
**Introducing technological pedagogical content design: A
model for transforming knowledge into practice**

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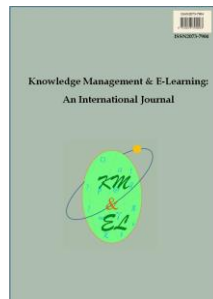
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Introducing technological pedagogical content design: A model for transforming knowledge into practice

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Abstract: With the extraordinary growth of both mis- and disinformation, it has become even more vital to prepare content to provide accurate information so that users receive concepts correctly. With the spread of the Internet and the Web 2.0, websites are responsible for publishing information. While most attention is on the advanced technology and graphics to attract users, many studies have indicated that users are not satisfied with the content of many websites. Hence, this paper introduces Technological Pedagogical Content Design (TPCD) model for explaining the concept of integration of pedagogy into content and technology. Further, practical instruction of using the TPCD model for designing digital services, especially websites is suggested. TPCD has fundamentally employed the concept of the Technological Pedagogical Content Knowledge (TPACK), which is a well-known framework in the field of teacher education to increase the teachers' knowledge for integrating technology into teaching and learning. However, TPCD transforms TPC Knowledge into TPC Design as practice by integrating pedagogy into technology design in a broader context. TPCD uses human science findings to design a user-centered website with a pedagogical perspective for creating, selecting, and organizing content. Given the speed and variety of technology capabilities and the increasing content volume, TPCD helps designers identify target objectives, based on true users' demands, and select appropriate content and suitable technological tools to increase desirability, usability, accessibility, and findability of information. Further, technical research on TPCD may open perspectives for developing a learning content management system for educational and other digital services.

Keywords: TPCD model; Website designing; Web-centered design; Pedagogical integration; Accuracy

Biographical notes: Zahra Hosseini has 20 years of teaching and research

experience as an assistant professor at the Islamic Azad University in Tehran-Iran. She holds a Ph.D. in Educational Technology and specializes in TPACK. She has written extensively on the development of TPACK through a variety of approaches (e.g., project-based learning and direct learning). Hosseini has recently been transforming TPACK into a design model as TPCD and extending it to non-educational environments that open pedagogical insights in information technology to user-centric design. She offers guidance and counselling to website owners and designers in designing or redesigning their websites.

Kimmo Hytönen is an owner and partner of companies developing computer aided control of heavy machinery, human-machine interfaces, Software as Service products and related consulting. He has 30 years of experience in the materials handling business. He has several patents related to materials handling control systems. He is interested in development of services and control systems utilizing TPC in the design process of new systems and services and in analyzing and improving existing ones.

Jani Kinnunen is a researcher at Åbo Akademi University on information systems and economics. He has published about 90 peer-reviewed journal and conference papers. His research interests include broad applications using econometric and machine learning solutions to various areas, such as economics, public policy, and investment analysis, and related decision support systems.

1. Introduction

In the current digital age people receive most information from digital services. Websites are usually responsible for transferring correct information. Therefore, many studies have attempted to define the important factors affecting the quality of websites (Li et al., 2017; Mohseni et al., 2018; Giao et al., 2020; Garrett et al., 2016). However, studies have also shown that social media is a powerful source of information (Kim et al. 2014; Westerman et al., 2014; Bontcheva et al., 2013; Hosseini et al., 2020) although because of the lack of visibility and validity of unknown authors, they may spread misinformation and disinformation throughout the world. This is also a security issue as searching the information through search engines may lead users to some paid and biased information and not original websites. Altogether, there are the good reasons to search for the key criteria to enhance the quality of websites in the different areas of e-commerce and business websites such as shopping websites (Kim et al., 2021; Semerádová & Weinlich, 2020), tourism websites (Sanabre et al., 2020; Mohseni et al., 2018; Li et al., 2017), non-economic websites such as matrimonial websites (Sharma et al., 2020), as well as educational websites (Baule, 2020; Bernstein et al., 2021). However, deficiencies in transferring information are reported to emerge from a lack of expected content (Bernstein et al., 2021) or difficulties in finding and reading content regardless of good accessibility and aesthetically pleasing features of web pages (Shao et al., 2020). While the importance of understanding the content in a website design process has been already considered (Rosen & Purinton, 2004), there seems to be a need for practical instructions, which help the web designers, in terms of using technology aspects, organize the content of a website. Therefore, this article addresses the conceptual and practical instructions for integrating pedagogical principles into technology to increase the quality of websites.

On the other hand, due to the importance of understanding the processes in the minds of users to get information and built their attitudes, human-interaction technology has been proposed and it has changed computing science fundamentally. As the result of a recent study has shown the influence of users' attitude on usage and satisfaction of technology (Rupere & Jakovljevic, 2021). Consequently, different models and tools to measure user experience and design user-centered websites, with greater focus on users' characteristics, motivations, and expectations, are developing. Still, some websites, which are expected to be reliable resources for receiving information, are not meeting the minimum expectations of users (Rocha et al., 2017; Abuaddous et al., 2016; Gonçalves et al., 2014). Therefore, this paper by introducing a conceptual and practical model aims to pull attention toward pedagogy as the required knowledge for preparing the content, which is presented on web pages. While integrating technology into pedagogy is a known conception, integrating pedagogy into technology for creating non-educational websites is a rather a novel idea. Using technology for educational purposes has already received attention from web designers.

Considering the technical aspects of available websites indicates that many large organizations have their own programmers to design their websites as unique and purposeful; but to save the budget, most website owners are using the default platforms of Content Management Systems platforms (CMS) such as WordPress, Joomla, Drupal, Wix and customizing them based on their needs. These platforms can offer different facilities for designing templates for organizations and companies to create attractive websites. However, knowledge and content management is still a strategy than a complete tool. Chetty et al. (2021) believes "if knowledge is efficiently and effectively managed, then its full potential is realised through the aligning of knowledge processes with the organisation's overall strategy, thus making it a veritable strategic asset" (p.243). For more than two decades, web designers have designed many educational platforms for e-learning (or blended learning). The platforms are often created through Learning Management System (LMS) environments such as Moodle and SCORM. They have many features of Web 2.0 to establish different features of implemented courses like a real classroom as an attempt to provide the interactive learning environment. The current pandemic has worked as a driver to increase the use and development of different e-learning platforms and systems (Teräs et al., 2020; Kinnunen & Georgescu, 2020, 2021; Kinnunen et al., 2021). While CMS focuses on introducing many templates with fashioned features for different purposes and increasing the ease of use of the platforms, LMS emphasizes how to organize educational activities such as exams and homework by making the learners involved. Due to the diversity of content, these tools may not be sufficient for using technology and organizing content. Therefore, Learning Content Management Systems (LCMS) have been proposed recently. This paper focuses on developing the content on a website and introduces practical instructions that can provide an initial knowledge and practice for development of a Learning Content Management System. In this regard, the conceptual framework of Technological Pedagogical Content Design (TPCD) for website design is considered. TPCD is built on viewing a user as an adult independent learner, who learns information (content) through web pages (technology), and it suggests using affordances of technology to facilitate transferring (learning) the information (content) rather than just receiving attractive pages.

In brief, this paper introduces TPCD as a model for integrating pedagogy into technology as well as technology into pedagogy for transferring a specific content. According to the broad variety in technology, design, and diversity in content, this paper presents TPCD for designing content-based websites. As the first step, manual instructions for designing the content of a website are proposed. However, as a perspective, TPCD has potential to develop the human-interaction technology models

with utilizing user-experience findings. It focuses on content and pedagogical principles and, further, it may develop the concept of the Learning Content Management System (LCMS) as a practice or a digital tool adding value onto both current content management systems (CMS) and learning management systems (LMS). Currently, the authors have progressed with the manual instructions to create a website of a business association in Finland as an actual practice using TPCD model.

2. TPCD foundation

This article introduces the TPC Design as a conceptual and practical model of the TPC knowledge framework and presents the instructions of using TPCD for designing a website. Technological Pedagogical Content Knowledge (TPCK or TPACK) is a theoretical framework, proposed by Mishra and Koehler (2006), that has been defined as the required teachers' knowledge for integrating technology into teaching (Fig. 1). TPACK has been validated in numerous studies. TPACK claims that teaching ICT skills to teachers, as an isolated item from content and pedagogy cannot improve the quality of their teaching and learning. Using technology merely for the sake of using it does not enhance students' learning. Teachers should know how to integrate technology in teaching to enhance learning in the context of each subject matter.

During the last decade, many researchers have applied different approaches for developing TPACK in teacher education programs such as collaborative learning, problem-based learning, project-based learning and directed education (Zhang et al., 2019; Niess, 2018; Hosseini & Tee 2011; Hosseini, 2016; Chai & Koh, 2017; Tanak, 2018). Since developing TPACK varies in the different contents and contexts, it still appears as a complex and complicated process for an operational instruction method or a digital tool. On the other hand, the rapid growth of technology causes that TPACK cannot prescribe a particular technology even for the same content and context. Therefore, some vague confusion about using TPACK in practice has acted as a barrier for innovative researchers.

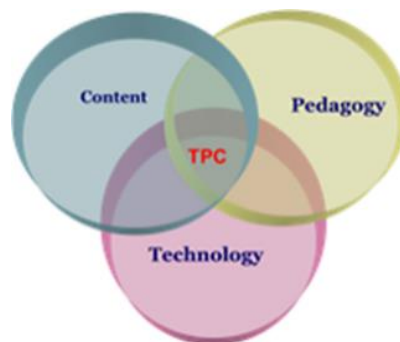


Fig. 1. Technological pedagogical content knowledge. Adapted from Mishra and Koehler (2006)

TPACK is a framework to integrate technology into pedagogy and content and TPCD proposed to integrate pedagogy into content and technology in a broader context which can be suited in educational and non-educational platforms. As the first step, this paper proposes using TPC conception for designing a website. TPC conception for designing the website is standing on three assumptions: (1) some websites are not successful in transferring information to their users; (2) websites have the affordance of

technology for teaching knowledge to the users of websites, who are assumed to be adult self-learners; and (3) the integration of technology to design the content of a website (TPC) facilitates transferring information to the users.

3. TPCD components

TPCD as well as TPACK has three main components and three integrative components. The main components include: (a) technology (b) pedagogy, and (c) content. The integrative components encompass integrating pedagogy into content or Pedagogical Content (PC), integrating technology into content or Technological Content (TC) and integrating technology into pedagogy or Technological Pedagogy (TP) that TPCD expanded and redefined as integrating pedagogy into technology or Pedagogical Technology (PT). While the concepts of technology, pedagogy, and content are familiar to designers, their integration can be complex and ambiguous, especially when the implementation of the design of a technology (like a website) is involved. In this section, the steps of integration of pedagogy into technology, particularly, in website designing are explained.

3.1. Integration of pedagogy into content (PC)

Considering pedagogical principles for creating, selecting, and organizing the content makes it easier for users to understand. Content is a selected part from unlimited information and materials on a topic that is called the source of the content. It may include paragraphs of text, pictures, videos, diagrams, etc. The main criterion for selecting content from the source of knowledge in each subject is the goal. Learning goal is a pedagogical term that defines the expected changes in cognitive or affective domains, or skills of users (learners) after receiving the content. Coordinating and aligning between the goals of the website owner and the users increases the effectiveness of the website. According to pedagogy, contents are created, selected, and organized based on the learning goals that are usually in different levels and domains (Hosseini et al., 2022d). Users have different characteristics, backgrounds, and learning styles, which means that the designer should consider alternative materials in content. Therefore, there is a need to define goals accurately through a goal map. The goals of a topic can be parallel or sequential. Two factors are considered to draw the goal map. The first is the subject structure, which can be linear or non-linear, and the second is how the user may progress, through the content related to the learning function, and reach the goal (Fig. 2).

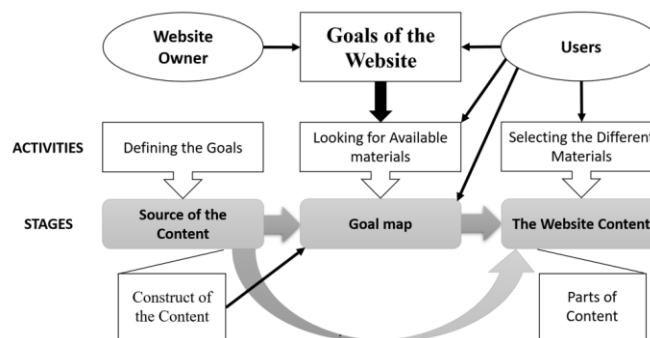


Fig. 2. Conceptual model of integration of pedagogy into content

Pedagogical Content (PC) component helps web designers prepare the meaningful parts of content of which each has a goal which determines what users are expected to know or do.

3.2. Integration of technology into content (TC)

Technology in TPCD to create a website refers to all the text and visual tools available to provide the content. Currently, this technology is mostly used to present content through content management systems (CMSs). However, integrating technology into content has more functions than presenting the content. Technology facilitates the access to unlimited knowledge resources and selecting the existing content and techniques for creating a variety of content such as text, video, audio, etc. In addition, the technology can categorize and organize large volumes of data through which users can easily access them or find them through passive or active participation. Finally, technology is the easiest and the most cost-effective way to get information through web pages. Different CMS programs and platforms are available to deliver content in a variety of alternative ways (Fig. 3).

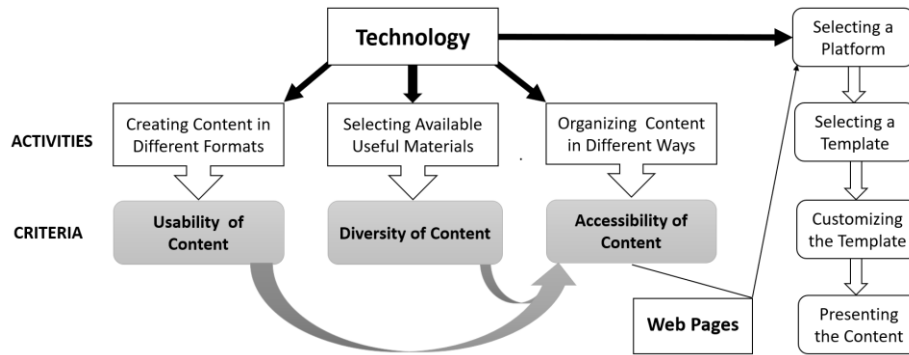


Fig. 3. Conceptual model of integration of technology into content

The most popular management systems (CMSs) are WordPress, Wix, Drupal and Joomla, which are used by many companies, organizations, and individuals to create and design their websites. The site design steps are roughly as follows: (a) Because hiring a program is very expensive for many organizations and companies, most website owners prefer to choose a ready-made platform based on their website goals or budget; (b) Each platform has different ready-made templates that website owners or designers use based on the purpose of the website or content. It can be suitable for news, online shopping, companies, etc. Template design can be minimal or traditional. Each tool has its own pattern variation; (c) There are options for customizing the template. A web designer can make some changes or use add-ons or plugins to change the template. The default content management system templates include menu, page, forms, gallery, and links for presenting the content. Web designers decide how much visual and textual material to provide and by what criteria and methods to link that content together.

3.3. Integration of pedagogy into technology (PT)

The integration of technology in education is a well-known concept in education and refers to how technology is used for teaching and learning processes such as creating or selecting Learning Management Systems (LMSs), the most famous of which is Moodle.

These platforms provide e-learning environments via the Internet. They try to create an interactive environment similar to a real classroom. Further, it can help in the development of various materials or tools for educational purposes. A look at the top learning tools shows that many general tools, which may be used for educational purposes, are defined as learning tools, such as YouTube, Google Search, PowerPoint, Zoom, Teams, etc. Although some of these tools are not for specialized training, they are used for educational purposes so that they are included in the list of top educational tools.

Integrating education into technology refers to the use of pedagogical principles including learning theories, educational psychology, and behavioral sciences to design a digital service to help users receive and understand content in a non-educational environment. (Hosseini & Kinnunen, 2021).

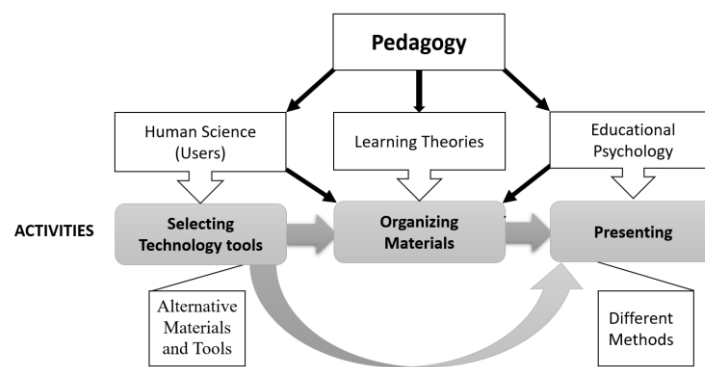


Fig. 4. Conceptual model of integration of pedagogy into technology

Currently, certain areas of educational science, such as human-technology interaction, user experience research, and design are recommended for user-centered design. However, pedagogical integration focuses more on human learning functions in technology design. Pedagogical findings provide knowledge about human beings through the findings of developmental psychology, cognitive development, and they explain how the user receives, communicates, and understands concepts through a digital service or product. Further, the human science helps designers understand needs, expectations, experiences, abilities, culture, learning styles, etc., as well as which materials are right for them. Due to the variety of users on the websites, it is recommended to provide alternative content for different users. Paying attention to the results of learning theories helps designers have a clear picture of human mind in the face of different information and data formats. This can help designers organize content across pages so that users can find it easier, faster, and more efficiently. Presenting content on each page requires knowledge of educational psychology (cf. Fig. 4). Gestalt design principles are examples to guide web designers to use graphic techniques based on mind processing (Hosseini et al., 2022d). Overall, the integration of pedagogical theories and principles increases the usability, usefulness, accessibility, and content of the website for its users.

4. Transforming the TPACK theory into the TPCD practice

Website design based on TPC emphasizes the key concept of TPACK theory that technology is not merely a tool for presenting information, but also facilitates the user's understanding of information. In addition, the attractiveness of the website is not only related to appearance. How it can meet the needs of users' expectations is more

important. This paper uses the TPACK foundation as required knowledge for technology integration to introduce the TPCD model for defining the pedagogical integration instruction and convey it to the action to build a website.

The most websites are technology-based or technology-centered websites. The designer selects the platform and the template and inserts the content in that order. Many website owners decide on the content of the website. Then they choose the platform and template of the website based on the type of their general goals such as official, blog, online shopping and so on. They are content-centered or (info-based) websites, while, in the user-centered website is designed to meet the needs, needs and expectations of users and select content based on that. Finally, the content is presented on web pages. At each stage of the decision, the usefulness and ease of use for the users is considered. Fig. 5 shows the key questions and decisions to create (design or renovate) a user-centered website.

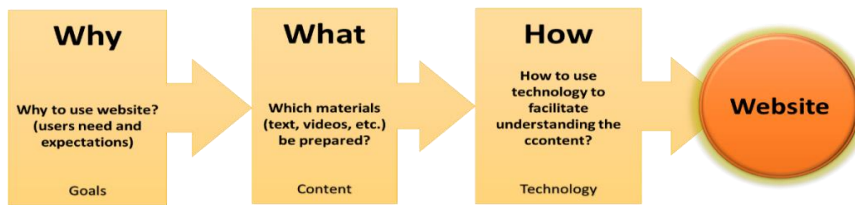


Fig. 5. The stages of designing a user-centered website based on TPC

While most web designers start by creating content and embedding it on a digital platform, TPC design suggests starting to build a website from educational activities as a definition of the goals. The following describes the activities of each step of creating a TPCD based website. Each step answers one of three questions.

4.1. Why: The purpose of creating a website

Every website is created based on a purpose. Existing platforms are designed to create websites for various purposes such as company building, blogging, marketing and so on. Although the proposed platforms help the web designer to manage the content in the technology, the usability of the content and technology depends on how much it meets the needs and expectations of users. Obviously, the owner is also looking for a profit or a goal by creating a website. In this regard, the first step of website design depends on how the goals of website owners and users overlap. What website owners expect from a user is different, such as buying products or services, providing information, creating positive attitudes or opinions about the product, or multiple goals.

Except for digital portals, which provide information and communication facilities for their members, most web pages are visible to everyone, and the web designer or owner may not know exactly who is viewing or reading the website, however, website owners, need to define end-users or target group. In fact, website owners by selecting purposeful content select the audience and keep them following it. Understanding users' characteristics, needs, backgrounds, skills, expectations, interests, etc., guide the web designer to know (i) whether the website has multiple users or audiences. And what content or level of access to information or interaction should be given to each group of audiences. (ii) If users need to categorize to access information such as the need to register (paid or free), because providing special access to users is part of the website. And (iii) add interactive pages as needed, such as filling out online forms, paying, or so on.

The websites of many public organizations use a variety of tools that provide statistical information about users by tracking users' journey through web pages or collecting data about them through short surveys. Conducting continuous interviews or surveys is an important way to gain in-depth information about user needs, expectations, and feedback, user experience research tasks that are essential to keeping web pages up to date. (Hosseini et al., 2022a). Considering the development and scope of modern methods of user experience research, Rohrer (2014) has summarized 20 popular methods in a three-dimensional framework as follows: 1) attitude versus behavior, 2) qualitative versus quantitative, and 3) context of use. Using each dimension, some key questions need to be answered through data collection and analysis.

After aligning the needs and expectations of users and website owners, to find out how to meet each expectation, they should be defined as objective and clear goals. According to Barnett and Coat (2005), each goal is a plan to change the cognition (knowledge), being, and action of the user (Fig. 6). Goal clarification is essential for creating a user-centered website and has two important functions: (1) Understanding how to meet the needs and expectations for creating outline content, (2) Ensure that all content on the website is in line with the objective goals. This prevents meaningless content from appearing on web pages. Overlapping categories are then used to link between pages on the website.



Fig. 6. Engaging in curriculum in higher education. Adapted from Barnett and Coate (2005)

When there are different groups of users, the web designer or content developer has different kinds of information about users' needs or expectations. It should set the main goals and each main goal should be divided into smaller goals in a row. Hence, the sub-objectives are determined and based on them, the outlines are proposed. The last two columns in this matrix emphasize the type of change (knowledge, attitude, and skills) and the kinds of material for each subobjective (Table 1).

Table 1
Matrix of goals and outlines

Goals	Outlines	Categories	Text/Image/Chart/etc.
Goal 1	Subobjective 1	Skill	
	Subobjective 2	Attitude	
	Subobjective 3	Knowledge	
	Subobjective 4	Knowledge	

4.2. What: Creating and selecting the content

The content includes text, visual and audio content material formats that is selected based on alignment with the purpose of the website owner and users. Because of the different types of users, different types of content, both original and complementary are considered. For that, a list of what the web designer expects different users to know or do is prepared. Most content-based websites are designed to provide information or news, laws, regulations, etc. Knowledge or information in any field is increasingly unlimited. Therefore, selecting the part of the content which is desirable and usable for users is very important and critical. A content developer needs to know what kind of content is right for each purpose and to avoid bringing up irrelevant content. Relativity, reliability, and trust are the most important factors for selecting information (Hosseini et al., 2022c). Depending on the diversity of users, different content is suggested for different users, backgrounds or learning styles.

To decide on materials, different materials are considered for a purpose (or outline). This does not mean that every user is bombarded with different types of content (text, images, etc.) about a content. Technology should be used to help users easily choose their way of receiving their information. Currently, many websites insert unrelated images just to fill space between texts or to attract the user's attention. The use of attractive but meaningless materials in technology is not consistent with the goals of TPC.

After providing reliable and relative information, the next challenge is to organize them. Content is suggested as "the most useful and flexible content when it has a well-structured structure" (Lynch & Horton, 2016, p. 19). Based on the outline matrix, the link of pages is clear. However, tracking user movement between content is important for linking pages (learning content objects). Each content has a specific structure that can be linear or non-linear (Fig. 7).

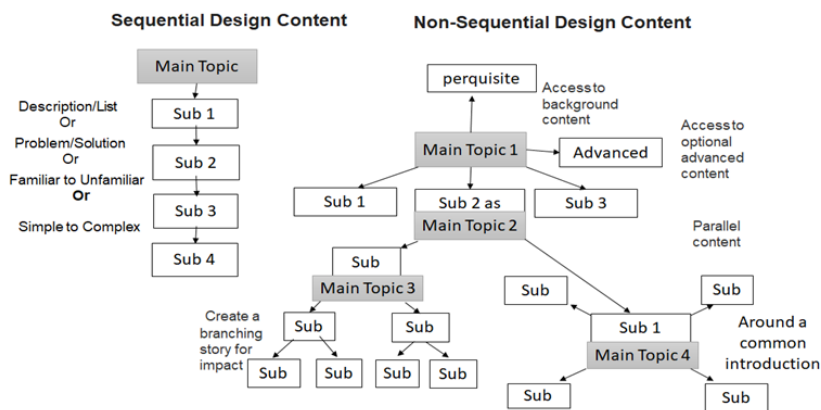


Fig. 7. Different construct of contents. Adapted from Hosseini and Okkonen (2022)

Mind mapping and concept mapping tools are useful for drawing content contracts: (a) For linear content structure, considering at least one of following criteria that has the root in pedagogical science is suggested: from known to unknown, simple to complex, tangible to abstract, analysis to synthesis, specific to general: empirical to rational, inductive to analogy, psychological to logical, actual to the general representative to the components, definite to the indefinite. (b) most page sequences are nonlinear. Some nonlinear sequencing methods include access to background content,

access to optional advanced content, around a common premise, parallel content, and creating a branching story for impact (Hosseini & Okkonen, 2022).

Different linear or non-linear forms other than content structure are based on learning functions and user expectations and preferences (usability, desirability, accessibility, findability). Connections are predictions of how the user is tracking information. Many pages are linked from multiple pages instead of two (one before and one after, like a line page). Predicting the relationship between different content based on the data provided from the first step, about the needs, expectations, and background of users. In fact, connections are expected to make users have the shortest and easiest journey through the site to reach their destination. The learning process and the levels of the mental process from memorization to critique can also guide the journey.

In Fig. 8, different paths for three different groups of users to reach the same destination are predicted and drawn in different colors. The effectiveness of a website depends on providing the easiest and fastest user journey on the web pages that are defined as the criteria of user experience.

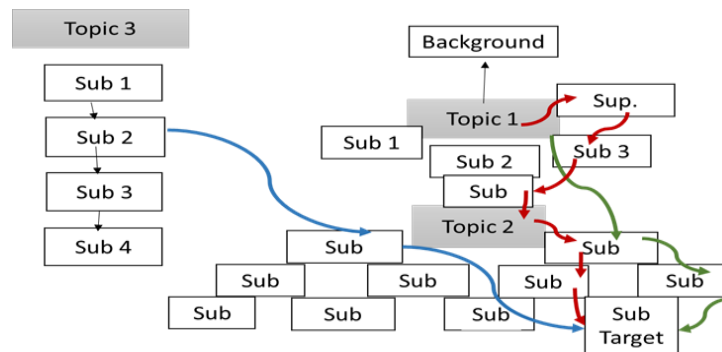


Fig. 8. Different user groups journeys through the content. Adapted from Hosseini et al. (2022a)

4.3. How: Organizing and presenting the content

Today, users are not patient enough to read a long text, especially since many website readers read web pages through their mobile phones. Therefore, all information on the web must be broken down into the pieces, what is called a Content Object in IT terms. When content objects have a learning purpose, they can be named as "learning content objects". There are many rules that justify the connection between learning content objects, which is more related to the structure of the content, users and the learning process. Some of these rules are a) Each content has sequences in its structure that must be considered. b) Depending on the decision of the web designer, the content can be categorized or presented based on logic, importance, history, etc. c) In many websites, updated content is the most important criterion, therefore, the latest update should be provided to the user first. d) Content can be categorized based on different inputs, for example, to members or moderators.

Many websites have huge amounts of data and multiple pages. Wrong classification and linking of data usually reduce the findability of information. While many web platforms look attractive at first glance, finding the required information among irrelevant or meaningless images and graphic design can be a problem for users. Web designers need to be aware that accessibility, usability, and information findability

do not be sacrificed for attractiveness. Reasonable classification, simplicity, meaningfulness, minimalism, clear guidelines, and feedback are important criteria for designing a web page (Hosseini & Okkonen, 2022).

5. Discussion

An IBM report predicted that knowledge would double every 12 hours by 2020 (Schilling 2013). Among this volume of information, there is a lot of disinformation and misinformation, and fake news. They are not verifiable, so they create information pollution. False information is being disseminated or even reproduced through social media regardless of the intent of their producers. Today, social media creates the largest community with billions of members. "Facebook, the largest social media platform in the world, has 2.4 billion users. Other social media platforms including YouTube and WhatsApp also have more than one billion users each. These numbers are huge, there are 7.7 billion people in the world, with at least 3.5 billion of us online. This means social media platforms are used by every third people of the world, and more than two-thirds of all internet users" (Ortiz-Ospina, 2019). While social media posts may have unreliable sources of information, many users search for the information they need from various social media platforms and consider them as useful sources of information (Kim et al. 2014; Westerman et al., 2014; Bontcheva et al., 2013; Hosseini et al., 2020).

Technology hardware is moving towards using small-screen mobile devices instead of computers for information search. Also, changes in users' preferences for reading short messages, receiving quick responses, and interacting, instead of patiently reading long texts, have increased the popularity of social media. On the other hand, the inefficiency of websites, the inattention of organizations and especially the government organizations in selecting, preparing, and updating the content of their website as well as loading a large amount of information on web pages, reduce the popularity of websites among users. Acosta-Vargas et al. (2017), after evaluating government websites in 20 countries, concluded that most websites do not achieve the desired level of compliance. When the main websites do not meet the needs of users and finding the right information is a complex task, users are led to more biased, monetary, and expired information. Users may find the information they need more easily, quickly, and interactively on social media or paid websites, which increases the risk of information accuracy, security, and credibility.

Due to the practically unlimited amount of information, checking the accuracy, validity, safety, and reliability of the information is a big and serious problem. Journalists and researchers suggest important keys that can help users be critical of information on social media and web pages (Wardle & Derakhshan, 2018; Petratos, 2021). The aim of this paper was to introduce a model for increasing the quality of websites, especially when transferring information to users. Technological Pedagogical Content Design is a useful model for creating a user-centered website with a great potential. Theoretically, it has a strong scientific support from the pedagogical science, which provides the necessary background for obtaining information about human characteristics and the functioning of human mind. In addition, it uses the methods, techniques, and experiences of previous efforts to prepare, organize and present knowledge to create a quality and accurate user-centered website.

6. Conclusion

The access to accurate, valid, and reliable information is essential to maintain social safety and stability. While technology has contributed to easy access to unlimited information, validating the information accuracy is still a big challenge, especially for non-specialists and ordinary users. Digital services are responsible for providing accurate, reliable, and trustworthy information to Internet users. Websites are the main tool for transferring information. However, many websites are not adequate to reach their users. In the last two decades, human science has received more attention from technology designers. Pedagogy as an important section of human science can lead technology designers to know their users. TPCD with the pedagogical viewpoint is a promising model for building a user-centered design. According to TPCD, the users are like adult independent learners who receive and experience new knowledge through technology.

TPC is an intersection of technology, pedagogy, and content as shown in Fig. 9. Pedagogy applies the knowledge related to learning theories, learning styles, and psychological learning in user analysis. Content defines the selected part of a subject matter and technology means all available techniques for transferring the content. Integration of pedagogy and content sets the objective goals for writing meaningful content outlines and how each content including text or image should have a specific goal. It prevents the web page from being loaded with meaningless text or visual content to distract or mislead users. Having the goal for each piece of content increases the accuracy of the content on the website. The integration of technology into content helps to prepare different formats or alternative materials and increases the findability of the content. The integration of pedagogy into technology guides the web designer to predict different paths for users with different learning styles and regarding the function of the brain to memorize, understand or criticize the available information through various methods and techniques. This increases the desirability and usability of the website (cf. Fig. 9).

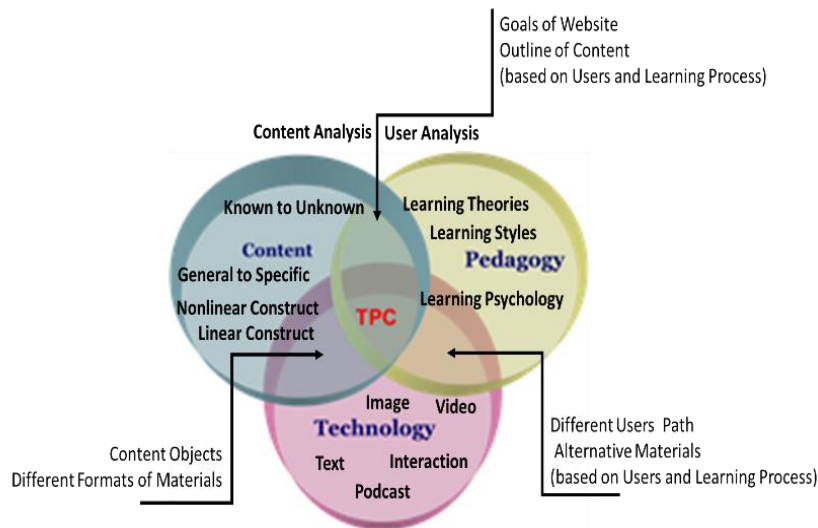


Fig. 9. TPC as the intersection of technology, pedagogy, and content

Technology is changing rapidly, and content is increasing tremendously, so the proposed technology design model needs to be sustainable yet flexible. This paper proposes TPCD as a conceptual and practical model derived from the TPACK

framework. It translates knowledge into action and has the potential to design various aspects of technology, especially when it comes to accurate and valid information transfer. TPCD has been applied to redesign the English pages of an organization's website in Finland (Hosseini et al., 2022b). Because the TPCD model considers learning principles for organizing content, it also opens technical and practical perspectives for developing learning content management systems.

Author Statement

The authors declare that there is no conflict of interest.

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