Methodological Challenges of Studying Children in a Living Laboratory: Case example of Conceptual PlayLab

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Digital technologies have created possibilities in research unavailable when Vygotsky first introduced his cultural-historical approach for studying children's development. More needs to be known about the relations between methodology and method when using digital tools in the early developmental period (1-5 years). In this paper we introduce the concept of a living laboratory to capture the research dynamics of this cultural age period in family homes and preschool settings under conditions of an educational experiment. We discuss Vygotsky's theoretical concepts as foundational for theorising the use of digital tools for researching in a living laboratory. Central for a living laboratory are: (1) capturing development in motion, (2) including the past in the present research context, (3) designing studies in ways that go beyond fossilised complete forms of development, and (4) creating study conditions for condensed and amplified forms of development. To bring these conditions into the research contexts where a condensed form of development emerges opens up a dynamic yet dialectical way of studying early development. We showcase digital tools, such as VR and digital data collection, as part of (1) undertaking an educational experiment of a Conceptual PlayWorld, and (2) a cultural-historical conception of longitudinal research for studying the conceptual development of infants, toddlers and preschoolers within a living laboratory.

Keywords: cultural-historical, method, methodology, early childhood, digital, VR, development.

Introduction

The aim of this paper is to conceptualise the method and methodology of studying in naturalistic settings infants, toddlers and preschoolers' conceptual development. An approach that can create developmental conditions in a *condensed form* can give researchers new directions for studying early conceptual development in naturalistic early childhood settings. Taking insight from Vygotsky's [11] study of the history of the development of higher mental functions, we theorise the developmental dynamic of infants and toddlers as part of their everyday experiences in early childhood settings, but under *amplified conditions.*

In this paper we specifically draw upon the methodological principles outlined by Vygotsky, but do so in a context of digital tools not available in Vygotsky's time, and the cultural age period that has received less attention and therefore we suggest is under theorised. We have named the outcomes of our conceptualisation of researching infants, toddlers and preschoolers in condensed and amplified developmental conditions as a *cultural-historical living laboratory.*

Core to the discussions presented in this paper, is determining how a living laboratory can give insights into the dialectical nature of the merging of cultural and biological development of infants, toddlers and preschoolers. The foundations of Vygotsky's cultural-historical conception of development identifies that "the basic uniqueness of child development consists in the merging of cultural and biological processes of development." [11: 23] and this means "the basic problem of research [is] to be the thorough study of the one order and the other and a study of laws of their merging at each age level" [11: 22]. Here lies the methodological problem of studying children in naturalistic settings, and the challenge of finding the methods which can achieve this kind of dialectic study of infants, toddlers and preschoolers.

To achieve the goal of our paper we begin by drawing upon the foundational methodological principles of research outlined by Vygotsky and review these in relation to what is known about studying children in everyday settings. We discuss an educational experiment in the context of the digital methods we have developed in our Conceptual PlayLab (https://www.monash.edu/conceptual-playworld). We conclude by theorizing a living laboratory of condensed and applied developmental conditions captured digitally in the study of infants, toddlers and preschoolers' conceptual development.

Cultural-historical principles of studying development

To theorise how to study the development of infants, toddlers and preschoolers, as is the focus of this paper, a close interplay between methodology and method is needed. First, with the backdrop of the biological development of the child, it can be argued that there is no uniform or even universal conception of cultural development. By its very nature, the development of the child will always be in relation to the societal values, the institutional contexts and conditions that realise these values, and the personal orientation of the child who enters into, is shaped by, and who shapes their cultural conditions [5]. This dynamic is complex, and is in constant motion [11]. It brings its own unique challenges to researchers interested in studying young children's development in naturalistic settings. This means researchers need methods that will capture the dynamics of societal values and institutional practices in relation to the child's emerging developmental trajectory.

Second, cultural development in contemporary settings, such as family homes and early childhood settings, is also located historically. Many practices and beliefs surrounding children's development have formed in relation to societal needs at different historical times, and researchers can become blind to these. For instance,

... the timing of one or another stage or form of development to certain points of organic maturity, occurred over centuries and millennia and led to such a fusion of the one process and the other that child psychology stopped differentiating the one process from the other and became convinced that mastery of cultural forms of behavior is just a natural a symptom of organic maturity of any bodily trait. [11: 23].

This is not history as facts about past events, as is the everyday reading. To understand how the past is located in the present in naturalistic settings requires researchers to look for evidence of the existence of the ideal forms of cultural development [10] that are there from the beginning for a child, and how these ideal forms act as developmental conditions that have become valued within the particular communities in which the research is being undertaken. Vygotsky argued that the "historical study of behavior is not supplementary or auxiliary to theoretical study, but is a basis of the latter" [11: 43]. This means researchers need to pay close attention to cultural development of the past located in the present, not as a self-evident biological trait of the infant/toddler/preschooler, but rather as the pull of cultural practice realising cultural (and not biological) development of the child.

Third, Vygotsky argued that a great deal of research was performed as a postmortem of already developed children. He suggested that the orientation in this research was to study the product of development and not the process of development. He recognised that researchers needed to,

encompass in research the process of development of some thing in all its phases and changes-from the moment of its appearance to its death-means to reveal its nature, to know its essence, for only in movement does the body exhibit that it is. [11: 43].

In bringing together the historical with the cultural, it becomes evident that cultural-historical research seeks to, "study something historically [and this] means to study it in motion" [11: 43]. This is not a linear process, but it is a dialectical relation between the biological and the cultural forms of development that merge at different periods within the life course of a human being. In contrast, and in drawing on a metaphor from geology, Vygotsky [11] argued that many researchers study what has already formed:

Our psychological fossils show, in a petrified and arrested form, their internal development. The beginning and end of development is united in them. They actually are outside the process of development. Their own development is finished. ...making them incomparable material for study. [11: 44].

To capture in motion the dialectical unit of cultural and biological development with the different merging points over time, means that researchers need innovative tools and well theorised methods for undertaking this kind of research in naturalistic settings (discussed further below).

Fourth, different to some study frames, is that the *process* of the research and the *development* of a motive orientation are viewed as important as the *end result* of the research [11]. Captured as a revolutionary, rather than evolutionary conception of children's development, Vygotsky [12] presented periods of development in relation to the motive orientation of the child, and transitions between these are evidenced as a change in motives. Conceptualised as the cultural age of the child, research-

ing children's development brings forward the societal values, institutional practices, the social situation and the child's social situation of development. But to study the life course of developmental conditions of a child within a particular society demands an approach that represents in condensed form children's development.

Although more theoretical points are evident across the 6 volumes of the Collected Works, it is beyond the scope of the word limitation of this journal to present all. However, the 4 methodological points discussed in this section foreground method challenges that researchers need to pay attention to when studying infants, toddlers and preschoolers in a living laboratory. Therefore, central for our conception of a living laboratory is capturing children's development,

    1. in motion
    2. where the past has its traces in the present
    3. beyond fossilised complete forms
    4. in a condensed and amplified form

Therefore, to study the merging of cultural and biological processes of development in relation to the *cultural age* of infants, toddlers and preschoolers in the living laboratory needs particular conditions. To bring these conditions into the research context in a condensed form opens up a dynamic yet dialectical way of studying infants, toddlers and preschoolers' development of imagination in play as foundational for concept formation. But to achieve this goal, we introduce an educational experiment as a positive force for creating these conditions in a condensed form.

A condensed form of development:
An educational experiment

Setting up developmental conditions in research has always been a challenge for researchers. One of the important conceptualisations introduced by Vygotsky [11] in his cultural-historical writings on development has been the idea of setting up research conditions which capture the developmental conditions of children. First, the "greatest difficulty in genetic analysis consists precisely in using experimentally elicited and artificially organized processes of behavior to penetrate into how the real, natural process of development occurs" [11: 94]. Second, Vygotsky [11] suggested that, when researchers set up experimental conditions away from real life, that this creates "...the enormous problem of transferring the experimental outline [method] to real life always opens up before genetic research" [11: 94]. How do researchers design experimental research methods that can be fitted into the everyday life of teachers, children and their families? Third, when researchers transpose into everyday life situations an experimental method that works in a laboratory, can we feel confident about the results? Vygotsky wondered,

"If the experiment discloses for us a sequence of patterns or any specific type, we can never be limited by this and must ask ourselves how the process being studied occurs under conditions of actual real life, what replaces the hand of the experimenter who deliberately evoked the process in the laboratory". [11: 94].

As a result of these challenges, researchers have looked to naturalistic settings and conceptualised their methods in relation to undertaking research in everyday life. That is, naturalistic studies have tended to follow the activities of teachers, children and their families as they participate in institutional practices, community activities, and study how development arises in everyday life in their society [6]. However, this presents its own challenges. Rather than waiting in everyday life for development to unfold as part of a naturalistic study of children's development, Vygotsky suggested that it was possible to research development in ways that deals with the problems of experimental research, at the same time as overcoming the problem of spending long periods in the field studying developmental conditions as they arise. His advice was to create research conditions in which the development of children was amplified in intensity and condensed in time and place. Thereby giving research conditions of development in a condensed form. In our Conceptual PlayLab we have been aware of these methodological challenges and have sought methods that have overcome these problems. In particular, we have drawn upon and taken forward, the method of an educational experiment.

An educational experiment [4] in the living laboratory of an early childhood setting is an extended collaboration between the participants and the researchers. An educational experiment is conceptualised as a dialectical study [4] because the process creates conditions that help researchers to identify through research, children's development, whilst also making visible how these conditions are planned and implemented. It is not a problem of practice, but rather it is a theoretical problem that is studied. In our case, to study how to research the cultural age period of infants, toddlers and preschoolers within early childhood settings as they develop their imagination as foundational for concept formation.

Davydov's educational teaching experiment in schools is one such approach for creating developmental conditions of children in secondary schools [1]. Hedegaard's [4] educational experiment in schools was formulated based on Davydov's theoretical-dialectical knowledge but expanded in relation to:

    • Theoretical principles behind the educational experiment
    • Teacher's program
    • Children's activities and how they contribute to the child's motive orientation
    • Appropriation of knowledge and thinking strategies

Conceptualised as a double move of planned activities and children's activities, Hedegaard was interested to study how school discipline content knowledge in primary schools becomes personally meaningful to children. She wrote:

The teaching activity must consider children's engagement with each other and the demands of solving tasks together; it should also ensure that the tasks draw on the children's everyday knowledge and interest, and promote shared engagement. The teaching activities should seek to combine these elements with the educa-

tional goals and subject matter knowledge in ways that transform and combine children's everyday knowledge *and goals with their motives and interests, into new motives.* [4: 188, our emphasis].

Significantly, the leading motive of the primary school child is learning yet our central problem is in relation to studying infants, toddlers and preschoolers, where imagination is the developing motive orientation [12]. Consequently, we looked to Lindqvist [7] who also drew on Davydov's teaching experiment, Hedegaard's educational experiment, and importantly Vygotsky's method of a double stimulation when studying 3 to 5-year-olds in playworlds. In line with Vygotsky [11], Lindqvist was interested in the cultural development of the preschool child, rather than studying biological maturity. She defined it as, "a form of action or intervention research, where everyday situations are systematically intervened, and an educational perspective is combined with a research perspective" [7: 67]. She introduced a playworld intervention into practice to study the aesthetical development of the preschool child within the practices of play.

Lindqvist's [7] methodology for researching young children in a common playworld and Hedegaard's [4] conception of a double move are contemporary examples of an educational experiment for the study of young children. Lindqvist's [7] research focused primarily on play as the leading activity, but unlike Hedegaard [4] she did not examine the development of discipline concepts. Rather she was interested to study the development of children's play through drama pedagogy. Both Lindqvist's [7] and Hedegaard's [4] conception of an educational experiment inspired us with developing methods and a methodology for researching in a living laboratory infants, toddlers and preschoolers' development of imagination as foundational for concept formation. But infants, toddlers and preschoolers' leading motive is for the development of imagination [12] in play [9] and an educational experiment as yet, has not been theorised in relation to this motive orientation. How an educational experiment can create developmental conditions in a *condensed form for the infant/toddler/preschooler cultural age period* has not yet been undertaken.

Davydov and Hedegaard captured the developmental practices and activities of the children through observations, and Lindqvist used videotape recordings of planned dramatizations and organised play sequences, in addition to journal documentation and discussions with children and teachers. In our educational experiment the latter could not capture the development of infants, toddlers and preschoolers. As such, new methods needed to be developed as part of our educational experiment.

Core to our educational experiment was capturing the ongoing practices of the teachers in social relations with the infants, toddlers and preschoolers as concepts become personally meaningful in imaginary situations. In our research, special attention was placed on how this takes place within a living laboratory where we created the conditions for a condensed form of development of imagination as foundational for concept formation. We now give a brief overview of the educational experiment

we employed to amplify the conditions for conceptual development in imaginary situations of infants and toddlers.

Condensed form of development for infants and toddlers: A Conceptual PlayWorld as an educational experiment

In our educational experiment, a *Conceptual PlayWorld* creates developmental conditions in condensed form, amplifying infants, toddlers and preschoolers' imagining and conceptual development. A *Conceptual PlayWorld* is a play-based model of practice inspired by a story. The five characteristics of a *Conceptual PlayWorld* were conceptualised in relation to Vygotsky's [12] conception of development, and are summarised as follows:

1. *Selecting a story for the imaginary play:* the story has to be dramatic with emerging tensions and crisis in the plot, relevant to the children's cultural age and their interest and experiences, and both enjoyable for both the children and the teachers (e.g. How to move a possum out of a house?).

2. *Designing the imaginary spaces:* the children along with the teachers design the space, indoors or/and outdoors where their imaginary play is developed. The physical space is extended and expanded through children's play (e.g. a tent can have the new meaning of a possum's nest).

3. Entering and exiting the imaginary situation: being in role, children and the teacher are the characters of the imaginary situation (e.g. a baby possum, a mummy possum or an aunty possum).

4. *Planning a problem to be solved:* in search of the resolution key in the drama of the story, children form and use concepts in order to provide answers to the problematic situations that the characters are experiencing (e.g. identifying the footprints of a possum to follow her trace- focus on the external biological characteristics of a possum).

5. *Planning the role the teacher will take in the imaginary play:* teachers plan their role to be equally present with the children, or to model practices in role, or to be needing help from the children in line with the cultural as well as the biological aspects of the children development (e.g. the teacher in the role of the wise grandma possum).

The *Conceptual PlayWorld* model creates developmental conditions in condensed forms amplifying infants, toddlers and preschoolers' imagining and conceptual development. Within the educational experiment of a *Conceptual PlayWorld* quality learning challenges, opportunities and possibilities emerge that allow the social and cultural development of imagination, as a higher mental function, in dynamic relation with the formation of concepts. Within this amplified pedagogical framework, young children enter into and participate in the group activity setting sharing the learning experience with the teacher and their peers as a team. Imitation, interactions, body positioning, gesturing, the use of means, tools and objects, the exploitation of a wide range of props and artefacts are criti-

cal in the *Conceptual PlayWorld* activity setting. Being in the imaginary situations children face the demands of the activity settings as well as put new demands on the activity setting. The child shapes the *Conceptual PlayWorld* in the same way the *Conceptual PlayWorld* shapes the child's experience.

To support our educational experiment of a *Conceptual PlayWorld* we designed an app (Figure 1) for researchers so that they could capture in digital form moments of imagining in play and imaging in science, as was the focus of our research of infant and toddler development. The digital video recording could be captured on the app, so that teachers and researchers working in collaboration could document imagination in play and imagination in science moments. This gives the possibilities to capture the ideal form of infants/ toddlers/preschoolers/school age children development "in the moment". Long video segments or continuous 30 second video recordings are possible through the tool. This can also be achieved in selfie mode if the teacher is working on their own. By capturing in the moment and ongoing video recordings of the educational experiment in action, data are collected that show the developmental conditions and outcomes acting together.

But to support our educational experiment, the app also held videos of each of the 5 characteristics of the Conceptual PlayWorld (Figure 2). This meant the educational experiment included opportunities for viewing examples of the developmental conditions in condensed form where the activity setting and the new practice tradition of the institutions for imagination in play and imagination in Science, Technology, Engineering and Mathematics (STEM)were available.

Alongside of the use of the app, we also used 2 digital video cameras (see Tables 1—4 further below) to digitally record the educational experiment during the process of development, where it was also possible to study how the conditions of the intervention itself changed the educational experiment, as noted by Vygotsky and Luria "we were studying one and the same activity each time in its new concrete expressions, but that, over a series of experiments, the object of research changed" [13: 114], because the conditions and the children's growing competences were always in the process of development.

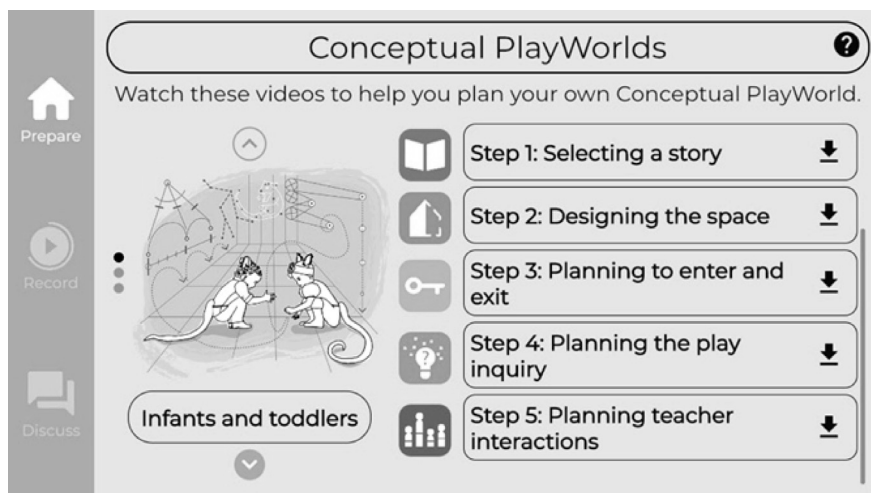*Fig. 1*. App designed to capture in everyday practices the real form of development of children

Fig. 2. App for introducing an ideal form of development in a Conceptual PlayWorld

Educational Experiment to amplify Children's STEM Concept Formation in Family Settings

The prefix 'educational' in an educational experiment has been used as a deliberate attempt to emphasise that the purpose of intervention in an experiment is not to capture objective reality in the best possible manner but rather to offer opportunity for participants' subjectivity and perspective to create the transformative practices that ensure their wellbeing. It is from this perspective 'Conceptual PlayWorld for families' model was designed. It would be worth arguing that the prime focus of Vygotsky, Leontiev, Luria and Davydov's work was not merely understanding development or learning as a conscious process but also as a purposeful, meaning-making and educational practice. This idea is important to understand educational experiment as transformative practice and not merely as studying the functioning of the conscious mind. Seen from this lens, educational experiment as a methodology is not just an intervention in a given setting but rather an effort to transform existing ways of learning and developing for children. Hedegaard [4] argues that "the educational experiment is a multi-faceted planned preparation of teaching which has, as its goal, the creation of optimal conditions for the learning and development of the participating children" [4: 185]. As a methodological approach for intervention in the family homes Conceptual PlayWorld follows principles of double move as delineated by Hedegaard [2; 3] Conceptual PlayWorld for families is a planned intervention that is jointly developed by parents/caregivers and researchers. Children's play and storytelling which are part of their everyday life are used as a collective space for joint problem solving or exploration. These explorations in a Conceptual PlayWorld are theoretically guided by the understanding of how children learn and also by the STEM concepts employed in sustaining children's curiosity. Instead of a traditional experimental approach where authority of the researcher is supreme, educational experiment values participant's agency in creation of transformative practice. Thus the effort as Hedegaard [4] remarks, in an educational experiment helps children to "formulate their own models which create connections between theoretical concepts and specific events". [2: 187].

We are presenting here a snippet of data to argue how principles of double move presented by Hedegaard [3; 4] were used in the context of "Conceptual PlayWorld for Families" (CPWf) in creating a motivating condition for children's concept formation. Furthermore, an argument is being made for using visual data and digital tools in recording and analysing children's concept formation. The following four characteristics define how this CPWf was created in collaboration with the families:

Using group/collective activity as central to developing a problem scenario: Instead of focusing on the individual child the educational experiment was designed with an expectation to engage the entire family. It is envisaged that this collaborative activity setting, largely created by the adult would create the possibility for children to explore the problem scenario collectively. The CPWf model makes two broad suggestions in this regard: one it encourages parents to take different roles alongside the child/ren. One of the parents could be just above the child's existing understanding and keep asking questions or making suggestions from the child's perspective, the other adult could take a role of offering new concepts or further explorations. This careful planning to design a collective activity as suggested in the Characteristic 4 and 5 of the Conceptual PlayWorld model helps families to stretch their children's thinking. The image below (Figure 3) shows parents working together to create a problem scenario.

(2) Opportunities for children to explore and formulate their own 'modes of action': The problem scenario is designed with a purpose that children would feel empathy with the character. This empathy or affective engagement would help children to be agentic in shaping their activity setting. Therefore, an educational experiment challenges the binary of researcher and the re-

Fig. 3. Shows parents working with a child in creating a collective problem scenario

searched participants. Often in traditional experimental settings children are merely researched. Thus, children are not responding to the stimulus being presented by the researcher rather creating their own developmental conditions for learning. In one of our resource production projects conducted in the home setting the four-year-old child designed her own mini-game to explore the concept further. In this case, children's story book Rosie's walk was used to set up a problem scenario where Rosie's (the hen) friend plans to come to her house and Rosie had to design a map so that her friend could come and visit her. While working on this problem the child designed a game of 'Robot's walk'. There were three participants: father, daughter and her doll 'Hiya'. The father had to be Hiya's robot and search for Hiya's doll which was lost. Hiya is in her car which was pulled by the child using a string. The father can't move or touch Hiya's car. Thus, the father was giving directions to the child to move in different rooms as they were searching for Hiya's doll. This example highlights the possibility for children's own intentional action to become part of an educational experiment. The image below (Figure 4) shows the child's exploration in the game of designing the map for the 'Robot's walk'.

(3) Digital tools in supporting children's active exploration and development of their motives: Central to this educational experiment model has been developing a transformative practice that can support children's exploration. In the specific example mentioned above the parents also used digital tools (iPad) for showing how google map app functions if the child has to go from her home to school. The ideal form [10] of practice helped the child to explore her curiosity further as she wanted to use the iPad later to search for different places. Digital tools thus acted as an auxiliary means to enhance children's exploration [8].

(4) Development of thinking and concepts: In a CPWf the effort is not to draw a one-to-one correspondence between stimuli and children's action. It would also be worth arguing here that concept formation would not be a one-shot process. In this context the educational experiment follows children's engagement in Conceptual PlayWorld over an extended period of time. Vygotsky [11] highlighted that the mechanistic and structural understanding of mental processes is one of the central challenges with the experimental methods. He remarked that,

We are intentionally simplifying the matter in order to isolate the most essential characteristic of the experimental method in psychology. It is understood that actually the matter is much more complex. Not one stimulus, but a whole series of stimuli, sometimes complexly constructed groups of stimuli and, corresponding to this, not one response, but a long chain of responses or their complex combinations characterize an experiment. [11: 31].

In the context of Conceptual PlayWorld, children's imagination is the central object of inquiry but it also takes into consideration a number of bordering and auxiliary concepts e.g. child's agency, logical thinking, tool-mediated action to explain children's concept formation. Thus, the effort is to move away from the stimulus response relationship to a wholeness approach that analyses children's social situation of development to understand their learning and development.

A living laboratory: Educational experiment over time

Our living laboratory and approach comes in line with the fundamentals of a cultural-historical standpoint and positioning in empirical research: (a) capturing processes in motion, (b) recognizing past in the present, and (c) focusing beyond fossilized complete forms. We present another case example in this section to illustrate how data in our living laboratory is formed over time. We foreground a systemic, holistic, and in motion methodological approach to the collection of qualitative empirical data that can capture the uniqueness of the child's development as well as the complexity of the early childhood educational reality. Paying attention to this dynamics and interrelations of child and environment is foundational to our living laboratory.

Four forms of data generation and data collection practices are presented: (a) tracing across different cultural age periods, (b) mapping of personal pathways, (c) tracking across diverse educational realities, and (d) shaping practice with the teachers. The suggested forms are illus-

Fig. 4. Image showing child's engagement with drawing a map for Rosie's friend

trated in the following tables (Tables 1, 2, 3 & 4) in regard to the methods and tools used as well as with the theorization that lies behind each methodological choice.

The forms come in line with a digital orientation of data gathering and analysis discussed above. The following scheme of digital data gathering practices exploits a wide range of visual tools such as digital cameras and software applications to allow illustrative practices of analysis of the generated and collected data. The use of digital tools creates a corpus of data where the dynamics of authentic children's experience can be unpacked. In this framework, the processes of becoming can be mapped, qualities such as expressions, gestures, body positioning, sounds are captured, the transformations of the context become visible, and layers of dialectic interrelations between the personality and the environment unfold. These illustrative practices build through a deep and extensive engagement of the researcher with the research data.

Across the three cultural age periods: infants, toddlers, and preschoolers

Following a cultural-historical research methodology, the child's learning and development is studied and captured as a real-life phenomenon within the child's everyday educational reality in the early childhood settings. Table 1 illustrates how a variety of the activity settings of *Conceptual PlayWords* are digitally documented (Column 4) across different classrooms with children being in different cultural aged periods (Column 1). The educational experiment (Column 3) of the *Conceptual PlayWorld* amplified the development of imagination as well as a wide range of STEM concepts formation (Column 2). Being with the *Conceptual PlayWorld* children developed diverse and advanced forms of imagining such as imagining led by the child, joint imagining and collective imagining. They also used their imagination as a means to develop a motive orientation to the collective, to share an intellectual and abstract space as well as to join, contribute and shape the group activity. Children formed STEM concepts such as the biological characteristics of a possum (Figure 1), the design process of building a possum habitat (Figure 2), the possum as part of the ecosystem (Figure 3) while playing within imaginary situations with the early childhood teachers being in role too (Column 2). The way a child enters into and participates in an activity setting, the intentions and demands she/he makes on the activity settings and the demands made on the child as well as the practice traditions within the center are also documented (Column 5).

Using the concept of *cultural age periods* gives us a different way of conceptualising the research process over time. By following infants as they become toddlers, and then preschoolers as presented in Table 1, we argue that this is more than a longitudinal study. In our theorisation we do not just focus on the child, but study the interrelations of child and environment over time. This gives different possibilities in research where a common amplified developmental practice of a *Conceptual PlayWorld* is used in subsequent years with the same children, as we now present in the section that follows.

Personal pathways: the transitions between the cultural are periods

Following a developmental research methodology, transitions have a critical role in understanding the child's development. Table 2 illustrates a case example of one child participating in the activity settings of a

Table 1

Across the three cultural age periods: infants, toddlers, and preschoolers

Cultural age	Digital Vignette	Methods	Tools	Theorization
Infants	Figure 1	— Educational experiment as an intervention within everyday educational reality in the early childcare centers	— Digital video cameras (e.g. GoPro camera, 360 camera, wearable cameras) used by the research team to capture the whole activity setting in the processes of becoming including qualities such as expressions, gestures, body positioning, sounds and implicitly or explicitly expressed motives, intentions, demands, practice traditions — Application: Fleer's Conceptual PlayWorld Research tool (https://www.monash.edu/conceptual-playworld/app) used by the ECT to capture authentic children's experiences and spontaneous moments of children's engagement with the CPW	— Vygotsky [11]: learning and development within everyday experiences under amplified conditions — Hedegaard [4]: a dialectical framework that creates condensed conditions that help researchers to identify through research children's development — Lindqvist [7]: playworlds as a space for systematic interventions within everyday situations; educational and research perspective as a unit
Toddlers	Figure 2			
Preschoolers	Figure 3			

Conceptual PlayWorld as an infant and then, a year after, participating in a different *Conceptual PlayWorld* as a toddler (Column 1). The set of vignettes (Column 2) is indicative of the way the child's imagination is developed as the teacher introduces the ideal form of imagining to the infant (Figure 1) and then the child, as a toddler, can lead the imaginary situation independently (Figure 2). This framework allows us to follow and study children over time (Columns 3 & 4) as they make transitions between cultural age periods, as they move through social situations, and as they select, shape and transform their personal pathways (Column 5). What is important here is that the personal pathways are conceptualized and mapped not as individualistic trajectories but as a transformation, an ongoing qualitative change of group relations, as the child develops in a dialectic interrelation with his/her environment.

The use of the concept of *developmental pathways* allows us to focus on what is unique for each child and capture the nature and the qualities of her/his development in relations to the opportunities and the possibilities that emerge within the *Conceptual PlayWorlds*. Following focused children through their transitions between different cultural age periods and through participating in diverse *Conceptual PlayWorlds* as illustrated in Table 2, we argue that a new cultural-historical framing in the notion of the longitudinal study is introduced. Going beyond repeated observations and stable variables, we do not aim to focus on the continuum of the gathered data. Our focus is on closely capturing the qualitative changes and transformations in a child's learning and development trajectory in dialectical relation to the social and cultural reality of the child within the *Conceptual PlayWorld*. That differs from longitudinal studies that aim to explore either cultural or social changes over time. The several ideal developmental pathways that *Conceptual PlayWorlds* make available to the child and the child's positioning towards these pathways become visible. Getting an insight into diverse trajectories of children from diverse early childhood centers allows us to highlight the catalytic role of the environment in children's development as presented in the following section.

Across diverse early childhood settings

From a cultural-historical methodological standpoint what is also important is to capture how the conditions for children's learning and development also differ across diverse institutional settings. The table presented below (Table 3) illustrates how the educational experiment of a *Conceptual PlayWorld* travels across diverse early childhood centers (Column 1). Different early childhood educators created unique developmental conditions to support each child's concept formation within diverse *Conceptual PlayWords* (Column 3). A wide range of quality learning experiences and opportunities for development emerged tailored to the children's needs in each classroom and in each center (Figures 1, 2, 3 & 4). The variety of institutional practices and the societal values that these practices reflect were highlighted and documented though the available visual tools (Columns 4 & 5).

Focusing on diverse institutional practices and practice traditions across different early childhood centers or within the same setting the study showcases how different contexts can create diverse and unique conditions for development. As shown in Table 3, a range of centers participate in the study. This allows us to delve into diverse educational realities, to understand how societal values are interpreted in different frameworks, how institutional contexts and practice traditions are formed, what are the important factors that shape and reshape a quality learning environment, and importantly, how the child orients herself/ himself within this environment and how she/he is shaped and shape this environment. The added value of the across settings observations is that it leads to a broader as well as a more accurate understanding of the educational reality oriented by the context but not limited by it.

Shaping practice with the teachers
Within this framework, the role of the early childhood teachers and their perspective in research are critical. In Table 4 are illustrated several forms of collaboration between teachers and researchers (Columns 1 & 2) such as everyday introductory professional development sessions

T a b l e 2

Personal pathways: the transitions between the cultural age periods

Cultural age	Vignette	Methods	Tools	Theorization
Infant	Figure 1	— Educational experiment as an intervention over time as part of a longitudinal study	— Digital video cameras (e.g. GoPro camera, 360 camera, wearable cameras) used by the research team to capture the transformations of the context, & the dialectic interrelations between the child and the environment over time	— Vygotsky [11]: development as a process, in motion — Vygotsky [12]: double stimulation and auxiliary means
Toddler	Figure 2		— Application: Fleer's Conceptual PlayWorld Research tool (https://www.monash.edu/conceptual-playworld/app) used by the ECTs to document the flow of educational reality in the centers over time	— Hedegaard [4]: several ideal developmental pathways dialectically related to the social and cultural reality of the child

Across diverse early childhood settings

Settings	Vignette	Methods	Tools	Theorization
Center A	Figure 1	— Educational experiment as an intervention — Across center collaboration through joint planning sessions	— Digital video cameras (e.g. GoPro camera, 360° camera, wearable cameras) used by the research team to capture diverse educational realities across different settings — Application: Fleer's Conceptual PlayWorld Research tool (https://www.monash.edu/conceptual-playworld/app) used by the ECTs to document and reflect on their practice	— Hedegaard [4]: diverse institutional practices and practice traditions across different institutional settings or within the same institution — Hedegaard [5]: societal values, institutional contexts and conditions that realise these values, and the personal orientation of the child who enters into, is shaped by, and who shapes their cultural conditions
Center B	Figure 2			
Center C	Figure 3			
Center D	Figure 4			

(Figure 1), interactions and reflections (Figure 2) as well as ongoing support through consultancy and collaborative planning (Figure 3 & 4), and follow up meetings (Figure 5) and how the overall collaboration is documented (Column 4). The extended collaboration between early childhood teachers and researchers (Column 3) is beneficial in a twofold way. Firstly, it allows both parts to contribute to a continuous quality improvement planning based on each part's strengths. Secondly, capturing through diverse ways the teachers' perspective adds to the illustrative practices by giving the inside story of the everyday educational routine. This framework allows research to go beyond the level of adding academic knowledge to the level of shaping practice and transforming educational reality in the process of development (Column 5).

Using Vygotsky's and Hedegaard's conceptualizations of the role of the researcher, we include the researcher in the implementation of the study design. Like Hedegaard, we argue that this is not a problem of practice as in action research for example, but it is a theoretical problem. Researching through an educational experiment is a theoretical problem of development since a condensed form of development has to be thoughtfully designed, strongly supported and adequately studied. The resolution key to this theoretical problem comes from the collaboration between the research team and the early childhood teachers. The amplified conditions are designed collaboratively with the early childhood teachers in the centers who have skills to amplify learning and development through play and imagination within the *Conceptual PlayWorlds*. Going beyond the limitation of an intervention within existing contexts, the *Conceptual PlayWorlds* educational experience emphasizes on the transformative practices that reconstructing and enriches the existing learning and development conditions creating opportunities that advance and improve educational reality.

Taken together (Tables 1—4), the above dialectical model of research practices allow us a deep insight within the process of a child's development and the educational practice as a real life and an everyday phenomenon. Within this living laboratory, children's participation in research is consciously realized and understood as the research procedure occurs with the children rather than on the children. At the same time, teachers' participation in research is positioned within a collaborative and supportive environment that aims to shape practice, advance teachers' confidence and competence and create new ways of activity rather than document and interpret the existing forms of activities.

T a b l e 4

Collaboration with the teachers

Forms of Collaboration	Vignette	Methods	Tools	Theorization
Introductory PD sessions	Figure 1	— Educational experiment as an ongoing collaboration between teachers & the research team — Informal discussions between the teacher & the research team during the everyday educational reality — Focus group sessions — Stimulated recall interviews	— Digital video cameras used by the research team to capture the ECTs reflexions on the process over time — Digital meetings that build through a deep and extensive engagement of the researcher with the research data	— Hedegaard [6]: a double move of planned activities and children's activities; extended collaboration between ECT and the research team — Vygotsky and Luria [13]: studying CPWs as one and the same activity each time in its new concrete expressions, as the object of research is changing over time because the conditions & children's needs andinterests are always in the process of development
Interactions during everyday educational reality	Figure 2			
Consultancy during planning sessions (in person and remotely)	Figure 3 Figure 4			
Follow up discussions	Figure 5			

Conclusion

The examples from the home settings and early care centres presented here makes an attempt to employ our previously theorised discussions on the principles of a cultural-historical methodology (in the introduction section) to develop a living laboratory that uses digital tools both to record data but also to amplify children's experiences of learning. Vygotsky [12] argued for psychology to move from "a purely descriptive, empirical, and phenomenological study of phenomena to disclosing their internal essence" [12: 189]. This challenge of 'disclosing the internal essence' demands a methodological approach that could move beyond the concrete and obvious. This paper reports two case examples where Conceptual PlayWorld has been used as an intervention to design possibilities for children's STEM concept formation in home and early care settings. This is modelled on Hedegaard's [6] formulation of educational experi-

ment. Following Vygotsky's advice of going beyond a mechanistic relationship between variables the effort in the living laboratory designed for this intervention is to understand the higher mental functioning in all its complexity. As Vygotsky argued the study focuses "not on one stimulus, but a whole series of stimuli, sometimes complexly constructed groups of stimuli and, corresponding to this, not one response, but a long chain of responses or their complex combinations [that] characterize an experiment." [11: 31]. Extending these arguments to understand children's concept formation the Conceptual PlayWorld as an intervention creates a condensed and amplified experience for children and their caregivers and teachers where the object of inquiry is seen:

1. in-motion
2. beyond fossilised complete forms
3. the past in the present, and
4. where the researcher has a central role in developing practice in collaboration with teachers/families,

opening up research into child's development as is reflective of the living laboratory.

In our first example the living laboratory is shown through an educational experiment of a conceptual PlayWorld in the family home. This followed by showing how an educational experiment of a Conceptual PlayWorld in a childcare setting. Together they illustrate how a cultural-historical methodology frames the methods of researching the development of very young children using digital tools captured as a living laboratory.

Vygotsky's time did not have digital tools — therefore in contemporary contexts where these tools are being used, it was important to theorise how we used these methods for allowing:

1. Development in condensed form
2. Amplification of conceptual development

Digital tools in this context were used as auxiliary means that helped to trace the psychological structures and complexes that underlie development of higher mental functions like imagination or problem solving. Thus, living laboratories present a dialectical model of data collection and more importantly shape transformative practice for children's concept formation in contexts of the researcher and collaborators within the study design.

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Методологические проблемы изучения детского развития в «живой» лаборатории на примере Лаборатории понятийной игры

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Цифровые технологии открывают для исследователей возможности, которых не существовало во времена, когда Выготский разрабатывал свой культурно-исторический подход к изучению детского развития. Необходимо лучше понимать, как устроена взаимосвязь методологии и метода при использовании цифровых инструментов в изучении раннего (1—5 лет) периода в развитии детей. В настоящей

статье представлена концепция «живой» лаборатории, которая позволила бы исследовать динамику данного культурного возрастного периода в домашней обстановке или в детских дошкольных учреждениях в рамках формирующего эксперимента. Мы рассматриваем теоретические положения Выготского как обоснование для использования цифровых инструментов исследования в «живой» лаборатории. Ключевыми моментами для лаборатории являются: 1) охват развития в движении; 2) включение прошлого в текущий контекст исследования; 3) проектирование исследований, выходящих за рамки застывших, завершенных форм развития; 4) создание условий для изучения свернутых, интенсифицированных видов развития. Конструирование исследовательских контекстов, удовлетворяющих данным условиям и позволяющих сжатым формам развития раскрыться, представляет собой динамичный и в то же время диалектический способ изучения раннего развития. В статье мы рассматриваем цифровые инструменты (такие как видеосъемка и сбор цифровых данных), во-первых, как часть формирующего эксперимента «Мир понятийной игры» (Conceptual PlayWorld), а во-вторых, как элемент культурно-исторической концепции лонгитюдного исследования развития понятий у младенцев и детей раннего и дошкольного возраста в формате «живой» лаборатории.

Ключевые слова: культурно-исторический, метод, методология, раннее детство, цифровой, видеосъемка, развитие.

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