197 | 0.25 |
| Tatarstan | 0.377662 | 1.010049 | 0.549 |
| Yaroslavl | 0.282636 | 1.032151 | 0.058 |

The next step of our analysis was to analyze the effects of age, sex, and time to took to fill out the questionnaire on the PDSS original and corrected scores. The zero-order Pearson's correlations are presented in *Table 7*.

**Table 7**

*Means, standard deviations, and correlations with confidence intervals*

| Variable | ***M*** | ***SD*** | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1. Age | 14.53 | 1.66 | | | | |
| 2. Sex | 46% boys | 0.50 | 0.02 [–0.01, 0.05] | | | |
| 3. PDSS Score Corrected | 12.80 | 5.68 | 0.11** [0.08, 0.14] | 0.23** [0.19, 0.26] | | |
| 4. PDSS Score | 14.14 | 6.32 | 0.08** [0,04, 0,11] | 0.19** [0.16, 0.22] | 0.98** [0.98, 0.98] | |
| 5. Time of filling the questionnaire | 13.64 | 3.93 | –0.06** [–0.09, –0.02] | 0.05** [0.02, 0.08] | 0.01 [–0.02, 0.04] | 0.01 –0.03, 0.04] |

*Note. M and SD are used to represent means and standard deviations, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. * indicates p < 0.05. ** indicates p < 0.01.*

The study results show that the age and sex of the participants were significantly correlated with the PDSS scores. The sex and age differences in the corrected PDSS scores are presented in *Figure 3*.

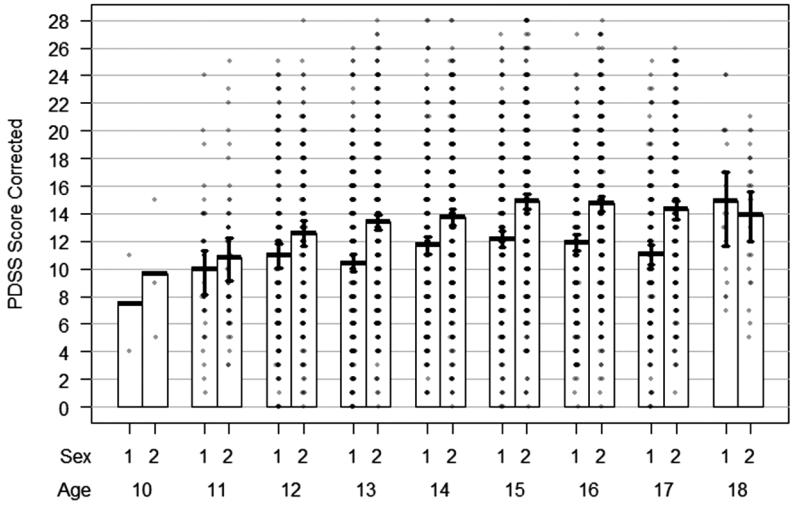


*Figure 3.* The age and sex differences in the PDSS corrected score

*Note. Bayesian Highest Density Intervals (HDIs) are presented as whiskers. For the "Sex" variable, 1 = boys, 2 = girls.*

From *Figure 3*, it can be seen that 1) for age groups from 13 to 17 years, boys have lower PDSS scores than girls, and 2) there is a monotonic increase in PDSS scores from age 10 to 15, with a plateau afterward. Note that a higher PDSS score means more sleep-related problems.

## Discussion

In the current study, we investigated the psychometric properties of the Russian version of the PDSS questionnaire across a wide range of geographical regions in Russia. Our analysis revealed that the PDSS maintains the same unifactorial structure previously reported. We have also shown that although the PDSS was originally designed for participants of ages 10-15, it demonstrates good psychometric quality for a broader age range, allowing it to be used for participants up to 18 years old.

Simultaneously, we found that improved psychometric characteristics of the questionnaire, compared to the adaptation of the PDSS by Randler and colleagues (2019), can be achieved by omitting one of the original items: "How often do you need someone to awaken you." According to the IRT analysis, this item has limited value in differentiating participants in our study.

We hypothesize that this result may be associated with changes in the organization of morning routines since the PDSS questions were initially formulated. In contrast to the time when the original version of the questionnaire was developed

(Drake et al., 2003), when it was common for parents or other adults to check on and wake up children if they were too sleepy, this responsibility is now largely delegated to alarm clocks on mobile phones that children typically possess. Excluding this item from the questionnaire increased the model fit and psychometric characteristics of the scale while preserving the same structure with only one factor. Overall, the construct validity of the instrument was demonstrated to be valid across various geographical regions and can be used for Russian-speaking youth samples to evaluate daytime sleepiness.

We observed no regional effects in the distribution of the PDSS total scores. In Russia, regional effects encompass seasonal variability in daylight. Previously, seasonal effects have been linked to disruptions in human behavior, most notably in mood and sleep patterns (Kasper et al. 1989). To date, only a few studies have investigated the potential seasonality of sleep and sleep problems, with the majority conducted in Nordic countries.

In one study, age-dependent effects of season on sleep (Thorleifsdottir et al. 2002) were identified for two specific items assessing 1) difficulties initiating and maintaining sleep, which were more frequent during the winter months, and 2) early morning awakenings, which were more common during the spring. However, one of the most recent and largest studies to date on the effects of extreme variation in natural illumination (the "Tromsø study," Sivertsen et al., 2020) has demonstrated minimal influence of seasonality on sleep status. However, participants in that study were all over 40 years old, which limits its results' generalizability to younger individuals. The lack of natural illumination effects on sleep quality in our study aligns with the previous findings of the Tromsø study (Sivertsen et al., 2020), indicating that these results apply not only to adults but also to schoolchildren.

In summary, our findings suggest that the extreme geographical properties of the data collection sites and potential seasonality effects were unlikely to impact the validity of the initial adaptation of the PDSS. It is possible that the more important factor is not the geographical characteristics of the participants' location, but rather the individual differences in their circadian typology (Adan et al., 2006; Adan et al., 2012). However, this hypothesis requires further investigation.

We also analyzed the effects of participants' age and sex on sleep quality. Our findings revealed both sex and age effects on sleep quality, with boys reporting fewer sleep-related problems than girls and younger children reporting fewer problems than older children. These age effects have been previously demonstrated in various studies (Alfano et al., 2009; Don et al., 2009; Owens et al., 2000) and have been attributed to factors ranging from developmental changes in the hormonal status and nervous system functioning in adolescents, to environmental effects such as shifts in academic responsibilities or the easing of daily regime requirements by parents. Adolescents also tend to go to bed later and wake much later than their adult or child counterparts due to changes in circadian rhythm and altered sleep drive, whereby the pressure to fall asleep accumulates more slowly in older adolescents (Galland et al., 2017).

The gender differences identified in our study are consistent with previous findings. Sleep disturbances have been reported to be more prevalent in girls after the

onset of puberty and the beginning of the menstrual cycle (Johnson et al., 2006). However, it should be noted that Randler and colleagues (2019) did not report any gender differences, possibly due to their smaller sample size and the statistical power of their study.

## Conclusion

In conclusion, our study confirmed the validity and utility of the Russian version of the PDSS, enhancing the generalizability of this instrument. We have also replicated previously reported age and sex effects on sleep quality in schoolchildren. We recommend the widespread use of the PDSS for research and evaluation of daytime sleepiness and its influence, especially by health professionals, psychologists, and other specialists in Russia.

## Ethics Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Psychological Institute of Russian Academy of Education, (protocol code 2020/4-1).

## Informed Consent from the Participants' Legal Guardians (if the participants were minors)

Informed consent was obtained from the legal representative of all the children involved in the study.

## Author Contributions

Conceptualization was by I.Z., S.M., V.I., J.M., A.T., T.A., and M.L.; methodology by I.Z., S.M., V.I., J.M., A.T., T.A., and M.L.; software by P.K and A.M.; formal analysis by I.Z.; investigation by I.Z., S.M., V.I., J.M., A.T., T.A., P.K., A.M., and M.L.; resources by S.M.; data curation by I.Z.; original draft preparation by I.Z.; review and editing by V.I., M.L. and S.M.; visualization by I.Z.; supervision by S.M.; and project administration by V.I.

All authors read and agreed to the published version of the manuscript.

## Conflict of Interest

The authors declare no conflict of interest.

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FAMILY PSYCHOLOGY

# The Impact of Romantic Attachment Styles on Jealousy in Young Adults

Apollinaria V. Chursina[a, b, c*]

[a] *Lomonosov Moscow State University, Moscow, Russia*
[b] *University of Granada, Spain*
[c] *Psychological Institute of the Russian Academy of Education, Moscow, Russia*

*Corresponding author. E-mail: avchurs@gmail.com

**Background**. Romantic attachment is reflected in various aspects of dyadic interaction in a couple, since it is a self-reinforcing system of cognitive, emotional and behavioral patterns. Romantic jealousy was shown to be associated with dimensions of attachment insecurity in various studies worldwide.

**Objectives**. To identify differences in expressions of romantic jealousy based on romantic attachment style. To determine the influence of attachment-related anxiety and attachment-related avoidance on cognitive, emotional, and behavioral jealousy.

**Design**. The sample comprised 171 heterosexual individuals. The "Experiences in Close Relationships — Revised" questionnaire (ECR-R; Fraley, Waller, & Brennan, 2000; adapted for Russian by Chursina, 2022) and "Multidimensional Jealousy Scale" (MJS; Pfeiffer, & Wong, 1989) were used.

**Results**. A number of significant differences were identified between insecure and secure attachment styles. *Avoidant attachment* is characterized by cognitive jealousy, *ambivalent attachment* is characterized by cognitive and behavioral jealousy, while *dismissing attachment* showed no significant differences in the manifestations of jealousy in comparison with secure attachment style. Emotional jealousy is equally characteristic of all types. The primacy of romantic attachment in relation to cognitive and behavioral jealousy was also proved.

**Conclusion**. The experience of jealousy differs among romantic attachment styles. *Attachment-related anxiety* is a predictor of intrusive thoughts and behavioral manifestations of jealousy, while *attachment-related avoidance* is less, the greater the manifestation of jealousy behaviors.

***Keywords:***
romantic attachment, romantic jealousy, two-dimensional model of attachment, attachment-related anxiety, attachment-related avoidance

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## Introduction

The concept of romantic attachment (Hazan & Shaver, 1987) goes back to the classical theory of attachment developed by J. Bowlby and M. Ainsworth (Ainsworth, Blehar, Waters, & Wall, 2015; Bowlby, 1982). This theory emphasized the importance of relationships with the primary caregiver for the child's emotional development, and developed the idea of attachment as a complex system that includes cognitive, emotional, and behavioral components and patterns. The key notions are the internal working models of attachment, a system that includes unconscious attitudes and expectations about relationships in general. These ideas formed the basis of the two-dimensional model of individual differences in romantic attachment (Bartholomew, & Horowitz, 1991), where the main dimensions are image of the self and image of the significant other, later also identified as anxiety and avoidance of romantic attachment, respectively (Fraley, Waller, & Brennan, 2000).

These representations are mainly associated with evaluating oneself as deserving of love, support, and acceptance if the image of self scale or attachment-related anxiety is considered. Attachment-related avoidance, or image of the significant other, on the contrary, represents ideas about the people around as trustworthy and worthy of establishing close relationships. The combination of high and low values on these scales makes it possible to apply a typology of four romantic attachment styles: secure, fearful-avoidant (hereinafter "avoidant"), preoccupied (hereinafter "ambivalent", since it corresponds to the classic ambivalent type described by J. Bowlby and M. Ainsworth), and dismissing-avoidant (hereinafter "dismissing").

### *Romantic Attachment Style as a Predictor of Relationship Functioning*

Numerous studies by scientists around the world describe the relationship between romantic attachment style and different characteristics of dyadic interaction (e.g., Butzer, & Campbell, 2008; Conde, Figueiredo, & Bifulco, 2011). Since attachment is a self-reinforcing dynamic system, the characteristics of internal working models provide differences in the manifestations of interaction in a couple. Dimensions of attachment insecurity are associated with marital satisfaction (e.g., Rodriguez, Coy, & Hadden, 2021). Attachment-related avoidance prevents the development of intimacy and open communication in a couple, while attachment-related anxiety determines the need for confirmation of love from a partner. Modern research still debates whether marital satisfaction is higher if both partners have a secure attachment style, or whether it is enough for one of them to have it, thus acting as a buffer in the couple. However, recent research rejects the buffer hypothesis (Lozano, Sze, Fraley, & Chong, 2021). Nevertheless, in addition to anxiety and avoidance of romantic attachment, dyadic regulation processes are also important, for example, the context of interdependence and partners' behavior in a particular situation (Overall & Simpson, 2015; Simpson, & Overall, 2014).

Various coping strategies can also serve as a buffer for the dimensions of attachment insecurity and relationship satisfaction. Emotion-focused dyadic coping buffers attachment-related anxiety, while problem-focused coping buffers avoidance (Vedelago, Balzarini, Fitzpatrick, & Muise, 2023). These ideas are consistent with the attachment security enhancement model (ASEM; Arriaga, Kumashiro, Simpson, &

Overall, 2018). This approach is intended to neutralize the negative effects of insecure romantic attachment in a couple and to strengthen the model of the self and the model of the significant other. Attachment anxiety is addressed through increased self-confidence, while avoidance is reduced in situations of increased positive dependency.

Sexual functioning in a couple is also mediated by the influence of romantic attachment (Dunkley, Dang, Chang, & Gorzalka, 2016). Attachment-related avoidance has an overall, generalized negative impact on a couple's sexual satisfaction (Heresi Milad, Rivera Ottenberger, & Huepe Artigas, 2014). Both attachment anxiety and avoidance are associated with negative emotional experiences during sex, although anxiety mediates caregiving motives at the same time, which promote positive emotional reactions (Beaulieu, Brassard, Bergeron, & Péloquin, 2022). Stefanou and McCabe (2012) also highlight the influence of both dimensions of attachment insecurity on sexuality in a couple, in particular, on satisfaction, frequency of sexual intercourse, and motivation, but emphasize the need for targeted research on the topic.

### *Romantic Jealousy and Its Relationship with Romantic Attachment Style*

Jealousy in romantic relationships is a complex of cognitive, emotional, and behavioral patterns that arise in response to a perceived threat to an individual's relationship (Pfeiffer & Wong, 1989). The cognitive component of jealousy includes intrusive thoughts and suspicions about the potential infidelity of a romantic partner. The emotional aspect reflects the degree of negative affect regarding situations that provoke jealousy. Behavioral jealousy describes actual actions aimed at assuring a romantic partner's fidelity. In this work, we rely specifically on a multidimensional approach to jealousy, since it is most consistent with the concept of the attachment system as a unity of emotional, cognitive, and behavioral patterns.

Scholars argue that there are different types of variables associated with jealousy. In their systematic review, Martínez-León et al. (2017) distinguish personal, interpersonal, and sociocultural variables. Despite the fact that there are ideas about the influence of cultural factors, physiological and hormonal processes, and a real experience of infidelity, a large body of research is associated precisely with personality traits, since they are clearly expressed in the processes of interpersonal interaction.

Jealousy in relationships is also related to romantic attachment style. Ambivalent attachment is most associated with various dimensions of jealousy (e.g., Marazziti, Consoli, Albanese, Laquidara, Baroni, & Catena Dell'osso, 2010), since it is characterized by a pronounced fear of rejection by the partner and represents a kind of insatiable need for love. Fear of losing the attachment figure contributes to increased patterns of jealousy. A similar pattern occurs with avoidant attachment, since both dimensions of attachment insecurity are present in this style. The difference lies in the degree of involvement in close relationships against the background of pronounced jealousy. People with anxious attachment describe themselves as being more jealous and having low self-esteem.

Individuals with ambivalent attachment have significantly higher levels of jealousy, as well as fewer positive feelings and lower self-esteem in laboratory-induced jeal-

ousy situations (Kim, Feeney, & Jakubiak, 2018). In experimental conditions, it was individuals with anxious attachment who demonstrated a greater number of jealousy patterns. There are also gender differences in jealousy (e.g., Güçlü, Şenormancı, Şenormancı, Köktürk, 2017), with women exhibiting emotional and cognitive jealousy to a greater extent.

Jealousy demonstrates age differences in women (Shackelford et al., 2004). Consequently, it could also be emphasized that jealousy decreases as a marriage progresses. Although this could be explained by aging and hormonal changes, we also emphasize that the dimensions of attachment insecurity change as the marriage progresses (Fraley, 2019). A person accumulates the experience of positive interaction in a stable relationship with a romantic partner, which helps reduce attachment anxiety.

Therefore, there are differences in the expression of jealousy depending on the romantic attachment style (Sharpsteen, & Kirkpatrick, 1997). Internal working models of attachment provide a certain scheme, a predisposition regarding the perception of relationships as a whole and, accordingly, reinforce their functioning in a certain way. Jealousy, since it represents some anticipation of potential infidelity and threat to the relationship, is also a kind of internal working model, so it seems necessary to study the characteristics of this associations for different romantic attachment styles.

### *The Current Study*

The purpose of this study is to replicate existing research in the field of psychology of attachment and romantic jealousy for the first time with a Russian sample. The study is designed to expand existing understanding of the relationship between attachment style and romantic jealousy and to identify characteristics specific to different attachment styles.

## Methods

### *Participants*

The sample comprised 171 heterosexual persons aged 20–54 (M = 33.06, SD = 7.94), 64 men (37.43%) and 107 women (62.57%). All the participants cohabited with their romantic partners. 77.2% had higher education, 10.5% had incomplete higher education, 2.3 and 9.9% had completed secondary and secondary specialized education, respectively.

### *Instruments*

*The Experiences in Close Relationships - Revised questionnaire* (ECR-R; Fraley, Waller, & Brennan, 2000; adapted for Russian by Chursina, 2022) was used to assess romantic attachment style. It is based on a two-dimensional model of individual differences in romantic attachment that assesses attachment-related anxiety and attachment-related avoidance. The questionnaire consists of 36 statements related to romantic relationships, rated on a 7-point Likert scale of agreement/disagreement, and is aimed

at determining the degree of anxiety and avoidance of intimacy in relationships with a romantic partner.

*The Multidimensional Jealousy Scale* (MJS; Pfeiffer, & Wong, 1989) was used to evaluate the patterns of romantic jealousy considering its three types of patterns (emotional, cognitive, and behavioral patterns). It consists of 24 statements related to various aspects of jealousy, rated on a 7-point Likert scale based on frequency of manifestations for the cognitive and behavioral scales, and by severity of manifestations for the emotional scale.

### *Procedure*

All study participants were informed about its objectives and gave voluntary informed consent to participate. Data was collected online.

## Results

### *Relationship Between the Indicators of Romantic Attachment and Jealousy*

In a study of jealousy in adults with different romantic attachment styles, significant correlations were identified between the scores on the multidimensional jealousy scale and measures of insecure romantic attachment. Correlations were found between the cognitive jealousy scale and both dimensions of romantic attachment insecurity: anxiety ($r = 0.50$, $p < 0.00$) and avoidance ($r = 0.29$, $p < 0.00$), as well as with the type of romantic attachment variable ($r = 0.21$, $p < 0.01$). Romantic attachment anxiety also showed a significant correlation with behavioral jealousy ($r = 0.41$, $p < 0.00$).

**Table 1**

*Descriptive statistics for MJS questionnaire scales in individuals with different romantic attachment styles*

| Scale | Secure attachment style | | Avoidant attachment style | | Ambivalent attachment style | | Dismissing attachment style | |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD |
| Cognitive jealousy | 2.11 | 1.25 | 3.38 | 1.39 | 3.24 | 1.73 | 2.37 | 1.15 |
| Emotional jealousy | 4.88 | 1.12 | 5.12 | 1.13 | 5.01 | 1.16 | 5.03 | 0.90 |
| Behavioral jealousy | 2.07 | 0.86 | 2.75 | 1.19 | 2.77 | 1.06 | 1.95 | 0.80 |

Therefore, adults diagnosed with attachment insecurity are more prone to demonstrate cognitive jealousy, namely, to have obsessive thoughts about the potential infidelity of their partner, while the correlation of this parameter is significantly higher for the measure of attachment anxiety than for avoidance. Behavioral jealousy (committing acts driven by jealousy and aimed at testing hypotheses about a partner's potential infidelity) is characteristic of adults with romantic attachment anxiety.

### *Jealousy Manifestations in Individuals with Different Romantic Attachment styles*

To identify more specific patterns of manifestations of jealousy in adults with different types of romantic attachment, we applied one-way analysis of variance, namely the method of multiple comparisons (Tukey HSD test).

#### *Comparison of Secure and Avoidant Romantic Attachment Styles*

Two significant differences were identified: on the cognitive jealousy scale (HSD = –1.27, $p < 0.00$) and on the behavioral jealousy scale (HSD = –0.68, $p < 0.003$). Securely attached individuals have significantly fewer intrusive jealous thoughts about potential infidelity in its various forms than those with an avoidant attachment to the romantic partner. Additionally, securely attached individuals exhibit significantly fewer jealousy behaviors than avoidantly attached adults. A negative self-image and a negative image of a significant other represent "double doubt" and provoke jealousy in its various dimensions: the person doubts their own worthiness for love and at the same time doubts their partner and their partner's positive qualities.

#### *Comparison of Individuals with Secure and Ambivalent Romantic Attachment Styles*

Two significant differences were identified: on the cognitive jealousy scale (HSD = –1.13, $p < 0.01$) and on the behavioral jealousy scale (HSD = –0.70, $p < 0.03$). Individuals with ambivalent attachment to the romantic partner demonstrate significantly more behavioral manifestations of jealousy and have significantly more thoughts about the possible infidelity of the partner than adults with secure attachment. In this case, the main role is played by the negative image of self, where people consider themselves undeserving of love, support, and acceptance, which corresponds to the classical ideas of attachment theory.

#### *Comparison of Individuals with Secure and Dismissive Romantic Attachment Styles*

No significant differences were found.

The study found a number of significant differences in the expression of jealousy among young adults with different romantic attachment styles. These differences, revealed through multiple comparisons, where jealousy is significantly higher in individuals with avoidant and ambivalent attachment—that is, where insecurity is manifested through anxiety in romantic attachment—turned out to be more congruent with classical ideas about the relationship between romantic attachment and jealousy. The fact that rejecting romantic attachment (and this is the type where insecurity is associated only with the avoidance dimension, against the background of low romantic attachment anxiety) did not find significant differences compared to secure attachment only confirms that the avoidance dimension cannot be a factor associated with the origin of jealousy, to confirm which we used regression analysis methods (linear regression).

### *The Impact of Romantic Attachment on Jealousy Patterns*

Three models were built, one for each dimension of jealousy (cognitive, emotional, behavioral), where the independent variables were both dimensions of attachment insecurity, anxiety and avoidance.

The model of cognitive jealousy ($R2 = 0.25$, $F = 28.17$, $p < 0.00$), explained through measures of attachment insecurity, revealed romantic attachment anxiety as a significant predictor ($\beta = 0.49$, $t = 6.61$, $p < 0.00$). Therefore, anxiety in romantic attachment is a prerequisite for the formation of the cognitive aspect of jealousy, namely jealous thoughts about one's partner.

The model of emotional jealousy explained through indicators of romantic attachment insecurity was statistically insignificant ($R2 = 0.01$, $F = 0.89$, $p < 0.41$). Therefore, negative emotional patterns during the experience of jealousy are not conditioned by romantic attachment, that is, in this case we can say that all people equally negatively experience situations that provoke jealousy.

The model of behavioral jealousy ($R2 = 0.27$, $F = 31.13$, $p < 0.00$), explained through indicators of insecurity of romantic attachment, showed that both anxiety ($\beta = 0.57$, $t = 7.78$, $p < 0.00$) and avoidance ($\beta = -0.15$, $t = -2.11$, $p < 0.04$) are significant prerequisites for the development of behavioral jealousy. Therefore, romantic attachment anxiety shapes patterns of behavioral jealousy, that is, those actions that are associated with the experience of jealousy or testing a romantic partner for potential infidelity. However, avoidance, on the contrary, inversely predicts jealous behavior, that is, less avoidance is a prerequisite for jealous behavior.

## Discussion

This research demonstrated that the experience of jealousy differs for adults with different romantic attachment styles. A number of differences were identified between insecure romantic attachment styles compared to secure attachment styles. Avoidant attachment is characterized by cognitive jealousy (thoughts about a partner's potential infidelity); such individuals are both emotionally sensitive and suspicious. Ambivalent attachment is characterized by both cognitive and behavioral jealousy (specific actions with the aim of preventing or localizing the threat of infidelity of a partner), which corresponds to the theoretical idea that people with this type of attachment are the most jealous. It is noteworthy that dismissing attachment showed no fundamental differences in the manifestations of jealousy in comparison with secure attachment. At the same time, emotional jealousy is characteristic of all attachment styles equally, demonstrating that the perceived threat of infidelity equally causes negative emotions in each individual.

Other studies (e.g., Rydell, & Bringle, 2007) highlight the association of attachment anxiety with cognitive and behavioral jealousy, but not with emotional jealousy. We believe this is because, regardless of attachment style, monogamous relationships still involve exclusivity, meaning that potential infidelity will trigger negative emotional states. However, some scholars have found connections between attachment anxiety and all components of jealousy (e.g., Rodriguez, DiBello, Øverup, & Neighbors, 2015). Moreover, there is evidence supporting the association of

attachment anxiety with emotional, cognitive, and behavioral online jealousy (Sullivan, 2021).

The primacy of romantic attachment in relation to cognitive and behavioral jealousy was also described in the present study: it is the anxiety of attachment to a romantic partner that is a significant prerequisite for their development. Our findings are consistent with the results of Deng et al. (2023), who noted the predictive effect of attachment anxiety in relation to jealousy. This connection is mediated by a low level of self-differentiation. Indeed, attachment anxiety is associated with a state of alertness and control (like a "radar"), and fear of rejection. Neuroticism (Richter, Schlegel, Thomas, & Troche, 2022) and low self-esteem (DiBello, Rodriguez, Hadden, & Neighbors, 2015) were also reported as predictors of romantic jealousy; therefore, more research on romantic jealousy, attachment, and personality traits is needed. In addition to being significantly associated with various aspects of jealousy, attachment-related anxiety is also associated with dyadic interactions, for example, dyadic distrust (Toplu-Demirtaş, Akcabozan-Kayabol, Araci-Iyiaydin, & Fincham, 2022). Furthermore, anxiously attached individuals induce feelings of guilt in their partner in response to negative situations in the relationship, and thus feel more secure and stable (Overall, Girme, Lemay, & Hammond, 2014).

It is advisable to study dyadic mechanisms in the manifestation of jealousy depending on the style of romantic attachment. Pfaus et al. (2023) consider ideas about synchrony in relationships, including in relation to the attachment system in a couple. Since attachment is self-reinforcing in both caregiver and romantic partner relationships, it will inevitably influence various aspects of relationship quality by reinforcing dysfunctional patterns due to the lack of positive experiences. Depending on the patterns of attachment in a couple, behavioral and emotional synchrony or asynchrony may occur, which is also associated with hormonal processes. Moreover, perceptions across dyads of attachment insecurity are consistent (Molero, Shaver, Fernandez, Alonso-Arbiol, & Recio, 2016) and are associated with low relationship satisfaction, so the consistency of perceptions of jealousy patterns remains an issue.

## Conclusion

The study demonstrated the strong association and primacy of romantic attachment in relation to jealousy. These findings are of particular interest in the context of attachment theory in general and the two-dimensional model of romantic attachment in particular. First, we established the patterns of the experience of jealousy within a multidimensional model of jealousy and romantic attachment: we found that manifestations of cognitive and behavioral jealousy vary for different types of romantic attachment; in particular, these phenomena are most characteristic of individuals with avoidant and ambivalent attachment. Second, we found that the anxiety of romantic attachment acts as a predictor of thoughts and behavioral manifestations of jealousy, while there is less avoidance of romantic attachment, the greater the manifestation of jealousy behaviors.

## Limitations and Suggestions for Future Research

Several limitations must be taken into account before interpreting these results. First of all, the study was conducted on a sample where the vast majority of participants have higher education and belong to the middle class, living mainly in Moscow. Despite the particular features of the education system in Russia, its universal accessibility at all levels, the study should be expanded to other social contexts and regions, since the results may differ. The sample was also not age-balanced. In addition, in view of the fact that the supposition of continuity of adult and child attachment, strictly speaking, is an assumption and has been confirmed by only a few longitudinal studies, it is difficult to unequivocally state the primacy of romantic attachment in relation to jealousy. Finally, it is also necessary to examine the influence of both personality characteristics potentially associated with jealousy and attachment style (for example, the level of self-differentiation or paranoid traits), as well as to examine the processes of dyadic interaction, since this study involved individuals, but not couples.

## Ethics Statement

The study and consent procedures were approved by the Ethics Committee of the Faculty of Psychology at Lomonosov Moscow State University (approval No: 2020/87).

## Conflict of Interest

The author declares no conflict of interest.

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