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Analytical Study of Physics Education Websites' Content

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Abstract The current study is compatible with the scientific mobility in dealing with the Internet as a source of knowledge. It aims to introduce the Physics Education Websites (PEWs) and guide their followers toward the most credibility of them by analyzing their content. The sample consisted of (36) websites which were selected according to specific criteria by using Alexa search engine. To collect data, a questionnaire was used as a tool of analysis included (25) items which were distributed to (5) standards: authority, coverage, currency, accuracy and objectivity. The findings showed variations in the availability ratio of credibility standards and indicators in relevant websites. Finally, the study recommended that it is necessary to review and update the PEWs periodically; because physics as a natural science needs observing its accelerating discoveries and activities.

Keywords Physics Education, Physics Education Websites, Websites' Credibility Standards

1. Introduction

Nowadays, Websites are considered as one of the important sources of information for a wide spectrum of audience. There are various types of websites including sites for government organizations, business, sports, and education. Educational websites are designed by Universities, schools and research centers to introduce experiences to the relevant audience all over their academic levels. Many studies have pointed to the importance of educational sites in interactive learning anytime and anywhere, and also developing additional skills for students such as effective communication, leadership, critical thinking and problem-solving [11]. These sites also offer opportunities for instructors and researchers to develop their abilities through communication with their counterparts, participation in online conferences and follow-up to relevant scientific journals.

Physics Education Websites (PEWs) introduce a suitable virtual environment for the audience to deal with physics. A lot of physical phenomena such as motion in space, electricity, magnetism, atoms and nucleus cannot be understood without hands-on activities in the laboratory which are occasionally difficult to do [1]. But through models, photos, diagrams and videos which are provided by PEWs, the learner can understand events and phenomena, linking between their elements, manipulate mathematical relationships, and form physics theories. These sites also include different kinds of sources such as books, pamphlets, and articles which help interested people in thinking and deep knowledge [3].

When examining a specific topic, a follower seeks to visit more than one relevant website, but the problem is which of these sites has credibility and a higher accuracy? Although there is no way to control the quality of published content in these sites in all fields, researchers are trying to develop standards that applied to the Websites to verify their characteristics and reach a higher degree of precision required for all followers and visitors to access the relevant site safely.

One of the most common methods for websites assessment was Quality Evaluation Method (QEM) proposed by Olsina et al. [8]. It can be considered as one of the main approaches consists of four main factors for analyzing websites' content: functionality, usability, efficiency and site reliability. Also, a Web Assessment Index (WAI) can be used to achieve the same purpose, and have four main components: accessibility, speed, navigability, and site content [6]. Other studies shed light on an importance of the review of educational websites periodically. For example, the study conducted by Hasan [4] evaluated the usability of educational websites from the point view of students, Singh and Kumar [10] introduced a practical model for website quality evaluation, Moustakis et al. [7] presented a hierarchical framework which supports website quality assessment, Vultur and Marincas [12] evaluated the academic websites of the most important Romanian Universities, and finally Papadopoulos [9] who examined the evaluation of the new version of the Hellenic Open University (HOU) website.

The current study falls in line with the contemporary effort which aims to introduce PEWs and guide the followers to the most credibility of them. This study is important for educators, researchers, students and all those interested in physics. It tries to answer the following question:

What is the availability ratio of credibility standards in Physics Education websites?

2. Method

2.1. Study Sample

Table 1. Classification of Physics Education Websites

Classification	Category	Number	Percentage
1a. Owner	Individual	24	66.67%
	Organization	12	33.34%
1b. Home of Owner	USA	21	58.33%
	Arabic World	5	13.89%
	United Kingdom	3	8.33%
	Canada	3	8.33%
	Europe	2	5.56%
	India	1	2.78%
	Singapore	1	2.78%
2. Content	Educational lessons	26	72.22%
	Media	10	27.78%
3. Audience	Public Ed. Students	20	55.56%
	Specialists	11	30.56%
	University Students	5	13.89%

Study Population consisted of (106) PEWs in Alexa Search Engine. Alexa was used because it provides users with the global and local ranking of websites according to the number of visitors, allows the user to rate the site and view links to external relevant sites, evaluates websites periodically, and also gives an information about the owner, date of creation, last update, contact, and address of the site. Study sample was selected purposively as in the following procedures:

- Determining the categories in Alexa search engine: main category(Science), sub-category 1(physics), sub-category 2(education).
- Choosing PEWs that have the high global rank.
- Websites which is consider as a part of university website were excluded, because their global rank is the university rank, they also include study programs, courses, and activities related to physics departments which are not important to achieve the purposes of the current study. Websites relevant to physics education journals were also excluded because they focus on publishing studies and have a high degree of specialty.
- PEWs were selected during the time interval (15 June – 15 August) in 2016.
- Finally, the number of websites which was used as a sample of the study is (36) which is equal (34%) of the study population. Table (1) shows classification of PEWs in terms of three categories: owner of the site, content, and audience.

2.1.1. Owner of the Site

Owner (or owners) may be individuals who hired their personal efforts, qualifications, and experiences to design a website, or may be organizations that use the site as a part of their media for physics news and activities. The results in the table (1) indicate that individuals own PEWs more than organizations, the ratio is (2:1). Figure (1a) shows the percentage of websites' owners: individuals and organizations. Data in the table (1) also shows that United States of America has the largest number with (21) sites out of (36). The sites originating in the Arabic World have the second rank by (6) sites, then Canada, United Kingdom, Europe, India, and Singapore which have (3, 3, 2, 1, 1) sites respectively. Figure (1b) shows the percentage of websites in terms of the home of the owner.

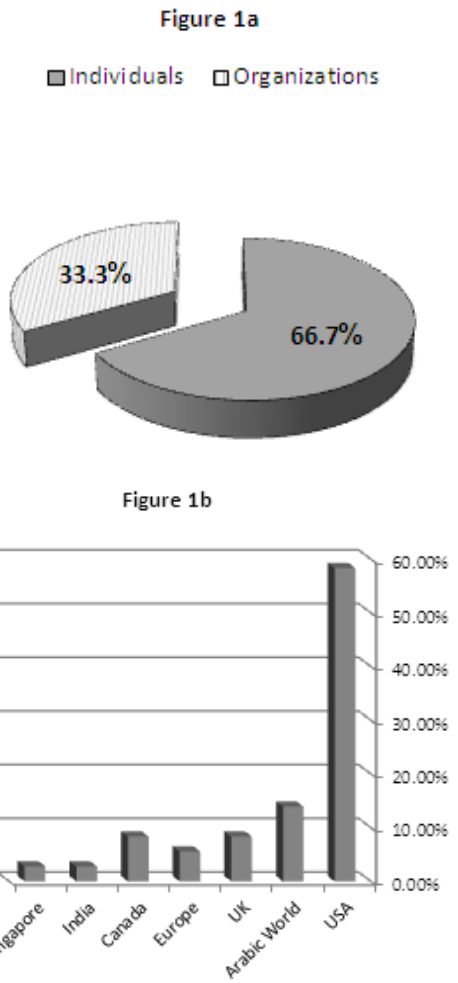

Figure 1. Classification of PEWs according to the owner

2.1.2. PEWs' Content

It was divided in this study into two kinds: 1- media which offer news, articles, conferences and workshops in physics. 2- educational lessons which are offered for students in

public schools or for undergraduate and postgraduate students in universities. The results in the table (1) indicate that the number of sites that offer educational lessons is (26) out of (36), while the number of media sites is 10 only. Figure (2) shows the percentage of websites in the study sample with respect to their content.

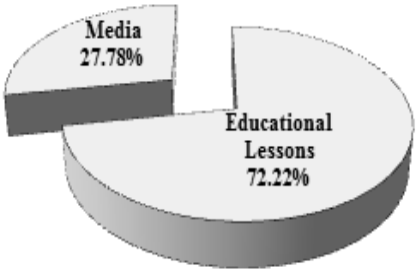

Figure 2. Classification of PEWs with respect to Content

2.1.3. Audience

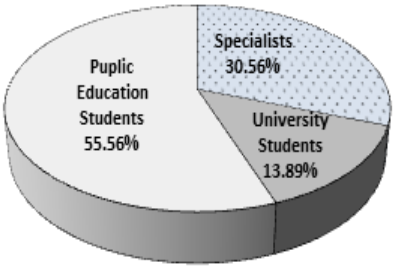

Figure 3. Classification of PEWs with Respect to the Audience.

The current study divided the audience into three groups: 1- specialists such as professors, researchers, physics supervisors and teachers, 2- university students all over their levels, 3- students in the public education all over their stages: elementary, preparatory and secondary. The results in the table (1) indicate that the number of sites that offer content for students in the public education is (20) out of (36) sites. This number is higher than those sites that offer their services for professionals and university students. Figure (3) shows the percentage of PEWs with respect to the audience.

2.2. Study Tool

To analyze PEWs' content and collect data, a survey of a recent literature on education and websites' standards was reviewed [2, 5, 13] to establish a questionnaire which was used as a tool (or a scale) of analysis included (25) items and (5) Standards:

1- **Authority** (items 1-5): It reveals that the person or organization responsible for a website has the qualifications, experience, and knowledge to create and publish it.

2- Coverage (items 6-10): which is related to complete and comprehensive Information in physics.

3- Currency (items 11-15): It is important to know when the site was created, when it was last updated, and if all of the related links are effective.

4- **Accuracy** (items 16-20): It is the responsibility of website to introduce reviewed information with clear writing and without typographical errors.

5- **Objectivity** (items 21-25): means clear motivation and multilingual information with a minimum level of bias.

2.3. Tool Validity

To verify a validity of the study tool, the researcher picked eight specialists in physics and information technology to confirm whether the tool could effectively measure the purpose intended for this research, clarification of some items and their correlation with standards, so as to present the tool and its content in a suitable manner. Also, an internal validity which is determined by the degree to which a study minimizes systematic error (or bias) was verified by calculating Spearman's rank correlation coefficient of each item and the total score of the standard as in table (2).

From table (2) most of the correlation coefficients are significant which refers to validity of the tool which is used to collect data in the study.

2.4. Reliability Test

In order to attain the reliability goals for the tool, Cronbach's alpha coefficient was calculated from the result of the pilot study (n=8), and thus determined the extent or degree of consistency within the tool. The Cronbach's alpha coefficient is 0.87 showing that the reliability level of study tool is high.

2.5. Procedures

After verifying the psychometric measurements of the study tool, the researcher applied the tool on the PEWs which were used as the study sample to analyze their content. Then repeated these procedures after three weeks and applied Holsti formula to calculate the reliability coefficient which is equal (0.9), this value is relatively high and refers to reliability analysis.

Table2. Spearman's Rank Correlation Coefficient of Each Item and the Total Score of the Standard

		Authority	Coverage	Currency	Accuracy	Objectivity	Total Score
Authority	Correlation Coefficient	1	0.322	.529**	.736**	.427**	.831**
	Sig. (2-tailed)	.	0.056	0.001	0	0.009	0
	N	36	36	36	36	36	36
Coverage	Correlation Coefficient	0.322	1	.687**	.563**	.333*	.677**
	Sig. (2-tailed)	0.056	.	0	0	0.047	0
	N	36	36	36	36	36	36
Currency	Correlation Coefficient	.529**	.687**	1	.713**	.359*	.850**
	Sig. (2-tailed)	0.001	0	.	0	0.031	0
	N	36	36	36	36	36	36
Accuracy	Correlation Coefficient	.736**	.563**	.713**	1	0.315	.846**
	Sig. (2-tailed)	0	0	0	.	0.061	0
	N	36	36	36	36	36	36
Objectivity	Correlation Coefficient	.427**	.333*	.359*	0.315	1	.603**
	Sig. (2-tailed)	0.009	0.047	0.031	0.061	.	0
	N	36	36	36	36	36	36
Total Score	Correlation Coefficient	.831**	.677**	.850**	.846**	.603**	1
	Sig. (2-tailed)	0	0	0	0	0	.
	N	36	36	36	36	36	36

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

3. Study Findings and Discussions

Study findings were obtained after applying the study tool on the PEWs which were used as a sample. An average and standard deviation were calculated for each item, and also an intervals of a typical five-level Likert scale were calculated to determine the availability ratio of credibility standards and indicators as follows: calculating the Range(max. score – min. score = 5-1= 4), then calculating the category interval (=Range/max. score = 4/5 = 0.8), so we have 5 intervals as shown in table (3).

Table 3. Average Intervals of the Tool Items and Their Availability Ratio in Relevant Websites

Average Interval	Availability Ratio
1.00 - 1.80	Never
1.81 – 2.60	Rarely
2.61 – 3.40	Occasionally
3.41 – 4.20	Often
4.21 – 5.00	Always

Also, averages were transformed to Percentage of Availability from the equation: Percentage = [(Average – 1)/Range] × 100%.

Data were collected and then arranged in the table (4) to discuss the study question: "What is the availability ratio of credibility standards in PEWs?".

Table (4) shows that standard 3 (S3: Currency) has smallest weighted average with value (2.67) out of (5) and percentage of availability (41.8%). Item X_{12} states that (Information is up to date) occupied in rank (14) in the scale with average (3.56), this item and its value raised the availability ratio of S3 in the PEWs which were used as a sample in this study. This result reflects that most of the websites seek to provide their followers and visitors with updated physics news, information, discoveries, and applications. Other websites do not take care of update their self continuously because their content is historical written lectures include physics concepts or laws or theories, and it is not important to update them frequently, but merely refers to the date of loading the lecture or the date of these laws and theories.

On the opposite side, item X_{15} states that (Related links are current and updated regularly) has average (2.06) and rank (24) decreased the availability ratio of S3 in the PEWs. The importance of including a website with friendly relevant sites or links increase followers' understanding and diversifying their knowledge, but most importantly is a regular update of these sites and provide followers on which of these websites appear and which of them disappear from time to time.

Standard 4 (S4: Accuracy) has largest weighted average with value (3.97) out of (5) and percentage of availability (74.3%). Three items of this standard (X_{20}, X_{19}, X_{18}) occupied in the first three ranks in the scale with averages (5,

4.97, 4.94) respectively. These values refer to high availability ratio of credibility of S4 in the PEWs which were used as a sample in this study. This result refers to the specificity of physics, which is a branch of science includes historical texts, theories, and mathematical derivations based on models and illustrated diagrams, with least literary texts that may have the writer or publisher falls in spelling and linguistic errors and poor drafting.

On the opposite side, items X_{17} states that (The presence of reviewers or editorial board) and X_{16} states that (Citations to scientific data or references) with averages (2.28, 2.64) and late ranks (21, 19) respectively decreased the availability ratio of credibility of S4 in the PEWs. Because of existence huge numbers of relevant websites, it is important for the website to have an editorial and advisory board which is increasing the validity and credibility of the site for the visitors and followers. The role of this board is to examine any material that is introduced and published in the site scientifically and linguistically. Most of the PEWs which were used as a sample in this study have not editorial and advisory board because (66.67%) of these sites established by individuals with no financial support and sponsors.

Standards (1, 5, 2) which is referred to (Authority, Objectivity, Coverage) have convergent weighted averages with values (3.72, 3.69, 3.68) and percentages of availability (68.0%, 67.3%, 67.0%) respectively. In standard 1, item X_5 states that (Free(No paid) to access to information) occupied position (7) in the scale with average (4.72). This item and its value reflect that physics websites which were used as a sample in this study formed an open space for all followers to access to these sites freely. While item X_2 states that (Author identification, qualifications, and credentials) with average (3.11) and late rank (17) decreased the availability ratio of credibility of S1, which forms an impression to the followers that the owner of the site and his qualification are unknown, and causes weakness of validity of this site.

Table 4. Averages and Standard Deviations of Items in the Tool of Analysis

Item No.	Indicators	Average	Standard Deviation	Percentage of Availability	Rank	Availability Ratio
	Standard 1: Authority					
X1	Webmaster and Sponsor (or sponsors) identification	3.36	1.74	59.0%	15	Occasionally
X2	Author identification, qualifications, and credentials	3.11	1.69	52.8%	17	Occasionally
X3	Presence of contact information	3.75	1.38	68.8%	11	Often
X4	Presence of privacy and security policies	3.67	1.51	66.8%	13	Often
X5	Free(No paid) to access to information	4.72	0.70	93.0%	7	Always
	Weighted Average = 3.72			68.0%		
	Standard 2: Coverage					
X6	Website specializing in physics	4.78	0.59	94.5%	6	Always
X7	complete and comprehensive of Information provided	4.28	0.81	82.0%	8	Always
X8	Including videos, graphics, flashes, etc.	4.08	0.97	77.0%	9	Often
X9	Presence of related links	3.19	1.62	54.8%	16	Occasionally
X10	Available Newsletters or journals	2.08	1.71	27.0%	23	Rarely
	Weighted Average = 3.68			67.0%		
	Standard 3: Currency					
X11	Presence of creation date	2.56	1.98	39.0%	20	Rarely
X12	Information is up – to - date	3.56	1.00	64.0%	14	Often
X13	date of the last update easily found	2.92	1.68	48.0%	18	Occasionally
X14	News Tape	2.28	1.78	32.0%	**22**	Rarely
X15	Related links are current and updated regularly	2.06	0.89	26.5%	24	Rarely
	Weighted Average = 2.67			41.8%		
	Standard 4: Accuracy					
X16	Citations to scientific data or references	2.64	1.69	41.0%	19	Occasionally
X17	The presence of reviewers or editorial board	2.28	1.67	32.0%	**21**	Rarely
X18	Easy navigation, well-organized site	4.94	0.23	98.5%	3	Always
X19	Professional-quality and clear writing	4.97	0.18	99.3%	2	Always
X20	Absence of typographical errors and broken links	5.00	0.00	100%	1	Always
	Weighted Average = 3.97			74.3%		
	Standard 5: Objectivity					
X21	Absence of biases on the site	4.83	0.61	95.8%	5	Always
X22	The motivation for the site is clear: to inform? to persuade? to explain?	4.92	0.50	98.0%	4	Always
X23	The intended audience of the site is indicated	3.67	1.39	66.8%	12	Often
X24	ideas and thoughts are presented freely	3.86	1.25	71.5%	10	Often
X25	The site is multilingual	1.17	0.61	4.3%	25	Never
	Weighted Average = 3.69			67.3%		

Standard 5 refers to objectivity which is considered as the most important standard that should be taken care when websites are designed. Item X_{25} states that (The site is multilingual) has the last rank in the scale with low average (1.17), which is decreased the availability ratio of credibility of this Standard. This is because (94%) of websites in the study use the English language, this is normal because of its outreach, while websites in other languages are followed by interested persons who fluent in this language. For this reason, the researcher scans websites in English and Arabic only, because of the fluent in these two languages, which reduce the number of relevant websites in other languages in the study sample.

On the other side, items X_{21} states that (Absence of biases on the site) and X_{22} states that (The motivation for the site is clear: to inform? to persuade? to explain?) have the fifth and fourth ranks in the scale with high averages (4.83, 4.92) respectively. These values and ranks indicate that this standard has relatively high availability ratio of credibility in the PEWs which were used as a sample in this study, and allow the followers to access the website freely and safely.

Finally, data in the table (4) shows differentiation between items in Standard 2 which refers to Coverage. Item X_{10} states that (available newsletters or journals) has the low rank in the scale and average with values (23, 2.08) respectively, which decreased the weighted average of the S2. This is because (66.67%) of the sample designed by individuals with their own efforts, and the existence of newsletters and journals will require high financial cost, which is out of the owner capabilities. While items X_6 states that (Website specializing in physics) and X_7 states that (complete and comprehensive of Information provided) have the sixth and eighth ranks in the scale with high averages (4.78, 4.28) respectively. These values and ranks indicate that this standard has relatively high availability ratio of credibility in the PEWs which were used as a sample in this study.

4. Conclusions

This study refers to the importance of PEWs and provides information about them after analyzing their content. It confirmed that each of these sites should have a design verifying all of credibility standards. Also, it showed a descriptive statistics about the websites which were used as a sample of study such as Individuals own PEWs more than government or civil organizations, the USA has the largest number of these sites. Also, the percentage of PEWs that offer content for students in the public education is higher than the percentage for those sites that offer their services for professionals and university students. The results showed variations in the PEWs' standards: authority, coverage, currency, accuracy and objectivity. Accuracy Standard (S4) has high availability ratio of credibility standards while Currency Standard (S3) has the lowest availability ratio among websites which were used as a sample of the study. Standards (1, 2, 5) which are referred to (Authority, Objectivity, Coverage) respectively have convergent weighted averages and approximated availability ratio. From results and discussions, the study recommends that PEWs should be provided their visitors and followers with physics information and experiences with a high degree of precision and objectivity. Also, it is essential to review and update these websites and related links periodically.

Appendix: Physics Education websites which were used as the study sample

No.	Website Title	Website URL	Country	Domain	Category	stage	Owner
1	The Physics Classroom	http://www.physicsclassroom.com/	USA	.com	Lessons	students	single
2	physicstutorials	http://www.physicstutorials.org/pt/index.php	Europe	.org	Lessons	students	single
3	splung	http://www.splung.com/	USA	.com	Lessons	Univ.	single
4	IB Physics Stuff	http://ibphysicsstuff.wikidot.com/	Europe	.com	lessons	Students	single
5	Furry Elephant	http://furryelephant.com/	USA	.com	Lessons	Students	single
6	Fear of Physics	http://www.fearofphysics.com/	USA	.com	lessons	Students	single
7	physics.som.sg-first class in phy. Tuition	http://physics.com.sg/	Singapore	.com.sg	lessons	Students	Org.
8	Mr. B's physics planet	http://bowlesphysics.com/	USA	.com	lessons	Students	single
9	Iona physics	http://ionaphysics.org/	USA	.org	lessons	Students	single
10	National Science Teachers Ass.(NSTA)	http://www.nsta.org/	USA	.org	Media	specialist	Org.
11	American Ass. Of physics teachers(AAPT)	http://aapt.org/	USA	.org	Media	specialist	Org.
12	Society of physics students	https://www.spsnational.org/	USA	.org	Media	specialist	Org.
13	Physics teacher education	http://www.phystec.org/	USA	.org	Median	specialist	Org.
14	Studyphysics!	http://studyphysics.ca/	Canada	.ca	Lessons	Univ.	single
15	crashwhite	http://crashwhite.com/	USA	.com	lessons	Students	single
16	flipping physics	http://www.flippingphysics.com/	USA	.com	lessons	students	single
17	The physics aviary	http://www.thephysicsaviary.com/	USA	.com	lessons	Students	single
18	The Feynman Lectures in Physics	http://www.feynmanlectures.caltech.edu/	USA	edu.	lessons	Univ.	Org.
19	ComPADRE-Resources and services in physics ed.	http://www.compadre.org/	USA	.org	lessons	Students	Org.
20	Light and Matter	http://lightandmatter.com/	USA	.com	lessons	Univ.	single
21	lecture notes	http://www.lecture-notes.co.uk/	UK	.co.uk	lessons	Univ.	Single
22	Institute of physics (IOP)	http://www.iop.org	UK	.org	Media	specialist	Org.
23	school physics	http://www.schoolphysics.co.uk/	UK	.co.uk	lessons	students	single
24	The Indian Association of physics teachers (IAPT)	http://indapt.org/	India	.org	Media	specialist	Org.
25	American Physical society (APS)	http://www.aps.org/	USA	.org	Media	specialist	Org.
26	Canadian Association of physicists	http://www.cap.ca/	Canada	.org	Media	specialist	Org.
27	The supporting physics teaching	http://www.supportingphysicsteaching.net/	USA	.net	lessons	Students	single
28	physicslessons	http://www.physicslessons.com/	USA	.com	lessons	Students	single
29	easyphysics	http://www.easyphysics.net/	USA	.net	lessons	Students	single
30	Real World Physics Problems	http://www.real-world-physics-problems.com/	Canada	.com	lessons	students	single
31	learn AP Physics	http://learnapphysics.com/	USA	.com	lessons	Students	single
32	موقع الفيزياء التعليمي	http://www.hazemsakeek.net/ar/	Arab	.net	Media	specialist	single
33	الفيزياء العربية	http://www.arabphysics.com/	Arab	.com	Media	specialist	Single
34	موقع العلوم الفيزيائية	http://www.pc1.free.fr/	Arab	.free.fr	Lessons	Students	single
35	شبكة الفيزيائيين العرب	http://www.phys4arab.net/	Arab	.net	Media	specialist	single
36	المدرسة العربية الالكترونية	http://www.schoolarabia.net/	Arab	.net	lessons	students	Org.

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