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on their platforms to gather data on interactions with the interactive elements of the cross-media textbook. Such forms of communication free publishers from the need to act as intermediaries between authors and readers.

Figure 1
The communication field model of a printed textbook

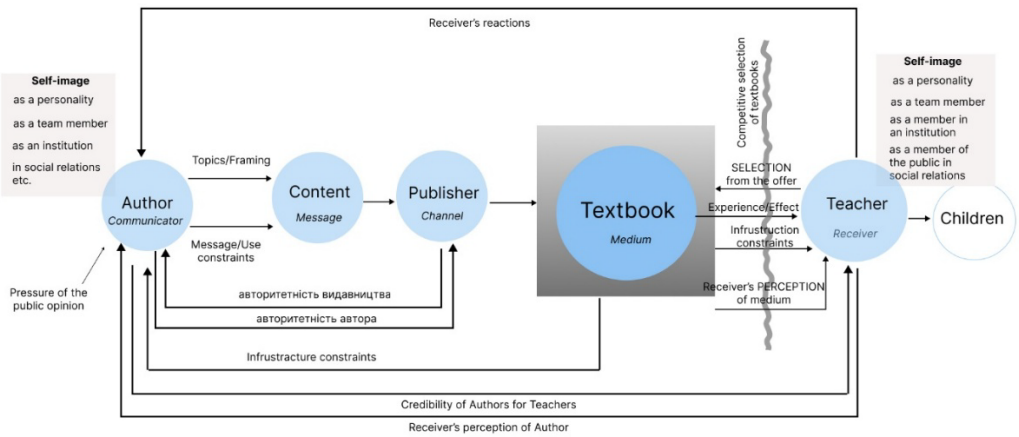
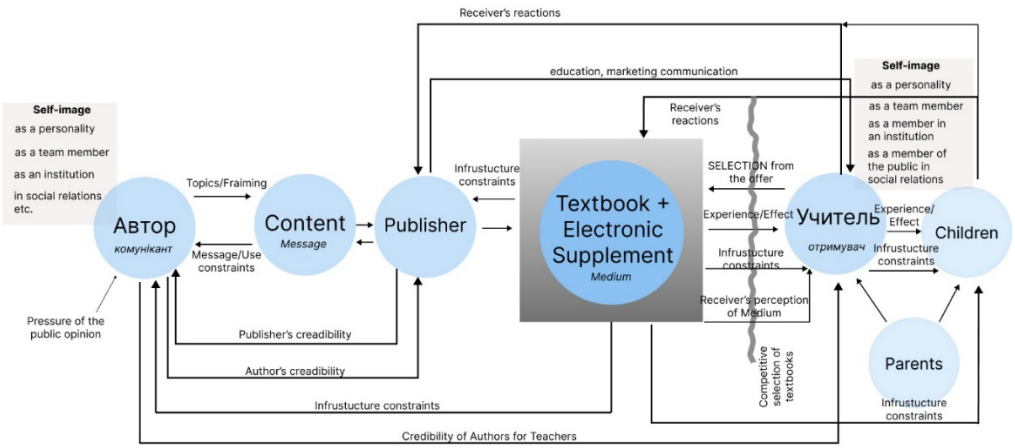


Figure 2
The communication field model of a cross-media textbook



Publishers' brand communications have intensified due to the integration of brand style elements in digital educational materials and all accompanying methodological tools. These changes

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in communicative activity empower publishers to communicate independently, regardless of the authority of the authors.

In addition, publishers exert more influence over authors due to their credibility. In the era of printed textbooks, authors might have chosen a publisher based on reputation, established connections, the atmosphere within the publishing team, and the author's fee. In cross-media production, however, these factors may be supplemented by the publisher's technological capacity to implement the author's idea and the publisher's significance as a stakeholder in the textbook creation process particularly concerning government agencies. After all, publishers have helped shape the requirements for electronic interactive applications and can advocate for their interests, influencing regulations during the implementation of electronic applications in public procurement.

The role of children in cross-media production is also growing. As children interact with interactive elements, their activities can be tracked and recorded. The ability to personalize learning paths according to specific student outcomes significantly enhances the child's engagement with the publisher. In addition, children's feedback can be directed to both the transmitter – the cross-media textbook – and the publisher. Therefore, publishers who have created technological platforms and websites for electronic applications must communicate directly with the end consumer regarding product quality.

We also included parents as a distinct element in the communication model for the production of a cross-media textbook. After all, some educational platforms provide for the creation of parent accounts, enabling parents to monitor their children's learning, pay for educational services, and communicate with teachers.

Changes in the social communication environment of the educational publishing sector

Different communication channels influence both the perception and structure of information. For example, if a printed book in the form of a codex is used as a channel for delivering information in a textbook, the structure will be clear, and the content will be linear. Such a channel does not promote communication between the student and the teacher to the same extent as multimedia materials. It is more oriented towards in-depth reading. The ability to convey information through a single object, which is a characteristic of the entire teaching and methodological complex, since didactic materials are selected for it — makes the product an authoritative source of knowledge.

Authors Anna-Lena Kemp and Åke Grönlund note that "not long ago, representations of a subject in textbooks were held as objective mirrors of reality, enclosed and explicated by scientists in print or other symbols" (Kempe & Grönlund, 2019, p. 2916). In other words, the knowledge in a textbook reflects the interpretations of its authors, making it resistant to transformation, and discouraging the construction of individual knowledge. The scholars further state: "By using endorsed artifacts like textbooks in schools, knowledge becomes standardized, and unified into a single voice, the recognized view of the subject matter" (Kempe & Grönlund, 2019, p. 2916).

With the wide variety of media formats available today, cross-media textbooks no longer impose a single authorial version of knowledge. Since in cross-media formats the content of electronic and print media is complementary and inseparable, the main challenge for publishers lies in how to connect the content of both media through factors such as layout, content, and compositional techniques. In a cross-media textbook, information is presented in a mosaic form, unless the printed material is designed to deliver theoretical content and the electronic format aims to reinforce it.

Different types of cross-media publications can be designed differently based on how the electronic content is organized. Their form depends significantly on the bandwidth of the software or device. Organizing additional material on a platform—such as a separate website or software application —requires the publisher to combine the design concepts of both the printed textbook and the electronic application. In addition to the design connection between these two components, all electronic applications hosted on the platform must be interlinked. Since the learning platform is

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capable of creating a virtual environment separate from the physical classroom, the information delivery channel must provide functionality for a hypertextual non-linear structure. Users should be able to navigate through the content in any order using well-designed navigation elements.

The platform as a well-organized space with a specific purpose—distinct from a communication platform or online store, like those that house a variety of multimedia resources on a publisher's website, allows for the tracking of interactivity and user actions. The ability to communicate with users is a crucial consideration when developing a platform's structure. If the platform's functionality includes social interaction and personalized algorithms, its format and content must also align with these requirements.

Product and communication: interaction in the socio-communicative space of education

In the study of the phenomenon of collaborative digital textbooks in Sweden, researchers Kempe and Grönlund explain that new educational developments should be perceived not only as effective learning tools but also as "a complex socially evolved vehicle" (Kempe, & Grönlund, 2019, p. 2915). They emphasize that "every educational instrument is shaped by different historical notions of 'teaching', 'learning', and 'knowledge', as well as the 'activities' that are supposed to result in 'learning'" (Kempe & Grönlund, 2019, p. 2915). According to Squires and Price, a socio-constructivist perspective on knowledge facilitates the identification of fundamental learning questions that should be incorporated into software evaluation (Squires & Preece, 1999).

The printed textbook was intended to "transmit" knowledge which in the printed era was viewed as unanimous and canonical. The idea behind the publication was not to encourage teachers or students to construct their own knowledge based on the material provided. Instead, students were required to "memorize" the printed content and accurately reproduce generally accepted concepts of the world. As stated by Kempe and Grönlund (2019),"the teacher, on the other hand, has to perform the role of a gatekeeper in order to protect the norms conveyed in the textbooks and assess students' achievements according to these norms" (as cited in Fleck 1979; Banks 1993; Pingel 2010; Kress and Selander 2012; Selander 2016; Åberg and Åkerfeldt 2017).

Richard Mayer, the developer of the multimedia learning theory, adopts a constructivist view of learning, in which multimedia are not simply systems for delivering information, but rather "cognitive tools for constructing knowledge" (Mayer, 2020, p. 14). The researcher challenges the idea of learning as "knowledge transmission" by asserting that "students are not empty vessels" (Mayer, 2020, p. 16). Mayer's cognitive theory of multimedia learning suggests that information processing occurs through the active participation of the recipient. Consequently, the learner must select and organize material, build connections, organize information, and synthesize it with their prior knowledge.

Mayer describes multimedia learning as a meaning-making activity, where the learner attempts to construct their own understanding–individual knowledge–a personal representation of the information presented. The learner's responsibility is to create their own meaning while the teacher's role is to facilitate the process of meaning-making. Additionally, the multimedia format of knowledge presentation should "provide guidance for how to process the presented information" (Mayer, 2020, p. 17). The researcher explains such moderation by highlighting the main points, thought organization, and connecting new information with past experiences.

The introduction of electronic materials in the classroom, which are not presented in a linear, monolithic format, has transformed students' role from passive consumers of information to its producers. The digital tools that an electronic application can provide students with offer more opportunities for creativity and help them build their own understanding of accepted concepts or ideas. For example, modern programs enable students to create their own melodies, program algorithms, and model the environment; immersion techniques are particularly effective with electronic systems.

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In Italy, students even participate in the creation of textbooks. "The aim is to engage students in a process of active construction of knowledge" (Anichini, Parigi & Chipa, 2017, p. 104). An article by Italian researchers states that "teachers who choose this kind of practice claim that auto-production supports and promotes teamwork, encourages discussion and planning, thus providing a dynamic environment for cognitive and social growth of students" (Anichini, Parigi & Chipa, 2017, p. 104).

Therefore, the communicator's work with a cross-media textbook involves constructing their own knowledge based on the diversity of resources and activities offered by multimedia.

The desired effect of using the product

Among the numerous effects of multimedia materials—such as encouraging learning, enhancing responses, providing synchronous feedback, and allowing for personalization, their main function, in our opinion, is to assist the cognitive process. This approach to the goals of social communication activities in creating cross-media textbooks is learner-centered and focuses on the learner rather than on the technology used.

Mayer develops a learner-centered approach to creating new educational products based on the ideas of Norman and Landauer. Norman criticizes scientific and technological innovations that stem from a machine-centered approach to machine design, asserting that such a focus on technology does not support human cognitive processes; rather, it hinders and disrupts them. Landauer identified two phases of technology implementation: the first is automation, and the second is augmentation. At the augmentation stage multimedia learning technologies are developed as computer systems are intended to augment human abilities to learn new things (Mayer, 2020, pp. 13–14).

If the goal of creating a cross-media textbook is to assist students in the learning process, then, according to Mayer, research questions should focus on the relationship between design advantages or features and information processing. The most productive research question in this area would be: "How can we adapt multimedia to enhance human learning?" (Mayer, 2020, p. 13).

Another goal lies in the realm of communication. The hybrid format of the cross-media publishing project facilitates a smoother transition in the roles of teachers and students. While participants in the learning process continue to use the familiar artefact – the printed book – electronic content can gradually take on the role of immersing participants in more active communication interactions, thereby enhancing cognitive processes and aiding in the construction of individual knowledge.

The cross-media textbook presents knowledge in various multimedia formats. It is no longer just a presentation of information through the author's lens, but an opportunity to reconstruct an event, reproduce direct speech, and illustrate the actual course of a chemical or physical process. Such representations of facts encourage students to engage in more discussions with their peers, express their opinions, and stimulate their imagination. They aim to create favorable conditions for communication during lessons: "The learner is given a more active role in processing the content by making their own representations together with peers and not just remembering facts individually" (Kempe & Grönlund, 2019, as cited in Selander and Skjelbred, 2004; Selander and Kress, 2010; Ellis et al., 2011).

Conclusions

Changing the main product for the educational process affects the connections and roles of social actors within the social communication environment. With the advent of electronic applications as a mandatory component of printed textbooks, the approach to representing knowledge is changing, as are the roles of participants in the educational process and their activities concerning the new product and the anticipated effects of the socio-communicative product.

Studying the phenomenon of collaborative digital textbooks in Sweden, researchers noted that "transforming the traditional printed textbook into a collaborative digital textbook consequently

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involves much more than a simple renaming of a signifier; it involves a reinterpretation of meaning, functions in school and the future but these questions are seldom addressed concerning cDTB in the literature that we found" (Kempe & Grönlund, 2019, as cited in Horsley and Martin, 2015; Rodríguez et al., 2015).

A comparison between two models of communication in textbooks – monomedia print and cross-media – highlights the increasing role of intermediaries in the transmission of information within cross-media production. A printed textbook with an electronic supplement also becomes communicationally tied to the end consumer, providing the publisher with additional tools to influence them. The emergence of a cross-media product generally makes the publisher visible in the market.

Digital products create technological incentives for the audience. By downloading an app that includes all the textbooks from a single publisher, consumers have more motivation to choose that provider. Digital communication erases time boundaries and weakens the barrier effect of channels, thereby shortening the distance between the publisher and children, parents, and teachers, making the relationship more synchronous. Even the ability to switch from the app's electronic content to the publisher's website with a single click increases the potential for building a stronger publisher brand and improving its positioning in the eyes of the audience.

The possibilities of digital formats and electronic channels of information delivery allow authors and publishers to present knowledge in textbooks in a mosaic-like manner, reducing the one-dimensionality of information interpretation. The digital environment serves as a powerful formative factor: an author's story can be transformed into video, audio, animations, a comic strip, or a game, thereby changing the author's communication message and intended media effects in accordance with the publisher's vision and the audience's needs.

However, with the diversity of media formats for presenting content, it is essential to apply a learner-centered approach and utilize them to maintain a beneficial cognitive load while minimizing unnecessary burden. The choice of a specific content format should be justified by the task the author sets in each block of information. Employees of publishing organizations, and editors in particular, can guide authors in choosing appropriate forms of knowledge representation in textbooks.

The technical characteristics of devices and the choice of technology for presenting information in electronic applications influence the form and content of a cross-media publication. Software requirements must align with the publication's desired communication objectives.

The concept of a cross-media educational product depends more on the requests and reactions of children, parents, and teachers than that of a traditional paper textbook. In the field of cross-media communication, the child's role as a recipient becomes more pronounced. Through electronic technologies, publishers can receive direct feedback from students and analyze their behavior patterns. At the same time, the development of requirements and methodologies for evaluating textbooks with electronic applications should take into account the concept of knowledge construction by students as embedded in multimedia technologies.

The changes outlined in the structure of social communications within educational publishing serve as a fundamental prerequisite for addressing practical questions related to the development of electronic applications for textbooks. To create a system for evaluating cross-media products and methodologies for training teachers and publishing editors, it is necessary to understand the object of social communication – its structure, functions, interrelationships, and impact on communication participants.

Declaration of generative artificial intelligence and technologies using artificial intelligence in the writing process. During the preparation of this article, the author used AI tools only as aids in preparing the manuscript, in particular for checking grammar and style — Grammarly, translating individual formulations into English — DeepL.

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