

# Characteristics of a Persuasive Educational System: A Systematic Literature Review

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**Abstract:** The need to compete for users' attention and provide them with the best user experience has increased the use of persuasion strategies in modern systems. Currently, Persuasive Systems (PSs) promote healthy behavior for well-being, energy consumption, and learning. Although the educational domain has limited investigation compared to other areas, PSs in education have been shown to be effective in motivating students. This paper summarizes the existing evidence on Persuasive Educational Systems (PESs), emphasizing research on the current design methods, evaluation methods, and characteristics. We follow Kitchenham's method to perform a systematic literature review about PESs published between 2014 and 2020, with 19 relevant studies selected. We highlight some results from the analysis of selected papers such as persuasion strategies, use of a personalized persuasion technique, study of students' susceptibility to strategies, integration of gamification mechanisms, and proposed tools to design PES. Moreover, we discuss interesting facts such as the common practice of using more than one tool to design PES, aspects of interaction, persuasion, learning, and the challenges in evaluating persuasive impact. Finally, as the main contribution of the paper we identify the seven necessary characteristics to build a persuasive educational system.

**Keywords:** persuasive systems; education; learning; persuasive strategy; personalized persuasion; design tools; evaluation tools; systematic literature review



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## 1. Introduction

Captology, an acronym of Computers as Persuasive Technology, is the area that studies how users are influenced, motivated, or persuaded when interacting with technology. Persuasive Technologies (PT) are interactive systems designed to change people's attitudes or behavior [1]. In this type of technology, two more specific concepts are addressed; Persuasive Systems (PSs) and Behavior Change Support Systems (BCSSs). A PS is a computerized software or information system designed to reinforce, change, or shape attitudes, behaviors, or both without using coercion or deception [2]. PSs can be developed for different technologies (mobile devices, websites, or desktop) to impact the users' motivation, attitude, or behavior change through stimuli (rewards, reminders, prizes, among others). BCSSs are defined as information systems designed to form, alter, or reinforce attitudes or behaviors, or both, without using coercion or deception [3]. Although PSs and BCSSs are similar in definition, BCSSs were introduced as a new emerging area for science

in the web environment, while PSs are applied in various technologies. Furthermore, Ref. [3] stipulates that BCSSs should be based on theory for persuasive systems design, for example, The Functional Triad [1] and the Persuasive Systems Design (PSD) Model [2]. A PS has four main characteristics: the type of change, the psychological outcome, the persuasive strategies, and the application domain. That is, persuasive systems are designed for a specific domain, to achieve a type of change in a psychological outcome, through persuasive strategies. Table 1 shows the four characteristics, examples of attributes, and the reference. The four characteristics and some attributes are established in the theoretical framework that Oinas-Kukkonen has established for the design and evaluation of persuasive systems [2,4]. In particular, attributes of the type of change and persuasion strategy. In [5], they conducted a literature review about persuasive systems and presented a broad classification of systems by psychological outcome and domain. This study allowed us to complement the list of attributes of these characteristics.

**Table 1.** Four main characteristics of a persuasive system.

Characteristic	Attribute	Reference
Type of change	Formation, alteration, or reinforcement.	[4]
Psychological outcome	Engagement, encouragement, motivation, awareness, enjoyment, commitment, attitude, behavior, or act of compliance.	[5]
Persuasive strategy	Reduction, tunneling, tailoring, personalization, self-monitoring, simulation, rehearsal, praise, rewards, reminders, suggestion, similarity, liking, social role, trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, verifiability, social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition.	[2]
Domain	Health, ecological consumption, education, economy, security, among others.	[5]

This research is centered on PSs focused on the educational domain due to the opportunities that technology provides for learning. Nowadays, it is possible to influence students through technology. However, designing usable, accessible, or credible interactive systems is not always enough. Modern interactive systems compete for the users' attention and users expect an ever-increasing quality. Because of the users' expectations it is crucial to understand the target users, their needs, preferences, and even their personality [2,6]. Furthermore, it is important to study systems' characteristics needed to provide students with a positive user experience.

To the best of our knowledge, there is no definition in the literature for the concept of a Persuasive Educational System (PES). Therefore, based on [1–3,7] we propose to define a PES as an interactive system designed for an educational context that, through persuasive strategies, allows the student to form, alter, or reinforce optimal attitudes or behaviors for learning.

This article presents a Systematic Literature Review (SLR) based on Kitchenham's method [8]. The SLR purpose is to summarize the existing evidence on persuasive systems focused on education, emphasizing on the design methods, evaluation methods, and the characteristics of a PES. The results allowed us to identify the characteristics necessities to build a persuasive educational system (see Table 6); we consider this a significant contribution because the technology provides the student with individual and personalized connections that improve interactivity in real-time [9]. However, researchers agree on the fact that the implementation of PSs in the educational context is less studied compared to others, despite the learning opportunities that PESs provide [10,11]. Studies show that persuasive strategies, such as competition, engagingly motivate students to achieve their goals [12] and researchers claim that it is possible to achieve a better level of motivation by encouraging students to do their homework or consult additional resources through a PS [1].

The rest of the papers is structured as follows. Section 2 addresses the design and evaluation of PS to know the main design tools and the evaluation mechanisms. Section 3

presents the related work. Section 4 describes the method followed to perform the SLR, and Section 5 presents the results. Section 6 presents the discussion of the most relevant facts found in the SLR, and Section 7 the conclusions and future work of this research.

## 2. Design and Evaluation of Persuasive Systems

Knowing the tools used to design persuasive systems, as well as the evaluation mechanisms, allows us to know what the creation of a persuasive system implies. Regarding the design process, there are useful tools used to understand the persuasion process through technology; for example, The 8-Step Process [13], The Functional Triad [1], and The Persuasive Systems Design (PSD) model [2]. We consider it important to have a general knowledge of each one of them to contextualize ourselves in the design process.

- As the name implies, The eight-step process describes eight steps to follow as best practices in the early stages of persuasive technology design. The steps to follow in the process are the following:
  1. Choose a simple behavior to target.
  2. Choose a receptive audience.
  3. Find what prevents the target behavior.
  4. Choose a familiar technology channel.
  5. Find relevant examples of persuasive technology.
  6. Imitate successful examples.
  7. Test and iterate quickly.
  8. Expand on success.

The process can be envisioned in three main stages: context study, system construction, and reformulation of the system's target behavior. The first stage deals with steps 1 to 5, the second stage with steps 6 and 7, and the third with step 8.

- The Functional Triad is a framework that describes three roles in which a system can be persuasive from the user's perspective: as a tool, as a medium, and as a social actor. Each role has its own techniques to persuade the user but, in general terms, a system can be persuasive as a tool by making the target's behavior easier to persuade; as a social actor, it can be persuasive by rewarding people with positive feedback; and as a medium by allowing people to rehearse the target's behavior.
- The PSD model is based on the Functional Triad and is currently the most used since it helps to understand how to persuade through technology and how to execute the process. The model suggests the following three steps for the design process of a PS:
  1. The first step is named "understanding key issues behind persuasive systems". The author of the PSD model states that a system can be analyzed and designed only after obtaining a reasonable level of understanding of seven postulates.
  2. The second step analyzes the persuasion context. It determines who the persuader is, the expected type of change, the usage context, the user, the technology, the route, and the message to be sent.
  3. The last step is to design the system's characteristics by writing the implementation of persuasive strategies in the form of a software requirement.

Since the PSD model is the most widely used, it has also been the basis for proposing new tools to design PSs. In 2018, Ref. [14] proposed improvements for the PSD model by adding user-centered design techniques. The goal was to guide designers and developers (even researchers) with all the aspects needed to analyze user and usage context, and propose user-involving solutions. Furthermore, the framework includes three stages of the Extreme Programming (XP) methodology to coordinate the software development process.

Regarding the process of evaluating PSs, it is important to understand the two different ways to evaluate them: (i) based on the system's persuasive qualities or (ii) based on its impact. The PSD model has been used as an evaluation tool to evaluate PSs based on their persuasive qualities. In addition to being a design tool, the model has been used as an evaluation tool due to the detailed list of persuasive strategies. In [15], the authors created

a check-list to evaluate the persuasive qualities of a system based on the PSD model. Other proposals for evaluating persuasive systems also include the verification of implemented persuasion strategies and the usability attributes [16,17]. Both studies proposed heuristics based on the PSD model and the usability heuristics of Jakob Nielsen [18].

The second way to evaluate a persuasive system is through the impact generated on the user. In [19], the authors evaluate the persuasive influence of a system that promotes physical activity. Users interacted with the system in an 8-week pilot study. After the period ended, the participants answered a questionnaire. The authors created an Unified Theory of Acceptance and Use of Technology model (UTAUT) based on the responses. The results showed that the system generated satisfaction in users by promoting physical activity. In another study, a persuasive mobile game for English language learning was designed [20]. To define the impact of the system on the user's learning, the authors evaluated the participants' knowledge and motivation through questionnaires (before and after interacting with the system for three weeks). The results showed that the participants produced a good performance despite their low motivation.

Persuasive systems are interdisciplinary systems. They are based on theories such as computer science, persuasion, and, additionally, knowledge regarding the application domain. The PSD model is the most used framework for persuasive interventions development as it is regular and can be used to develop persuasive systems for different domains, although it lacks specific knowledge of the application domain. That is why we can observe systems that are designed using more than one tool, as in the case of PESs. This SLR will allow us to identify the elements that make up a PES, and also the tools that have been used for their development.

### 3. Related Works

To the best of our knowledge, there is no a systematic literature review of PESs. However, in [5,9], they address persuasive systems in education to some extent.

In [5], they performed a review from 2001 to 2014 about persuasive systems. In the review process, the authors excluded conceptual frameworks, pilot studies, and papers that describe the development of a system without evaluation. A powerful contribution of this review was the classification of 84 articles by the domain to which the persuasive technology was related, the persuasive strategies implemented, and the psychological outcome. The study allows us to know how deep the educational domain had been studied compared to others. The main domain studied was health with 45 classified studies, while education only had 10 classified studies.

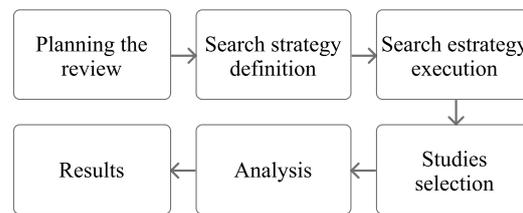
In [9], they studied the articles published between 2010 and 2017 to identify the main works that relate to the use of persuasive technology in education. They identify 82 studies related to the criteria of "persuasive technology education", "persuasive technology research", "persuasive technology health", "persuasive technology education", "persuasive marketing", and "persuasive social". This study allowed us to know the user profiles on which the selected studies have focused, among which are children with special needs and university students from different disciplines. Likewise, the study highlighted the different activities that motivated studies based on persuasive technology. For example, the cooperation between the teacher and the student to carry out daily tasks.

We observed some differences between the approach of these studies and the approach of our investigation. First, we detected that they did not focus only on PESs. Second, they did not analyze the design and evaluation tools used to build persuasive interventions. Third, we observed that they did not identify characteristics to conform to PESs. Due to our investigation, we can provide an answer to these three points.

### 4. Method

We studied literature current state about Persuasive Educational Systems (PESs) by performing a Systematic Literature Review (SLR) based on Kitchenham's method [8] to

summarize the existing evidence on persuasive systems, focused on education. Figure 1 illustrates the process we followed to perform the review.



**Figure 1.** Methodology for the systematic literature review.

#### 4.1. Research Questions

We defined the following research questions to guide the review process:

- RQ1. What are the tools used to design PESs?
- RQ2. What are the tools and criteria used to evaluate PESs?
- RQ3. What are the characteristics considered to design a PES?

RQ1 deals with the tools used to design PESs and the area they belong to. RQ2 addresses the evaluation tools and criteria considered to submit a judgment about the systems. RQ3 deals with identifying the characteristic considered by the author to build the proposed PES, for example the methods, techniques, technologies, or the elements of a user's profile.

#### 4.2. Search Process

To accomplish the review goal, which is to answer the research questions, we conducted the literature review in 4 databases: ACM Digital Library, IEEE Explore, Science Direct, and Scopus. We selected the databases given the coverage they have in the area of technology and computing. We used a search structure based on keywords and logic connectors to search for relevant studies in the databases. We submitted the following search strings to be searched by title, abstract, and keywords:

*(Persuasive System OR Persuasive Technology OR Captology) AND (Framework OR Guidelines OR Design OR Evaluation) AND (Education OR Learning).*

#### 4.3. Inclusion and Exclusion Criteria

In order to delimit and restrict the scope of the systematic review, it was decided to consider only articles published in more recent years, which meant that the starting year was set at 2014. We reviewed the title and abstract of the articles as the first inclusion measure to ensure that the located papers were related to the purpose of the SLR. Then, we applied the following inclusion and exclusion criteria as the second filter:

- Inclusion criteria
  1. Publications that discuss the opportunities, benefits, or ways to improve the learning process through PES.
  2. Publications that present the most recent version of a study.
  3. Publications in academic journals, conferences, or books.
  4. Publication between 2014 and 2020.
  5. Publications written in English or Spanish.
- Exclusion criteria
  1. Publications that address a learning process in a domain other than educational.
  2. Papers without sufficient details about the development process of the PES proposed.
  3. Papers without sufficient details about how persuasion is implemented.
  4. Publications included in more than one database.
  5. Publications available in the form of abstracts or power point presentations.

## 6. Publications that did not follow peer review.

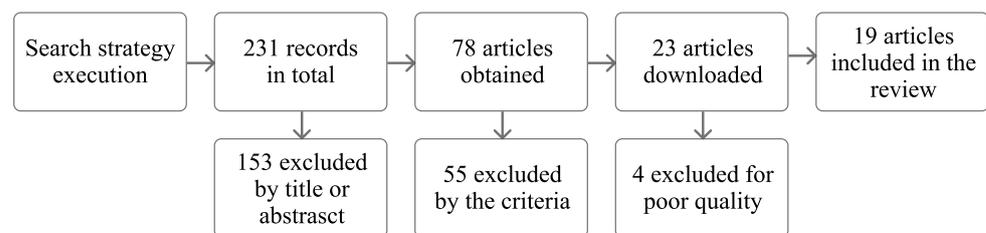
### 4.4. Quality Assessment

We performed a quality assessment process of the papers after the search process and the inclusion and exclusion criteria, to select only those who have a certain level of quality. The quality assessment criteria are:

- QA1. Does the paper study a topic related to PESs?
- QA2. Does the paper proposes a new tool for design or evaluation of PESs?
- QA3. Does the paper present the design or evaluation process of a PES?

## 5. Results

The original search displayed 231 results; 1 in the ACM Digital Library, 22 in IEEE Explore, 194 in Scopus, and 14 in Science Direct. We reviewed the titles and abstracts of the articles and we selected 0 from the ACM Digital Library, 11 from IEEE Explore, 63 from Scopus, and 4 from Science Direct. Then, we applied the inclusion and exclusion criteria to the remaining 78 articles and we downloaded 23 of them. The 23 downloaded studies were submitted to the quality assessment by the authors. Because of the collaborative analysis, we obtained 19 relevant articles for the review (see Figure 2).



**Figure 2.** Selection process of relevant studies for the SLR.

The analysis of the existing PESs allowed us to answer the research questions and find some interesting facts. For example, we identified that the selected papers address three different approaches related to their primary aim (see Table 2). In addition, we observed that none of the selected papers proposed a new tool to verify if the psychological outcome has been reached. For example, if the student's attitude changed thanks to the PES.

**Table 2.** Classification of the selected articles by approach.

Approach	Study	Total
The study of a topic related to PESs	[10,11,21–27]	9
The proposal of a new tool to design PESs	[20,28–32]	6
The design or evaluation of a PES	[15,33–35]	4
		19

Table 3 presents the general characteristics of the selected papers (reference, year, author, and primary aim) and the results of the quality assessment.

Table 4 answers RQ1 and RQ2, summarizing the design and evaluation tools used by the selected studies and their evaluation criteria. Table 5 summarizes the new design tools that have been specifically proposed for PESs. Table 6 answers RQ3. The table summarizes the characteristics considered by the selected papers to design PESs. We placed emphasis on this finding and we describe each characteristic in the following sections.

### 5.1. Tools

Tables 4 and 5 should not be confused, although both present the tools used in the studies, the difference lies in the focus of the study. Table 4 presents the design tools,

the evaluation tools, and the criteria used by the studies that propose the design and/or evaluation of a persuasive educational system. This studies include game-based and non-game-based interventions. Table 5 shows the tools on which other studies were based to propose a new tool to design PESs.

**Table 3.** Selected paperes.

Study	Authors	Year	Primary Aim	QA1	QA2	QA3
[21]	Abdullahi et al.	2018	Identify how students' cognitive ability scores relate to their susceptibility to rewards, social learning, and trustworthiness.	✓	X	X
[28]	Bakri et al.	2014	A conceptual model to design PESs to encourage toddlers to learn the Arabic language.	X	✓	X
[15]	Cheong et al.	2017	Evaluate the inherent persuasion of two New Generation Digital Learning Environments (NGDLEs).	X	X	✓
[29]	Daud et al.	2018	A model to design online learning in Islamic education with the appropriate persuasive features.	X	✓	X
[22]	Daud et al.	2019	Identify persuasive elements in association with emotions to be used in designing online knowledge for Islamic content.	✓	X	X
[20]	Elaish et al.	2019	A framework to design mobile games to enhance motivation in learning.	X	✓	X
[33]	Elaish et al.	2019	Development of a persuasive mobile game to enhance the motivation and learning of the users.	X	X	✓
[23]	Engelbertink et al.	2020	Identify the most suitable strategies for a blended learning course, according to participants' perception.	X	X	✓
[10]	Engelbertink et al.	2020	Evaluate the added value that PT brings, to what extent it motivated students, and the role played by the teacher in the blended course.	X	X	✓
[30]	Filippou et al.	2015	Guidelines for designing persuasive interventions to help students improve study scheduling, class preparation, and group study.	X	✓	X
[24]	Filippou et al.	2016	Identify the most significant study strategies and behaviors that enhance academic performance, as a preamble to the design of a PES.	✓	X	X
[31]	Leite et al.	2018	A conceptual framework for the development of persuasive educational interfaces.	X	✓	X
[32]	Mele et al.	2020	A method for developing educational applications based on behavioral and cognitive models, and gamification.	X	✓	X
[25]	Mhd Salim et al.	2019	Identify students' motivation and learning strategies that affect their academic performance in using MOOCs among tertiary education students.	✓	X	X
[26]	Orji F. et al.	2018	Study how to design and implement personalized persuasive interventions using social influence strategies to improve learning engagement.	✓	X	X
[11]	Orji F. et al.	2019	Study if tailoring persuasive systems using students' persuasion profile will improve the efficacy of the system to promote a desired learning behavior of students.	✓	X	X
[27]	Orji F. et al.	2019	Study what the interrelationship is among social comparison, social learning, reward, and the competitive behavior of students.	✓	X	X
[34]	Qasim et al.	2018	Develop a persuasive mobile game to assist the students to increase their interest in learning mathematics.	X	X	✓
[35]	Zainuldin et al.	2015	Design and evaluation of an Arabic learning courseware base on An O/C matrix.	X	X	✓

**Table 4.** Tools used for the design of PES and the tools and criteria for their evaluation.

Study	Design Tool	Evaluation Tool	Criteria
[15]	N/A	PSD Model.	Persuasive qualities.
[33]	Multimedia Mobile Content Development MMCD process, Fogg's procedures, and [20].	User testing, Quasi-Experiment, and MSLQ Questionnaire.	The user's learning and motivation.
[23]	PSD Model, Participatory design.	N/A	N/A
[34]	The Functional Triad and Analysis–Design–Develop–Implement–Evaluate (ADDIE) methodology.	Evaluation with experts	Functionality/Design
[35]	O/C Matrix, Multimedia component, E-Flashcards, and Learning styles.	Pre–Post test, Observation and 3 Checklist: motivation, behavior and time focus.	Effectiveness (learning of the users) of the courseware.

**Table 5.** Bases of the new tools proposed to design PESs.

Study	Tool Proposed	Tools or Theories on Which It Is Based
[20]	Framework	PSD Model, The Functional Triad, Mobile educational frameworks, Learner and learning context, Bloom's taxonomy.
[28]	Conceptual model	PSD, Multimedia principles, e-Flashcards.
[29]	Conceptual model	PSD, PSD Model, Questionnaires, Delphi technique.
[30]	Guidelines	Fogg Behavioral Model, Hook Model.
[31]	Framework	Connectivism theory.
[32]	Guidelines	Fogg's Behavioral Model (FBM), Bloom's taxonomy, The 'flow' model.

**Table 6.** Characteristics of a persuasive educational system identified in the selected papers.

Characteristic	Description	Study
Persuasive strategies	Techniques implemented in the development of the study to influence the user.	[10,11,15,20–35]
Susceptibility	Probability that a user will produce a positive response to a persuasive strategy.	[11,21,26]
Personalized persuasion	Development of the study with the strategies to which potential users are susceptible.	[11,26]
Gamification	Game elements considered for the development of the study.	[15,32,33]
Context	Elements of the environment considered for the development of the study.	[23,25,29]
Student areas	Elements or attributes of the student taken into account for the development of the study.	[21,22,24,25,30,32,35]
Theories	Principles or knowledge other than persuasion taken into account for the development of the study.	[15,32]

## 5.2. Characteristics of a Persuasive Educational System

We identified seven characteristics in the selected articles that the authors considered to build a PES (see Table 6). We describe each characteristic and sub-characteristic below.

### 5.2.1. Persuasive Strategies

Persuasive strategies are techniques used in persuasive technology design to boost behavior or attitude change [26]. The PSD model provides 28 strategies [2]; due to this, listing is the most commonly used model by the selected papers. Table 7 presents the persuasive strategies addressed by the selected papers to perform their studies based on the PSD model and other strategies mentioned by the studies that are not part of the model's

strategies, such as information quality, mobile loyalty, mobile simplicity, convenience, acceleration, Iman, and Islamic identity.

**Table 7.** Persuasion strategies considered by the selected papers.

Persuasive Strategy	Study	Total of Studies
Social learning	[10,11,15,20,21,26,27,29,33]	9
Social comparison	[10,11,15,20,26,27,29,33]	8
Competition	[11,15,20,26,27,29,33]	7
Reduction	[10,15,20,22,23,29,33]	7
Rewards	[10,11,15,21,23,27,29]	7
Self-monitoring	[10,15,20,22,23,29,33]	7
Trustworthiness	[10,15,21–23,29,33]	7
Tunneling	[10,15,20,22,23,29]	6
Liking	[10,15,22,23,29]	5
Personalization	[10,15,22,23,33]	5
Praise	[10,15,22,23,29]	5
Recognition	[15,20,22,29,33]	5
Social facilitation	[10,15,20,29,33]	5
Suggestion	[10,15,20,23,29]	5
Tailoring	[10,15,20,22,29]	5
Conditional/rewarding	[20,21,27,33]	4
Cooperation	[10,15,20,33]	4
Expertise	[10,15,22,29]	4
Real-world feel	[15,22,23,29]	4
Third-party endorsements	[15,22,23,29]	4
Surface credibility	[15,22,23,29]	4
Simulation	[10,15,29]	3
Verifiability	[10,15,29]	3
Information quality	[20,29,33]	3
Normative influence	[15,22,33]	3
Mobile loyalty	[20,33]	2
Mobile simplicity	[20,33]	2
Convenience	[20,33]	2
Rehearsal	[10,15]	2
Reminders	[10,15]	2
Similarity	[10,15]	2
Authority	[15,22]	2
Social role	[10,15]	2
Acceleration	[22]	1
Iman	[22]	1
Islamic Identity	[22]	1

### 5.2.2. Susceptibility and Personalized Persuasion

The susceptibility regarding persuasive systems refers to the likelihood of a user to produce a positive response to a particular persuasive strategy. In [36] they studied the persuadability of a set of strategies. Then, they proposed a questionnaire called the Persuadability Inventory (PI) for five strategies; rewards, competition, social comparison, trustworthiness, and social learning. The selected paper [11,21,26] adjusts the PI to study students' susceptibility to persuasion strategies and designing PES under the personalized persuasion approach. Personalized persuasion is a design approach used to make an informed selection of persuasive strategies. That is, to identify the persuasion strategies to which potential users are most susceptible and implement only those strategies in the system design. The persuasive system's success depends directly on the users' response to the strategies. Therefore, the personalized persuasion approach expects that an informed selection of strategies will boost the persuasive impact of systems.

In [21], they studied how students' cognitive ability scores are related to their susceptibility to persuasive strategies. They adjusted the questions from the Educational Testing Service kit (ETS) to assess cognitive ability. They also adjusted the PI to identify susceptibility towards rewards, social learning, and trustworthiness. The results showed that people with a high cognitive level are more susceptible to social learning than people with a low cognitive level. People with a low cognitive level are more susceptible to reliability than people with a high cognitive level. Finally, the results show that there is no significant difference between people with a high or low cognitive level regarding their susceptibility to the reward strategy.

In [26], they studied how to design and implement personalized persuasive visualization to improve learning engagement using social influence strategies (social comparison, competition, and social learning). Researchers defined persuasion profiles by creating groups identifying students' susceptibility to show each student group only the implemented section in the system with the strategy to which they were susceptible. In a subsequent study [11], they assessed the efficacy of the system to promote the desired learning behavior. The participants interacted with the system, and after they were asked to answer the following four questions, whether: (1) the system would influence me, (2) the system would be convincing, (3) the system would be personally relevant for me, and (4) the system would make me reconsider my study habits.

### 5.2.3. Gamification

Gamification is a design approach that applies game mechanics in everyday non-game activities and situations to boost engagement, fun, and good behaviors [37]. In [15,32,33], they address gamification as a strategy to persuade students to adopt desirable learning behaviors.

In [15] they evaluate the inherent persuasion of a virtual learning environment that incorporates gamification as a starting point, the Motivational Active Learning (MAL). The purpose of the study was to identify the strategies of four categories the PSD model (Primary Task Support, Dialogue Support, System Credibility Support, and Social support) that were present in the VLE, although the MAL was not designed explicitly for persuasion. The study confirms that the strategies of the social support category align very well with the use of gamification. Gamification mechanisms such as badges and points can be used to trigger some persuasive strategies such as comparison, competition, and recognition. In addition to the similarity between persuasive strategies and gamification elements, such as praise and rewards of the dialogue support category.

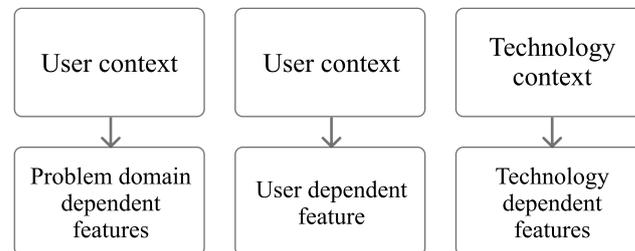
In [33] they address the concept of game-based learning to develop a mobile game application to Boost Students' Motivation in Learning English Vocabulary. The authors did not use a gamification framework for the design of the system. However, this study highlights the opportunities of persuasive strategies for the design of game-based interventions. Table 7 shows the persuasive strategies implemented to build the application proposed in this study.

In [32] they addressed gamification as a tool to design persuasive technology in the educational context. The authors claim that points, levels, individual and team missions, badges, individual and team leaderboards, visual progress, and notifications are some of the most commonly used mechanisms in gamified learning content. Based on their statements, the authors proposed a set of guidelines on how to implement these gamification mechanisms in learning management systems.

### 5.2.4. The Context

The context in persuasive systems refers to a set of necessary aspects to recognize inconsistencies in a user's thinking, discern opportune and/or inopportune moments for delivering messages, and effectively persuade [2]. This includes recognizing the intent of the persuasion, understanding the persuasion event, and defining and/or recognizing the strategies to use. The persuasive event refers to the usage context, user context (goals,

motivations, lifestyle, among others), and the technology context (Figure 3). In [23,25,29], they focused on aspects of the PESS' context due to the importance of context in the design of persuasive interventions.



**Figure 3.** The elements of the persuasion event.

In [29], they studied persuasion strategies suitable for implementation in Islamic education. Islamic education is traditional, and the adoption of technology has only begun to be accepted. This is a domain-dependent problem. The study focuses on the use context of the persuasion event.

In [23], they performed a study to identify the most suitable strategies for a blended learning course, according to participants' perceptions. Table 7 presents the persuasive strategies addressed in the study. The problems studied by the article are domain-dependent (the context of use) and technology-dependent (the context of technology) since blended learning combines face-to-face education and virtual education. The study aims were to identify the best strategies of the PSD model to promote learning in this approach.

In [25], they studied students' motivation and learning strategies that affect their academic performance in using MOOCs. The authors claim that the results can be used to fulfill the first phase of designing a persuasive system based on the PSD model (understand the issues behind a system). These results are a user-dependent feature; that is, the study focuses on the user context of the persuasion event.

#### 5.2.5. Student Areas

We called student areas the elements or attributes of the student taken into account for developing the study, especially those related to the cognitive, emotional, and behavioral areas of a student.

- **Cognitive area**

In [21], they studied an element related to the student's cognitive area; the cognitive score in relation to persuasion strategies. Moreover, in [25], they studied this area. They identified six study strategies that represent students' motivation and learning strategies that affect academic performance from which two of them are related to students' cognitive area. The first study strategy reported by students is to try to think through a topic and decide what is supposed to be learned from the topic, rather than just reading it. This is metacognitive self-regulation, the practice of being aware and understanding your thought processes. The second study strategy consists of students thinking about possible alternatives when he/she reads or hears an assertion or conclusion in the course, this is the practice of critical thinking. Both strategies may lead to good academic performance. Finally, Ref. [35] is another selected study that took into account the cognitive area of the students for the development of the study. They considered the learning styles (visual, audio, and kinesthetic) of potential users as an element to design an Arabic sounds learning courseware.

- **Behavioral area**

The behavioral area address how the student behaves in their study process. One of the elements studied by [24,30] is time management. In [24], they describe that time management "involves scheduling, planning, and managing one's study time. This includes not only setting aside blocks of time to study, but the effective use of

that study time, and setting realistic goals". In [30], propose seven guidelines for a persuasive mobile app prototype to increase the likelihood that students will adopt habits, three for scheduling, two for preparation class, and two for group study.

- Emotional area

In [22], they considered the emotional area of students to identify elements of persuasion in association with students' emotions to be used in designing online knowledge for Islamic content. The authors used the Kansei Engineering (KE) method. KE is "a proactive product development methodology, which translates customers' impressions, feelings, and demands on existing products or concepts into design solutions and concrete design parameters" [38]. Table 7 presents the persuasive elements identified in the study.

Each of the studies presented addresses a student area (cognitive, behavioral, and emotional), which provides new user-centered design lines. However gamification is also an element that is related to these areas. In [32], they state that gamification mechanisms should be designed in PESs to address the emotional and cognitive areas. They even stipulate that such mechanisms would address the social area.

#### 5.2.6. Theories

We observed that some studies strengthened the development of their proposal by using more than one tool. We think is logical since persuasive educational systems are multidisciplinary systems, that is, interactive systems designed with persuasive qualities for a specific domain.

In [15,32], they used the PSD model and Fogg's behavior model (respectively) as a persuasive tool, and they also used application domain theories, educational theories. In [15], they evaluated the inherent persuasiveness of two virtual learning environments based on the strategies of the PSD model. These virtual learning environments consider educational approaches such as mastery learning, personalized systems of instruction, micro-learning, and Technology-Enabled Active Learning (TEAL). Bloom's Taxonomy is another model that was present as a tool to reinforce the application of persuasive systems in the educational domain. In [32], they used taxonomy because of the role it plays in defining learning objectives. Objectives indicate what we want students to learn; they are explicit formulations of the ways students are expected to change through the educational process [39].

Pedagogical approaches are a key point in the learning and teaching process and help increase academic practices. Therefore, using theories to define learning objectives, for example, strengthens the application of persuasive systems in the educational environment.

## 6. Discussion

As we mentioned in Section 5, Tables 4 and 5 are the answers to RQ1 "What are the tools used to design PESs?" and RQ2 "What are the tools and criteria used to evaluate PESs?". Table 6 is the answer to RQ3 "What are the characteristics considered to design a PES?". To build these tables we analyzed the selected papers. In this process we identified the following interesting facts:

1. The number of tools used to design a PES.
2. The area to which the tools belong.
3. Challenges for the proposal of new tools to design PESs.
4. Challenges in the evaluation process of PS, specifically in the evaluation of the persuasive impact.

We present the discussion of these facts in two areas: Persuasive Educational System Design and Persuasive Educational System Evaluation.

### 6.1. Persuasive Educational System Design

Regarding the design process of PESs, we observed that the use of more than one tool is a common practice. We consider that a PES is a system that, to be designed, needs the support of areas such as persuasive systems, interactive systems, and e-learning systems. The studies in Table 4 use the PSD model strategies to design the persuasive aspect. However, they do not use the required tools for designing PESs to be educative, persuasive, and interactive at the same time. We believe the reason is that there is no tool that addresses three areas. Furthermore, we observed in Table 5 that the new tools proposed for designing PESs are based on other well-established tools. However, none of these proposals include a persuasive system design tool, an interactive system design tool, and a tool to support the educational objective at the same time. For example, the PSD model for persuasive design, Bloom's taxonomy [39], was used to reach educational objectives, and the Rapid Contextual Design methodology [40], was used for interactive development. This fact is not necessarily a disadvantage, but it is an opportunity to contribute to the field of PESs design.

At the beginning of this article, we presented the well-known characteristics of a PS (Table 1), but, as a contribution, we identified in this research other characteristics related to PESs (Table 6). We highlighted personalized persuasion as an enriching technique for the PESs design process. Personalized persuasion is a design technique used to encourage the expected persuasive impact on students. The technique established that designing persuasive interventions pretending that the selected strategies will work the same for all users is undoubtedly an inappropriate practice. The personalized persuasion approach allows identification of the relationship between user preferences and persuasion strategies. That is, performance of an analysis of the users' susceptibility to persuasive features and provision of a focused intervention. The articles that address the personalized persuasion approach established an important guideline on how to conduct research. However, they analyzed a small number of strategies compared to the ones provided by the PSD model, of which there are 28. This opens the opportunity to expand the study and analyze other strategies. The personalized persuasion approach provides an opportunity to encourage the expected persuasive impact on users. This is because the success of a PS depends on the users' answers to persuasive features (the users' susceptibility). That is why this approach should be integrated into the PES design process, and the tools proposed in Table 5 do not address it.

Based on this SLR results, we realize that there are no design tools with the seven characteristics. These strategies open new research opportunities in the area of PES design. For example, How can we improve the user experience of PESs with the identified characteristics? How can they enhance the persuasive potential of PESs? In addition, we consider that the characteristics should be organized in a formal representation, such as an ontology, to determine the relationships between them. This will allow us to propose design guidelines to build PESs.

### 6.2. Persuasive Education Systems Evaluation

The evaluation of the persuasive impact, that is, evaluating whether or not the system persuaded the user, involves certain aspects. Although persuasive interventions are by definition designed to change attitudes or behaviors, none of the studies analyzed so far include them in the design or evaluation process.

The first aspect to consider while evaluating persuasive interventions is that a fully functional version of the system is required, which can take considerable time. The purpose of the system also plays a relevant role in the evaluation process, for example, to decide the type of change or the psychological result the system seeks to generate in the user. Each of the psychological results have different structures. Therefore, they can be measured in different ways. For example, engagement refers to user interaction with an interface. This can be measured using page views, bounce time, dwell time, and other metrics. If the system manages to "catch" the user, then it could be concluded that the system has

persuaded them. However, what if the goal is to impact the attitude or behavior of the user? How can it be measured? In order to measure a change in psychological results, it is necessary to take into account the application domain of the system and define what behavior or attitude will be studied. For example, a system with the objective to persuading the user to exercise daily can monitor the user's physical activity for a specified period and assess whether the target behavior was achieved or not. In addition, the acquisition of habits theory comes into play for this. How long does it take to say that the behavior changed? Is it already a habit? Moreover, one of the biggest challenges is to identify the change through the data collected by the system. When this is not possible, questionnaires are applied to understand the user's perception. In some domains, it is difficult to track the user's behavior through the system, especially when it comes to attitude. Therefore, it could be necessary to integrate wearable technologies to obtain the information necessary to establish change. This may go against the sixth postulate of the PSD Model: persuasive systems must be non-intrusive.

Now, assuming that it was possible to evaluate the persuasive impact generated by the system on the user, what if the result is negative? If the system failed to persuade the user, the system design would need to be iterated and re-tested. This, again, could take considerable time. Additionally, it implies that the design was not adequate to persuade the targeted users. One of the reasons for this reported in the literature is the use of the one-size-fits-all approach. In other words, design the persuasive qualities of a system in the hope that they will work the same way for all users.

## 7. Conclusions and Future Work

We presented in this article a systematic literature review of the current state of the Persuasive Educational Systems (PESs). We analyzed studies from 2014 to 2020 based on the presented method. As a result, we obtained 19 articles and we identified the tools used for PESs design, the tools and criteria used to evaluate, and the characteristics of a PES. We discussed deficiencies in the design and evaluation process of PES after analyzing the selected papers. As a result of the deficiencies, we are in the process of creating a conceptual model, an ontology of Persuasive Educational Systems to promote suitable attitudes in students, leveraging the personalized persuasion approach. In future research, we will complete the ontology development.

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