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IMPLEMENTATION OF THE VISUAL DICTIONARY ON TEXTILE AND FASHION INTO THE MOBILE APPLICATION

The article reveals the essence of mobile applications as one of the modern education methods in higher education among students majoring in clothing design. The paper described implementing the existing form of a book dictionary into the mobile application as a customized visual dictionary that meets the national guidelines' requirements and the learning outcomes declared in them. The article substantiates the content of the conceptual and categorical apparatus of the mobile application (dictionary) for students majoring in clothing design. It proves the effectiveness of its use in the educational space.

Keywords: mobile learning, mobile application, visual dictionary, mobile education.

ЗАХАРКЕВИЧ ОКСАНА, КОШЕВКО ЮЛІЯ

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ВПРОВАДЖЕННЯ ВІЗУАЛЬНОГО СЛОВНИКА З ТЕКСТИЛЮ ТА МОДИ У МОБІЛЬНИЙ ДОДАТОК

У статті розкрито сутність мобільних додатків як одного із сучасних методів навчання у вищих навчальних закладах студентів спеціальності «Дизайн одягу». У статті описано впровадження існуючої форми книжкового словника в мобільний додаток як налаштованого візуального словника, що відповідає вимогам національних рекомендацій і заявленим у них результатам навчання. Дослідження спрямоване на формування понятійно-категоріального апарату мобільного додатку для текстильно-швейного виробництва, що міститься у «Візуальному словнику з текстилю та одягу», та вивчення його впливу на формування та вдосконалення професійних компетенцій як студентів, так і викладачів. У цьому дослідженні також йдеться про впровадження мобільного додатку в навчальний процес як методу мобільного навчання у вищих навчальних закладах. У статті обґрунтовано зміст понятійно-категоріального апарату мобільного додатку (словника) для студентів спеціальності «Дизайн одягу». Доведено ефективність його використання в освітньому просторі на основі соціальних опитувань викладачів та студентів різних рівнів навчання.

Ключові слова: мобільне навчання, мобільний додаток, візуальний словник, мобільна освіта.

Introduction

All over the globe, scientists in different research areas significantly try to understand each other and write their reports in the same language. It is no secret that the most popular language nowadays is English. English is now considered a global language, with approximately 400 million native speakers. Not only is there this amount of native speakers, but over a million more speak the language as a second or foreign language. Due to this, English has now been considered the language of science. English is necessary to keep up with fellow scientists and see your work reach a global audience.

The sewing industry and apparel design are familiar to most works for readers. However, professionals in the area need help with standard terminologies due to the endless variety of clothing types and styles. Ever-changing fashion trends do not help to overcome such difficulties. Moreover, emerging techniques and designs of clothes spread new terminologies every day. The question of differences between the specific garment types might need to be clarified in the design due to the unclear definitions that lead designers to completely different appearances of the clothing items. Furthermore, such terms take their origin in other countries simultaneously. Therefore, there is more than one proper term for some clothing items.

Different definitions of garment types, especially in different languages, are obstacles to successful online search, preparing technical documentation, developing and implementing expert systems, and other elements of artificial intelligence in apparel design. Therefore, to do a qualified fashion review or perform an online search of

specific garments with keywords, it is necessary to determine the description of each garment type and its main features. A popular means of the new technology era is deep learning [1], which can exclude human factors and differences in experts' opinions from specific design process steps.

Organizing the database of properly labeled images of garments is the first step to performing automatic fashion reviews, online searching, and forming descriptions of garments. It is advisable to label specific features of the particular garment type rather than its name because the parts are standard and can be explicitly determined.

Understanding fashion includes knowing many specific fashion and apparel terms. Such information is provided in the visual dictionaries, containing words that are explained and contextualized. An example of such a book is "Visual Dictionary In Textiles & Apparel," [2] which includes terms with concise definitions accompanied by samples taken from traditional and modern fashion design. Some online visual glossaries of fashion provide similar visual information on the subject. However, they are mostly restricted to the simple sketches of the fashion items with labels and terms which need to be explained or contextualized.

Nowadays, reading information from objects is becoming more critical, so mobile applications are being created to make it easier for students to stay at the university. The mobile application can be accessed at any time and almost anywhere. It is available continuously, without breaks or weekends. In addition, the presence of the application on the device saves users the time spent opening the browser and finding the right site.

Every day, more and more people use the Internet through mobile devices. Using the mobile application involves the high-quality and rapid acquisition of knowledge, teaching students the techniques of independent work with the material, and increasing the productivity of educational career as a student and teacher. Today's market for mobile applications is very developed, and interest in integrating them into learning will continue to grow as current trends in education require new, modern, and, most importantly, effective teaching methods. In addition, mobile technology can make learning more enjoyable, meet today's requirements, and provide the correct information at the right time. Today's mobile applications available for use in the garment industry are primarily focused on supporting the market for finished products in the fashion industry and not on the development and improvement of the educational process, which is extremely important in a pandemic and globalization of the educational space. Thus, there is an urgent need to develop such mobile applications that will be aimed at their use by specialists and educators in the garment industry.

Developing a mobile application for students majoring in clothing design will help students quickly find information about the conceptual and categorical apparatus of the specialty. Therefore, it is an urgent task.

Higher educational institutions require both practical and theoretical approaches to learning, including new constructivist theories of learning that emphasize students' active use of the latest methods and mobile environments in the 21st century.

The conceptual and categorical apparatus of textile and garment production, contained in the "Visual Dictionary In Textiles & Apparel," is part of the professional competencies of teachers and students and is the mobile application's content. Therefore, it is essential to study the development and formation of knowledge and skills of students and teachers with the help of mobile technologies in teaching and learning.

Learning outcomes are commonly understood as the learning results students achieve from their learning experiences and studies. Each study course (a.k.a learning component (LC)) provides several specific learning outcomes. The national guidelines usually declare learning outcomes (LO) for the particular subject expertise. The following learning outcomes are the most relevant for students working with clothing design.

Analysis of published data and stating the problem

More than several scientific works are dedicated to the question of the digital transformation of apparel design and manufacturing [1, 3, 4]. Most papers describe pattern design systems and their implementation into design processes. Some works [3] introduce the basic concept of digital enterprise management, analyzes the shortcomings of the current clothing enterprise management, and discuss the key points of digital transformation of clothing enterprise management combined with the characteristics of clothing enterprises. Researchers are unanimous on the advisability of digital transformation of apparel design on all steps of garment development and its manufacturing.

During the last several years, the study of mobile applications in the different manufacturing fields has been an emerging trend in the scientific literature. Such a statement is proved by the number of scientific works dedicated to the question [4–14].

Nowadays, buying clothing online through brand stores, general online stores, or circular economy platforms is possible. The paper [4] proposes the analysis of an innovative taxonomy of mobile applications about the circular economy and presents a study on mobile applications supporting online commerce for clothing. Findings include that almost all the mobile applications analyzed have pictures illustrative of the clothes and accessories available for trading and their brief description.

In the research project [5], an independent case study on the new contactless 3D body measuring native mobile applications has been carried out. The research [5] analyzes body data obtained by mobile scanning apps with the help of various methods. The presented approach combines three measurements: manual body measuring with traditional instruments, 3D full-body scanning technology, and contactless body measuring via smartphone applications.

The study [6] developed a mobile app for the personal color analysis system, which determines the clothing

colors harmonized with a user's skin and hair coloring. The mobile application employs photographs of a user's skin and hair colors to automatically calculate and categorize personal coloring instead of using fabrics as an analyzing material. The application applies virtual packets of fabric swatches to virtual tee shirts and overlays them on the user's photographs to obtain a personal color analysis. Through this process, the application dramatically reduces personal time and cost and allows users to analyze individual colors repeatedly. The application is likely to assist consumers in choosing clothing colors substantively.

Scientific literature extensively covers the potential of learning using smartphones. Scientists and teachers recognize the pedagogical and technological advantages of mobile learning [9]. The most used mobile applications are in language learning and teaching [13, 14]. The analysis performed in papers [13, 14] has revealed that the quality and feasibility of individual tasks in different apps are not similar. Nevertheless, students expressed a positive attitude towards such learning tools.

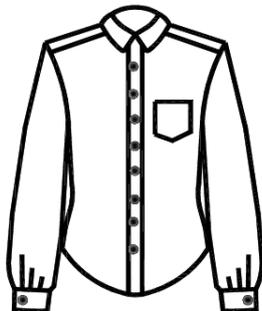
Scientists of the world conducted studies of mobile applications in learning/teaching in various fields. Among them are interactive learning environments for children [9, 10], training in clinical medicine [11, 12], language learning [13, 14], and the study of using smartphones and developing mobile applications for the students majoring in clothing design [7, 8], etc. Researchers find no evidence that mobile technology has improved students' ability to apply their skills in the field. However, students have said that one advantage of mobile technologies is accessing the necessary educational information even in extracurricular activities.

The purpose of present work is to provide a tool for mobile education for the students using their mobile phones equipped with the Android application program, which helps to view a book called "Visual Dictionary In Textiles & Apparel" [2]. Besides that, one of the objectives of the current study is to find out how accessible the conceptual apparatus of visual vocabulary is to students and teachers, whether it promotes rapid learning, whether users need an interactive transition, and what visual vocabulary assessment is during use.

Methodology

Evaluation of the visual dictionary. The visual dictionary consists of the most commonly used concepts and terms used in the professional field by teachers and students majoring in clothing design (Fig. 1). The dictionary covers the conceptual and categorical apparatus of materials science, clothing design, color, anthropometry, and many types of clothing.

Visual Dictionary In Textiles & Apparel



Shirt or shirtwaist
Blouse styled similar to a man's tailored shirt including one- or two-piece high stand collar, yoke, left chest patch pocket, and button band front opening. Hem is usually curved. (Also called **tailored blouse**).



Fig. 1. Page example of "Visual Dictionary In Textiles & Apparel"

We performed the survey aimed at quality assessment of "Visual Dictionary In Textiles & Apparel" by students and teachers during teaching and learning using a questionnaire (Fig. 2). This questionnaire is a scale with several bipolar (opposite) concepts that characterize the properties of an object, in this case, a visual dictionary. Choosing a value of 0 means neutrality, 1 (-1) – a low degree of expression of this quality in the evaluated dictionary, 2 (-2) – medium degree, 3 (-3) – high. The survey's respondents are garment industry representatives, faculty members (group 1), and students studying clothing design and manufacturing (group 2).

	-3	-2	-1	0	1	2	3	
Unreachability of the conceptual apparatus								Availability of the conceptual apparatus
Slow assimilation of the learning material								Rapid assimilation of the learning material
The inexpediency of interactive transition								The practicality of interactive transition
The irrelevance of the visual dictionary								Relevance of the visual dictionary

Fig. 2. Example of the questionnaire

Analysis of the market of mobile applications for fashion studies. The global market of mobile applications is constantly changing. Thus, in the next stage of the comparative study, an analysis of the already existing apps for learning/teaching fashion vocabulary and ones allowing the creation of visual dictionaries was carried out. We recognized mobile apps hosted on the Google Play and App Store platforms as the general statistical population of mobile applications used in textile and clothing production.

We have searched the mobile applications related to fashion dictionaries or guidelines according to the following criteria: (1) the availability of a component of clothing items definitions; (2) the download and registration are free; (3) the existence of updates between 2018 and 2022; (4) the availability in English; and (5) the availability on Google Play Store.

Analyzed mobile applications have the same characteristics. The search of the mobile applications consisted of the following combination of keywords: "Clothes dictionary," "Fashion dictionary," "Apparel dictionary," and "Textile glossary." This study aimed to implement the visual dictionary into the mobile application fitting Google Android OS, which has at least 80% of the global market share, so many smartphone users could use it [6]. Thus, we applied the keywords in the Google Play Store. Before choosing the application, we collected and analyzed data on about 279 applications we got as a result of the search. The following information was extracted from the mobile applications (Table 1): name, description, user ranking, number of downloads, author, and year of the last update.

Table 1

List of mobile applications analyzed

Name	Description	Language	Number of Downloads	Author	Year
Textile Dictionary	Sometimes, textile learners fall problems with understanding textile terms. This application is created based on textile-related words. It is composed of 4000 words at the first step, and more words will be added in the next update.	English	500+	TEX-CUE	2020
Textile eBook	Textile eBook is the best website that supports textile, apparel, and fashion design students and professionals by uploading and sharing free ebooks related to material, clothing, and fashion.	English	10000+	Textile Expert	2019
Textile Dictionary	Textile Dictionary will help the automobile industries, homemakers, dressmakers, interior decorators, retail-store customers, and even students studying these subjects to find the most common textile word. With this app, one will be able to find out and see the word	English	10000+	Textile Facts	2020

As one can see in table 1, there are only three applications that meet all the criteria. However, these apps do not allow customizing. That is why we applied the same methodology to search and extract mobile applications that will enable the creation of personalized dictionaries.

We have searched the mobile applications related to dictionaries and their creation according to the following criteria: (1) the availability to add words, their definitions, and images; (2) the download and registration are free; (3) the existence of updates between 2018 and 2022; (4) the availability in English; (5) the availability on Google Play Store, and (6) the availability to merge dictionaries and share them with fellow users. The keywords for the second search were "Create dictionary" and "Create glossary." As a result of it, we found 30 applications. Five of them meet the criteria (Table 2).

Table 2

List of mobile applications for creating personalized dictionaries

Name	Description	Users rank	Language	Number of Downloads	Author	Year
Word note: create	An app is a words saver app that helps one memorize words and phrases a user adds. Create a	-	English	50+	Velonder	2022

dictionary	personal dictionary, and remember the vocabulary.					
Dictionary.com English Word Meanings & Definitions	A free dictionary app with English language learning tools is built for every learner's level. With more than 2 million trusted definitions and synonyms, the app is optimized with the owner's mobile device to help one learn English or improve their English vocabulary. It works offline.	4.4	English	10 МЛН+	Dictionary.com, LLC	2022
Build Own Dictionary	Using this app, one can create dictionaries while learning a foreign language.	4.4	English	10000+	BitDeveloper	2022
Kalimaty – Create Your Own Dictionary	An app is a simple dictionary crafted for people who prefer to create their dictionaries for the English language or any language you want to learn and memorize its words.	3.7	English	10000+	ARABTEAM	2021
Create Dictionary	An app allows one to create customized dictionaries for themselves and add words with meanings, examples, and pictures of one's choice.	4.4	English	10000+	Hazzam	2021

Results and discussion

Assessment of the book "Visual Dictionary In Textiles & Apparel". After receiving grades from all respondents, the arithmetic means values for each pair of antonyms were calculated. Constructed curve based on the obtained data reflects the average subjective perception of the characteristics of the studied dictionary (Tables 3, 4, Fig. 3).

Table 3

The results of the evaluation of the "Visual Dictionary In Textiles & Apparel" (students)

Question	Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Average
Reachebility	a1	3	-3	2	2	3	3	3	2	2	3	1	2	0	3	2	2	2	3	2	1.947
Assimilation	a2	3	0	2	3	3	3	3	2	2	2	1	3	0	3	2	3	2	3	3	2.263
Interactivness	a3	3	0	3	3	3	3	3	3	2	3	2	3	1	3	2	2	3	3	3	2.526
Relevance	a4	3	0	1	2	3	3	3	2	2	2	2	3	0	3	2	3	3	3	3	2.263

Table 4

The results of the evaluation of the "Visual Dictionary In Textiles & Apparel" (teachers)

Question	Code	Experts							Average
		1	2	3	4	5	6	7	
Reachebility	a1	3	3	3	3	2	3	3	2.857
Assimilation	a2	3	3	3	3	2	2	0	2.286
Interactivness	a3	3	3	3	3	2	3	3	2.857
Relevance	a4	3	3	3	3	3	3	2	2.857

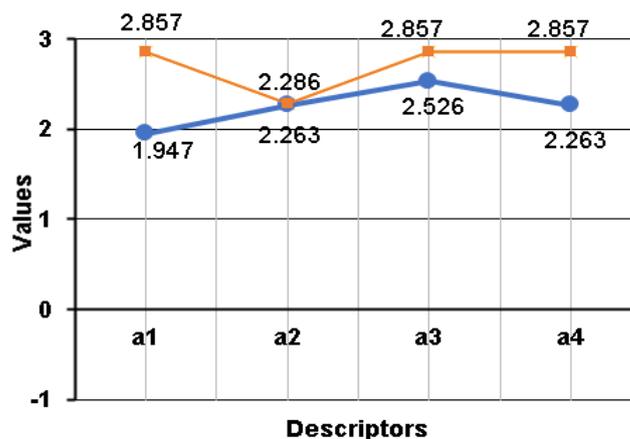


Fig. 3. Psychographic profiles of the "Visual Dictionary In Textiles & Apparel"

Analyzing the curve (Fig. 3), one can note that the visual dictionary satisfies the target consumers in the following characteristics: rapid assimilation of material, availability of conceptual apparatus, and interactive transition. Applicants also recommended the use of visual vocabulary in the workplace.

In addition, the respondents indicated which media they prefer in teaching/learning (Fig. 4). Among the surveyed experts on which media they like, the majority of respondents singled out books (71.4%), videos (85.7%), and visual vocabulary (71.4%). Students prefer online texts (78.9%), videos, and books (57.9). None of the respondents used podcasts (0.0%).

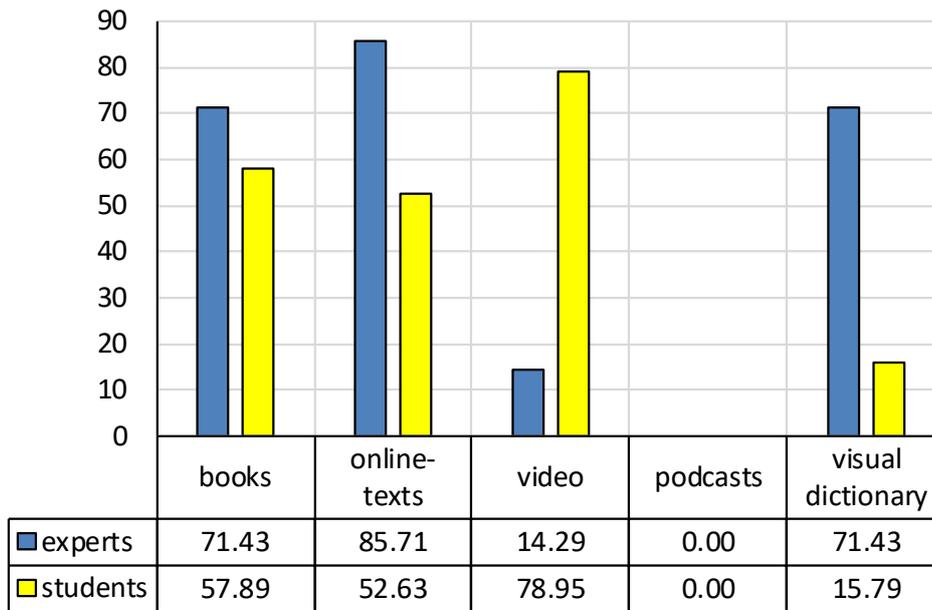


Fig. 4. The results of a survey of respondents on their use of media

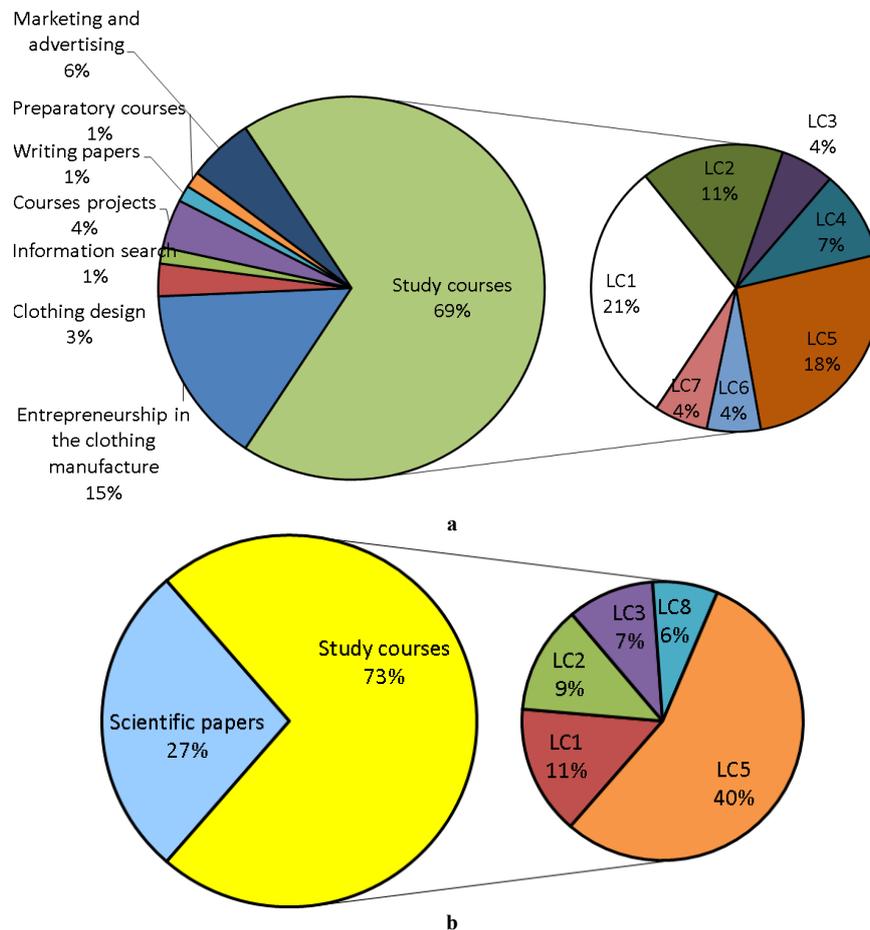


Fig. 5. The results of a survey on the advisability of using the visual dictionary in different areas:
a – students; b – teachers

Respondents were also asked to answer the questions in which areas or situations it is necessary to use the "Visual Dictionary In Textiles & Apparel." Among the experts' answers can be identified such study courses as Fundamentals of Product Desing (LC1), Fundamentals of Technology of Goods (LC2), Introduction to the specialty (LC3), Computer-aided Clothing Design (LC4), Foreign Language (LC5), Colour Science (LC6), Drawing and Fundamentals of Artistic Graphics (LC7), Research Methodology and Organization (LC8) (Fig. 5). Beside the studying all the respondents chose several other possible ways of implementation of the visual dictionary.

The majority of respondents also believe that the best format for a visual dictionary will be a mobile application (85.7%) or a printed version (57.1%) (Fig. 6). Compared to teachers, students provide the maximum percentage of mobile application use (78.9%). Only 14.3% of respondents prefer pdf format and online texts.

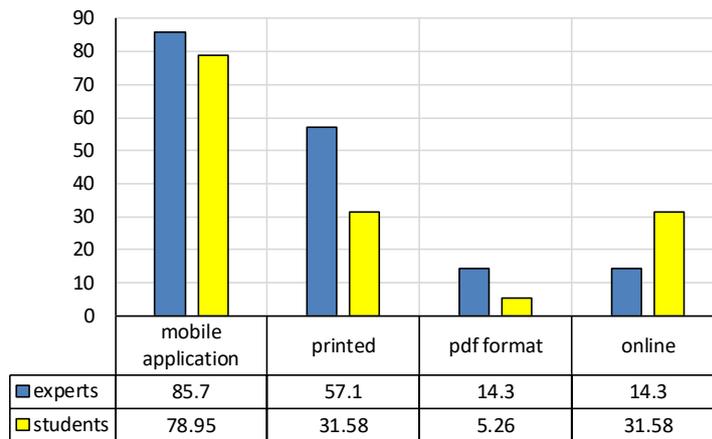


Fig. 6. The results of a survey of respondents on the preferability of the dictionary format

Customization of the mobile application for implementation of "Visual Dictionary In Textiles & Apparel". For the customization of the mobile application, we considered three possible solutions such as: "Build Own Dictionary," "Kalimaty," and "Create Dictionary."

The application called "Build Own Dictionary" allows one to create a dictionary or import it from one's device into the app. Users can delete or rename the dictionary and export it from the app to their devices. A student can add a word quickly with its translation and, optionally, its description to the dictionary. Other features of the app are: deleting or editing words in the dictionary, assigning a category name to the terms, and sorting the comments alphabetically, by time added, or by category. Users can search for a word or description in the dictionary and customize the colors and font sizes. It is possible to save all created dictionaries as an SQLite database in a DB file. The premium version enables the export/import feature, adding descriptions, assigning categories, customizing colors and font sizes, and sentence translation. In addition, it removes from the app all advertisements.

Another app named "Kalimaty" is a simple dictionary crafted for people who prefer to create their dictionaries for the English language or any other language. This app is a dynamic database of users' new words and phrases linked to real examples of these words, related to specific users' reading and listening, not just learner content. This application allows users to add categories and vocabulary lists with images and icons and add/modify words or sentences with their translation and pictures. Users can provide an explanation, illustration, and translation. There is an auto-translation for most English words, and users can listen to the pronunciation of those words. The functions of arranging, sorting, and searching a word in the customized dictionary are also available. The app allows word translation to retrieve the definition of unknown words. The application is free, and it does not contain any advertisements. It is working entirely offline, with no need for the Internet.

Using the app "Create Dictionary" allows creating customized dictionaries for themselves and adding words with meanings, examples, and pictures of the user's choice. This application will enable students to save glossaries on their professional activity subject areas. For separate languages/books, users can create different dictionaries. A feature allowing import of the backup dictionaries to any of their devices and sharing created dictionaries with friends will be very convenient when working on team projects. In addition, students can add words in a different language and their definitions in another. The application provides auto backup and custom word categories. The premium version of the app is free of any advertisement.

To implement the existing in the form of a book dictionary into the mobile application, we choose the app "Create Dictionary," available at the link <https://play.google.com/store/apps/details?id=com.hazzam.createdictionary&hl=ru&gl=US>. One can see in Fig. 7 the resulting screenshots of the customized visual dictionary.

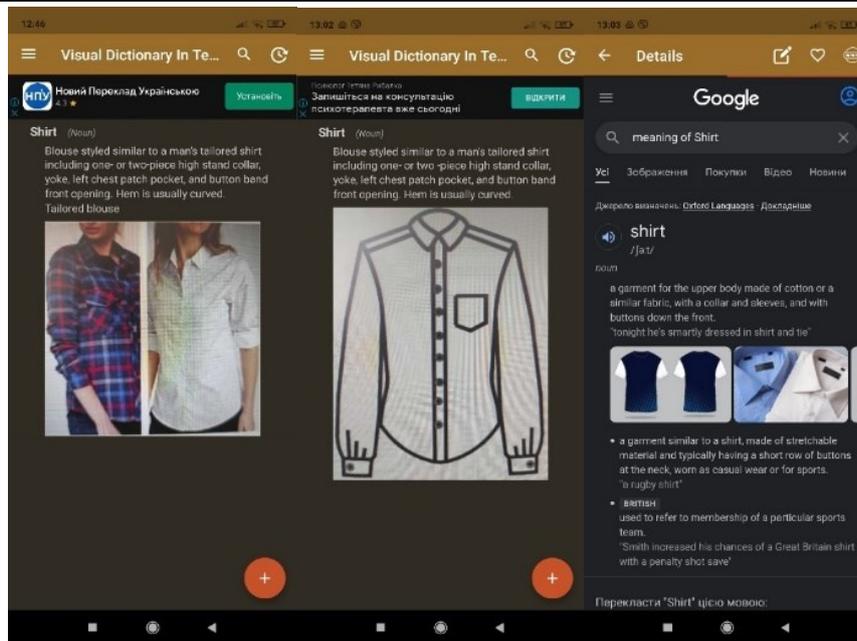


Fig. 7. Screenshots of the customized visual dictionary

Thus, combining the key features of the app "Create Dictionary" and the advantages of the book "Visual Dictionary In Textiles & Apparel," a resulting mobile dictionary app allows students to customize a dictionary by adding words, their meanings, and examples. A student can add a related picture to the word from the Internet or device memory even when there is no such image in the book. Besides that, the mobile format adds such a feature as sorting words based on alphabet/date/random.

As a result of customizing the dictionary, we achieved the study's objectives: the learning outcomes declared in the national guidelines (Bachelor's degree and Master's degree in clothing design) are reached using the customized mobile application for the study courses identified by respondents of the survey (Fig. 5).

For the Bachelor's degree, the learning outcomes are as follows:

- LO3. Students can use modern informational systems, technologies, and general and specific software in their professional activities.
- LO6. Students can use a professional glossary and basic definitions in materials science, design, technology, and garment manufacturing, as well as their quality indexes.
- LO7. Students can describe, identify and categorize the garments.
- LO14. Students can form a range of garments that meet the consumers' requirements and national standards.

The learning outcome for the Master's degree is as follows: LO3. Students can fluently communicate in state and foreign languages orally and in writing on scientific, engineering, and production issues in apparel design and manufacturing, presenting the results of their activities.

Conclusion

This study presented the "Visual Dictionary In Textiles & Apparel" implementation in the form of a mobile application based on existing mobile apps allowing customized dictionaries. The study is based on a survey of students majoring in clothing design and teachers with experience in fashion and apparel manufacturing. Most respondents preferred the customized visual dictionary in the mobile app format. The mobile application has many advantages in teaching students: it promotes faster assimilation of information, preparation for classes in the specialty, and is relevant in the professional and scientific field. In addition, it assists teachers in teaching activities in teaching various professional disciplines, writing scientific articles, and conducting research startups.

In the next stage of this research, it is advisable to study the exact impact of using the customized visual dictionary on learning outcomes, which are declared in the work programs of the study courses and national guidelines for the specialty of a clothing designer.

References

1. Zakharkevich O., Selezneva A., Kuleshova S., Slavinskaya A., Vovk J., Shvets G. Defining the main features of clothing to apply deep learning in apparel design. *Vlákna a textil*. 2018. № 25(4). P. 103-109.
2. Elnashar E., Zakharkevich O., Shvets G., Selezneva A. *Visual Dictionary In Textiles & Apparel*. Khmnelnytskyi: KhNU, 2019. 183 p.
3. Papachristou E., Kyratsis P., Bilalis N. A Comparative Study of Open-Source and Licensed CAD

Software to Support Garment Development Learning. *Machines*. 2019. Vol. 7(2). 30. <https://doi.org/10.3390/machines7020030>

4. Faria R., Lopes I., Pires I.M., Marques G., Fernandes S., ... Trajkovik V. Circular economy for clothes using web and mobile technologies. A systematic review and a taxonomy proposal. *Information*. 2020. Vol. 11 (3). 161. <https://doi.org/10.3390/info11030161>

5. Strunevich E., Detering-Koll U., Quattelbaum B. Investigation of usability and measurement accuracy of 3D body scanning mobile applications. *Communications in Development and Assembling of Textile Products*. 2020. Vol. 1(2). P. 130–140. <https://doi.org/10.25367/cdatp.2020.1.p130-140>

6. Hye R., In Kim Young, Liu Shaofeng. A mobile application for personal colour analysis. *Cogent Business & Management*. 2019. Vol. 6(1). P. 1–11. <https://doi.org/10.1080/23311975.2019.1576828>

7. Zakharkevich O., Poluchovich I., Kuleshova S., Koshevko J., Shvets G., Shvets A. “CloStyler” – mobile application to calculate the parameters of clothing blocks. *IOP Conference Series: Materials Science and Engineering*. 2021. 1031(1). 012031. <https://iopscience.iop.org/article/10.1088/1757-899X/1031/1/012031>

8. Zakharkevich O., Koshevko Y., Kuleshova S., Tkachuk S., Dombrovskyi A. Development of the mobile applications for using in apparel and shoes design. *Vlákna a textil*. 2021. № 28(2). P. 105–122. http://vat.ft.tul.cz/2021/2/VaT_2021_2_13.pdf

9. Kim Y., Smith D. Pedagogical and technological augmentation of mobile learning for young children interactive learning environments. *Interactive Learning Environments*. 2017. Vol. 25(1). P. 4–16. <https://doi.org/10.1080/10494820.2015.1087411>

10. Zaranis N., Kalogiannakis M., Papadakis S. Using Mobile Devices for Teaching Realistic Mathematics in Kindergarten Education. *Creative education*. 2013. Vol. 4(7). P. 1–10. <http://dx.doi.org/10.4236/ce.2013.47A1001>

11. Mackaya B., Andersona J., Hardingb T. Mobile technology in clinical teaching. *Nurse Education in Practice*. 2017. Vol. 22. P. 1–6. <https://doi.org/10.1016/j.nepr.2016.11.001>

12. Lumsden C., Byrne-Davis L. Th., Mooney J., Sandars J. Using mobile devices for teaching and learning in clinical medicine. *Archives of Disease in Childhood - Education and Practice*. 2015. Vol. 100(5). P. 244–251. <http://dx.doi.org/10.1136/archdischild-2014-306620>

13. Rosell-Aguilar F. Taxonomy and Framework for Evaluating Language Learning Mobile Applications. *Calico journal*. 2017. Vol. 34(2). P. 243–258. <https://doi.org/10.1558/cj.27623>

14. Pereira C., Terra R. A mobile app for teaching formal languages and automata. *Computer Applications in Engineering Education*. 2018. Vol. 26 (5). P. 1742–1752. <https://doi.org/10.1002/cae.21944>