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Are Open Textbooks Effective for Learning? Investigating the Issue of Human-computer Interaction in Pedagogical Design of Open Textbook Affordable for a Diversity of Learning Environments

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Abstract. This article discusses the impact of human-computer interaction in the pedagogical design of open textbooks affordable into a diversity of learning environments. An exploratory study is conducted, wherein an online questionnaire is administered to the second-year master's degree students from the Faculty of Psychology and Educational Studies. The results show that students are aware of the importance of metacognition in developing effective learning strategies. Thus, they use metacognitive strategies when taking notes, doing reflections, and employing mnemonics to enhance understanding. However, despite the current practice of using open didactical materials, students feel that the open textbooks approach needs to be relooked and changed to be more effective; it could be equipped with appropriate learning tools to provide more opportunities for immediate feedback and collaborative assessment. Individualization and collaboration are the key factors in developing metacognitive experience. These findings indicate that students are cognizant of the important role of open textbooks in promoting learning.

1. Introduction

Education today takes place in triple modalities: formal, informal, and non-formal. In various learning environments, different textbooks are used (e.g. printed textbooks, digital textbooks, open textbooks). Thus, it is expected that printed textbooks will become obsolete while the open alternatives will gradually replace them. Delimont et al. noted that university students and faculty members have positive perceptions towards initiatives of replacing traditional textbooks [1]. This could be because the open textbook design can depict reality better and that digital content might be personalized according to



students' motivation to learn. One could observe that the content of open textbooks presents the opinions of the teacher(s), and are "personalized" according to teachers' understands of learning.

Currently, there is much interest in the development of personalized learning environments. Such environments focus on the flexible adaptation of content to suit learners' requirements, preferences, knowledge, interests, and skills. In practice, personalization entails a new approach to digital education that refers to what extent pedagogy influences the personalized format. The underlying concept of the personalized environments is metacognition, which refers to "cognitive factors that are involved in monitoring, controlling, and interpreting one's thinking" [2].

We aim to investigate the impact of the usage of open textbooks and their transformative potential for better learning outcomes. For this, it was formulated the research question: *What are the correlations between metacognition and pedagogical design of open textbooks?* The idea is to prove the importance of increasing intrinsic motivation in learning with open textbooks through understanding the role of the human-computer component in the pedagogical design and the correlation between metacognition and affordability of open textbooks design.

2. Conceptual Framework

If learning outcomes are formulated as statements representing what students learn during lessons, then this would produce a tiny footpath for the pedagogical design of the successful didactic process (to understand concepts or/and to develop new skills). In our opinion to attain guaranteed learning outcomes, the impact of students' metacognitive skills on learning outcomes cannot be neglected. Within this conceptual framework, metacognition represents a complex epistemological construct – "an assumption of a person's thoughts about his thoughts which include metacognitive knowledge (one's awareness of what he knows), metacognitive skills (one's awareness of something he does), and metacognitive experiences (one's awareness of cognitive abilities it has)" [3].

Open textbooks are developed individually or collaboratively. They are available free of charge online under a Creative Commons License, and thus accessible to many people. Although open textbooks are connected to a large number of platforms, repositories, and environments, they are not associated with the metacognitive knowledge, skills, or experience of the student. However, the interaction between humans, both teachers and students remain an open question for interdisciplinary research. The classical formula is that open textbooks are, first of all, a source of knowledge, developed as a global fashion in digital technologies for education rather than the suite the cognitive needs of students. As such, the need to cater to the needs in the development of cognitive skills through the classical pedagogical design of open textbooks may not be adequately addressed.

Over the last few decades, the infusion of computers in schools has led to the emergence of digitalized forms of printed textbooks through which the content becomes freely available to everybody. Despite the earlier fear of the diminishing role of textbooks, the demand for open textbooks is on the rise. The "openness" movement has not yet replaced the textbook, as predicted; rather, it would appear that the level of interest and activity in promoting open textbooks are gaining momentum [4]. Various countries are adopting the initiative of openness in higher education. With increasing efforts to embrace a novel pedagogical design of open textbooks, we should not lose sight of the risk of merely replacing an old technology (print textbooks) with an innovation (open digital textbooks) without fundamentally questioning the affordability of open textbooks. As was noted by Hilton III and Laman, the open textbooks promise benefits, but their efficacy remains largely untested [5]. Similar concerns raised by Wiley, Hilton III, Ellington, and Hall' study who wrote that "no existing research empirically validates the arguments that (1) open educational resources can save K–12 public schools money; or (2) that open educational resources can promote deeper learning for students in K–12 public schools" [6].

The idea of a novel pedagogical design of the open textbooks can be materialized in the 5R model of open educational resources (Retain, Reuse, Revise, Remix and Redistribute), as mentioned by DeRosa and Robison [7]. However, this model requires the following cross – principles: self-regulation, personalization, feedback diversity, clarity, dynamism and flexibility, and ergonomics. Thus, the instructional designer needs to consider not only the reading capacity of the student but also, how

students learn, think, and what strategies use for successful learning. The first idea was to summarize the specific features of the existing open textbooks. The problem is that using this way is less suitable for metacognition. To illustrate this point, the differences between the open and traditional textbooks are analyzed, starting from dynamic electronic textbooks, which is “an enhanced version of a PDF version of a printed book” [8]. However, open textbooks require a digital learning environment.

There are multiple advantages to reading digitally. The biggest issue is reading comprehension (the process of making the text meaningful). In the opinion of Fesel, Segers, and Verhoeven, hypertexts are not more difficult for children than linear-digital texts; similar individual factors predict that comprehension of reading a linear text and hypertext and a graphical overview increases when prior knowledge is low [9]. As noted by Pitt, open textbooks have a positive impact on both educators and students [10]. Nevertheless, these studies investigate the textbook design from the perspectives of digital technology affordability. In our opinion, the design of open textbooks could be improved, if the content will include metacognitive tasks. The conceptual framework of open textbooks is presented in Figure 1.

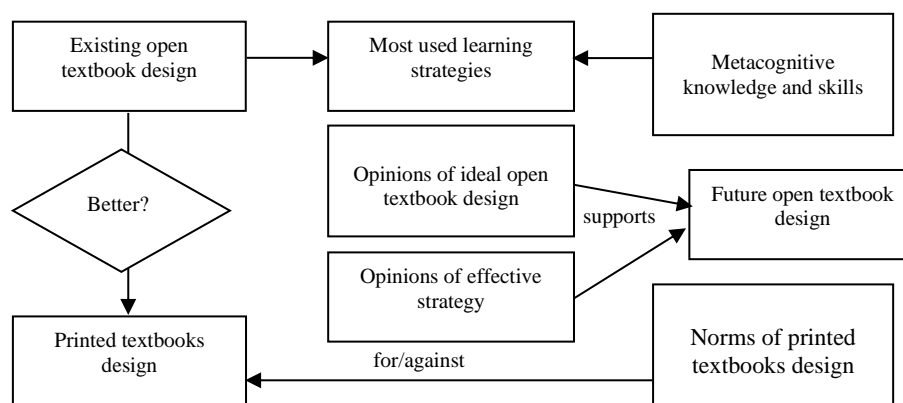


Figure 1. Conceptual framework of the open textbooks design research.

3. Research Methodology

3.1. Research Design

The cross-sectional survey design method is adopted for the study. This design enables a large amount of data to be gathered at one time and provides an opportunity for eliciting a greater understanding of the phenomenon under study, which in this case are the opinions of students regarding the efficiency of learning from the open textbooks and their future affordability. In this study, the students' experience of metacognition is the dependent variable, which is manipulated by us to understand future trends in the pedagogical design of open textbooks.

3.2. Participants

The participants are second-year master's program students in Psychology and Educational Studies. A data set is made up of 20-50-year-old students. Before the pedagogical experiment, students had undergone an “*Educational psychology*” course via face-to-face and online activities, then students completed the questionnaire. To avoid the confusion regarding the homogeneity/heterogeneity of respondents investigated, information related to the study, namely age, gender, background, and technology expertise were gathered. All of them are familiar with open textbooks.

3.3. Research Instrument: Online Questionnaire

It was decided to develop an online survey to explore students' opinions regarding the correlation between open textbooks design and metacognition norms. Questions consist of open and closed types at different levels of abstraction. All types of questions are included to obtain valuable contributions.

The online questionnaire consists of sixteen closed-ended questions and one open-ended question. Two questions require the ranking of specific characteristics. A consistent Likert type rating scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was designed. The language and the basic notions are familiar to the participants. However, not all students have strong previous knowledge of metacognition. To avoid confusion, some definitions are provided within the content. The sequencing of questions follows a logical flow from simple to complex. Questionnaire items and the associated research questions are given in Table 1. The reliability estimate obtained for the questionnaire was $\text{Alpha}=0.44$, based on the Cronbach Alpha method.

Table 1. Research questions and associated questionnaire items.

Research questions	Questionnaire items	Response format
What are the best strategies used by students when they learn with open textbooks?	(a) <i>What is the most-used strategy in online learning used by students?</i> (b) <i>What is the most effective learning strategy for reading an open textbook?</i> (c) <i>What is the most effective way to learn?</i> (d) <i>What are the differences between cognitive and reflective activities in the open textbook content?</i>	Select from the given alternatives (unique selection)
What are the correlations between metacognition and the design of a collaborative learning environment?	(a) <i>Is it possible to improve the metacognitive experience in learning with open textbooks?</i> (b) <i>How can metacognitive experience be aligned with oral and written communication, problem-solving, attention, memory, and self-instruction?</i> (c) <i>What types of collaborative methods enabled us to develop metacognitive skills?</i>	Yes/no questions Select from the given alternatives (unique selection) Likert type scale
What are the requirements for the innovative pedagogical design of open textbooks?	(a) <i>Is it possible to replace printed textbooks with open textbooks?</i> (b) <i>What is the most evident difference between cognitive and metacognitive task design?</i> (c) <i>How correct is the following statement "For effective learning, the environment offers synchronous and asynchronous communication tools, digital tools for taking notes and writing individual and collective journals?"</i> (d) <i>How can the technique of strategic questions improve the content of open textbooks?</i> (e) <i>What are the contributions of the digital manual to the theory and methodology of metacognition?</i>	Likert type scale Select from the given alternatives (unique selection) Likert type scale Likert type scale Open question

3.4. Research Procedure

Students received didactic materials through face-to-face courses. Then, they learned individually using university textbooks and presented their projects within practical activities. In the last activity, students received the link to an online survey and completed it online. The whole procedure is depicted in Figure 2. This procedure allows gathering data, analyzing, and classifying the students' opinions. The statistical treatment is applied and conclusions are developed. Responses are statistically analyzed with the research questions requirements of the study.

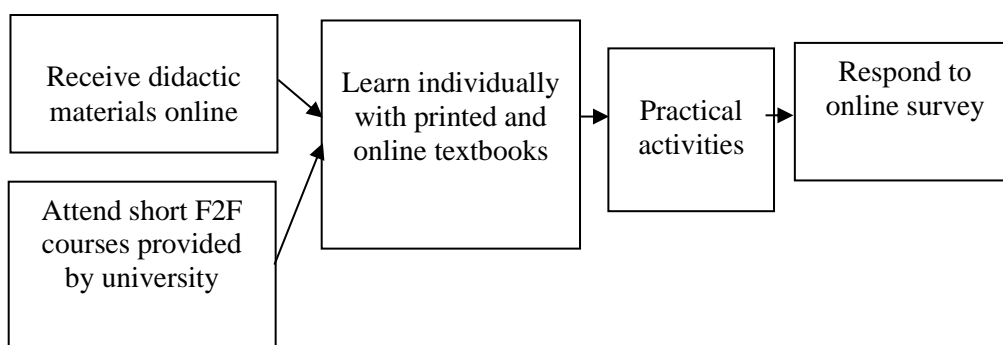


Figure 2. Research procedure

4. Results

This section presents the results obtained on established research questions focused on understanding correlations between metacognition and the pedagogical design of open textbooks.

4.1. Strategies Used by Students to Interact with an Open Textbook

Hybrid forms of education enable participants to choose various pedagogical strategies and to think about the better strategies for their learning. It was proposed the following question: What strategy do you frequently use in distance learning? Students were asked to choose from the following: online lectures, case study, group discussion, active learning, cooperative learning, the flipped classroom, attending the seminars, and the intensive reading of bibliographic volumes. The distribution of responses to strategies used by students frequently is shown in Table 2.

Table 2. Strategies often used by students in distance learning.

Strategies frequently used	Percentage
online lectures	33.4 %
active learning	26.7 %
group discussion	10.7 %;
case study	9.3 %
flipped classroom	9.3 %
cooperative learning	8.01 %
attending the seminars	1.3 %
intensive reading of bibliographic volumes	1.3 %

Table 2 indicates that most students (33.4%) prefer online lectures. As a pedagogic strategy, the online lectures rely primarily on “asynchronous communication to deliver the course information to the students” [11]. Online lecture may include links to open interactive textbooks or open versions of textbooks. However, in online lectures, students prefer active learning methods (26.7%).

Active learning refers to any instructional method that engages students in learning, requires students to perform meaningful learning activities and the students must think about what they are doing. It encompasses a wide range of activities, such as reading comprehensively, problem-solving, collaborative writing, decision-making, and strategic teaching. In all these methods, open textbooks are used. However, students must have metacognitive skills to learn from open textbooks. Regarding the methodology, students choose a case study, group discussion, flipped learning, and cooperative learning.

It was observed a strong correlation between used metacognitive strategies, intrinsic motivation, and open textbooks affordability. For example, students prefer to work in small groups to discover the meaning of provided content and create new digital pages through consensus. This goes to show the

relevance of innovative open textbooks pedagogical design to the current learning practices; thus, there is a need for further research into open textbooks affordability from the perspectives of students' skills.

4.2. Students' Opinions of the Most Effective Learning Strategies for Reading Open Textbooks

Learning from open textbook content requires to use of metacognitive/reflective thinking strategies. To determine if students are using such strategies, we pose the following question: "*Just imagine you are reading an open interactive version of an educational psychology textbook. After reading a chapter, what is the first thing that you will do?*" Students have to choose only one answer out of five alternatives: a) I will read the content again; b) I will review the content and I will take notes; c) I will reflect on the questions and discuss the main points with colleagues; d) I will develop a concept map and e) Other. Table 3 shows the distribution of responses.

Table 3. Distribution of responses to reflective strategies used after reading open textbooks.

Reflective Strategies frequently used after reading an open textbook	Percentage
a) I will read the content again	9.4 %
b) I will review the content and I will take notes	37.5%
c) I will reflect on the questions and discuss the main points with colleagues	25%
d) I will develop a concept map	21.9%
e) Other	6.2%

The survey pieces of evidence that most of the students choose to review the studied content and take notes. Making notes is a good learning strategy as it helps in encoding information. Reviewing the notes can further enhance the learning gained. A relatively high number of students have reported that they reflect on the studied content; discuss the main points with colleagues. The low number of students using concept mapping is perplexing, although studies have shown that it is a good metacognitive strategy. Is it because the students do not know how to do concept mapping as a mnemonic technique or because they do not believe in it? This point can be taken for further studies.

An interesting result emerges from "other"; 21.9% have reported about a mnemonic scheme. The effective use of mnemonics in university education has been debated in the scientific literature [12]. Students are aware of the effectiveness of the technique, which is part of the metacognitive strategy; this indicates their conscious application of metacognitive knowledge and skills. The study also shows that few students use the rereading strategy (9.4%), which has been shown in previous studies to be a poor learning strategy [13]. Avoiding rereading strategy indicates that students are aware of the varying effectiveness of the open textbook learning strategies. Students are aware of metacognition; they are also aware of knowledge about when and how to use metacognitive strategies most effectively.

4.3. Students' Opinions of the Most Effective Way to Learn

To understand the most important learning strategies perceived by students, we have decided to ask the question: What is, in your opinion, the most effective way to learn? They have to choose from the following alternatives: a) having been taught adequate content; b) knowing the methods and techniques of learning; c) developing attitudes toward personal knowledge and skills; d) using generalizations and conclusions; e) self-assessment of a priori knowledge; f) visualization of learning paths, and g) others. The distribution of responses is shown in Table 4.

Table 4. A most effective way to learn as reported by students.

Ways to learn	Percentage
a) having been taught adequate content	28.1%
b) knowing the methods and techniques of learning	28.1%
c) developing attitudes toward personal knowledge, skills, and attitudes	3.1%
d) using generalizations and conclusions	15.6%
e) self-assessment of a priori knowledge	9.4%
f) visualization of learning paths and	9.4%
g) others	6.3%

The results show that most students choose options a) and b) with the same frequency (28.1%). The best credit is given to “having been taught adequate content”. This is a significant result as we can infer from it that students are aware of the significance of metacognitive strategies for learning. Only a small number of students (9.4%) consider the visualization of learning paths; this fact probably explains why they do not use concept mapping in the first place. They prefer to use mnemonic techniques for learning, which is associated with learning preferences and intellectual competence. For example, those with high spatial intelligence may appreciate concept mapping, while those with high linguistic intelligence appreciate mnemonics. Furthermore, concept mapping is associated with critical thinking [14].

4.4. Correlations Between Students’ Metacognitive Skills and Learning Design

To provide evidence for improving the current policies toward accepting the importance of metacognition and successful learning strategies, we ask students about their perceptions of the current practices in acceptance of metacognitive strategies in learning. The students’ opinions on the efficacy of existing education policies and understanding of the role of metacognition are shown in table 5.

Table 5. Students’ rating on the efficacy of university education in promoting metacognition.

Statement/question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
University policies promotes metacognition	32.3%	35.5%	19,4%	9.7%	3,2%
Do you agree that metacognition contributes to understanding the oral and written message, problem-solving and complex tasks, attention training, memory, and self-control?	32.3%	35.5%	19,4%	9.7%	3,2%

Students feel that university initiatives and innovative pedagogic design help them to develop metacognitive knowledge and metacognitive skills.

4.5. Student’s Opinion on The Alignment of Metacognition with Oral and Written Communication, Problem-Solving, Attention, Memory, and Self-Instruction

To assess students’ opinions regarding the development of metacognitive strategies through written communication a question is posed: “Do you agree that metacognition contributes to understanding the oral and written message, problem-solving and complex tasks, attention training, memory, and self-control?” From Table 5, it is shown that a large percentage of students, nearly 70% (32.3 plus 35.5%) agree that applying metacognitive strategies in university education contributes to a better understanding of the oral and written messages, problem-solving and decision-making on complex tasks, improving

attention, and memory and self-assessment skills. The finding indicates that students are aware of the importance of metacognition, which means that they have knowledge of metacognition and are using metacognitive strategies to improve their learning.

4.6. Students' Opinion on The Effectiveness of Methods in Developing Metacognitive Skills

According to Midoro, a learning environment is a place or community in which several activities occur to support learning; where relevant actors can draw upon some resources when performing these activities [15]. A learning environment can be real or virtual, collaborative or individual, adaptive or dynamic, and so on. To assess students' opinions on the efficacy of collaborative methods in developing metacognition, they are presented with the following question: *The most commonly used definition of metacognition is "Thinking about own thinking". Do you think virtual collaborative learning methods are developing this idea?* Students are asked to give a yes/no response.

Most students (80.6%) agree that a collaborative environment is better to develop metacognitive competencies, while only a small percentage of them disagree (19.4%). Therefore, we can infer that in a collaborative learning environment, students can monitor their cognition and evaluate the efficiency of the monitoring processes and strategies, which can be achieved through "awareness of comprehension and task performance" [16]. Overall, students feel that the existing policies are supportive of the development of metacognition. Students also believe that metacognition is important in promoting effective written communication, problem-solving, attention, memory, and self-instruction; and that a virtual collaborative environment can support the development of metacognition.

5. Design Requirements for Future Open Textbooks

Since students interact extensively with open textbooks and have a very positive perception towards the efficacy of open textbooks in promoting metacognition, it is important to further enhance the design of open textbooks so that it meets students' learning needs. The following sections discuss the characteristics of a good open textbook design as suggested by students.

5.1. Students' Opinion on the Characteristics of Open Textbooks That Promote Metacognition

It is indisputable that reflective practice for learning with open textbooks should and can be improved. An especially pedagogical designed open textbook can be considered an effective tool for the development of metacognitive skills. To investigate this issue, we ask students: *How can an open textbook be defined that will contribute to the development of reflective skills?* Students select one of the following options:

- an open version of the printed textbook;
- an interactive pattern with a learning analytics tool;
- a tool for self-instruction that allows generalizing the studied concepts;
- a specially designed content to understand complex processes;
- an interactive textbook that allows completing the knowledge gaps.

According to students' opinions, an open textbook that aims to develop reflective skills is not an open version of a printed textbook. The more important answer, as concluded by 38.7 % of the students, is a tool for teaching/learning/assessment with the possibility of generalizing ideas and drawing conclusions about what was learned. In second place (29%) is the interactive content with learning analytics tool. Students consider it less important to learn with a specially designed textbook that aims to understand patterns, phenomena, and complex processes (22.6%). This result indicates that the learning profile of the students should be a consideration when designing an open textbook. In our study, students are from the social science discipline (enrolled in the educational psychology program) and not from the pure sciences. It is observed that a very small percentage of students (9.7%) choose the option of an interactive textbook that allows completing the knowledge gaps. This lack of preference for such a design is consistent with strategies reported earlier by students; most of them prefer "having been taught adequate content". Thus, there should not be knowledge gaps; thus, this explains the lack of preference for "an interactive textbook that allows completing the knowledge gaps".

5.2. Students' Opinions on The Possibility of Replacing Current Textbooks with Open Textbooks

One of the most interesting questions of the survey is the possibility of replacing printed textbooks with open versions. According to students' answers, open textbooks will replace printed textbooks shortly (81.3% of the participants agree with this idea versus 15.6% who oppose). This finding is proven by various projects that aim to implement open textbooks in university education.

The climate of open textbooks learning is favorable due to two big global factors:

- most of the universities have educational platforms;
- students prefer to seek the newest information and technologies online.

All around, open textbooks allow students to gain knowledge by using the newest educational methodologies and technologies; they are cheaper, easy to use, and well suited to the current generation of learners. Moreover, open textbooks offer a unique opportunity to design a personalized learning environment, which may be individual, collaborative, and flipped.

From our point of view, for the design of a personalized learning environment, there must be special options for synchronous and asynchronous communication. According to students' opinions, as provided as answers to an open-ended question, the pedagogical design of open textbooks covers an interface for knowledge and tools for exercising the theoretical knowledge. Moreover, the design of the open textbook should include an option for generalizing the core concepts and conclusions. Students state that open textbooks can enhance learning in many ways, particularly through concise, and clear content; many examples, attractive drawings, case studies, and problem-solving exercises with intelligent hints. Besides, students note that digital content should accomplish the intelligence of learners. Nevertheless, open textbooks developed within the traditional curriculum will likely be a barrier to the effective development of metacognitive skills.

5.3. Students' Opinions on Differences Between Tasks Designed for Various Activities

What is the main difference between cognitive and reflective activities in learning with open textbooks in terms of learning design, didactical model, or didactic design? The provided answers can be divided into two main categories. Specifically, 45.2% of the students agree that the main difference is in the learning design; but 41.9% of them believe that in the didactic design. Only 12.5% of them note that the didactic model of open textbooks is important. This question refers to the correlation between the open textbook design and the impact of metacognition on learning theory. Based on the findings, the existing open textbook design is perceived by students to be inadequate in promoting effective human-computer interactions; and thus, the open textbook pedagogical design needs to be reconfigured. Therefore, open textbooks may be considered an important component in the all-inclusive portfolio.

5.4. The Importance of The Strategic Questions in Human-Computer Interaction

One of the interesting questions in the open textbook design is the strategic element in the content. An example of the strategic question is this: *What can I do to achieve the learning goal?* We ask the students to what extent they agree with the following statement: For the development of metacognitive knowledge, it is important to follow the technique of the strategic questions.

The explanation is provided. The technique of strategic question consists of the presentation of a list of options focused on the instrumentalization of metacognitive planning, assessment, and monitoring. It is expected that students would strongly agree with this statement. The results are a surprise to us as the percentage of students who agree and disagree is the same; 37.5% of students agree that strategic questions may be included in the content, while 37.5% of them do not agree with this statement. This result aligns well with the holistic sustainability approach and previous responses: students prefer to have been taught adequate content first, noted as the most favored teaching method.

5.5. The Contribution of An Open Textbook on Theory and Methodology of Metacognition

We agree that open textbooks may include tools for reflective thinking. We have decided to ask our students about this idea through a question: *What is, in your opinion, the contribution of open textbooks technology on theory and methodology of metacognition?* Most of the students (48.4%) indicate that

open textbooks should include the techniques for developing metacognitive knowledge and experience (skills); 38.7% of them consider learning with open textbooks; it is better to present the multimodal content interactively. Nevertheless, only 29% of the students consider the ‘personalized’ content to be important for learning; 19.4% of them highlight the effectiveness of learning analytics, and 16.1% of them highlight the importance of tools for diagnosing metacognitive knowledge.

On the one hand, the above-mentioned data indicate that the content of open textbooks may include concept mapping, interactive problem-solving, and other interactive techniques. These skills may improve reflective practice and therefore, lead to an increase in personal effectiveness. On the other hand, the students require “learning to learn” algorithms. However, there are “two levels of learning: a meta-level and a base-level” [17]. In general, the base-level learning refers to supervised learning and the meta-level to metacognition. In an intelligent computer program, any algorithms that learn how to learn must possess bias (at both levels). Bias at the meta-level constitutes a priori assumptions concerning the relation of individual data points. There are no best algorithms either for learning or for learning how to learn situations, but the key to learning to learn is representation.

People learn better by reflecting on their understanding of content and comparing it with reality. Starting from research [18], we can associate metacognition with developing higher-order thinking skills through fostering reflective tasks in an open learning environment. Therefore, metacognition is fluted by the approach that reflective thinking is opposed to static memorization and that the development of the metacognitive knowledge, skills, and experience cannot be separated from the pedagogical design of the open content. From this point of view, the content of the open textbooks may serve as an important platform for thinking regarding an affordable metacognitive theory.

6. Summary and Discussion

The student's most preferred answers regarding the relationship between metacognition and pedagogical design of open textbooks are summarized in Figure 3. It can be seen that online lectures, active learning, and collaborative environment are among the most important strategies in distance education, leading to open textbook utilization and the development of metacognitive skills.

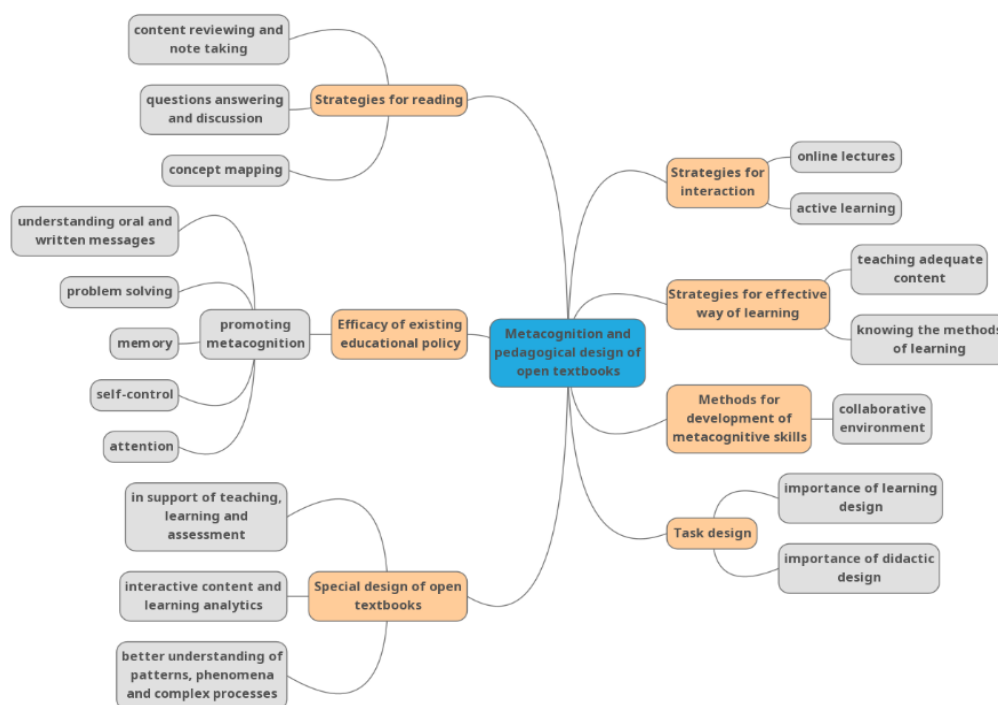


Figure 3. The students’ most preferred answers in terms of concept mapping.

The way of learning depends on the content, prepared by teachers, and students' knowledge about the methods of learning. The preferred strategies for content reading and evolving the metacognition are related to content reviewing and note-taking, answering questions, and participation in discussion, concept mapping. The students' tasks should be designed carefully taking into account the theories of learning design and didactic design. Also, the design of an open textbook differs from a print textbook in several ways: incorporation of interactive content and learning analytics tools as well as usage of techniques for better understanding the patterns, phenomena, and complex processes to support teaching/learning and assessment. Metacognition and pedagogical design of open textbooks are influenced by the efficacy of existing educational policy that promotes metacognitive skills development through decision making, problem-solving, and self-assessment.

The overall effect of using open textbooks in university education is positive. Through the analysis of the results of an online survey, we found that the design of open textbooks correlates with metacognition in two ways: reproductive learning and self-regulated learning. This finding is similar to that of previous studies by Hilton [19]. In this study, it is found that the design of a textbook is associated with the way readers approach their learning (i.e. the students generally achieve the same learning outcomes and they are positive regarding open textbooks). However, regarding the study results of Bushway and Flower, students are motivated to read when they are quizzed on the material, and their overall performance in the class improves [20]. The quiz is an important element of a textbook design but quizzes alone are not sufficient for an effective open textbook design; other elements are necessary. Our funding indicates that digital content needs to include tasks with immediate feedback and knowledge representation. This could be done in practice, in the case when learning objectives will be focused on metacognition. Although students like online lectures, they prefer active learning.

Prioritization of the active learning methodology opens a novel research area related to the affordable design of open textbooks, based on development of critical thinking and problem-solving skills. More research is needed to develop the model of reflective learning in the content of open textbooks. One thing is clear: in designing digital content, we need to think about student's needs and the context in which learning occurs. We estimate that the effect of such usage is greater for open textbooks than for printed textbooks. Open textbooks may include features, which contribute to a better understanding of topic. These features may be able to enhance the synergetic effect of self-regulated learning.

It is pertinent to note that the current or estimated features of open textbooks are not sufficient conditions to guarantee good learning outcomes. Future pedagogy must find the key to integrating open textbooks with metacognitive strategies, and creatively match the potential of open textbooks with the requirements of the Open Era and Global Sustainable Development Agenda. In turn, open textbooks will best highlight the synergetic effect, as observed after the adoption of dynamic and flexible instructional strategies and reveal the limitations of the open textbooks in sustainable education.

7. Conclusion and Future Research

Education today is not about opened textbooks, more than anything it is about the creation of competencies as opportunities for life-long learning construction of meaning [21]. People want to learn the easiest way, saving energy for effective problem solving and decision-making. Moreover, the human brain interprets printed and multimodal open messages differently. Research has shown that people generally read open text 20% - 30% slower than print. Thus, more important than reading is the personalization of content through the development of metacognitive knowledge and experience.

It takes time before a new behavior becomes innate in away. There is a stringent need to educate students to develop a deep background that goes further than the mere knowledge of ideas and schemata. Knowledge, or rather a state of being, able to overcome prejudices and misleading beliefs, also acts in the way a problem is faced and experienced. Thus, education is about a new technology of learning. It appears that students prefer open textbooks to replace printed textbooks shortly. The conducted survey allows us to identify the importance of metacognition on open textbook design. The combined focus on open learning and metacognition requires more knowledge about the correlation between textbook

design and students' skills in the open environment compared with traditional paper-based learning. The finding from this study is noteworthy as it represents higher education learners' voices and perspectives to inform instructional designers on the issue of the affordable pedagogical open textbook design.

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