Choosing an Educational Application for Children with ASD

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Abstract

Teachers, inclusive education specialists, parents, and students with autistic spectrum disorder (autism) are the participants of the educational process, which is aimed not only to teach such a student. The correction of communication skills is also the aim of such education, and the education process is complicated with no-doubt need to fit it to both individual needs and possibilities of every unique student. Supporting such education process with an information technology allows to simplify the decision making while choosing an application, that fits most needs of all the education process participants.

Keywords

ASD, Likert scale, decision-making support in education of children with ASD, stream

1. Introduction

Autism Spectrum Disorder (ASD) is usually diagnosed at the age of 2-4 years, when specialists can detect abnormalities in communication with other people and the outside world. The difficulties with social communication, interaction and specific imagination can be diagnosed. ASD is a general term used to group brain dysfunction, including autistic disorders, Asperger's syndrome, disintegration disorder in children, and other common developmental disorders.

A child with ASD has special needs in the organization of the educational process. Therefore, the education of such a child demands inclusive environment. An important factor of such education is the use of actual information technology to improve the educational process.

In recent years, new correctional and developmental and training programs were designed all over the world, and such applications are adjusted to be used on mobile devices such as smartphones and tablets, as well as laptops and PCs. Therefore, the issue of choosing the optimal software for a person with ASD is relevant, considering his personalized needs, as well as the results of psychophysical diagnostics.

2. Related Works

To feel more comfortable in a society, children with ASD can study in common schools with inclusive environment. Such education might involve a specially trained assistant, and grounds on personal educational programs, based on individual capabilities, the provision of additional educational services and support [1-3].

The process of teaching students with ASD in Ukraine includes the student itself, an inclusive class teacher (teacher's assistant), an important role is played by parents and the administration of an inclusive school (Fig. 1).

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The most effective technology for improving traditional learning is computer learning, an approach that is widely used to support students with ASD. Such technologies are especially popular with mobile devices like iPad [4, 5]. For traditional learning, it is very important to choose multimedia content, with an emphasis on infographic and visual components that will help focus the attention of people with ASD for a deeper immersion in the learning process [6-8]. The use of artificial intelligence algorithms to monitor the emotional state of a student with ASD is described in [9-11]. The design of the interface for teaching students with ASD in augmented reality [33] was described in [12-14] and proposed to study the skills of social orientation.

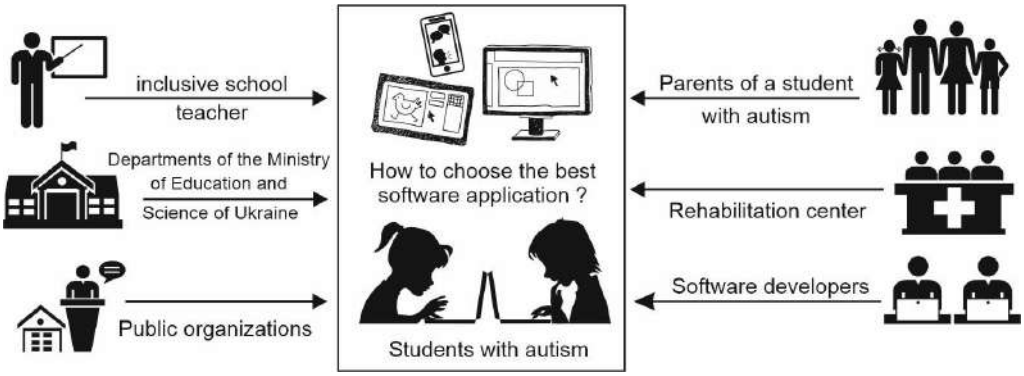


Figure 1. Participants in the process of inclusive education of students with ASD

A catalog of useful software applications based on iPad mobile technologies for people with ASD was formed by a researcher from the University of Edinburgh [15]. A similar classification of specialized software in the form of a *catalog wheel* considering the personal educational needs of autistic students, proposed in [16] by a researcher from the University of North Dakota (USA). Mobile technologies based on iPad and iPhone to improve the traditional education of students with ASD were analysed by specialists from the Institute of Informatics and Telecommunications [17, 18]. Researchers from Columbia University College have developed a specialized training framework LeFCA for people with ASD [19, 20]. Many specialized software for iPad devices, Android operating systems have been analyzed at the University of Florida (USA) [21, 24]. The mobile application AutVisComm [25, 26] designed for non-verbal students with RAS works on iPads, iPhones, and Android smartphones and tablets.

3. Methods and Materials

There is an urgent need to develop a unique learning trajectory for students with ASD, which will not only cover the learning needs of such students, but try to address the social, emotional and communication needs of children and youth with ASD, support their independence and well-being. Inclusive classroom staff should be highly educated and highly motivated. Cooperation with health professionals, in particular language therapists, medical specialists and mental health professionals, as well as specialists in health care, social care, should be ensured.

That is why, the implementation of actual information technology for education to support people with ASD, the use of innovative and personalized methods of curriculum adaptation, the use of strengths and interests of autistic students, etc. are crucial. Therefore, the creation of an information system for the selection of available software applications to support the learning of students with ASD is an urgent task.

3.1. The concept of information system to support an education of students with autism

To support a decision making in education of students with autism, authors suggest a concept of an appropriate information system. Such system is to help in choosing the best software to be used in

classes. Such software should meet the needs of all the participants of educational process, i.e., not only students with ASD and their teachers, but parents and other professionals, as well. To present such concept we used the context diagram. The following graphical elements were used: data streams, data drives, processes, and external entities (Fig. 2-3).

External entities in this diagram are *Teachers, teacher a*ssistants, *teachers of inclusive educational institution, Student with ASD, Parents of students with ASD, inclusive education specialists* (IES), and *Software developers*. The following data streams are submitted to the system input: *Request for training and development software, Request for supplemented training, Evaluation of software effectiveness, Demo version of training and development software, Learning test results*. The information flows are: *Recommended education and development software, Recommendations-wishes from teachers, parents, inclusive education specialists,* and *test results*.

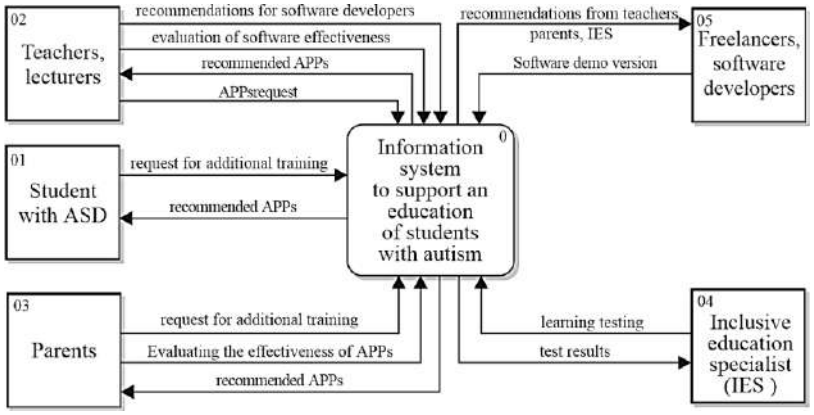


Figure 2. Context diagram of the information system for supporting the education of children with ASD

The processes here are *Process software requests for students with ASD, Search for educational software for students with ASD, Recommend educational software for teachers, Conduct a survey of the effectiveness of software use* and *Generate a request to develop educational and developmental Software*.

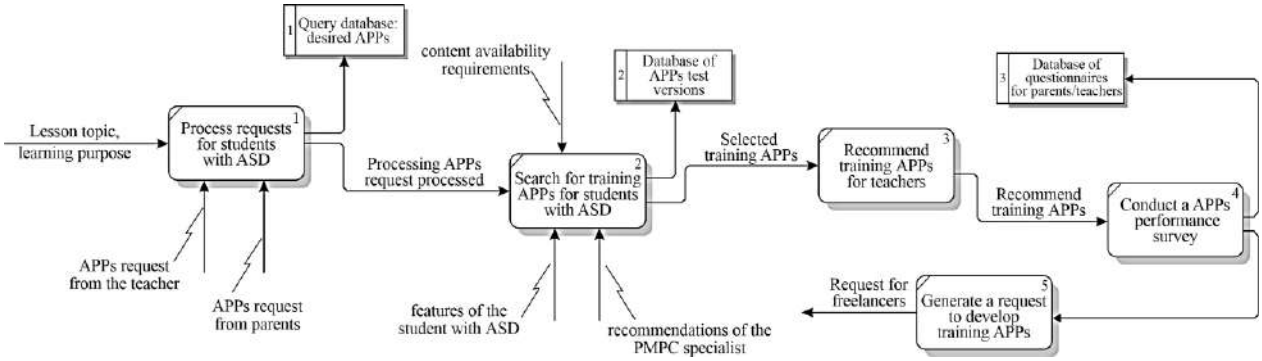


Figure 3. First level decomposition diagram

The tree structure with clearly defined hierarchical levels allows to present the structure of the developed system in the form of a hierarchy of tasks on a different levels. This technique is designed to optimize the interaction between tasks; the hierarchy of processes of the developed information support system for learning for children with ASD is shown in Fig. 4.

The main goal is to use the information support system for education of children with ASD, and the processes are *Create a set of recommended software for teaching children with ASD, Conduct a stream online,* and *Process the survey results*.

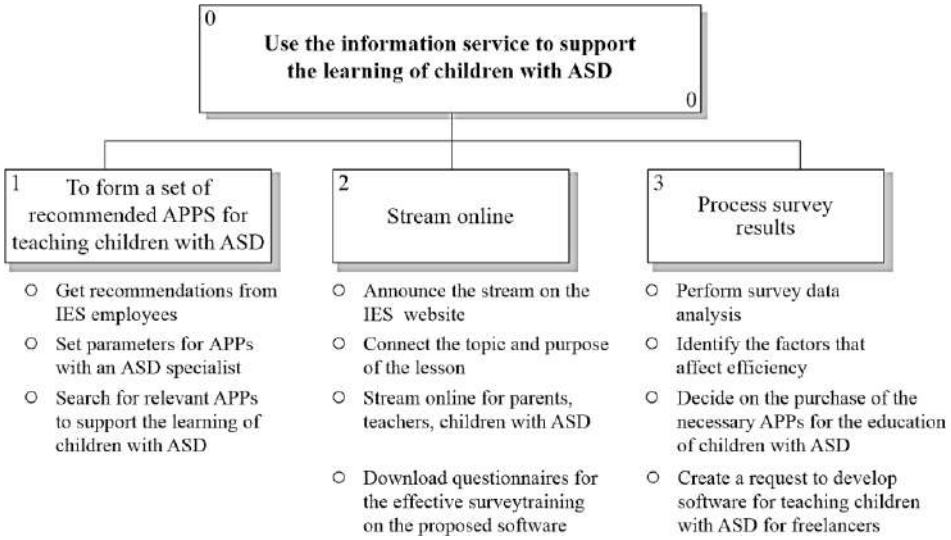


Figure 4. Hierarchy of tasks

In the presented above concept of a system for choosing the best software application for teaching children with ASD, there are several-steps testing of relevant software with a questionnaire survey of participants of the process, namely parents and teachers. Results

For further investigation, the specialized software was chosen. It is a software that supports the education of children with ASD and has positive feedback on the Internet (Table 1).

The main participants are parents and students with ASD, they get online acquainted with some software – guided by the IT specialist. This way of presenting information is quite convenient, as it does not require the presence of participants in one room. Also, it seems convenient to create a separate page for such broadcasts on the official websites of relevant institutions that support the education of children with ASD. The description of the stream is accompanied by relevant documentation on the recommended software, their short description, download links, preliminary rating compiled by IT specialists. After the the stream and testing of the proposed software, parents, teachers and others are invited to undergo a survey. The results of the analysis can be used in following decision-making.

Table 1
The software to support the education of children with ASD

Title	Link	Points
Math Kids	https://apps.apple.com/ua/app/math-kids-add-subtract-count/id1272098657	4.3/5
MP Weather	https://apps.apple.com/ua/app/marcopolo-weather/id905425870	4.5/5
Flashcards for Kids	https://apps.apple.com/ua/app/flashcards-for-kids-in-russian/id672994240	4.4/5
Speech Blubs 2	https://apps.apple.com/ua/app/speech-blubs-2/id1544715736	4.8/5
Lingokids	https://apps.apple.com/ua/app/lingokids-playlearning/id1002043426	4.7/5
Otsimo	https://apps.apple.com/ua/app/otsimo-special-education-aac/id1084723774	4.8/5

It is important to have an opportunity to watch the broadcasts offline afterwards. It seems most expedient to take part in online streams, because in the process of getting acquainted with educational support content one can always ask questions, consult on the relevant technical aspect, etc. The participation of the child with ASD is also important while streaming, as his or hers reaction to visual stimuli must be taken into account when choosing the appropriate software.

3.2. The methods and means to solve the task

Given the above, the most appropriate means to solve the task of online selection of applications for education support are as follows.

YouTube is a convenient and popular platform for real-time streaming. To implement a live broadcast, one need to download and install a special program *OBS Studio*. This is a software application, quite simple, has a clear interface, free of charge (https://obsproject.com/). Stream recordings should be available on the pages of institutions involved in supporting the education of students with ASD.

Google Forms can be used as one of the universal tools for the Internet. It provides the creation of contact forms, simplifies the collection of information. *Google Forms*, along with *Docs*, *Spreadsheets,* and *Presentations* is part of Google's suite of online application tools to help one implement them for free in your browser.

The results of the study are saved and processed in *Microsoft Excel*. This is a spreadsheet editor, part of the *Microsoft Office* suite. Data stored in *xls* format and can be conveniently used for further data analysis with the appropriate software.

IBM SPSS Statistics is a software environment for statistical data analysis that provides the basic needed for the analytical process at all stages. It provides the ability to analyze virtually any structured or unstructured data, including surveys and web data, as well as information in corporate databases. The SPSS statistics base includes a wide range of statistical procedures that will help to understand data, obtain reliable results, and visualize them.

RStudio is free, open source software for data analysis and visualization, research support, and more. *RStudio* is also releasing *RStudio Team*, a modular platform for commercial software products that gives organizations the confidence to use the *R*, *Python* and other research software. Together, open source software and commercial *RStudio* software form a complete cycle. *RStudio Desktop* installation packages are available for *Windows, OS X* and *Linux*.

The implementation of the multi-step testing of the studied software with a questionnaire survey of participants requires the use of scaling methods. There are a number of scaling methods used in surveys, that might be suitable, ie the semantic differential (Osgood scale), the Likert, Gutman, and Thurston scale. In this study, it is proposed to use the Likert psychometric scale to study the usability of educational software.

The questionnaire in the survey with Likert scale [27-31, 34, 35] uses a 5 or 7-point scale, which is ranked from one extreme relation to another. Likert scales are one of the ways to measure thoughts, perceptions and behavior. For example, in 5-point Likert scale users should indicate the level of agreement with the statement, from high to low with one neutral option in the middle. If the paper questionnaires were filled out, the obtained results should rather be translated into electronic form. After that, some additional analysis should be performed.

Here is an example of a Likert-type scale for "satisfaction" with a particular product:

- Very satisfied.
- Rather satisfied.
- Neutral.
- Rather unsatisfied.
- Very unsatisfied.

To assess the effectiveness of the student`s interaction and the recommended program, parents are asked to fill in a questionnaire with the following questions, and choose a score from 1 to 5 for the statements *Very dissatisfied - Very satisfied*:

1. How fast was the download was?
2. How complicated was the process of installing this software?
3. Are you satisfied with the cost of this software?
4. How convenient do you think the interface of this software is?
5. How useful do you find the supporting documentation for this software?
6. Are you satisfied with the stability of the recommended software?
7. Does this software allow to interact with other users?
8. How satisfied are you with the capabilities of this software?
9. Would you recommend this software to other children with ASD?

10. How effective was the recommended software for your child?

After completing the survey, the results are processed. If the paper questionnaires were filled out, the results should be transferred into electronic form.

4. Experiment

A prerequisite for the ability to watch the broadcast in real time is the presence of an announcement on the website of the appropriate institution (the site of an inclusive school) with a link. The description of the stream gives the characteristics of the recommended software applications. IT specialists start the broadcast by acquainting parents, teachers, and everyone with the optimal software to support training on the desired topics (Fig. 5).

The interaction of cartoon characters and children with ASD requires in-depth research because developers have to take into account the individual characteristics of each child and the behavior of such children. Color accents can also play a key role in the student's interaction with the software application. People with ASD often avoid sharp color accents, prefer harmonious additive color combinations, etc.

In software applications, one should also pay attention to the motor abilities of the child with ASD. For example, to move certain objects on a tablet or mobile device (Fig. 6), the child must have the appropriate skills.

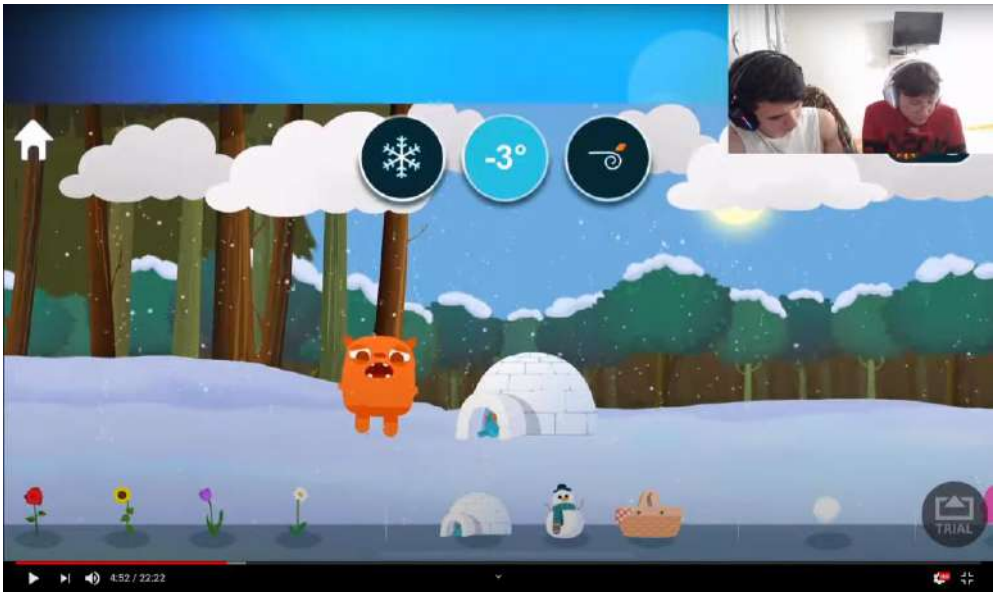


Figure 5. A fragment of the stream where the character is discussed to interact with a student

5. Discussions

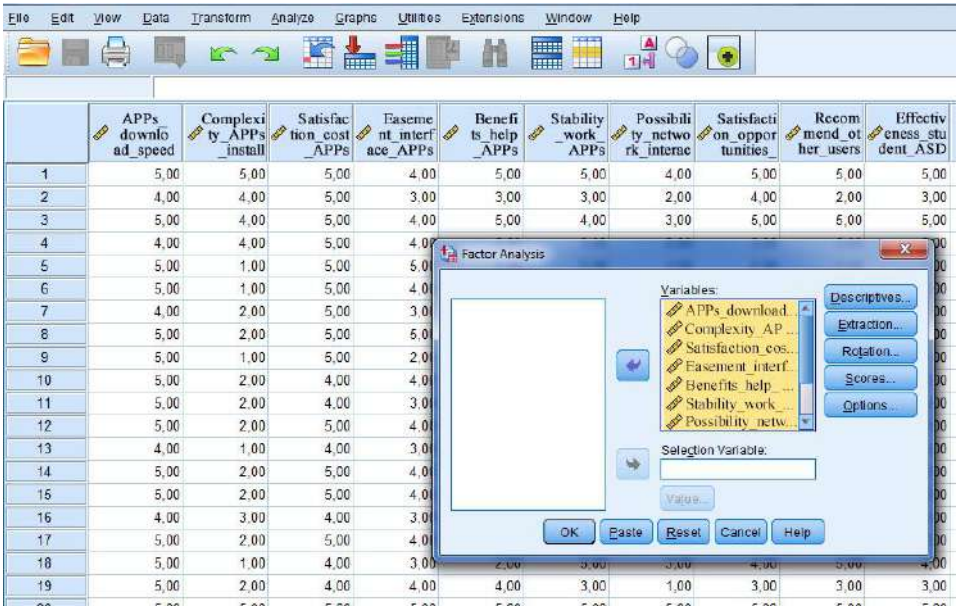
After the stream, parents, teachers, and anyone interested (for example, school administration) are asked to download a specially designed questionnaire that uses the Likert psychometric scale, implemented through *Google forms*. In a performed research, 38 respondents were involved in the survey, and the results from *Microsoft Excel* were uploaded to *SPSS Statistics* for further analysis. To perform factor analysis and isolation of the main components, the command *Analyze - Dimension Reduction - Factor* was performed (Fig. 7).

The factor analysis begins with the interpretation of the correlation matrix and compliance with the Bartlett sphericity criterion ($p < 0.05$), which indicates the feasibility of factor analysis, and the value of CMO on the accepted adequacy of the sample ($0.741 > 0.5$). The obtained results confirm the possibility of such an analysis. Correlation coefficients indicate the density of the relationship between the variables of this array (Fig. 8). In the resulting table, you can see high values of correlation between variables.

The isolation of a few factors is explained by the total variance, which works by the method of principal components (Fig. 9, a). Thus, the optimal number of factors is three. The graph of *shedding* (Fig. 9 b) shows its own values in the coordinate system, which confirms the number of factors. To obtain information that variables correlate with factors 1, 2, 3 allows the matrix to invert the component. For example, *Benefits of Software Help* correlates well with Factor 1, *Software Download Speed* with Factor 2, *Software Installation Difficulty* with Factor 3.

Figure 6. A fragment of the stream, which involves motor capabilities of a child with ASD

Visualization of the results of the survey based on Likert data is implemented with the means of *Microsoft Excel* spreadsheets in the form of a histogram with accumulation. Such visualization is possible after calculating the number of psychometric assessments of respondents, ie how many times was chosen *Very dissatisfied*, *Rather dissatisfied*, etc. The formula = COUNTIF (range: to; condition) was used for this sub-account (Fig. 10).



	APPs_download_speed	Complexity_APPs_install	Satisfaction_cost_APPs	Easement_interface_APPs	Benefits_help_APPs	Stability_work_APPs	Possibility_network_interne	Satisfaction_opportunities_	Recommend_other_users	Effectiveness_student_ASD
1	5,00	5,00	5,00	4,00	5,00	5,00	4,00	5,00	5,00	5,00
2	4,00	4,00	5,00	3,00	3,00	3,00	2,00	4,00	2,00	3,00
3	5,00	4,00	5,00	4,00	5,00	4,00	3,00	5,00	5,00	5,00
4	4,00	4,00	5,00	4,00						
5	5,00	1,00	5,00	5,00						
6	5,00	1,00	5,00	4,00						
7	4,00	2,00	5,00	3,00						
8	5,00	2,00	5,00	5,00						
9	5,00	1,00	5,00	2,00						
10	5,00	2,00	4,00	4,00						
11	5,00	2,00	4,00	3,00						
12	5,00	2,00	5,00	4,00						
13	4,00	1,00	4,00	3,00						
14	5,00	2,00	5,00	4,00						
15	5,00	2,00	5,00	4,00						
16	4,00	3,00	4,00	3,00						
17	5,00	2,00	5,00	4,00						
18	5,00	1,00	4,00	3,00	2,00	3,00	4,00	5,00	4,00	
19	5,00	2,00	4,00	4,00	4,00	3,00	1,00	3,00	3,00	3,00

Figure 7. Setting variables for factor analysis

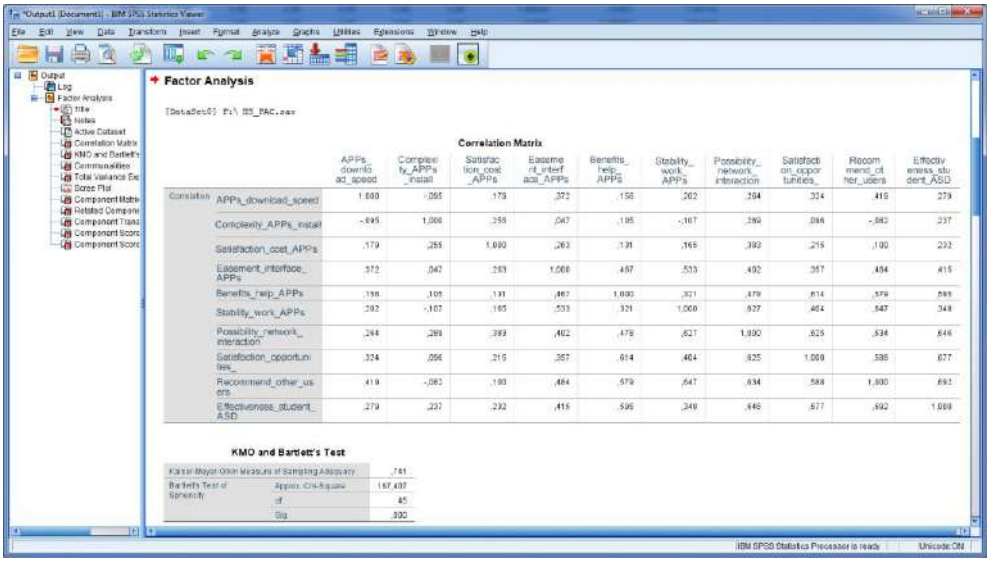


Figure 8. Type of correlation matrix, CMO and Bartlett coefficients

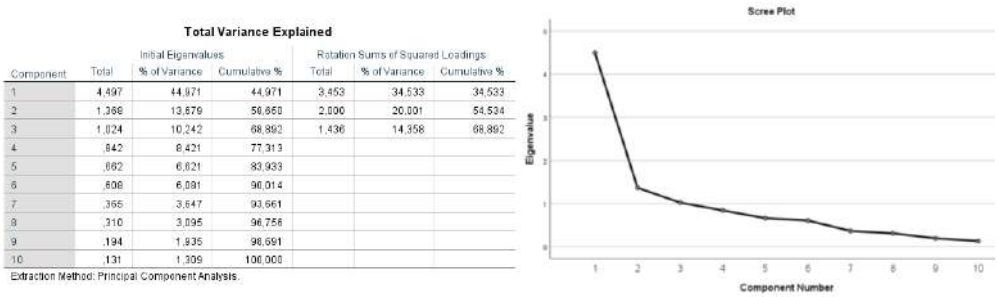


Figure 9. a) Isolated factors b) Shedding of components

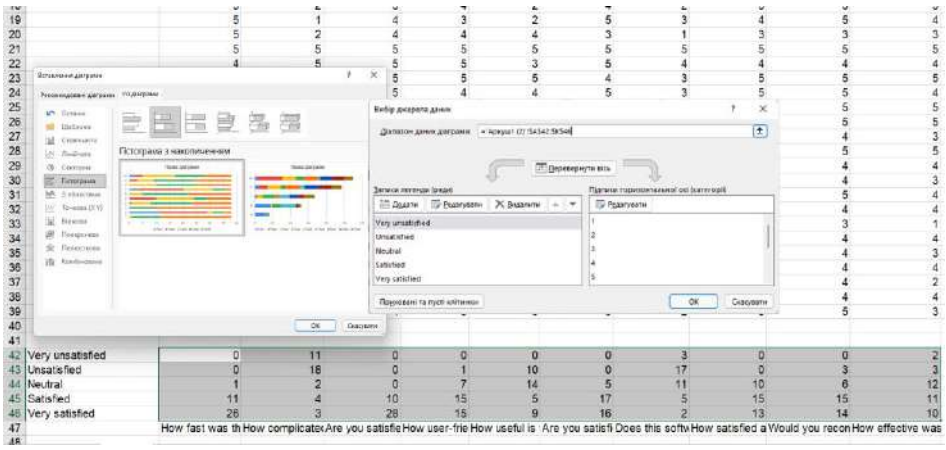


Figure 10. Excel window in the process of outputting data in the form of a histogram

Visualization of the results of the survey of respondents to determine the effectiveness of the software application *Math Kids* is shown in Fig. 11.

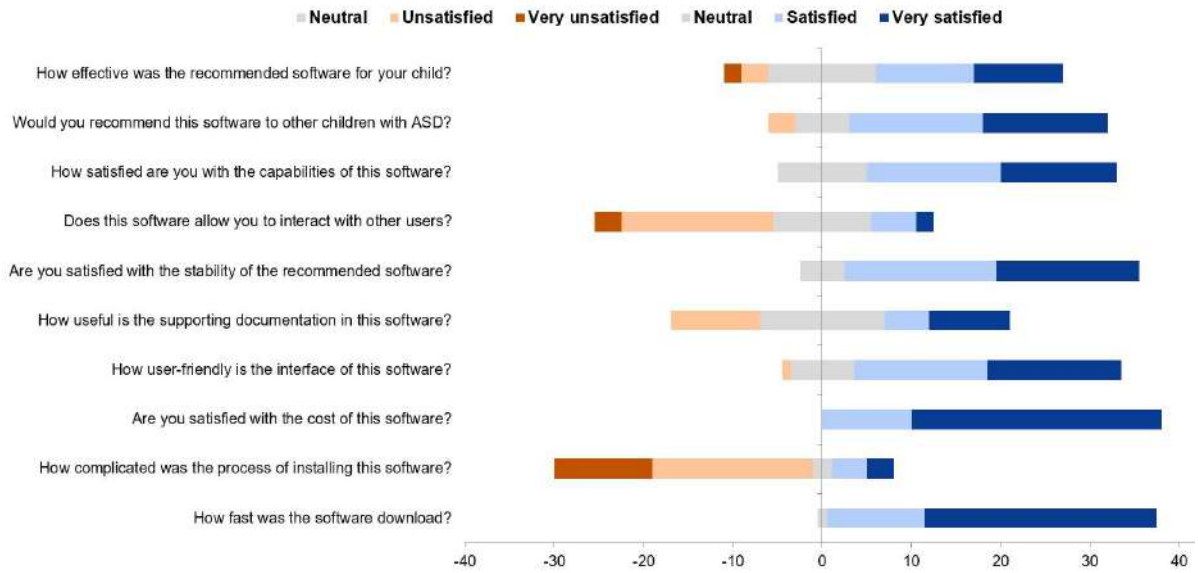


Figure 11. Visualization of the results of the survey of respondents to determine the effectiveness of the software application Math Kids

The results show that parents experienced some difficulties with downloading process. As a negative feature was mentioned the lack of communication with other students because most of the applications are designed for the individual training. The teacher would appreciate the ability to combine the results of all his students.

6. Conclusions

The article described the concept of supporting the process of choosing an application for teaching children with ASD. A system concept has been developed. Testing of the recommended software to support the learning of children with ASD was conducted and the results were analyzed. In the choice and substantiation of methods and means of solving the problem, it is proposed to evaluate the effectiveness of educational and developmental software by a survey using the psychometric *Likert* scale. The choice and justification of the means of solving the problem was made, *YouTube* platform with a special program *OBS Studio* was used for streams, the questionnaires with *Google Forms* tools were used for surveys, *Microsoft Excel* for data processing, *IBM SPSS Statistics* for data mining.

The *RStudio*, a software environment for statistical processing and visualization of data that uses the *R* programming language, is effective for processing and displaying *Likert* scale data. In future research, we will use *RStudio*, where *ggplot* packages (developed by Hadley Wickham) and *HH* (proposed by Heiberger), as well as the *Likert* package by Jason Brier [32]. This package contains options for pre-generalized data, but this option has limited flexibility.

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