Tools and Signs in Massive Open Online Courses: Implications for Learning and Design

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Keywords

Online learning · Design of massive open online courses · Cultural historical theory · Cognitive development · Developmental psychology

Abstract

Understanding learning as a psychological process has been downplayed in the design of massive open online courses (MOOCs). This study draws on the cultural-historical perspectives of Vygotsky and Galperin to offer the design principles for MOOCs to enhance the learning and development of learners. The study argues that the suggested design principles emphasize the interplay between digital tools and the design of MOOCs to facilitate learners' move from interacting with digital tools to developing their conceptual grasp and understanding of how to engage in online learning. During this process, digital tools acquire psychological significance to become *signs*, while the digital environment (MOOC) becomes a tool for studying the essence of online learning and positions learners as conscious agents who possess the capacity to learn.

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Today, online education (massive open online courses; MOOCs) has become a major topic in education (Castaño-Muñoz et al., 2018; Deng et al., 2019). One possible conceptualization of MOOC is a new teaching innovation and practice of education delivery that targets to promote active learning and develop educational communities including thousands of students (Ghazali & Nordin, 2018). Massive and open indicate that it offers unlimited courses and is open to everyone. Online course also gives the impression that teaching and learning are delivered online and there is no limit for individuals who want to participate (Jansen & Schuwer, 2015). In Norway, a small country in comparison with other European countries¹, the Commission appointed to examine the possibilities and challenges that accompany the development of MOOCs discussed the concepts of *massive* and *open* and based their definition of MOOCs on the following characteristics: (a) web-based, (b) scalable as regards the number of participants, and (c) open (Official Norwegian Report, 2014). The discussion pursued in this study is located in the Norwegian context, and, therefore, it adopts the Norwegian definition of MOOCs. However, in

¹ The current population of Norway in 2021 is 5,465,630. Source: Norway Population 1950–2021|MacroTrends.

both international and Norwegian perspectives, MOOCs are considered to offer new opportunities for learning, and recent hardware and software innovations are making MOOC platforms more available and easier to use (Simonson et al., 2020). In such conditions, understanding how to design MOOCs to enhance the learning and development of learners would seem crucial.

Learning design is described as a *metatheory* of education (Dalziel, 2009) focusing not on the discipline content but on the activity structures used to help students understand the content (Agostinho, 2009). It is argued that learning design can have a profound influence on how humans learn (Selwyn, 2016). Learning design is understood as the application of learning design knowledge when developing a concrete unit of learning – for example, a course, a lesson, a curriculum, or a learning event (Koper, 2005). Such an understanding is also relevant to MOOCs to reflect on the significance of the MOOCs' designs to enhance learning. While acknowledging several attempts to consider psychological aspects of learning in the design of MOOCs (Conole, 2015; Laurillard, 2014), this matter requires further attention (Hatzipanagos, 2015; Salmon, et al., 2017; Watson, 2014). In particular, introducing MOOC designs that may facilitate the development of learners' conceptual understanding and their understanding of how to learn online is crucial to enhance lifelong learning and professional development.

This study addresses this gap by considering a dual perspective in the design of MOOCs that (a) accounts for learning as a psychological process and (b) illuminates the interplay between digital tools and the design of MOOCs. In this study, digital tools are understood not only as software and hardware to perform operations but also as *elements* in MOOCs, such as text, video, and audio resources on webpages, discussion forums, quizzes, and assignments with which learners may engage. By adopting the cultural-historical perspective, this study argues that in MOOCs designed after the suggested principles, the utilized digital tools might acquire psychological significance for learners to become signs and to enhance their learning and development. When applied to newly emerged digital technologies, the boundary between tools and signs becomes indistinct as digital tools, such as computers and mobile phones, often acquire functional significance of signs when used, for example, to interact on social media or to engage in online games (Rubtsova, 2019; Voiskounsky, 2010). In doing so, digital tools and signs interplay and undergo mutual transformations to create a new reality in which social interactions influence

the development of human consciousness. To exemplify the design of a MOOC module and an assignment, we offer an empirical snapshot – professional digital competence (PDC) MOOC for English teachers. The discussion that follows considers the interplay between the digital tools and the design of the online environment to initiate rethinking, repurposing, and reusing of digital tools in the context of MOOCs. Such a discussion contributes to reflections on the epistemological and ontological consequences of digitalization that affect educational practices (Ludwig, 2015; Lynch, 2014; Vaesen, 2014).

Digital Tools to Assist Learning

The psychological tradition that has had the longest influence on the design of digital tools is the associationist theory, which reached its most influential expression in the operant conditioning research of Skinner and colleagues in the 1950s (Skinner, 1953). Light (1997) summarized the hallmarks of such an approach as (a) focusing upon achieving some desired patterns of behavior, (b) generating desired behavior patterns through small incremental steps, and (c) reinforcing correct responses through the delivery of extrinsic rewards. Skinner suggested that a “teaching machine” could be designed to carry out these functions in respect to human learning. Although studies comparing specific teaching machines with conventional teaching showed substantial advantages for machine instruction (Light, 1997), they were subject to many methodological limitations. These restrictions included an inability to predict, from intraprogram response data, whether any long-term learning occurred and whether knowledge and skills could be transferred to other contexts (Holland, 1965).

Later use of computers to support learning, computer-assisted instruction (CAI), addressed some of the shortcomings of the associationist approach, which was based on the idea of assisting the teacher to achieve an instructional goal. CAI software offered drills and practice and facilitated the provision of feedback for incorrect responses (Koschman, 1996). Reviews and meta-analyses concluded that CAI was moderately effective (Light, 1997).

Development of CAI software led to intelligent tutoring systems that could take into account the pattern of errors made by a learner over a specific time period and create mental models of learners. Intelligent tutoring systems analyzed student learning in terms of these mental models and responded to student actions based on oc-

currences of typical errors made by a student in comparison with ideal models (Gray et al., 1991; Ritter et al., 2007). The intention of increasing students' control over their learning led to the design of Logo, a modular programming language that provided simulation environments (microworlds) for students to explore as they discovered the power of reasoning (Kynigos et al., 2014; Stahl et al., 2006). The belief was that by using Logo to build programs children would learn logical (computational) thinking (Wegerif, 2015). This assumption, however, was not supported by research (Pea & Kurland, 1984); generalizable gains in students' problem-solving abilities were evident only when Logo learning was sustained over a substantial period (50–60 h) with active teacher input (De Corte et al., 1992). However, building on the constructionist ideas of Logo and the research in this area led to the development of Scratch – a visual programming environment that lets users create interactive media-rich projects (Resnick et al., 2009). The goal of Scratch is to introduce programming to young people with no programming experience while making their projects engaging, motivating, and meaningful. It is considered that programming in Scratch supports computational thinking which develops important problem-solving and design strategies with learners (Maloney et al., 2010). By engaging in the Scratch programming environments, young people are able to explore, express themselves, and learn in a social context (<https://scratch.mit.edu/>) while sharing their projects and receiving feedback from their peers.

Since the mid-1990s, however, the social dimensions of computer use have become a major research focus (Engeness & Edwards, 2017; Engeness & Mørch, 2016). Computer-supported collaborative learning (CSCL) researchers have explored how computers bring students together to learn collaboratively in small groups and in learning communities (Ludvigsen & Mørch, 2010; Noroozi et al., 2011; Stahl, 2013). A large number of studies have demonstrated that in order to improve students' learning outcomes in CSCL, educators' attention should be focused on the nature of the learning processes. Concepts employed in these discussions include relevance, width and depth of discussion, justification, reasoning, and knowledge creation (Noroozi et al., 2011; Stahl et al., 2006). External support is offered in the form of (a) feedback from a computer, (b) use of multiple representations and simulations, and (c) pedagogical agents in the form of categories, prompts, and scripts that scaffold learning in CSCL environments (Azevedo & Hadwin, 2005; Ludvigsen, 2012). Categories and prompts that identify what

is central to learners' activities (e.g., knowledge-building categories) have become a foundational aspect of CSCL environments (Ludvigsen, 2012). These categories may enhance students' capacity for social and cognitive regulation, learning disciplinary knowledge, and developing an awareness of how a systemic orientation to knowledge can appear (De Jong et al., 2012; Linn & Eylon, 2011; Wegerif, 2016).

In addition to various types of categories and prompts, collaboration, epistemic, and argumentative scripts in digital environments are seen to scaffold students' learning. Collaboration scripts, for example, provide guidelines for how group members should collaborate to accomplish learning tasks (Weinberger et al., 2007). Epistemic scripts structure and sequence discourse activities with respect to content and task strategies (Weinberger & Fischer, 2006), which may help learners construct arguments and contribute to solving problems (Noroozi et al., 2011). Argumentative scripts can be used to structure and formulate the construction of broad, deep, and justified arguments in CSCL environments (Stegmann et al., 2007). In line with the focus on the design and affordances of digital tools, the emphasis on the tools' main function of assisting learning draws attention to how the technology contributes to transforming our conceptions of what learning is, our expectations of what people should master, and our expectations of how human skills should be cultivated (Säljö, 2010).

The argument continues that external digital tools assist human cognitive activities – thinking, reading, perception, and problem-solving – which happen largely through coordination with digital tools for meaning-making (Säljö, 2012). Therefore, so-called hybrid minds operate in environments of external symbolic storages where human reasoning is located at the intersection of the human mind and external technological resources that have often been crafted over long periods of time (Cole & Derry, 2005; Säljö, 2012). Such an understanding resonates with the notion of extended cognition, with external resources being constituents of cognition (Vaesen, 2014).

However, the unique aspect of online learning is that learners' actions are embedded in digital learning environments (MOOCs) and may therefore exemplify new epistemic (embedded) practices (Säljö, 2012). By engaging in such practices, learners may develop their embedded cognition (Ludwig, 2015; Vaesen, 2014). Therefore, understanding how the design of digital learning environments may contextualize and affect learners' embedded practices and cognition is crucial.

Contextualizing Learning in MOOCs

To explore how previous research addressed the psychological aspects of learning in the design of online environments, this section considers the (a) studies that examined approaches to MOOCs' learning designs and (b) studies that discussed particular aspects concerned with MOOCs' learning designs such as learning and teaching trends, social aspects of learning and assessment in MOOCs. Since the empirical snapshots in this study are offered from the professional development MOOC for English teachers, the studies that discussed the design of teacher professional development MOOCs are also reviewed in this section.

In MOOCs, learning design is described as a methodology to make informed decisions on how to design learning activities in digital spaces (Conole, 2015). Traditional classroom methods – such as lectures, group discussions, and multiple-choice assignments – are widely used in MOOCs (Toven-Lindsey et al., 2015). Salmon (2013) offered a five-stage model to design MOOCs: (a) access and motivation, (b) online socialization, (c) information exchange, (d) knowledge construction, and (e) development. A review of 102 studies on learning and teaching in MOOCs identified four key learning and teaching factors that should be considered in their design: learner factors, teaching context, learner engagement, and learning outcomes (Deng et al., 2019). The authors reported that systematic research on learning and teaching trends in MOOCs is limited and that the relationships between many learning and teaching factors in MOOCs have not been identified. In emphasizing the value of a pedagogical approach to design a MOOC, Laurillard (2014) argued for the need to (a) orchestrate the work of participants, (b) provide a default sequence of activities, (c) differentiate core and optional activities, (d) provide links to issue-oriented discussion forums, (e) provide ways for participants to share ideas, and (f) create activities that build up to making work plans in a course journal. Downes (2013) suggests four success factors to exemplify a connectivist approach to a MOOC design: (a) autonomy – the assertion that MOOC participants employ their own goals and objectives, judgments and assessment of success in the process of interaction with others; each person responds to the phenomena – the communication of others to generate a unique structure and organization; (b) diversity of a broad range of criteria, including location and time zone, technology of choice, pedagogy and learning style; diversity accommodates for creating networks of participants and their

networks may differ in their organization; (c) openness implies that participants in the course are free to enroll, leave, move in and out of the course freely and at any time; openness applies also to the content of the course by encouraging participants to share content they received from the course and bring the content to the course they obtained elsewhere; and (d) interactivity of the course participants to enhance their learning; it is argued that interactivity emerges from the network as a whole rather than being transmitted or distributed by more powerful learners.

By considering social aspects of learning, MOOC instructors direct their efforts at creating premises for students' interactions and engagement. It has been indicated that students are more satisfied with online courses that include social interactions and reflections (Kasch et al., 2017; Weidlich & Bastiaens, 2019). In another study, after the learning environment had been enriched with social affordances, technically realized through Moodle plugins ("Meet the Students," "Course Contacts," and "Dialogue"), students of a 1-month-long online course reported the learning environment to be significantly more sociable and the learning experience to be more satisfying than in the control condition (Weidlich & Bastiaens, 2019).

In line with social aspects of learning, forms of assessment in digital learning spaces have been addressed (Castaño-Muñoz et al., 2018; Deng et al., 2019; Kasch et al., 2017; Laurillard, 2014). For example, to enhance formative assessments and feedback in MOOCs, five case studies pursued an approach to design a framework that integrates four common educational design principles of formative assessment (Kasch et al., 2017). Findings indicated that providing quality feedback at a large scale with low teacher costs was challenging in MOOCs, and this could be improved by adding scalable feedback methods, such as sum-up videos that respond to the students' needs and lecture videos that guide students through the several scenarios of learning in MOOCs. Improvements could also be made in multiple-choice assignments by increasing the diversity of question types and answer options (Kasch et al., 2017).

The potential of MOOCs for teachers' professional development (PD) has been widely explored (Castaño-Muñoz et al., 2018; Kleinman et al., 2013; Laurillard, 2014; 2016; Vivian et al., 2014). Laurillard (2016) reported that PD MOOCs might support a colearning model of the community of teachers by utilizing the features of a colearning approach: (a) issue-focused discussion forums that elicit valuable community discussions, (b) peer-as-

sessed assignments that enable teachers to learn from each other, and (c) discussion forums linked to off-platform tools for sharing resources and ideas. Such opportunities for flexible training methods are particularly valuable in times of rapid technological changes and with decreasing resources for formal education (Kleinman et al., 2013). Other researchers have suggested an approach to develop a free teacher PD MOOC by using the Google+ community to share and build a repository of online resources, short concept videos, flexible learning pathways, and blend of content and exemplars that also break down discipline language and concepts into relatable items. Examination of the teachers' engagement and experience in the PD MOOC has proven the suggested design features useful (Vivian et al., 2014).

Although studies indicate that resources, activities, teacher facilitation, discussion forums, and forms of assessment are of primary importance in the design of MOOCs, with a few exceptions in the works of Laurillard (2016), Conole (2015) and Downes (2013), research is lacking considerations about how the design of online environments accounts for the psychological aspects of learning. A potential reason for the lack of pedagogical and psychological theory application by e-learning practitioners is that, as academics outside of the field of education, they may find the diverse array of theoretical perspectives alien and overwhelming (McNaught, 2003). However, in order to enhance learning and the development of learners, MOOC designers need to account for the psychological aspects of human learning in the design of online environments (McAuley et al., 2010; Cormier, 2010). This study addresses this gap by using the perspective of the cultural-historical theory.

Theoretical Perspective: Cultural-historical Theory on Understanding Instrumental and Psychological Tools

One of the central ideas in Vygotsky's legacy was the concept of tools (Vygotsky, 1981; Vygotsky & Luria, 1993). By analyzing Köhler's research on the intelligence of higher apes, Vygotsky explored the difference in tool use between animals and humans. Vygotsky highlighted that apes' use of tools played a different role in their interactions with the environment as it did for humans (Vygotsky, 1997). His argument was that humans' use of material – conceptual and linguistic mediational tools in the context of social practical activity – connected a person and the surrounding reality. Vygotsky indicated that tool

mediation during practical activity initiated changes in human consciousness, and these tools acquired special meanings when put to use in human activity. Hence, external tools come to be internalized as *signs*. For Vygotsky, the psychological significance of tools-signs for the development of human consciousness made them different from animal use.

The difference between humans' and animals' tool use was addressed in detail by the contemporary of Vygotsky, Galperin, in his candidate dissertation (Galperin, 1998) entitled *Psychological Significance and Difference between Tools Use by Humans and Auxiliary Means by Animals*. In his work, Galperin studied the differences in tool use between humans and animals, arguing that there was a fundamental difference between the tools developed by humans and auxiliary means (i.e., tools) used by animals, and this difference was of a psychological nature. Galperin suggested that the tools humans created and used in practical activities enhanced the development of new psychological functions. The core difference between humans' and animals' tool use was in the functional significance of the used tools. For example, when holding a tool in the hand, a human or animal can use the tool as an extension of the arm. In this case, the tool acquires the arm's functions, and therefore, the tool's own functional significance appears to be downplayed. Alternatively, when a human or animal holds a tool, their arm can comply with the requirements of the operations of the tool use, and therefore, the arm acquires the tool's functional significance. By mastering the used tools and revealing the practices encapsulated in these tools, the human consciousness, in contrast to the animal mind, undergoes developmental transformations initiated in tool-mediated activities. In postulating so, Galperin extended Vygotsky's understanding of the difference between tool use in humans and animals in the appearance of tools-signs. Galperin suggested that utilizing tools not as an extension of the human arm but through acquiring the tool's functions by the arm and mastering the culturally developed operations of the tool use made humans' tools fundamentally different from animals' ones. He concluded that tools that had psychological significance for humans were characterized by the historically and culturally developed operations encapsulated in these tools, and these operations had to be mastered by humans for them to be able to employ the tools. Such an understanding of psychological significance of human tools urges the discussion about how these tools may acquire such a significance for humans. Such a discussion is important since it may offer considerations about how the design of MOOCs may as-

sist learners to master the digital resources (tools) embedded in the online environment to become signs and enhance the development of learners' psychological functions (conceptual knowledge and understanding of how to learn online).

Tools and Signs in the Cultural-Historical Perspective

Vygotsky and Rieber's (1998) understanding of the systemic organization of human consciousness was developed in his works in the 1930s. Vygotsky emphasized the developmental nature of human consciousness and argued that the process of inconsistent development of a child's consciousness was of primary significance for the systemic organization of human consciousness. Inconsistency in the development of a child's consciousness was explained by Vygotsky as the appearance of one predominant psychological function in the different periods of a child's development. These predominant functions (perception, memory, and thought) affected the development and organization of human consciousness and caused the reorganization and restructuring of the existing psychological functions, thereby establishing the dependency of all existing functions on the new dominant function. Such an organization of human consciousness reflected its systemic and hierarchical structure. The systemic structure of human consciousness emphasized the need for humans to develop their conceptual understanding as an ability to reflect the surrounding reality and engage in meaningful interactions with it. In analyzing conceptual development, Vygotsky introduced the categories of spontaneous and scientific concepts. The categorization was based on the way learners made sense: a person makes sense of spontaneous concepts during everyday practical activities in a nonsystemic way, usually by trial and error. In this way, a person is unable to separate essential from unessential features of concepts. Learners develop scientific concepts when engaged in systemic learning, by getting introduced to the essential features of key concepts. Vygotsky saw the benefits of such a "top-down" method of learning in the growing ability of a person to operate with the concepts and apply them in various contexts. Galperin extended Vygotsky's ideas on the development of scientific concepts by pointing out that the development and generalizing of concepts in learners happens gradually and over time. When engaged in the process of the development of their conceptual understanding, learners have to: (a) be introduced to the characteristic features of the target concept; (b) identify the presence or

absence of the characteristic features of the target concept in the object and then determine whether the object belongs to the target concept; and (c) engage in different tasks to enhance their ability to apply the target concepts in various situations. Vygotsky indicated that the hierarchical organization of psychological functions and the development of conceptual understanding could be developed only in humans, and it was inherently connected to the human use of tools, which acquire a special significance to become signs. Therefore, the systemic structure of human consciousness was connected to the origin, development, and functional meanings of signs. Signs first appeared in the process of communication among people, and operations with signs were internalized to become the psychological functions of a person. This pathway reflected the processes of mediation, sociogenesis, and the internalization of higher psychological functions. Galperin summarized Vygotsky's understanding of the functional significance of the sign mediation in (a) establishing new psychological functions and reorganizing existing psychological functions, (b) positioning sign mediation as the structural and functional center of newly developed psychological functions, and (c) separating lower psychological functions from higher psychological functions (Engeness, 2021). Thus, a sign could be considered a tool for creating the structural and systemic organization of human consciousness. Galperin concluded that the higher psychological functions were nothing but internal operations mediated by forms of communication, and higher psychological functions were developed in the process of mediated social communication during external activities of humans. Through the process of sign mediation and internalization of signs, humans develop their ability to voluntarily manage their behavior. Such an understanding conceptualizes the difference in how behavior is managed in humans (sign mediation) and animals (adaptation to the environment). By engaging in the process of developing signs' meanings, humans develop their capacity to understand and generalize the surrounding reality. Understanding of the surrounding reality empowers humans to make meaningful contributions to this reality.

With Vygotsky's perspective that any psychological function was external and social before it became internal and individual, the process of internalization reflects the transfer and transformation of human thought from the external interpsychological to the internal, intrapsychological plane (Vygotsky, 1978). The principle of internalization and externalization was developed further by Galperin through considering the phases of the development

of mental actions. He viewed such a process as the gradual transformation from external object-oriented activities (materialized action) into mental action (acting mentally) through social communication (communicated thinking) and individual speech (dialogical thinking) (Engeness & Lund, 2020). Galperin suggested that transformation of the action from the external to the internal mental plane of the learner happens through six consecutive phases or forms of activity: (a) motivation, (b) orientation, (c) materialized action, (d) communicated thinking, (e) dialogical thinking, and (f) acting mentally. In the motivational phase, a learner's attitude and relation to the learning outcomes that have to be achieved is formed. This is followed by the phase of orientation, where the orienting basis of the action is achieved by the learner developing a generalized orienting scheme of action. By applying the scheme as a guiding tool, a person who has never been previously exposed to the task completes it one step at a time. Creating an orienting basis of the action can happen in three possible ways:

- *incomplete*, where learning happens through trial and error; in this case, learning takes place slowly with many mistakes, and it is extremely sensitive to the slightest changes in the conditions of the learning situation;
- *complete and offered by the teacher*, where learners are informed in detail about the characteristics of the target concepts and about how they will engage in learning; this implies that the learners are equipped with all the necessary mediational resources and the plan of action (what to learn and how to engage in learning);
- *complete and constructed by learners* following an approach aimed at identifying the essential characteristics of the target concepts; using this approach, learners construct a specific orientation suited to solve the problem at hand; Galperin argued that with this type of orientation, humans develop their understanding of how to go about learning, and their agency as independent and conscious learners may be enhanced.

The transformation from materialized action to communicated thinking happens during learners' interactions with material or materialized objects and in making sense of these objects in speech. In the phase of a materialized action, the action is directed outside, and it connects the learner with external objects and the outside world. The transformation from communicated to dialogical thinking happens by learners substituting the externally oriented speech with its image. In dialogical thinking, the action is directed inside the learner in establishing communication with himself or herself (as another

person). The learner's ability to perform an action in the form of dialogical thinking reflects the pathway the action has undergone from its materialized to its dialogical form. Finally, in the final phase, the action is performed in hidden speech, which Galperin refers to as *acting mentally*. In this phase, artificial fragmentation into individual units is suspended, and the action acquires its natural flow. In this phase, the maximum automation of the action can be achieved. These phases of the development of mental actions can reflect a pathway to creating meanings in the specifically designed learning activities.

A Cultural-Historical Approach to Design Digital Environments

The legacies of Vygotsky and Galperin and, in particular, their tools-signs considerations have implications for outlining design principles (DP) of digital environments (MOOCs) aimed to enhance students' interactions and meaning-making of the integrated digital tools.

DP1: when designing a digital environment, it is important to identify (a) the target concept about which students need to develop their understanding and (b) the essential characteristics or structural parts of the target concept. In addition, the sequence of presenting the essential characteristics of the target concept to students should be identified based on students' prior knowledge and skills. *DP1* reflects Vygotsky and Galperin's considerations about the need to develop scientific concepts with learners due to the systemic organization of human consciousness. The emphasis on the sequence of presenting the essential characteristics of the target concepts by considering students' prior knowledge and skills indicates the need to clearly identify (a) the target group for the specific MOOC and (b) the sequence of presenting the characteristic features of the key concepts for the MOOC learners.

DP2: if a learning activity is to adequately assist the development of students' learning and their understanding of the learning process, it should be organized according to the third type of orientation: complete and constructed by students using an offered approach.

DP3: the overview of the entire activity, termed by Galperin as the *operational scheme of thinking*, should be integrated into digital environments to enhance students' understanding of the learning process they engage in.

DP4: the phase of materialized action indicates that some resources to assist the development of learners' conceptual understanding should be presented in the mate-

rialized form (texts on web pages, videos, etc.). Students' experiences from interactions with the materialized resources are transferred through collaborative interactions to the internal plane of the learners (materialized action results in communicated thinking, which leads to dialogical thinking and acting mentally).

DP5: the phase of communicated thinking urges educators to create premises for social interactions in digital environments (e.g., discussion forums and online collaborative meetings).

DP6: the role of feedback as well as facilitation of the learning process by teachers need to be accounted for in the design: feedback provided to students in digital environments might assist them in developing their conceptual understanding and enhancing their understanding about how to learn. Such feedback is particularly appreciated by students in the phases of materialized action and communicated thinking (Engeness, 2018, 2020). In the later phases of the learning process, such as dialogical thinking, feedback might be provided on request or with regard to how well students master the activity they are engaged in.

In summary, these DPs are intended to (a) enhance students' learning through their actions and interactions with the available digital tools and students' gradual developing of meanings of these digital tools to become signs and (b) develop students' understanding about how to learn in online environments. In doing so, students might enhance their capacity to learn and position themselves as active agents in knowledge practices. In the following, an empirical snapshot is presented to exemplify the DPs arising from Vygotsky and Galperin's legacy. Although this snapshot is from the PDC MOOC for English teachers in Norway, it may exemplify a useful approach to design digital environments for students of various age groups.

Empirical Snapshot: Design a Module and an Examination Assignment in the MOOC

The PDC MOOC for English teachers was first introduced in Norway in 2019. The course was developed by researchers and development specialists from Østfold University College. The PDC MOOC has a structure of an xMOOC; it is built-in on the Canvas platform and is aimed at enhancing the development of PDC in English teachers in Norway. xMOOCs are defined as institutionally focused, largely reliant on video resources, and providing automated assessments through quizzes (Armellini & Pa-

Table 1. Progress plan and the modules in the PDC MOOC

Module	Progress plan (week)
1. Digital technology in English subject	2–3
2. Designs for learning and subject didactics	4–5
3. Classroom management with digital technology	6–7
4. Multimodal texts	8–11
5. Assessment <i>of</i> and <i>for</i> learning	12–14
6. Student response systems and digital tests	16
7. Digital resources and tools	17
8. Flipped classroom	18–20

dilla Rodriguez, 2016; Fidalgo-Blanco et al., 2016). All these elements are present in the PDC MOOC. The PDC MOOC comprises eight modules to be completed by its participants over the course of twelve weeks. The list of the modules in the PDC MOOC and the progress plan the teachers are to follow are presented in Table 1.

Module 8's flipped classroom (FC) is a typical example of the modules in the PDC MOOC. The aim of the FC module is to develop teachers' understanding of the concept of FCs and enhance their digital competence to create FC assignments. The module comprises three main parts: (a) a theoretical part introducing the concept of FCs in teaching and learning English (8.0–8.3.2), (b) a practical part introducing relevant digital tools and how to create an FC assignment (e.g., screencast software, Mayers' theory on multimedia, and learning and formative assessments) (8.4–8.4.9), and (c) an examination assignment, in which teachers create an FC (8.5–8.5.3). The three distinctive parts of the FC module and the progress plan the teachers are to follow serve as an operational scheme of thinking that indicates what teachers will learn and how they will engage in learning in the module. The sequential design of the module is presented in Table 2.

In the first part of the module (8.0–8.3.2), teachers are introduced to the theoretical resources to reveal the essential characteristics of the FC approach (learners' interactions with materialized resources – textual information, videos, podcasts, and other in the phase of a materialized action). The teachers may develop their understandings of the available theoretical resources by engaging in online group discussions (communicated thinking) and assess their understandings of the target concepts by engaging in the multiple-choice test (dialogical thinking). The second part of the module (8.4–8.4.9) is structured in a similar way: teachers are first introduced to the theoretical resources by being presented with the

relevant digital tools and reflecting on issues – such as how to set up a studio, screencast software, and Mayer’s theory on multimedia and learning (materialized action) – followed by online discussions to develop teachers’ understandings of the target digital tools (communicated thinking) and, finally, a multiple-choice test to provide an opportunity for teachers to explicate their (mis)understandings (dialogical thinking). When engaged in the examination assignment (8.5–8.5.3), the teachers follow similar phases: they are introduced to an FC examination assignment (materialized action), they engage in collaborative online group meetings to develop their understandings of the FC examination assignment (communicated thinking), and they design an FC and produce a reflection video (dialogical thinking). All components of the examination assignment were marked by the course instructors. Østfold University College funded the instructors’ facilitating of the PDC MOOC. The text of the examination assignment is presented in Table 3.

From the perspective of Galperin’s types of orientation, both the FC module and the examination assignment were designed according to the third type of orientation: complete and constructed by learners. The variety of the resources (theoretical and practical) the teachers may select enables them to develop their conceptual understanding of an FC (by identifying the characteristic features of an FC), create an FC (employ these characteristic features in their products), and reflect on its pedagogical value. The assessment criteria of the examination assignment might indicate an approach for how to engage in learning. In addition, the structures of the FC module and the examination assignment, both designed after the third type of orientation and comprising consecutive learning phases, may offer an approach to learning that the teachers may pursue. By adopting such an approach, the learning activity is aimed at (a) helping teachers master new conceptual knowledge about FCs and (b) developing teachers’ understanding of the nature of online learning to enhance their capacity for learning to learn. By engaging in learning with the available digital tools, teachers may progressively develop their understandings of these tools. The design of the FC module and the FC examination assignment may contribute to the digital tools acquiring a particular psychological significance for the teachers, which empowers the teachers to mediate their actions and, in doing so, develop their conceptual understandings about FCs and how to learn in the PDC MOOC.

In summary, the teachers’ actions and interactions with digital tools available in the PDC MOOC designed

Table 2. The sequential design of module 8 Flipped Classroom

8.0 Introduction and competency aims
8.1 What is flipped learning?
8.1.1 How does flipped learning work?
8.1.2 Definitions of flipped learning
8.2 The flipped classroom and teaching English as a foreign language
8.2.1 What does research say about flipping your classroom?
8.2.2 Why should you flip/not flip your classroom?
8.3 Use of video in education
8.3.1 From video consumers to video producers
8.3.2 N. Selwyn (2016): A short history of education and technology
Discussion: introducing flipped classroom
Test yourself
8.4 Flipped classroom in praxis
8.4.1 How to set up your first recording studio?
8.4.2. Screencast software
8.4.3 Use of audio, voice commentary and talking head in videos
8.4.4 How to create educational videos with your mobile phone
8.4.5 How long should videos be?
8.4.6 Mayer’s theory on multimedia and learning
8.4.7 Have your students watched videos at home?
8.4.8 Flipped classroom and formative assessment
8.4.9 What should we do in school?
Discussion: benefits and limitations of flipped classroom
Test yourself
8.5 Flipped classroom examination assignment
8.5.1 Collaborative group meetings
8.5.2 Using references in the assessment
8.5.3 Submit your examination assignment – flipped classroom
Module 8 test – flipped classroom

after the suggested DPs exemplify teachers’ engagement in online learning and show how teachers’ meaningful contributions to the online (embedded) learning practices can be made. In doing so, the teachers may develop their embedded cognition (Ludwig, 2015; Vaesen, 2014). As teachers engage in such practices, the employed digital tools may acquire a psychological significance to become signs that mediate teachers’ actions in the digital environment and enhance the development of teachers’ conceptual understanding and their capacity to engage in online learning.

Concluding Remarks: From Digital Tools to Digital Media

The discussion on the role of digital tools in human learning has been previously addressed by researchers who referenced digital tools’ reductionist and instrumental nature (Orlikowski & Iacono, 2001). However, the mediating role of cultural resources for developing cognition and advancing knowledge is a distinguishing feature of the cultural-historical approach to learning (Lund & Engeness, 2020). From the cultural-historical perspec-

Table 3. Examination assignment: flipped classroom

The main goal of this examination assignment is to create a flipped classroom that can be used in your teaching practice. You may choose any topic relevant to the curriculum in English, and the topic of your choice should be specified in the assignment. Your flipped assignment should contain a combination of videos, textual information, and other resources. However, all resources used in your assignment should be self-produced. Remember to reference the sources you have used. Your flipped classroom assignment should be designed for three teaching hours

You will need to submit the following two elements, which comprise the examination assignment (both elements should be submitted in Canvas):

1. A link to the flipped classroom assignment (log-on information must be enclosed if log-on is required)
2. A reflection video (maximum length of 10 min). In the reflection video, you should present in detail your flipped classroom assignment, providing reasons for the choices you have made. You should also argue for the pedagogical value of your flipped classroom: How will the students develop their conceptual understanding? The reflection video should be produced as a screencast with you as a narrator (talking head in the lower-right corner of the screen). You can submit your reflection video as a link or an mp4 file. The following tutorial offers practical advice about how to make a video (link to the tutorial)

Assessment criteria

The following questions will be addressed by the course instructors evaluating your flipped classroom assignment

Does your flipped classroom assignment:

- (a) contain competency aims and learning objectives students should achieve?
- (b) demonstrate your ability to utilize a flipped classroom's distinctive features/benefits?
- (c) demonstrate your ability to produce videos and other resources of an appropriate quality?
- (d) introduce a learning design that indicates the sequence of activities in which students will engage?
- (e) reflect on a teacher's role in the flipped classroom assignment?
- (f) present your reflections about the pedagogical value, benefits, and limitations of the flipped classroom assignment?

How to Engage in the Examination Assignment

We suggest that you follow the steps outlined below to solve the examination task

1. Read the task carefully and think about the topic for your flipped classroom – consider theoretical and practical resources that might be useful. Please carefully read the assessment criteria
2. Your group leader will arrange a collaborative meeting to share and discuss these ideas with other students. The aim of the meeting is to solve the examination task by engaging in discussions with your peers. You will present your ideas about your flipped classroom and the resources that might be useful and discuss the pedagogical value of your flipped classroom
3. Create a draft of a plan for how to solve the examination task. Submit your draft to the course teacher to receive feedback on your ideas
4. Create your flipped classroom assignment and submit the following: (i) a link to the flipped classroom assignment and (ii) your reflection video

tive, the structural design of the PDC MOOC can be defined as an *artifact* – a human-made object that provides a means of making sense of the activities teachers engage in (Kaptelinin & Nardi, 2012; Miettinen & Paavola, 2018; Säljö, 2010). To conclude, the discussion presented in this study can be summarized in several points.

First, learners' actions and interactions in digital environments bring attention to the tensions and contradictions that may arise between digital tools and the design of digital environments. Informed by Galperin's theory, the suggested design principles of digital environments suspend these tensions and contradictions by facilitating learners' moves from interacting with digital tools (materialized action) to developing meanings in the collaborative discussions (communicated action) and then to learners' individual solving of the target assignments (dialogical thinking). In doing so, the trajectory of develop-

ing learners' understandings can be observed. In such a learning trajectory, the interplay of the digital tools and the design of the digital environment comes to the forefront, rather than the tensions and contradictions.

Second, the suggested DPs of online environments rooted in Vygotsky's and Galperin's understandings of sign mediation emphasize the social nature of teachers' interactions with digital tools in the PDC MOOC. The integrated discussion forums create premises for teachers' social interactions to enhance the development of teachers' understandings of the available digital tools and their ability to employ these tools to manage their learning.

Third, in the PDC MOOC, digital tools help the teachers orient in the digital environment and make sense of it. From this perspective, mediation by digital tools ceases to be merely an insightful metaphor and instead can be con-

strued in the process of teachers' interactions with the digital tools located in the specifically designed digital-learning environment. During these interactions and the transitions from the materialized action to communicated and dialogical thinking, teachers engage in the meaning-making process to develop their understandings of both the target concepts and how to learn online. In the PDC MOOC, designed according to Galperin's third type of orientation, teachers may master the essence of online learning through studying, for example, an FC approach, which carries a new function – not as a studied object but as *a tool for studying the essence of online learning*. In doing so, teachers may develop their understandings about how to manage their learning in digital environments.

Finally, in the process of a complex interplay and transformations happening through learners' interactions with digital tools in the specifically designed digital environments, a digital medium is created (Rubtsova, 2019; Rückriem, 2009). Such a digital medium appears to acquire a functional significance to enhance the development of learners' understandings of the essence of learning in digital environments and positions them as conscious and independent learners who are able to envisage, engage, and drive forward their learning. Emerging new digital media give rise to new epistemologies, leading to the discovery of new worlds, and the position of a human in relation to these worlds must be understood. Further

research is therefore needed to examine learning and teaching in digital media constructed according to the suggested design principles. Such research will contribute to developing our understanding of the pedagogic potential of digital media aimed to enhance the learning and development of learners in online environments.

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Statement of Ethics

No ethical approval was required for the preparation of this paper, as no human or animal subjects were used.

Conflict of Interest Statement

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