

ARTICLE



<https://doi.org/10.1057/s41599-022-01218-0>

OPEN

Impact of school closure due to COVID-19 on phonemic awareness of first-grade primary school children

Kerem Coskun^{1✉} & Cihan Kara¹

The purpose of the present research was to disclose the impact of school closures due to COVID-19 on phonemic awareness of first-grade primary school students. The research sample comprised two cohorts. Cohort-1 consisted of 59 first-grade primary school students, while there were 193 students in Cohort-2. A total of 252 first-grade primary school students were recruited into the research sample. Data were collected with the Phonemic Awareness Test which was specifically designed for the research. Mediation analysis was used for data analysis. Results of the mediation analysis indicated that school closures due to COVID-19 led to significant decreases in phonemic awareness of first-grade primary school students. Results are also discussed along with student-teacher interactions.

¹Department of Primary Education, Artvin Coruh University, Sehir Kampusu, 08000 Artvin, Turkey. ✉email: keremcoskun@outlook.com

Introduction

COVID-19 led to school closures around the world when it was announced as a pandemic on 11 March 2020. Governments had to close down educational facilities from kindergarten to university to slow down transmission of the virus, and reduce the burden on health systems. This is because schools are places where intense social contact occurs (Armitage and Nellums, 2020; Eames et al., 2011; Viner et al., 2020). As a consequence, school closure appeared to be plausible for decision-makers who are responsible for public education. However, the bill to be paid due to school closures has been observed gradually.

Lockdown restrictions and home confinements reduced the well-being of children and enhanced psychological damage among children owing to less social interaction and more experience of a sense of isolation (Brooks et al., 2020). Lockdowns and home confinements were other measures along with schools being closed. School closure due to COVID-19 was one of the most disruptive events in educational history because it led to 1.6 billion students being kept from their schools and teachers (United Nations, [UN], 2020). It deprived students of teachers' guidance, help, instruction, and demonstration. Students had to receive guidance, help, and instruction through screens and teachers gave their instructional procedures and support through screens. This kind of learning can be conceived of as out-of-school learning. Students must understand and internalize curricular contents delivered from screens with minimum teacher guidance, help, instruction, and demonstration in the context of out-of-school learning. Children have to gain self-regulated learning skills in order to achieve the learning standards expected by national curriculums. This is because self-regulated learning skills allow students to view learning tasks as a controllable process, something that they can handle and feel remarkable responsibility for their achievements. In other words, self-regulated learning skills allow students to gain awareness of how to be motivated, knowledgeable, decisive, and self-efficacious when faced with a learning task (Zimmerman, 1990). When the fact that primary school students possess developmental cognitive disadvantages is taken into consideration, they are more dependent on teachers so they are more vulnerable to deficiencies in self-regulated learning skills. Higher achieving students acquired self-regulated learning skills and did manage to overcome the challenge and difficulties arising from online learning environments but lower-achieving children failed to cope with the difficulties emerging from flimsy and shaky teacher guidance in online learning environments. As a result, school closures due to COVID-19 devastated lower-achieving children rather than higher-achieving children; this, in turn, expanded the existing gap between higher-achieving children and lower-achieving children (Grewenig et al., 2021). School closures due to COVID-19 destroyed direct interaction between teachers and students (Andrew et al., 2020). Students were greatly affected owing to their lack of self-regulation skills and the absence of direct interaction with their teachers.

Moving the classroom as a place of learning to the home environment and online learning environment led to shaky student-teacher interactions. Weakened student-teacher interaction led to adaptation for both parties (Grewenig et al., 2021; Kuhfeld et al., 2020). Students had difficulty in focusing and performing learning tasks while deprived of strong teacher instruction, demonstration, support, and help. On the other hand, the teachers experienced difficulties stemming from being away from their students. The disappearance of direct student-teacher interaction led to adaptation problems for both teachers and students. As a result, the online learning environment weakened student-teacher interaction and this was associated with

underachievement in turn (Chetty et al., 2020; The DELVE Initiative, 2020). Furthermore, the breakdown in student-teacher interaction was accompanied by students being exposed to distractors from the screens of smart digital devices in home settings. The distractors meant students spent more time interacting with the digital devices but less time on studying and learning tasks during home confinement.

The cost of school closures due to COVID-19 emerged as learning loss. Learning loss is described as the decrease in knowledge and skill gain in any curricular domain. Learning loss can be identified when knowledge and skill gain does not occur at the same level and the same pace in two subsequent years (Pier et al., 2021). Learning loss has begun to emerge in curricular subjects which are taught in schools. Literacy is one of the curricular subjects that underlie future academic achievement and development in cognitive and social domains. In primary schools, literacy is the subject in which primary school students learn to write and read, and gain a mindset that enables them interpret, comprehend and generalize what they read. Additionally, literacy teaching in primary school allows primary school students to improve their existing listening and speaking skills. As can be seen from the description of literacy, it is a multifaceted concept. Word recognition, decoding sounds in auditory and written forms, word knowledge, and vocabulary are components of literacy (Indrisano and Chall, 1995; Lonigan, 2015; Venezky, 1990). Phonemic awareness is also another skill that can be included in the concept of literacy. Phonemic awareness refers to a student's insight into phonological structure and sound, and sound structure of words (Stahl and Murray, 1994). Phonemics allows primary school children learning to read and write to easily recognize words, blend sounds and manipulate sounds so as to produce new words. Moreover, it consists of analysis (partitioning words into their constituents) and synthesis (combining letters, syllables to yield a word). Phonemic awareness, in turn, fosters the alphabetic principle, which refers to primary school children knowing that specific words represent specific sounds (Stahl et al., 1998; Ehri, 1995). Therefore, phonemic awareness is known to be a very crucial predictor of good reading and has seminal functions in literacy acquisition and reading comprehension (Adams, 1990; Blachman, 1984; Bradley and Bryant, 1978; Castles and Coltheart, 2004; Clayton et al., 2020; Hulme et al., 2002; Lundberg et al., 1980; Mann and Liberman, 1984; Melby-Lervåg et al., 2012).

Curricular programs aiming to improve phonemic awareness of kindergarten or primary school children are mainly conducted by ministries of education around the world to enhance phonemic awareness. Moreover, disadvantaged children who are at risk of reading failure, benefit more from these interventional programs than normally developing children (Buckingham, 2020; Hatcher et al., 2004; National Reading Panel, 2000; Savage et al., 2018). Quality of instruction delivered by teachers is very important in terms of success of interventional programs. Even in small group interventions or large group interventions, teachers and their interactions with students play crucial roles in developing phonemic awareness of students. Intense and close social interaction between teachers and students is possible in classroom environments but school closures due to COVID-19 disrupted the social interaction in classrooms and it is worth determining the extent of learning loss in phonemic awareness. The impact of school closures on reading was assessed and evaluated for reading for school closures with shorter durations (Engzell et al., 2021; Gore et al., 2021; Kuhfeld et al., 2020; Tomasik et al., 2021). However, the impact of longer duration school closures on phonemic awareness of primary school children has not yet been revealed. Therefore, the contribution of the present research is to

reveal the impact of school closures due to COVID-19 on phonemic awareness.

School closures in Turkey. The 2019–2020 instructional year commenced on the 9th of September 2019. The outbreak of COVID-19 in Wuhan, China quickly turned into a pandemic and disseminated to the rest of the world. When the first case was identified on 13 March 2020, the Ministry of National Education closed all schools in Turkey. After the school closure, the Ministry decided to teach all of the curriculum through distance instruction and activated a portal called EBA (Web of Education and Communication). From March 2020 to June 2020 teaching and learning activities were carried out through EBA. In the middle of June, the 2019–2020 instructional year ended and summer holidays started. The 2020–2021 instructional year started on 31 August 2020. However, the Ministry decided that all of the classes should be divided in half, with the first group attending primary school on Monday and Tuesday, while the second group attended on Thursday and Friday. The number of COVID-19 cases hit a peak suddenly in November 2020 so the Ministry closed the schools again. Then all primary school children continued receiving instructional and curricular activities through EBA until the 1 June 2021. From 1st of June to 2nd July primary school children attended school on just two days of the week and summer holidays started. As a result, from 13 March 2020 to 2 July 2021, Turkish primary school children were dependent on a distance learning portal, EBA. Furthermore, Turkey is one of the countries where schools were closed for the longest time, after Mexico, among OECD countries (Eğitim Reformu Girişimi, 2021). Hence, the magnitude of learning loss among Turkish first-grade primary school children is worth examining.

Purpose of the research. Literacy has several dimensions which need elaborating. However, classes in primary schools were disrupted and student-teacher interaction disappeared. This required exclusion of speaking, listening, and reading comprehension from the scope of the study. However, it was possible and easy to design and implement a measurement of phonemic awareness, and to collect data through online testing procedures. As a consequence, this study just focused on phonemic awareness of first-grade primary school students.

The impact of short-term school closures was measured and assessed in the relevant literature especially for reading; however, the impact of long-term school closures and the overview is missing. No research has yet addressed the long-term impact of school closure due to COVID-19. Besides, Turkish primary school children experienced the longest school closure in the world. Thus, the impact of long-term school closures on learning loss in phonemic awareness will be measured and determined. The following hypotheses were developed to test if school closure due to COVID-19 influenced phonemic awareness and whether socioeconomic status (SES) of first-grade primary school student had a moderating role in this relationship:

Hypothesis-1: Did school closure due to COVID-19 lead to learning loss in phonemic awareness of first-grade primary school children?

Hypothesis-2: Did SES have a moderating role in the causal relationship between school closure due to COVID-19 and scores on the phonemic awareness test?

Method

Study 1: Development of Turkish Phonemic Awareness Test (TPAT). The aim of Study 1 was to develop the TPAT and identify its reliability through internal consistency. Development of the TPAT was conducted in four phases. First, the theoretical

basis of phonemic awareness was scrutinized to establish item constructs and an item pool to measure phonemic awareness and the relevant literature was investigated for how phonemic awareness was measured and assessed in other languages. For this purpose, Gil (2019), Goswami and Bryant (2016), Foy and Mann (2001), Mann and Liberman (1984), Mann (1993), Treiman (1991), and Vazeux et al. (2020) were investigated. The Phonologic Distinctness Test designed by Elbro (1990) and Composite Phonologic Awareness Test developed by Singson and Mann (1999) later adapted by (Foy and Mann, 2001) were reviewed and it was observed that those instruments measure phonemic awareness through phoneme judgment, phoneme deletion and phoneme completion tasks. As a result, the decision was made that the TPAT should consist of two subtests; phoneme judgment task and phoneme completion task. Ten items were designed for each of the subtests. In phoneme judgment tasks, the arrangement of letters in a word were changed and the participants were asked to order the letters by manipulation and to produce the word. In the phoneme deletion tasks, ten words were given with one letter omitted and the participants were required to find the true sounds and write the letter in the blank space. The Turkish primary school curriculum was reviewed and the most frequently used words were found. Ten words were selected for the phoneme judgment task; ten words were determined for the phoneme deletion task. Then, the initial form of the TPAT was created. In the second phase, the initial form was given to two field experts to review; the first one was a first-grade primary school teacher, and the second one was a researcher whose research interest is literacy teaching. After their reviews, one item in phoneme judgment was reordered and the final form of the TPAT was produced. In the third phase, ethical considerations and official permissions were addressed. A protocol which included the purpose and procedure of the study was prepared and submitted to the local education authority in Artvin, Turkey. A panel from the local education authority examined and approved the study protocol and gave official and ethical permission. In May and June 2019, 5 primary schools were visited, and the aim of the study and procedure were explained to the headteachers and first-grade primary school teachers. Eighteen first-grade primary school teachers accepted participation in the study by their students. Then their students were met and told what they would have to do and given a letter for parental consent. The letter included information about the procedure and aim of the study and what the students needed to do, and the parents were asked to sign if they accepted the conditions. A total of 231 letters were signed and received. As result, 231 first-grade primary school students participated in Study 1.

In the fourth phase, data collection and analysis were completed. What to do and how to respond to the tasks was explained to the participant children. The TPAT form was given to them. The average duration of test completion was about 10 min and they returned the answer sheets. Each correct response was coded as “1” and each wrong response was coded as “0”. Then, item analysis was carried out with item-total correlation, and internal reliability was analyzed for each of the items. Results of item analysis and internal reliability are demonstrated in Table 1.

Results of item analysis revealed that all of the items were adequately correlated with the total score due to higher correlations than 0.30. For Cronbach Alpha, if the item is deleted, it should not lead to an increase in overall consistency and it was observed that all of the items measured the same trait, phonemic awareness. As for reliability, the overall Cronbach Alpha coefficient for the TPAT was 0.94. Based on the results of item analysis, the TPAT is a reliable instrument for measuring

Table 1 Results of item analysis.

Subtest	Item	Mean	SD	Corrected item total correlation	Cronbach alpha If item deleted
Subtest 1:	Item 1	0.79	0.40	0.85	0.93
Phoneme	Item 2	0.78	0.40	0.84	0.93
Completion	Item 3	0.79	0.40	0.86	0.93
	Item 4	0.80	0.39	0.86	0.93
	Item 5	0.74	0.43	0.78	0.93
	Item 6	0.77	0.42	0.79	0.93
	Item 7	0.80	0.40	0.86	0.93
	Item 8	0.76	0.42	0.81	0.93
	Item 9	0.80	0.40	0.88	0.93
	Item 10	0.80	0.40	0.87	0.93
Subtest 2:	Item 11	0.91	0.28	0.48	0.94
Phoneme	Item 12	0.92	0.27	0.47	0.94
Judgment by	Item 13	0.94	0.23	0.50	0.94
Phoneme	Item 14	0.90	0.28	0.42	0.94
Manipulation	Item 15	0.90	0.27	0.43	0.94
	Item 16	0.92	0.27	0.43	0.94
	Item 17	0.91	0.28	0.46	0.94
	Item 18	0.79	0.40	0.37	0.94
	Item 19	0.86	0.33	0.41	0.94
	Item 20	0.84	0.36	0.38	0.94
Overall Cronbach Alpha: 0.94					

phonemic awareness among first-grade primary school children (Field, 2009; Nunnally and Bernstein, 1994).

Study 2: Revealing the impact of school closures due to COVID-19 on learning loss in phonemic awareness

Design of the study. Social sciences have three aims of revealing social reality by prediction and control of variables, interpretation of social phenomenon within natural settings, and emancipation of human beings (Habermas, 1972). The first aim depends on quantification of variables, the second aim emphasizes deep investigation of social phenomena and inductive reasoning, and the latter one focuses on critical theory. In Study 2, variables were quantified by attributing numbers to each of the participants' dispositions and performance. In an epistemological sense, it is assumed that social reality exists independently from the mind and that it can be captured if certain procedures are followed. Therefore, Study 2 was conducted in the quantitative research tradition (Cohen et al., 2007) owing to quantification of variables, the purpose of prediction and control, and the epistemological stance.

More specifically, it was impossible to control and manipulate school closures due to COVID-19, the independent variable in the research, and occurrence of its manifestations which were outside deliberate interventions, so Study 2 was designed as ex-post facto research (Kerlinger, 1966).

Variables. It was envisaged that the school closures due to COVID-19, the independent variable, would influence phonemic awareness among the first-grade primary school students, the outcome variable of the study. In social science, human behavior is a result of a series of composite factors so it is necessary to control confounding variables and the other variables that mediate causal relationships between the independent variable and outcome variable that has potential influence on dependent variables. SES is one of the mediator variables that has potential to influence the causal relationship between school closure due to

COVID-19 and phonemic awareness skills of first-grade primary school students. This is because SES has positive influence and relationship to phonemic awareness (Dacian et al., 2016; Gentaz et al., 2015; Hackman and Farah, 2009; Lundberg et al., 2012; McDowell et al., 2007; Nichols et al., 2004). In the analytic cycle, SES was controlled and assigned as mediator variable because SES could mitigate the negative impact of school closures due to COVID-19. On the other hand, family size (FS) is considered a potential risk factor, because it was reported that FS reduces scores for academic achievement and there is a negative association between FS and academic achievement (Arshad et al., 2020; Downey, 1995; Martin, 2008). Therefore, FS was included in the analytic procedure.

Measurements. Phonemic awareness was assessed through the TPAT, which consists of two subtests. The socioeconomic status (SES) of the participant students was measured with Hollingshead (1965) two-factor index. Hollingshead's two-factor index includes maternal education and occupation, and paternal education and occupation. Hollingshead's two-factor index gives a value to each occupation from 1 to 9, while it assigns a number from 1 to 7 for each level of parental education. In Hollingshead's two-factor index, occupational score is weighted by 5, whereas educational score is weighted by 3. After weighted scores are calculated for mother and father, maternal and paternal scores are added and then the total is divided by 2. As a result, parental background is determined. In the study, the two procedures for Hollingshead's two-factor index were carried out and parental backgrounds of the participant children were turned into a composite score and continuous variable.

Data collection process. Overall the Turkish education system was affected by the coronavirus and a proposal was prepared and submitted to the Ministry of National Education. A panel from the Ministry of National Education scrutinized the proposal and approved it in terms of ethical considerations and official permission. Due to the fact that all primary schools in Turkey were closed after 13 March 2020, it was impossible to collect data thorough face-to-face meetings with participants. Therefore, it was decided that the data would be gathered through Google Docs. Items on the TPAT and questions about parent education and profession, and familial background were uploaded to Google Docs. On the first page of the Google Docs, the aim of the research, and the procedure about how to respond to items on the PAT were given. Questions related to familial and parental background were inserted on the second page of the Google Docs. The third page of the Google Docs included the TPAT items. It was planned that the first round of data collection would be conducted in May and June 2020 because of the fact that literacy teaching would be completed in May 2020. Links to Google Docs were shared with primary school teachers to send them to parents whose children were in first grade of primary school. First, parents were asked to respond to the questions about SES and other familial backgrounds. Then, children were asked to answer the relevant questions on the TPAT.

A total of 59 parents responded to questions about SES, their child's age, and gender before their children completed the tasks on the TPAT and the first cohort of the research included 59 parents and children. Therefore, the first cycle of data collection ended at the end of June 2020. These comprised Cohort 1. The second cycle of data collection was launched on the 20 May 2021 and ended on the 15 July 2021. The previous method for data collection was conducted and as a result, 193 first-grade primary school students and their parents participated in the research. Therefore, Cohort 2 consisted of 193 participants.

Table 2 Total effect of the model.

Model	Estimate	R ² _{X,MY}	SE	t	P	LLCI	ULCI
Cohort _(1,2) (X) → SES(M ₁), FS (M ₂) → TPAT (Y)	-2.32	0.46	0.74	-3.19	0.00	-3.74	-89

Table 3 Results of direct effect.

Model	Estimate	R ² _{X,Y}	SE	t	P	LLCI	ULCI
Cohort _(1,2) (X) → TPAT (Y)	-2.19	0.44	0.72	-2.95	0.00	-3.66	-0.74

Table 4 Indirect effects of SES and FS.

Model	Estimate	SE	P	LLCI	ULCI
Cohort _(1,2) (X) → SES (M ₁) → TPAT (Y)	0.05	0.03	0.2	-0.41	-0.11
Cohort _(1,2) (X) → FS (M ₂) → TPAT (Y)	0.07	0.02	0.46	-0.07	0.02

Information about Cohort 1: Pre-Pandemic Group. Cohort₁ students began primary school on the 9 September 2019. They attended primary schools and received face-to-face instruction until the 13 March 2020 when the first COVID-19 case was identified in Turkey. They attended curricular and classroom activities for over 6 months. After that they learned curricular skills and knowledge through EBA, which is the distance teaching portal designed by the Ministry of National Education. Therefore, Cohort 1 was labeled as the Pre-Pandemic group.

Information on Cohort 2: Post-Pandemic Group. Cohort 2 children attended school from the 31 August 2020 to the beginning of November 2020 for 2 days per week. They were taught curricular skills and knowledge through EBA between November 2020 and the end of May 2021. After May 2021, they attended schools two days per week. They never received fulltime face-to-face instruction during the 2020–2021 instructional year. Their school life was dramatically devastated by COVID-19; hence, Cohort 2 children were labeled as the Post-Pandemic Group.

Data analysis. Study 2 addressed how school closures due to COVID-19, an antecedent variable in the study, influenced learning loss in phonemic awareness among first-grade primary school children, the consequent variable. Study 2 also aimed to determine variables mediating the causal mechanism between school closure due to COVID-19 and learning loss in phonemic awareness. SES and family size were assigned as mediator variables in the causal model. The PROCESS macro developed by Hayes (2015) was used to conduct moderation analysis. Moderation analysis based on total effects of the model results is shown in Table 2.

Testing Hypothesis 1. Results in Table 2 revealed that the standardized beta coefficient of the model was strong and significant ($\beta = -2.32, t_{(252)} = -3.19, P < 0.01, \text{path } c$).

Results for the direct influence of Cohort (X) on MR (Y) are displayed in Table 3.

Results in Table 3 indicate that the direct effect of Cohort (X) on TPAT (Y) was considerably strong and significant ($\beta = -2.19, t_{(252)} = -2.95, P < 0.01, \text{path } c'$) and 44% of the variation in the scores for TPAT was explained solely by Cohort_(1,2), the

independent variable in the study. Results from Tables 2 and 3 show that Hypothesis 1 was confirmed.

Testing Hypothesis 2. The effects of SES and FS, mediator variables in the study, were analyzed and results are shown in Table 4.

SES does not have a mediating role in the effect of Cohort_(1,2) on TPAT scores and its effect is not significant ($\beta = 0.05, P > 0.05, 95\% \text{ CI } [-0.41, -0.11], \text{path } c'$). As for FS, it has a very weak mediating role but is not significant ($\beta = 0.07, P > 0.05, 95\% \text{ CI } [-0.07, 0.02], \text{path } c'$). Based on the results in Table 4, it was concluded that Hypothesis 2 was rejected.

The model constructed based on direct, indirect and total effects is presented in Fig. 1.

Discussion

The results of Study 2 showed that school closures due to COVID-19 created substantial learning loss in phonemic awareness of first-grade primary school students and SES and FS did not mediate the causal relationship between the cohorts and TPAT scores. Lack of mediation is proof of the fact that first-grade primary school children experienced learning loss in phonemic awareness, regardless of their SES and FS during long term home confinement in Turkey.

Learning is a concept referring to gaining new knowledge, insight, and skill, and permanent changes in cognitive, behavioral, and social-emotional performance through practice and experience (Schunk, 2012). Human learning occurs in a definite cultural setting through interaction with one another. Furthermore, social interaction has salient functions in human learning. This is because social interaction allows transmission of knowledge, skill, and behavior (Tomasello et al., 1993). There are several ways of learning by imagining roles and perspectives (Mead, 2015; Piaget, 2001), simulating mental states of others (Harris, 2000), conceiving of others as people (Hobson, 1990), engaging in joint attention with others (Bruner, 1983), and attributing mental states to others (Wellman, Cross and Watson 2001). Intense social interaction that allows learning to take place in different ways occurs in classroom settings as a cultural environment. In primary school classroom settings, students can internalize all the demonstrations, instructions, and performances related to phonemic awareness by the teacher. Hence knowledge and skills concerning phonemic awareness are crystallized in mental representation and added into the behavioral repertoire (Tomasello et al., 1993). Social interactions between student and teacher enable first-grade primary school students to react, reproduce, and construct what is demonstrated and instructed by the teachers, and teachers, in turn, can give feedback to the reaction, reproduction, and construction of the students. To sum up, the classroom setting is the place where social-cultural properties of human learning are facilitated.

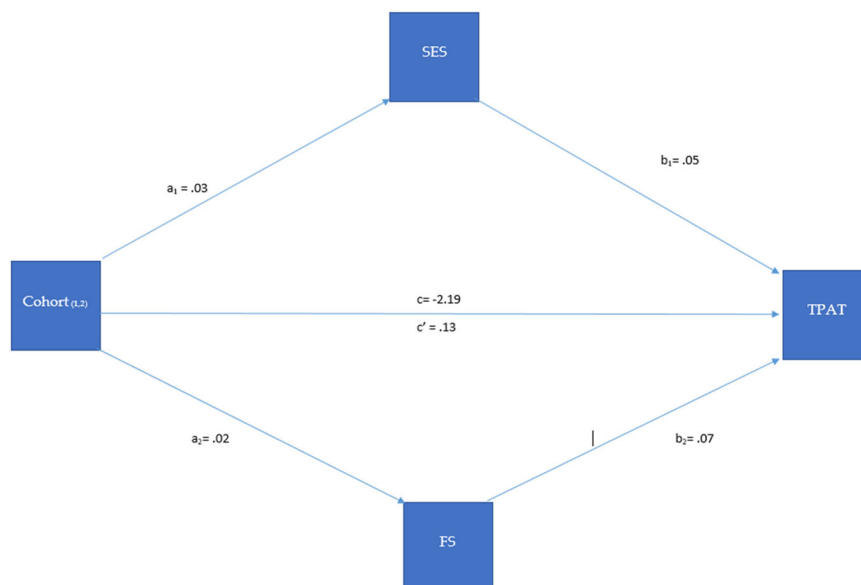


Fig. 1 Direct, Indirect, and Total Effects of Cohort $(_{1,2})$ on TPAT.

Cohort₁ first-grade primary school students could engage in joint attention, and intersubjective participation, and had experience of their teachers' roles and perspectives for about 6 months. On the contrary, Cohort₂ first-grade primary school students experienced more exposure to online learning environments which obstructed the opportunities for the social-cultural aspect of learning provided by classroom environments and received all literacy teaching in online learning environments. As a consequence, the two cohorts differed from each other in terms of being in the classroom environment or exposure to the online learning environment. This difference, in turn, created a learning loss in phonemic awareness for Cohort₂ first-grade primary school students and explained the causal relationship between the cohorts and learning loss in phonemic awareness.

Learning loss in phonemic awareness in Cohort₁ first-grade primary school students can also be explained by the Vygotskian Theory of Learning. Vygotsky (2012) noted that learning occurs when a student performs or does a task which was not previously completed. This improvement is possible via assistance, help, and guidance from others who are more skilled and more knowledgeable. According to Vygotskian Theory, learning is the process in which the student fulfills certain tasks through collaboration, assistance from adults or more skilled peers. In addition, the teacher is the most salient factor in classroom settings (Rivkin et al., 2005; Hanushek, 2011; Hanushek and Rivkin, 2012). Rich feedback, guidance, and help from the teacher are embedded in classroom settings but are impossible in the online learning environment. The shift in learning location from classroom setting to online learning environment changed the social interaction between students and teachers and impaired the teachers' help, guidance, direction and instruction. Cohort₂ first-grade primary school students received literacy teaching through screens and were deprived of their teachers' help, guidance, collaboration, direction, and instruction, whereas Cohort₁ first-grade primary school students received literacy teaching in classrooms settings where they were supported by their teachers' help, guidance, direction, and instruction for 6 months. In other words, school closures due to COVID-19 broke the link between Cohort₂ students and their teachers in terms of the teachers' help, guidance, direction, and instruction. As a result, school closures due to COVID-19 significantly diminished the scores of the Cohort₂ students from TPAT in comparison with the Cohort₁ students.

Results of Study 2 deal with requirements and properties of phonemic awareness instruction. Phonemic awareness instruction must be playful, engaging, deliberate, and purposeful in terms of ensuring students gain competent insight into the structure of spoken and written language. This is because phonics instruction is abstract and complex for first-grade primary school children who have already completed kindergarten and entered primary school. In phonemic awareness instruction, tasks or operations must be considered in terms of level of difficulty by teachers. Teachers also have to consider how to use oral or written cues. Finally, teachers must incorporate the use of letters and auditory-sound based activities. Teachers' understanding of instructional practices about phonemic awareness is very important (Barber and Mourshed, 2007; Muñoz et al., 2018; Yopp and Yopp, 2000). Along with principles of competent phonic awareness instruction, teachers need rich and deep social interaction with their first-grade students to conduct playful, engaging, deliberate, and purposeful phonemic awareness instruction. The teachers of Cohort₁ had the opportunity to design playful, engaging, deliberate, and purposeful instruction for their classes, to implement instructional design by incorporating the use of letters and auditory-sound-based activities, giving required cues for 6 months. However, the teachers of Cohort₂ had to consider the difficulties of delivery of phonemic instruction through screens and encountered problems related to social and physical separation from their students. This separation prevented them from giving instructional cues and incorporating the use of letters and auditory-sound-based activities. Therefore, teachers of the two cohorts experienced very distinct instructional conditions. Hence, different instructional conditions caused differential performance in phonemic awareness between the cohorts.

The causal relationship between the cohorts, the independent variable of the study, can be addressed in the context of the distinction between fluid intelligence and crystallized intelligence. Cattell (1963) formulated that human intelligence is composed of two types: fluid intelligence and crystallized intelligence. Crystallized intelligence is fostered through culture, individual history and experience in which language has significant roles, while fluid intelligence is dependent on genetic and biological features of the individual. Crystallized intelligence is influenced by language and experience so schooling has a

remarkable role in its development (Blair, 2006; Horn and Blankson, 2012). Phonemic awareness is closely tied to crystallized intelligence (Carroll, 1993; 2005). On the other hand, manipulation of phonemes to produce words in spoken or written language and blending sounds to construct a word requires modeling of others, social interaction and experience, so crystallized intelligence is salient for developing robust phonetic skills. Disruption of student-teacher interaction and modeling the teacher owing to the school closures and transition from classrooms to online learning environments prevented crystallized intelligence from being activated and this led to a decrease in scores from the TPAT among Cohort₂ students.

SES and FS variables were recruited into the causal model as mediator variables to disclose the deteriorating effect of school closures due to COVID-19 more clearly. Mediation analysis indicated that neither SES nor FS mediated the causal relationships between the cohorts and the TPAT scores. Based on the results, it was concluded that school closures due to COVID-19 created learning loss in phonemic awareness regardless of SES and FS. In other words, neither higher SES nor small FS mitigated the negative influence of school closures due to COVID-19 on phonemic awareness.

Conclusion

The results of Study 1 indicate that the TPAT is a reliable instrument in assessing phonemic awareness of first-grade primary school students. Furthermore, the overall results of Study 2 indicated that there is a significant decrease in Cohort₂ students' TPAT scores in comparison with Cohort₁ students. This significant decrease was attributed to Cohort₂ students' deprivation from intense student-teacher interaction and receiving insufficient care, support, and help from their teachers in online learning environments. In addition to that SES and FS did not manage to mediate the causal relationship. This result proves that Cohort₂ students experienced learning loss in phonemic awareness and deprivation from the social interaction with their teachers regardless of their SES and FS.

Governments around the world opened schools and are determined to keep schools open. Therefore, seeking out whether opening schools will compensate for learning loss in phonemic awareness can make remarkable contribution to our knowledge related to impact of COVID-19 on human beings. Learning is so complex that it cannot be explained through a single variable. Along with this fact the present study dealt with the school closures due to COVID-19 as independent variable, phonemic awareness as dependent variable, SES and FS as mediator variables in order to reveal clear impact of the independent variable. Future research may encompass different mediator variables such as quality of parent-child interaction, attribute of home learning environment, birth order, executive function of primary school students. Besides, impact of the school closures due to COVID-19 on different learning domains such as social studies, reading comprehension, mathematical skills, science can be scrutinized by establishing different causal models in future research.

Data availability

The data are not available because of the fact that the participant primary school children and their parents were assured that their responses would be stored confidentially and would not be shared with any other third parties.

Received: 10 February 2022; Accepted: 30 May 2022;

Published online: 13 June 2022

References

- Adams MJ (1990) *Beginning to read*. MIT Press, Cambridge, MA
- Andrew A, Cattan S, Costa Dias M, Farquharson C, Kraftman L, Krutikova S, Phimister A, Sevilla A (2020) Inequalities in children's experiences of home learning during the COVID-19 lockdown in England. *Fisc Stud* 41(3):653–683. <https://doi.org/10.1111/1475-5890.12240>
- Armitage R, Nellums LB (2020) Considering inequalities in the school closure response to COVID-19. *The Lancet Global Health* 8(5):e644. [https://doi.org/10.1016/S2214-109\(20\)30116-9](https://doi.org/10.1016/S2214-109(20)30116-9)
- Arshad H, Husky MM, Goelitz D, Bitfoi A, Carta MG, Koç C, Lesinskiene S, Mihova Z, Otten R, Fermanina C, Kovess-Masfety V (2020) Birth rank as a determinant of academic achievement: results from a European survey of primary school children. *Eur J Dev Psychol* 17(5):629–648. <https://doi.org/10.1080/17405629.2019.1700108>
- Barber M, Moursled M (2007) How the world's best performing systems came out on top. McKinsey & Co., London
- Blachman B (1984) Language analysis skills and early reading acquisition. In: Wallach GP, Butler KG (eds) *Language learning disabilities in school-age children*. Williams & Wilkins, Baltimore, pp. 271–287
- Blair C (2006) How similar are fluid cognition and general intelligence? A developmental neuroscience perspective on fluid cognition as an aspect of human cognitive ability. *Behav Brain Sci* 29:109–125. <https://doi.org/10.1017/S0140525X06329032>
- Bradley L, Bryant P (1978) Difficulties in auditory organization as a possible cause of reading backwardness. *Nature* 271:746–747
- Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, Rubin GJ (2020) The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet* 395(10227):912–920
- Bruner J (1983) Play, thought, and language. *Peabody J Educ* 60(3):60–69. <https://doi.org/10.1080/01619568309538407>
- Buckingham J (2020) Systematic phonics instruction belongs in evidence-based reading programs: a response to Bowers. *Educ Dev Psychol* 37(2):105–113. <https://doi.org/10.1017/edp.2020.12>
- Carroll JB (1993) *Human cognitive abilities: a survey of factor-analytic studies*, 1st edn. Cambridge University Press
- Carroll JB (2005) The Three-Stratum Theory of Cognitive Abilities. In: Flanagan DP, Harrison PL (eds) *Contemporary intellectual assessment: theories, tests, and issues*. The Guilford Press, New York, pp. 69–76
- Castles A, Coltheart M (2004) Is there a causal link from phonological awareness to success in learning to read? *Cognition* 91(1):77–111. [https://doi.org/10.1016/S0010-0277\(03\)00164-1](https://doi.org/10.1016/S0010-0277(03)00164-1)
- Cattell RB (1963) Theory of fluid and crystallized intelligence: a critical experiment. *J Educ Psychol* 54(1):1–22. <https://doi.org/10.1037/h0046743>
- Chetty R, Friedman JN, Hendren N, Stepner M, & The Opportunity Insights Team (2020) How did COVID-19 and stabilization policies affect spending and employment? A new real-time economic tracker based on private sector data. National Bureau of Economic Research, Cambridge, MA, pp. 1–109
- Clayton FJ, West G, Sears C, Hulme C, Lervåg A (2020) A longitudinal study of early reading development: letter-sound knowledge, phoneme awareness and RAN, but not letter-sound integration, predict variations in reading development. *Sci Stud Read* 24(2):91–107. <https://doi.org/10.1080/10888438.2019.1622546>
- Cohen L, Manion L, Morrison K (2007) *Research methods in education*. Routledge, London
- Dacian D, Ioana T, Damsa CI (2016) Enhancing the pre-literacy skills of Roma children: the role of socio-economic status and classroom interventions in the development of phonemic awareness. *New Educ Rev* 45(3):39–52. <https://doi.org/10.15804/ner.2016.45.3.03>
- Downey DB (1995) When bigger is not better: family size, parental resources, and children's educational performance. *Am Sociol Rev* 60(5):746–761
- Eames KT, Tilston NL, Edmunds WJ (2011) The impact of school holidays on the social mixing patterns of school children. *Epidemics* 3(2):103–108. <https://doi.org/10.1016/j.epidem.2011.03.003>
- Eğitim Reformu Girişimi (2021) Eğitim izleme raporu: Eğitim ortamları. https://www.egitimreformugirisimi.org/wpcontent/uploads/2010/01/E%CC4%B0R21_EgitimOrtamlari.pdf
- Ehri LC (1995) Phases of development in learning to read words by sight. *J Res Read* 18:116–125
- Elbro C (1990) Differences in dyslexia. A study of reading strategies and deficits in a linguistic perspective. Munksgaard, Copenhagen
- Engzell P, Frey A, Verhagen MD (2021) Learning loss due to school closures during the COVID-19 pandemic. *Proc Natl Acad Sci USA* 118(17) <https://doi.org/10.1073/pnas.2022376118>
- Field A (2009) *Discovering statistics using SPSS*. Sage Publications, London.
- Foy JG, Mann V (2001) Does strength of phonological representations predict phonological awareness in preschool children? *Appl Psycholinguist* 22(3):301–325
- Gentaz E, Sprenger-Charolles L, Theurel A (2015) Differences in the predictors of reading comprehension in first graders from low socio-economic status

- families with either good or poor decoding skills. *PLoS ONE* 10(3):e0119581. <https://doi.org/10.1371/journal.pone.0119581>
- Gil JM (2019) Lectoescritura como sistema neurocognitivo. *Educ Educadores* 22(3):422–447
- Gore J, Fray L, Miller A, Harris J, Taggart W (2021) The impact of COVID-19 on student learning in New South Wales primary schools: an empirical study. *Austral Educ Res* 48:605–637. <https://doi.org/10.1007/s13384-021-00436-w>
- Goswami U, Bryant P (2016) *Phonologic skills and learning to read*. Routledge, London
- Grewenig E, Lergetporer P, Werner K, Woessmann L, Zierow L (2021) COVID-19 and educational inequality: how school closures affect low- and high-achieving students. *Eur Econ Rev* 140:103920. <https://doi.org/10.1016/j.eurocorev.2021.103920>
- Habermas J (1972) *Knowledge and human interests*. Beacon Press, Boston, MA
- Hackman DA, Farah MJ (2009) Socioeconomic status and the developing brain. *Trends Cogn Sci* 13(2):65–73. <https://doi.org/10.1016/j.tics.2008.11.003>
- Hanushek EA (2011) The economic value of higher teacher quality. *Econ Educ Rev* 30(3):466–479. <https://doi.org/10.1016/j.econedurev.2010.12.006>
- Hanushek EA, Rivkin SG (2012) The distribution of teacher quality and implications for policy. *Annu Rev Econ* 4(1):131–157. <https://doi.org/10.1146/annurev-economics-080511-111001>
- Hatcher PJ, Hulme C, Snowling MJ (2004) Explicit phoneme training combined with phonic reading instruction helps young children at risk of reading failure. *J Child Psychol Psychiatry* 45(2):338–358
- Harris P (2000) *The work of Imagination*. New York: Wiley & Blackwell
- Hayes AF (2015) An index and test of linear moderated mediation. *Multivariate Behav Res* 50(1):1–22. <https://doi.org/10.1080/00273171.2014.962683>
- Hobson RP (1990) On acquiring knowledge about people and the capacity to pretend: Response to Leslie (1987). *Psychol Rev* 97(1):114–121. <https://doi.org/10.1037/0033-295X.97.1.114>
- Hollingshead AB (1965) *Two-factor index of social position*. Yale University Press, New Haven
- Horn JL, Blankson AN (2012) Foundations for better understanding of cognitive abilities. In: Flanagan DP, Harrison PL (eds) *Contemporary intellectual assessment: theories, tests, and issues*. The Guilford Press, pp. 73–98
- Hulme C, Hatcher P, Nation K, Brown A, Adams J, Stuart G (2002) Phoneme awareness is a better predictor of early reading skill than onset–rime awareness. *J Exp Child Psychol* 82(1):2–28. <https://doi.org/10.1006/jecp.2002.2670>
- Indrisano R, Chall JS (1995) Literacy development. *J Educ* 177(1):63–83
- Kerlinger FN (1966) *Foundations of behavioral research*. Holt, Rinehart and Winston, New York
- Kuhfeld M, Soland J, Tarasawa B, Johnson A, Ruzek E, Liu J (2020) Projecting the potential impact of COVID-19 school closures on academic achievement. *Educ Res* 49(8):549–565. <https://doi.org/10.3102/0013189X20965918>
- Lonigan CJ (2015) Literacy development. In: Liben LS, Müller U, Lerner RM (eds) *Handbook of child psychology and developmental science: Cognitive processes*. John Wiley & Sons, Inc., pp. 763–805
- Lundberg I, Larsman P, Strid A (2012) Development of phonological awareness during the preschool year: the influence of gender and socio-economic status. *Read Writ* 25(2):305–320. <https://doi.org/10.1007/s11145-010-9269-4>
- Lundberg I, Olofsson A, Wall S (1980) Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. *Scand J Psychol* 21:159–173. <https://doi.org/10.1111/j.1467-9450.1980.tb00356.x>
- Mann VA, Liberman IY (1984) Phonological awareness and verbal short-term memory. *J Learn Disabil* 17(10):592–599. <https://doi.org/10.1177/002221948401701005>
- Mann VA (1993) Phoneme awareness and future reading ability. *J Learn Disabil* 26:259–269. <https://doi.org/10.1177/002221949302600406>
- Martin JM (2008) *Using Curriculum-based measures for assessing achievement in children who may have potential risk-factors for reading difficulty*. Unpublished master dissertation. University of Wisconsin
- McDowell KD, Lonigan CJ, Goldstein H (2007) Relations among socioeconomic status, age, and predictors of phonological awareness. *J Speech Lang Hear Res* 50:1079–1092. <https://doi.org/10.1044/1092-4388>
- Mead GH (2015) *Mind, Self and society*. Chicago: Chicago University Press
- Melby-Lervåg M, Lyster S-AH, Hulme C (2012) Phonological skills and their role in learning to read: a meta-analytic review. *Psychol Bull* 138(2):322–352. <https://doi.org/10.1037/a0026744>
- Muñoz K, Valenzuela MF, Orellana P (2018) Phonological awareness instruction: a program training design for low-income children. *Int J Educ Res* 89:47–58. <https://doi.org/10.1016/j.ijer.2017.02.003>
- National Reading Panel (2000) *Report of the National Reading Panel: Reports of the subgroups*. National Institute of Child Health and Human Development Clearing House, Washington, DC
- Nichols WD, Rupley WH, Rickelman RJ, Algozzine B (2004) Examining phonemic awareness and concepts of print patterns of kindergarten students. *Lit Res Instr* 43(3):56–82. <https://doi.org/10.1080/19388070509558411>
- Nunnally JC, Bernstein. IH (1994) *Psychometric theory*. New York: McGraw Hill.
- Pandemic school closures in Switzerland. *Int J Psychol* 56(4):566–576
- Piaget J (2001) *The language and thought of the child* (M. Gabain & R. Gabain). London: Routledge
- Pier L, Hough HJ, Christian M, Bookman N, Wilkenfeld B, Miller R (2021) COVID-19 and the educational equity crisis: Evidence on learning loss from the CORE Data Collaborative. Policy Analysis for California Education. https://edpolicy.ca.org/newsroom/covid-19-and-educational-equity-crisis#footnote1_gdx51np.
- Rivkin SG, Hanushek EA, Kain JF (2005) Teachers, schools, and academic achievement. *Econometrica* 73(2):417–458. <https://doi.org/10.1111/j.1468-0262.2005.00584.x>
- Savage R, Georgiou G, Parrila R, Maiorino K (2018) Preventative reading interventions teaching direct mapping of graphemes in texts and set-for-variability aid at-risk learners. *Sci Stud Read* 22(3):225–247. <https://doi.org/10.1080/1088438.2018.1427753>
- Schunk DH (2012) *Learning theories: an educational perspective*. Pearson, Boston
- Singam M, Mann V (1999) Precocious reading acquisition: examining the roles of phonological and morphological awareness. Paper presented at the Society for the Scientific Study of Reading, April 23–25, Montreal, Canada
- Stahl AS, Hester AMD, Stahl KAD (1998) Everything you wanted to know about phonics. *Read Res Q* 33(3):338–355. <https://doi.org/10.1598/RRQ.33.3.5>
- Stahl SA, Murray BA (1994) Defining phonological awareness and its relationship to early reading. *J Educ Psychol* 86(2):221–234
- The DELVE Initiative (2020) *Balancing the risks of pupils returning to schools*. DELVE report no. 4. <https://rs-delve.github.io/reports/2020/07/24/balancing-the-risk-of-pupils-returning-to-schools.html>
- Tomasello M, Kruger AC, Ratner HH (1993) Cultural learning. *Behavioral and Brain Sciences* 16(3):495–511
- Tomasik MJ, Helbling LA, Moser U (2021) Educational gains of in-person vs. distance learning in primary and secondary schools: a natural experiment during the COVID-19. *Int J Psychol* 56(4):566–571. <https://doi.org/10.1002/ijop.12728>
- Treiman R (1991) Phonological awareness and its roles in learning to read and spell. In: Sawyer EJ, Fox BJ (eds) *Phonological awareness in reading: The evolution of current perspectives*. Springer-Verlag, New York, pp. 159–189
- United Nations (2020) *Policy brief: Education during COVID-19 and beyond*. Accessed 14 September 2021. https://www.un.org/sites/un2.un.org/files/sg_policy_brief_covid-19_and_education_September_2021.pdf
- Vazeux M, Doignon-Camus N, Bosse ML, Mahé G, Guo T, Zagar D (2020) Syllable-first rather than letter-first to improve phonemic awareness. *Sci Rep* 10(1):1–12. <https://doi.org/10.1038/s41598-020-79240-y>
- Venezky RL (1990) Definitions of literacy. In: Venezky RL, Wagner DA, Ciliberti BS (eds) *Toward defining literacy*. International Reading Association, Delaware, pp. 2–16
- Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, Mytton O, Bonell C, Booy R (2020) School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. *Lancet Child Adolesc Health* 4(5):397–404. [https://doi.org/10.1016/S2352-4642\(20\)30095-X](https://doi.org/10.1016/S2352-4642(20)30095-X)
- Vygotsky LS (2012) *Thought and language*. MIT Press
- Wellman HM, Cross D, Watson J (2001) Meta-analysis of theory-of-mind development: The truth about false belief. *Child Dev* 72(3):655–684
- Yopp HK, Yopp RH (2000) Supporting phonemic awareness development in the classroom. *Read Teacher* 54(2):130–143
- Zimmerman BJ (1990) Self-regulated learning and academic achievement: an overview. *Educ Psychol* 25(1):3–17. <https://doi.org/10.1207/s153>

Acknowledgements

The present study is dedicated to Doğan Cüceloğlu who was known Turkish Socrates and passed away on 16 February 2021.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was taken from and Ministry of National Education (Ref. No. 70297673-605.01.E.1663611). The ethical approval required voluntary participation and informed consent. Therefore, aim of the study, procedures were explained to both the participant primary school students and their parents on the first page Google Docs. by which the data were collected.

Informed consent

All of the measures were inserted into Google Docs and the data were collected through Google Docs. On the first page, the aims and procedures were explained to the participant primary school students and their parents. It was emphasized that they are voluntary in participation in the study. Options of “I accept to participate” and “I do not

accept to participate” were placed at the bottom of the first page. If they chose to “I accept to participate”, they could proceed the next page of the measures.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-022-01218-0>.

Correspondence and requests for materials should be addressed to Kerem Coskun.

Reprints and permission information is available at <http://www.nature.com/reprints>

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2022