Analyzing of main trends of STEM education in Ukraine using stemua.science statistics

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Abstract. STEM-education is a modern effective approach that nowadays can be interpreted in very different ways and it even has some modification (STEM/STEAM/STREAM). Anyway, the "New Ukrainian school" concept includes approaches similar to STEM-education. However, there wasn't analyzed the current state of STEM-education in Ukraine. We propose to analyses it by using SEO analysis of one of the most popular STEM-oriented cloud environment in Ukraine stemua.science. It is proposed to use the cycle for cloud-based educational environments (publishing/SEO analysis/team's brainstorm/prediction/creation of further plan) to improve their efficiency. It is found, that STEM-based and traditional publications are characterized by similar demand of educational process stakeholders. However, the way how teachers and students found the publication proves that traditional keywords (47.99 %) used significantly more common than STEM keywords (2.67 %). Therefore, it is proved that STEM-methods are less in demand than traditional ones. However, considering the huge positive effect of the STEM method, stemua.science cloud educational environment provides a positive effect on the educational process by including the STEM-aspects during finding traditional approaches of education by stakeholders of the educational process.

Keywords: cloud educational environment, STEM, trends, education, scientific method.

1 Introduction

Nowadays, STEM is a very developed, modern and effective branch of education in all, elementary, middle and high education. However, there no single concept to implement it. Therefore, it was proposed to modify STEM to STEAM or even STREAM. By the way the interpretation of those approaches may differ and be modified (for example, A may be deciphered as ART [37] or as ALL [39]; R may be deciphered as READING [2; 29], as WRITING [2; 29] or RELIGION [22]). And it is a challenge as for the

implementation of the STEM in cloud educational systems [43] and as for personal author who creates the STEM-lessons [17]. And it seems relevant to analyze the most demand directions in STEM/STEAM/STREAM education.

Nowadays, stemua.science [31] (Ukrainian STEM-cloud environment) is successfully functioning and few hundreds of works are already published in the e-resource. The recourse is characterized by open-type with moderation and it means that each teacher can present own work to the sociality by publication on web. Therefore, it is possible to use 2 years' experience of its functionality to provide analysis on demand usage of the methods presented on stemua.science.

This work aims to provide an analysis of the trends of usage of the STEM-methods and prediction of the further trends in STEM-education. In addition, it will be described the most popular topics and analysis of it which will be useful for the authors further.

2 Literature review and problem statement

It is well-known that STEM-education is a reaction to the market changes in USA at the beginning of the XXI century which is characterized by needs improvement of math knowledge and skills and providing critical thinking and making decisions of modern workers. Therefore, it was necessary to make changes in educational system by taking into account those challenges [7; 45].

Ukraine provides the reforms of education during a durable period. And the reforms of educational system differed from each other. Today, the reforms provided with impression of USA educational system witch partially implemented in the European countries due to its efficiency in USA. The planed reforms ("New Ukrainian school" [3; 6; 10]) are similar to those were provided in Poland where implemented the integration to study all natural subjects [13] and commonly there used transdisciplinary approaches in different forms such as providing of transdisciplinary days where students investigate some objects using whole day and research it from different points of understanding (physics, chemistry, history, art and etc.). In addition, it includes elements of international educational programs such as Science education (European Commission) [11] and Education 2030 [21]. However, Ukraine, unlike Poland, characterized by buffer state of the educational system. It means that reforms, declared by the Ministry of Education and Science of Ukraine, will be provided slower and it is necessary to provide analysis of its state. Despite the fact that STEM-education does not officially declare necessary to implement, the new educational programs include its elements such as research projects and there planned to implement transdisciplinary subject "Sciences", which, in addition to transdisciplinary, foresees using of the methods based on research. This is very similar to STEM-approach in education. Anyway, STEM-education nowadays in Ukraine is very popular and developed educational branch [5; 6; 36].

The creation of educational resources for teaching STEM no longer relies solely on the activity of traditional publishers [41]. It means that different publishers can provide the investigation of the STEM-based content and important role in it is belongs to cloud-based education environments and the effect of them usage may be even better

compare to traditional approaches in education [8; 9; 14; 46] or can create some new possibilities to provide the experiment or visualization [49]. In addition, cloud-based environments characterized by possibility to overcome the limitations of traditional classrooms [30], can provide active way of cognition [4] and may provide personal-oriented education [26]. One of their advantages is possibility to find trends in the educators need by using SEO analysis results.

Nowadays, few cloud STEM-based environments function on the web. For example, http://www.sciencebuddies.org/ web-environment [12; 20] provides methodical support for STEM-education and there presented methods related to scientific and engineering methods. However, open-source statistical information about current state and trends related to this environment isn't presented. Other systems, also do not provide analysis of the current state of cloud trends in STEM-education.

Considering the above, we assume that STEM methods are used less common than traditional approaches of education in Ukraine. However, in order to prove it, providing the analysis is necessary.

3 Methods

Methods of deduction, induction, analysis, and synthesis were used. To archive results, SEO analytical systems were used. To active semantical analysis of the stemua.science, online.seranking web-service was used. Online.seranking web-service was chosen due to its high level of visualization and providing more detailed analyzing compare to well-known Google Analytics or Yandex Metrics. To obtain statistical information, Cloudflare web-service was used.

Analysis of trends of STEM-education in Ukraine was provided by analyzing the main keywords and topics on stemua.science people used. Further prognosis and the general state of STEM-education was provided using this data.

4 Method of the using SEO analysis data to find trends in the field

Development of the SEO provided the development of analytical data introduced by different SEO-services [1; 18; 48]. It is well known that SEO analytic is used in commercial [15; 42] but we propose to use it social cloud educational projects by analyzing their data and provide improvement based on the SEO analytic. Previously, it was proposed to use Google Trends (SEO analytics) to find correlation of its results with demand and it's forecasting in tourism [27; 28], housing prices and sales [47] and private consumption [44]. So, results of SEO analysis can be used to find trends and provide forecasting in different fields.

We propose to use SEO-based analysis in educational field to provide forecasting of the demand it optimization of the cloud-based environments by using of the circle of content creation in cloud educational environments (include stemua.science). The circle can be interpreter as the cycle of creation and publishing of the materials, presenting of

the results, providing of the SEO analysis of the current state of the social cloud educational projects, analysis of the main keywords used to find the publication (in our case, its scientific works and methods), providing of the authors brainstorm, prediction, creation of the further plan of social cloud education system development and then circle recycling starts from publishing (fig. 1).

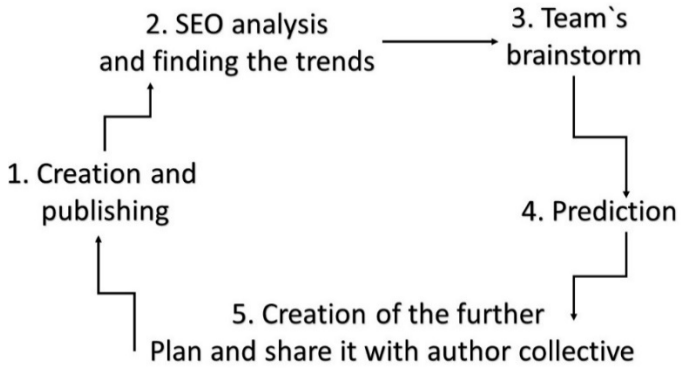


Fig. 1. Proposed method to improve the content quality of educational cloud web-environment and finding the trends

Finding the trends comes possible by modern SEO approaches such as semantic analysis [16]. The service online.seranking provides a detailed analysis include finding the most common keywords and topics people finding on. In addition, it gives the possibility find relationships between keywords people used to find and topic where its presence.

We propose to use the results of the analysis to find the main trends in STEM cloud informational field by using its correlation with the demand on the methods presented in the stemua.science environment due fact that there presented both, digital methods on casual education classes and modified methods related to STEM-approach in education. Examples of the STEM-based methods and traditional methods presented in table 1.

Table 1. Examples of STEM-based methods and traditional methods

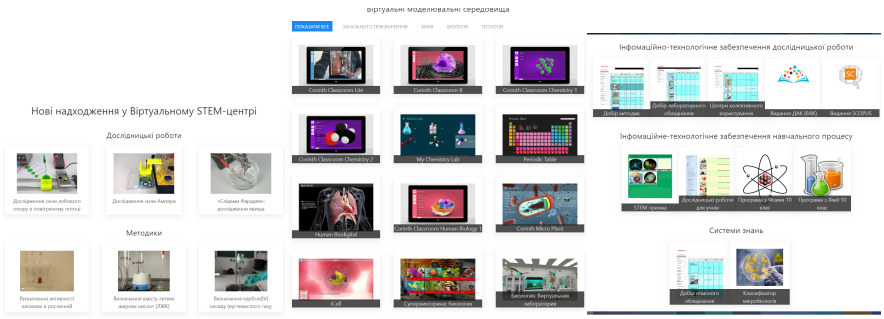
STEM-based		**Traditional**	
Method	**Research work**	**Method**	**Research work**
Determination of protein isoelectric point	Water transport in the plant. Production of the artificial leaf	Determination of water hardness	The anatomical structure of the leaf
Determination of carbon dioxide in the gas mixtures	Explore the wildlife of the area using Google Lens	Methods of analysis of legal acts on the site zakon.rada.gov.ua	The structure of the Euglene green

Therefore, it is possible to provide both analysis of the most useful publications in the cloud environment and most common keywords people using to find the necessary

publication. The last indicators actually will characterize the demand of the teachers and students on educational products.

5 The general state of stemua.science and it's semantic

The general idea of the stemua.science [31] is to integrate all necessary instruments of STEM-education in one cloud environment. Therefore, it represents virtual modeling environments [33; 34], including modern nowadays augmented reality instruments [19; 23; 24; 25; 38; 40], research works and methods by which it is possible to make them. In addition, ontological scientific instruments [32; 35] which will be useful for both student and teacher in their STEM-activities are located in the cloud environment. Therefore, stemua.science contains areas for all of those directions. Methods and research works, virtual modeling environments and ontological instruments of stemua.science cloud environment is presented in figure 2.



a) b) c)

Fig. 2. Methods and scientific works (a), virtual modeling environments (b) and ontological instruments (c) of stemua.science cloud environment

The cloud environment stemua.science is yang but perspective web-site. As shown in figure 3, the stemua.science is in the same semantic field that educational environments of Ukraine. However, all websites do not relevant to STEM-education and, all except studupedia.com.ua, do not characterized by containing information can be used for lessons preparation but contains information such as videos or news. Stemua.science now characterized by 782 organic keywords and 486 people per month of organic traffic (up to 20 000 unique users per mount).

Nowadays, even Ukrainian STEM-resources are demanded worldwide. Articles, written in Ukrainian, are used by users from differed countries. Sure, as it was devoted for, Ukrainian users are the most common visitors of the web-site and their traffic is up to 20 000 views of the website per day. Due to high level of STEM-education development in the USA, visitors of United States of America are characterized by high activities on the differed STEM-cloud services, include, stemua.science. The amount of their visits is up to 2 000 per day. A lesser amount of traffic comes from visitors

from Germany, Netherlands, and the Russian Federation. Traffic distribution by countries is presented in figure 4 and table 1.

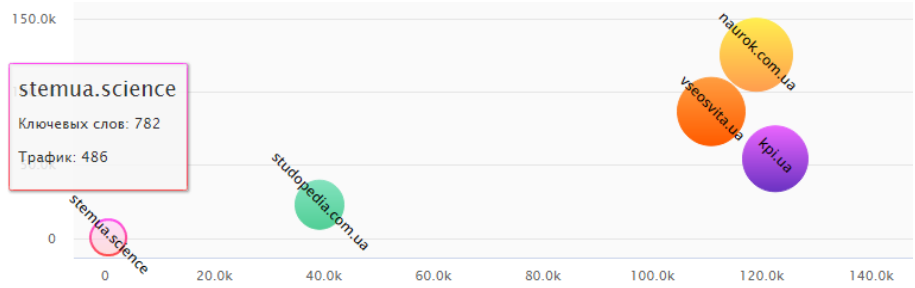


Fig. 3. Semantical characteristics of the stemua.science

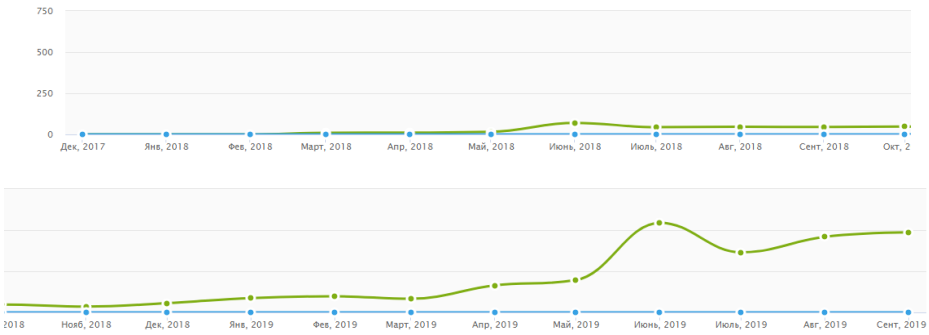
Fig. 4. Traffic distribution by countries

Table 2. Traffic distribution by countries

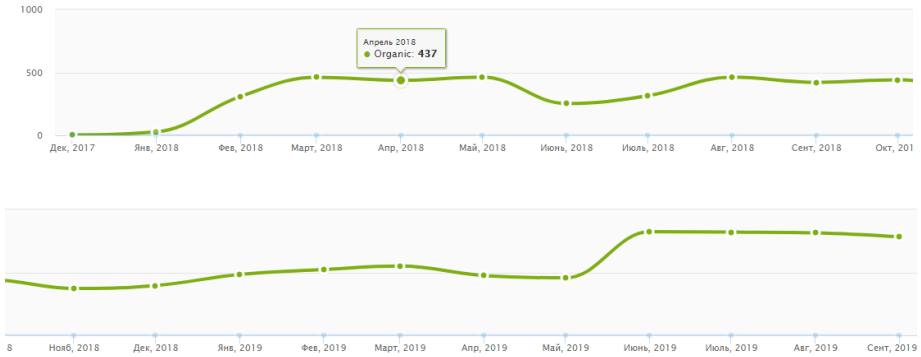
Country	Traffic, view per day
Ukraine	Up to 20 000
United States of America	Up to 2 000
Germany	Up to 300
Netherlands	Up to 250
Russian Federation	Up to 200

The organic traffic, amount of the keywords and potential costs of the traffics per mount are characterized by grooving which proves the further potential of the stemua.science environment. The dynamics of traffic, amount of the keywords and potential costs of the traffics of the stemua.science is presented in figure 5.

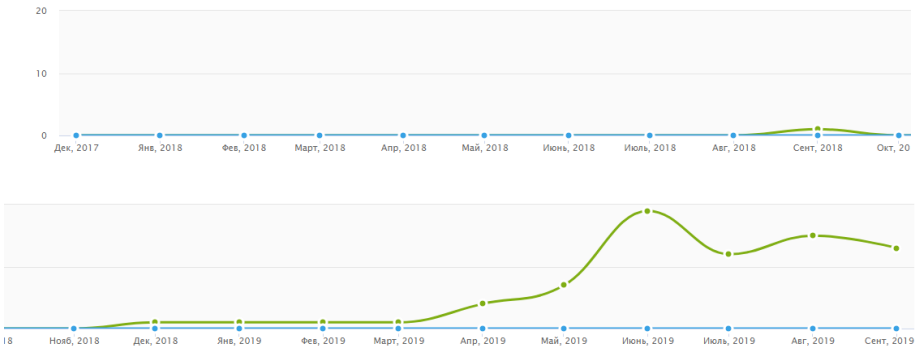
So, stemua.science is a useful international cloud resource. Its auditory is mostly represented Ukrainian teachers and students' trends and usage of its data can be used for the analysis of trends in Ukrainian education.



a)



b)



c)

Fig. 5. The dynamics of traffic (a), amount of the key words (b) and potential costs (c) of the traffics of the stemua.science

6 Finding trends of education in Ukraine, demand analyzing and adapting to trends

The results of the top pages of stemua.science in organic search represent the current state with demand on the developed methods. It proves that methods of both, traditional and STEM-approaches are used by stakeholders of educational process of Ukraine. The statistical information on the top pages of stemua.science in organic search in the table.

According to the table, 30.67 % of the organic traffic in the most popular publications comes from STEM-approach methods and research works which is not significantly higher than traffic obtained from traditional ones (with 28% of the organic traffic). Therefore, general relation between STEM-based methods and traditional ones will be close to 52 and 48 %, respectively. The relation between STEM-based methods and traditional ones in organic search is presented in figure 6 and detailed analysis of the statistical information on the top pages of stemua.science in organic search is presented in Table 3.

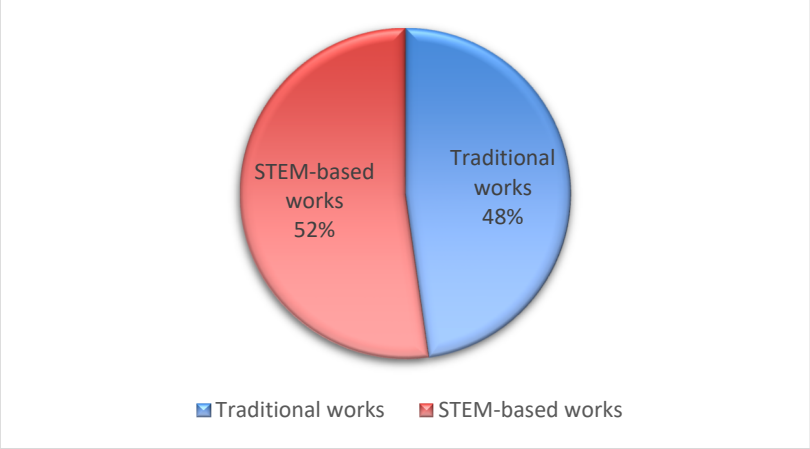


Fig. 6. The relation between STEM-based methods and traditional ones in organic search

However, a little bit more effective to find the demand of the students and teachers of educational process of Ukraine will be the keyword analysis that will represent the necessaries of the stemua.science portal. The teachers and students who are looking for the STEM-approaches will be commonly used terms which are a little bit different as declared in educational programs and they will be such as “the research of something” or transdisciplinary process researches. The group of users who are looking for information related to traditional educational process, unlike previous, will use the terms declared by educational programs of Ukraine. Therefore, it is possible to analyze the needs of users and classify them as searchers looking to find information for usage during traditional educational process and those ones which are related to finding information to create STEM-based classes. The analysis of most keywords presented in organic traffic is shown in table 4.

Table 3. The statistical information on the top pages of stemua.science in organic search

Name of the work	Traffic share, %	Estimated traffic	Keywords number	Type of the publication
Chlorophyll fluorescence monitoring	21.33	16	3	STEM
A study of the motion of a body thrown at an angle to the horizon	10.67	8	1	Traditional
Investigation of the refraction of light	8	6	3	Traditional/experiment simulation
Plasmolysis and deplasmolysis phenomena	5.33	4	5	Traditional
The study of the phenomenon of cooling the mixture	4	3	5	STEM
Methods of analysis of legal acts on the site zakon.rada.gov.ua	4	3	24	Traditional
Diffusion chamber modeling	2.67	2	1	STEM
Exploration of charged particle tracks by photos	2.67	2	2	STEM/experiment simulation

Table 4. The analysis of the most common keywords presented in organic traffic

Keyword	Relation with publication	Position	Traffic share, %	Traffic	Keyword mark
Chlorophyll	Chlorophyll fluorescence monitoring	25	21.33	16	Used in traditional education process
Body movement threw at an angle to the horizon	A study of the motion of a body thrown at an angle to the horizon	4	10.67	8	Used in the traditional education process
Refraction of light	Investigation of the refraction of light	24	6.67	5	Used in the traditional education process
Plasmolysis and deplasmolysis	Plasmolysis and deplasmolysis phenomena	1	4	3	Used in the traditional education process
Wilson camera	Diffusion chamber modeling	10	2.67	2	Is recommended demonstration in the traditional education process
Body movement threw upright	Investigation of body movement thrown upright	2	1.33	1	Used in the traditional education process
Thread tension force	Measurement of the moment of inertia of the body (option 2)	20	1.33	1	Used in the traditional education process
Aberration of lenses	Lens aberration studies	3	1.33	1	Used in the traditional education process
Spring hardness formula	Investigation of elastic properties of bodies	26	1.33	1	Used in the traditional education process

The analysis proves that organic traffic comes from the words mostly do not related to STEM education. Only term “Wilson camera” can be classified as keyword used untraditional classes (STEM-education). The terms like “chlorophyll”, “body movement thrown at an angle to the horizon”, “Refraction of light”, “Plasmolysis and deplasmolysis”, “Thread tension force”, “aberration of lenses” and, specially, “spring hardness formula” (due its used only for finding the answer on the concrete question) are can’t be classified as requests request made by users trying to finding the STEM-based material. So, 47.99 % of organic traffic (most common keywords) comes from the not-STEM keywords which are significantly higher than the ones from STEM-keywords (2.67 %; Wilson camera).

7 Discussion

So, the most important information, based on the results of the analysis of the most common keywords presented in organic traffic (table), is that stakeholders nowadays are looking for two main categories of the information: how to prepare traditional classes (teachers) and just-find-the-answers requests (students). This means that STEM-approach today not characterized by a high demand by the general stakeholders of the educational process of Ukraine. However, it is proved that there is a positive effect of the STEM-approach implementation and it is a good idea to increase the amount of its implementation. So, based on the statistical information on the top pages of stemua.science in organic search (table 3, fig. 5), which show similarity of the popularity of both STEM-based and not-STEM based publication. So, people who try to find the information on the traditional questions will be involved in the studying of the STEM-methods on the question which interested the users. Therefore, cloud environment stemua.science will gradually involve the teachers in providing the STEM-education by developing their methodological base of STEM-education even on the traditional requests.

However, nowadays, it is more necessary to create traditionally-based content. It does not mean that creation of the STEM-content isn’t important but it only means that nowadays the demand on the traditional education declared by educational programs is higher than on the STEM-based methods. The trends are changeable by time and it means that it is even more important to provide the dynamical analysis of the trends.

8 Conclusions

1. Firstly, it is proposed to used SEO analysis results to find the demand for the educational stakeholders.
2. The cloud environment stemua.science is representable to find the demand for Ukrainian educational stakeholders due its users mostly belong to Ukraine.
3. It is shown that educational stakeholders are mostly using not-STEM keywords to search for information.
4. The stemua.science environment involves educational stakeholders of Ukraine (and world) to provide the STEM-education.

5. The dynamic analysis of demand will be provided in the further researches to establish the changes of the educational stakeholders of Ukraine demand in further research work.

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