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Development of an E-Learning Persona: A Systematic Review

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Abstract: - This paper presents a systematic literature review (SLR) on the development of e-learning personas within the realm of human-computer interaction (HCI). E-learning personas, conceptualized as fictional representations of user groups, are instrumental for designers and stakeholders in e-learning. They provide insight into students' perspectives, preferences, abilities, and available IT infrastructure. This review addresses the notable absence of comprehensive SLRs in the e-learning domain, employing the PROSMA methodology and examining prominent datasets. The findings highlight several research gaps that offer directions for future inquiry, including the adaptation of learning methods to persona development, the application of k-means clustering for machine learning analysis, and the utilization of APIs for efficient data collection. These identified areas are pivotal for advancing the field of e-learning personas.

Keywords: Persona, e-learning persona, E-learning, Human-Computer Interaction (HCI), learner-centered design.

ACM CCS Concepts: Human-centered computing → Human-computer interaction (HCI).

I. INTRODUCTION

E-learning personas, a pivotal aspect of human-computer interaction (HCI), have significantly influenced user design in educational software, healthcare technologies, and digital accessibility for individuals with disabilities. Esteemed technology companies, such as Sony and Microsoft, have also utilized personas [1]. Introduced to HCI by Cooper, personas serve as a method to understand and articulate the goals and needs of different user types [3], especially in scenarios lacking direct user contact [4-6]. They act as shared mental models, aiding stakeholders in considering diverse perspectives [7]. As depicted in Fig. 1, personas are fictional user profiles that represent key or influential user groups [8].

Figure 1: An Example of an E-Learning Persona [9]

The integration of personas into HCI and User-Centered Interaction (UCI) research spans nearly a century, with recent studies focusing heavily on persona-based methodologies [11]. A considerable body of research seeks to enhance persona development and application [12], introducing innovative methods for persona creation [13]. Traditional research relied on quantitative and qualitative approaches, whereas contemporary studies emphasize data mining and automated persona generation [14, 15].

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The COVID-19 pandemic has intensified the focus on e-learning, as it became the primary mode of education during school closures [16]. Developing e-learning personas is vital to understanding learners' needs and user characteristics of e-learning systems, enabling developers and stakeholders to make informed decisions [17]. Learner-centered design extends user-centered principles to educational technology, where e-learning personas evolve from user personas, inheriting their strengths and limitations [17, 18]. E-learning personas, catering to individualized student profiles, consider factors like preferences, skills, prior knowledge, learning styles, and special needs, mitigating learning obstacles such as cognitive load and frustration [18, 19].

Despite similarities with general personas, interacting with learners presents unique challenges, impacting e-learning persona development [17, 18, 20]. Given these nuances, a thorough exploration of e-learning persona studies is essential to understand diverse creation techniques and methodological evolution. However, the literature lacks a comprehensive evaluation of methods and approaches for e-learning personas, with limited systematic literature reviews (SLRs) on persona technology in general [2, 4, 6, 21]. This research aims to fill this gap by systematically reviewing current studies on e-learning personas.

This paper aims to: (1) systematically collate, analyze, and synthesize pertinent literature in this field; (2) overview principal methods of e-learning persona creation, discussing their strengths and weaknesses; (3) provide insights into the current state of the field; and (4) draw implications for future research and practice, including emergent themes and strategies. The following research questions guide our study:

- RQ1: How have the research interests and methodologies in eLearning persona development evolved over time?
- RQ2: What are the major challenges and research gaps in the field of e-learning persona development?
- RQ3: What are the key trends and future directions in e-learning personas?

II. METHODOLOGY

A. Search Strategy:

To conduct this systematic review, a comprehensive search strategy was formulated to identify pertinent literature in the field of e-learning personas. The strategy encompassed five major databases: Scopus, Web of Science, IEEE Xplore, ScienceDirect, and ACM Digital Library. These databases were selected for their extensive coverage of relevant literature. The search concluded in November 2022.

In addition to database searches, snowball sampling was employed as an auxiliary method, in line with systematic review recommendations [22]. The search keywords were meticulously chosen by the authors, drawing from their expertise in the domain. The keywords encompassed various expressions related to e-learning personas and e-learning systems. Both singular and plural forms of "persona" were included. The search was limited to articles written in English and focused solely on journal articles and conference papers. The subject area was confined to computer science to maintain a focus on human-computer interaction (HCI).

The objective of the research was clearly defined to center on the development of e-learning personas. Studies concentrating on persona development in contexts other than e-learning were excluded. The search terms employed were as follows: (elearning OR e-learning OR learning systems OR learning styles OR learners OR online education) AND ("personas" OR "persona"). This strategic selection of filters significantly streamlined the pool of relevant papers, as summarized in Table I.

Table 1. Resulting Papers from Search Engines

Dataset	Search Statement	Results
Scopus	(elearning OR e-learning OR learning systems OR learning styles OR learners OR online education) AND ("personas" OR "persona")	147
Web of Science	Same as above	32
IEEE Xplore	Same as above	38
ScienceDirect	Same as above	8
ACM	Same as above	32
Total		257

Note: The search was restricted to English language papers, article and conference papers only, within the subject area of Computer Science and its applications.*

B. Selection Criteria:

The criteria for selecting relevant literature were established in accordance with the PRISMA guidelines [23]. The focus of the search was to comprehensively map the existing literature in computer science and computer software engineering that pertains to eLearning personas. The scope of the literature reviewed encompassed all publications available up to November 2023. At the conclusion of this phase, a total of 257 records had been systematically extracted for further analysis.

C. Quality Assessment:

The quality assessment of the literature for this systematic review was rigorously conducted, adhering to the following criteria: inclusion of original research articles, review papers, and conference papers. To ensure the integrity of the review, duplicate entries were meticulously identified and removed. The abstracts and articles underwent a detailed screening process to ascertain the relevance and academic merit of the content. Subsequently, each publication was subjected to a comprehensive evaluation.

An additional exclusion criterion was the language of publication; the review was confined to articles published in English. This led to the exclusion of one article that did not meet the language requirement. Post-elimination of duplicates, a further 61 publications were deemed not pertinent to the study.

Ultimately, 27 articles were selected based on their alignment with the specified inclusion and exclusion criteria. The process of literature inclusion and exclusion at each stage is illustrated in Figure 2, as per the PRISMA flow diagram.

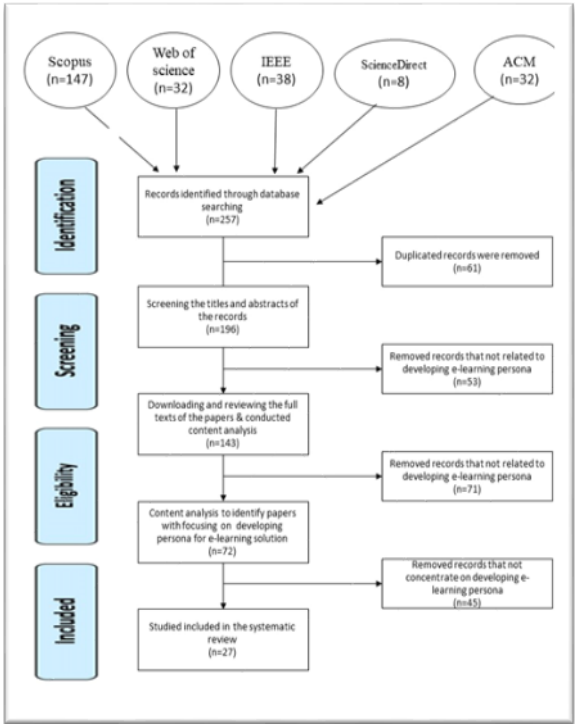

Fig. 2. PRISMA Flow Diagram of Literature Inclusion and Exclusion

D. Data Extraction:

In the data extraction phase of this systematic review, we meticulously analyzed 27 articles that met our inclusion criteria. We extracted data from original full-length research articles, review papers, and conference papers, excluding books, theses, and short articles. Case studies and reports that had been published previously were also not considered. The eligibility of the articles was contingent upon them being in English and relevant to the field of computer science.

To address the literature gap, our focus was narrowed to articles specifically discussing e-learning personas, excluding those pertaining to software persona development in general. Articles lacking details on the creation of eLearning personas were deemed unsuitable for this review. Consequently, the number of articles for inclusion was

narrowed down to 27. A significant challenge encountered during the extraction process was differentiating between the keyword "learning," as used in the context of e-learning personas, and "machine learning," which is prevalent in persona development studies.

Data were extracted using a standardized form [24], which helped us gather comprehensive details such as the title, keywords, publication year, type of research (article or conference paper), data sources (questionnaire, interview, social media), data size, analysis methods, number of citations, evaluations conducted, and recommendations for future research made by the authors. This extracted information was critically appraised, synthesized, and is discussed in the subsequent sections of this review.

III. Reporting Results

The results of this systematic review are reported in two main sections: descriptive analysis and literature classification. The descriptive analysis aims to statistically describe the corpus of articles, encompassing the types of documents, distribution of articles over time, and identification of the most frequently cited papers. The literature classification segment delves into categorizing the various research components, encompassing the types of research conducted, methods of data collection, and the analysis techniques employed.

A. Descriptive Analysis:

1) Document Types: Within the scope of our systematic review, conference papers emerged as the predominant type of research document, comprising 70% of the total studies analyzed, with a count of 19 papers. In recent years, there has been a noticeable increase in the number of journal articles addressing the research topic, indicating a growing interest in the field. It should be noted that while additional conference proceedings articles are available, they were not included in this review due to the delineated selection criteria.

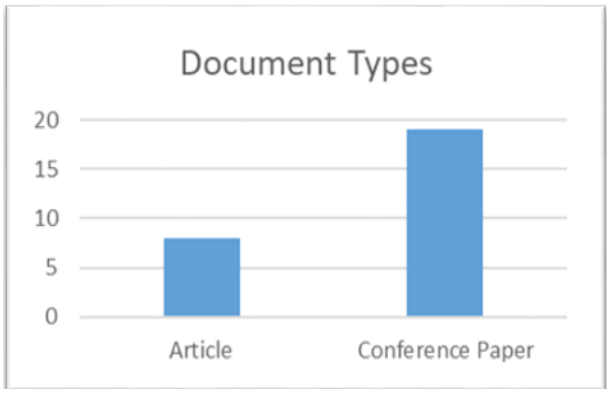

Fig. 3. Distribution of Document Types

2) Records Distribution Over the Years: An analysis of the yearly distribution of research papers revealed a steady increase in publications. The period from 2019 to 2021 was particularly prolific, which can likely be attributed to the intensified focus on e-learning due to the COVID-19 pandemic. The zenith was reached in 2019, with the publication of 9 articles. Despite the surge in e-learning research during this period, the year 2022 witnessed a decline to just 2 publications. This downtrend may be ascribed to the specificity of the study's focus on persona development within the e-learning domain, coupled with the restriction to the computer science field. Figure 4 illustrates the distribution of records over the specified years.

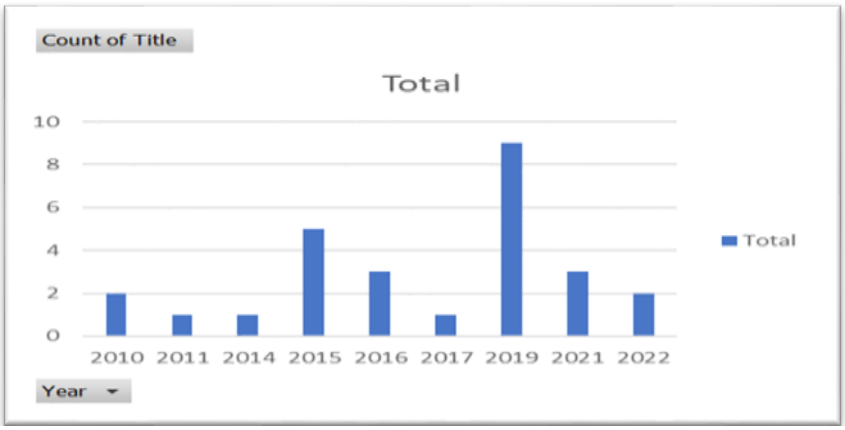

Fig. 4. Distribution of Research Records Over the Years

3) Most Cited Papers: An examination of citation frequencies was conducted to identify the most influential papers within the selected corpus. The citation data was sourced from Google Scholar as of November 20, 2022, to ensure comprehensive coverage across all prominent databases, with the maximum citations reaching 410 and the minimum at zero. Notably, three articles (16.3 percent of the total) did not receive any citations. There was a slight positive correlation observed between the age of a paper and its citation count. The work titled "Get out of MySpace!" by Jones N., Blackey H., Fitzgibbon K., and Chew E. holds the distinction of being the most cited paper, amassing 410 citations [25]. The top ten most cited papers in the domain are detailed in Table II.

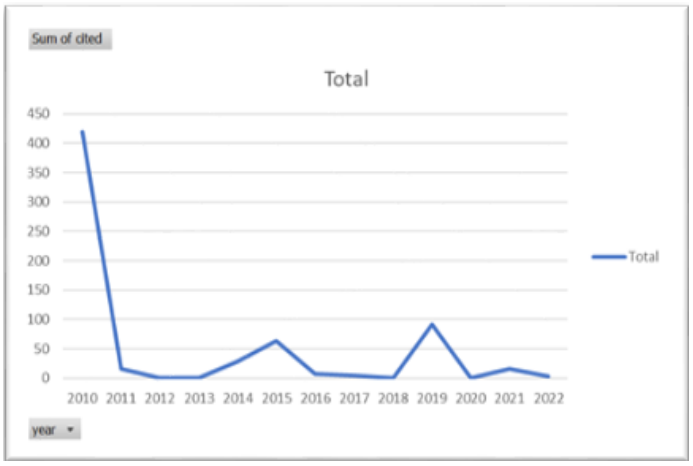

Fig. 5. Citation Frequency of Papers Over the Years

Table II. Most Cited Papers

Title and Authors	Citations
Get out of MySpace!" by Jones N., Blackey H., Fitzgibbon K., Chew E.	410
"Explaining predictive models to learning specialists using personas." by Brooks C., Greer J.	29
"Personas and identity: Looking at multiple identities to inform the construction of personas." by Marsden N., Pröbster M.	25
"Affordance-based user personas: A mixed-method approach to persona development." by Mesgari M., Okoli C., Ortiz De Guinea A.	24
"Defining Personas of University Students for the Development of a Digital Educational Game to Learn Portuguese as a Foreign Language." by Salomão R.C.S., Rebelo F., Rodríguez F.G.	10
"Understanding the student experience through the use of personas." by Lilley M., Pyper A., Attwood S.	16
"Personas design for conversational systems in education." by Almahri F.A.A.J., Bell D., Arzoky M.	17
"Using Personas as Curricular Design Tools: Engaging the Boundaries of Engineering Culture." by Ozkan D.S., Reeping D., McNair L.D., et al.	9

"Teaching user centered conceptual design using cross-cultural personas and peer reviews for a large cohort of students." by Anvari F., Richards D., Hitchens M., Tran H.M.T.	19
"Examining and mapping CS teachers' technological, pedagogical, and content knowledge (TPACK) in K-12 schools." by Giannakos M.N., Doukakis S., Crompton H., et al.	17

*B. Literature Classification***

1) Research Types: The corpus of articles reviewed predominantly employed quantitative research methodologies, with 13 papers utilizing this approach [9, 26, 27]. Qualitative research was the second most prevalent type, represented by 9 studies [19, 28, 29]. A subset of the literature utilized a mixed-methods approach, combining both quantitative and qualitative research [30, 31], as illustrated in Figure 6.

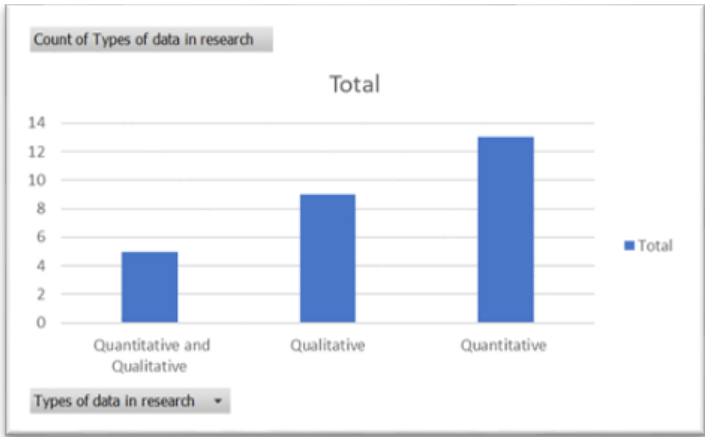

Fig. 6. Distribution of Research Types

To analyze the temporal trends of these research methodologies, each study was categorized by the year of its publication. As indicated in Figure 7, recent years have shown an uptick in the adoption of qualitative research methods in the development of e-learning personas [32, 33]. Conversely, the mixed-methods approach appears to have diminished in recent publications, indicating a notable trend in e-learning persona research.

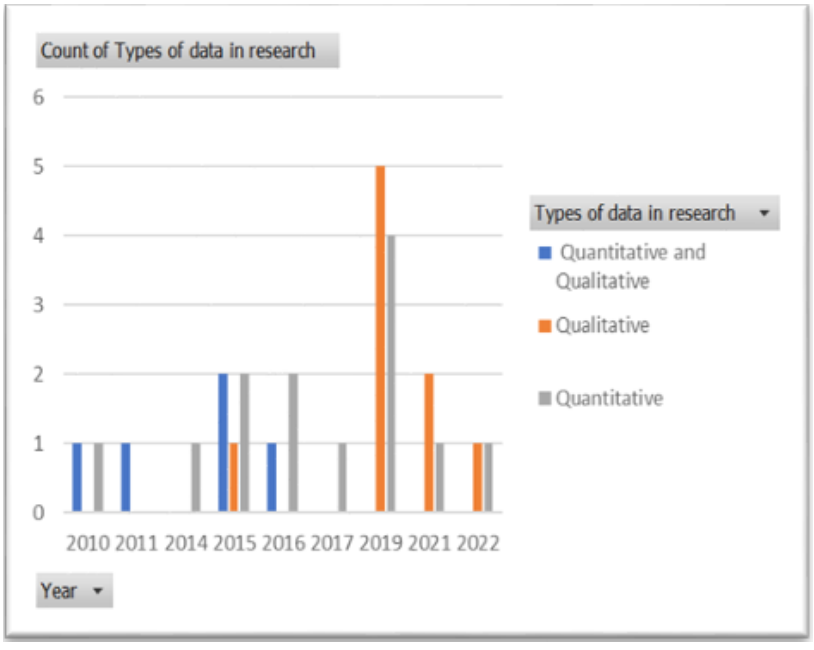

Fig. 7. Trends of Research Types Over Time

2) Collected Data Methods: The primary data collection method, as depicted in Figure 8, was questionnaires, utilized in 47% of the studies, equating to 9 papers [9, 19, 34, 35]. The concurrent use of questionnaires and interviews constituted the second most common approach, found in 29.9% of the articles, corresponding to 5 studies [26, 36, 37]. A trio of papers explored the adoption of emerging technologies for data collection, leveraging existing datasets augmented by APIs and machine learning techniques to develop e-learning personas [28, 33].

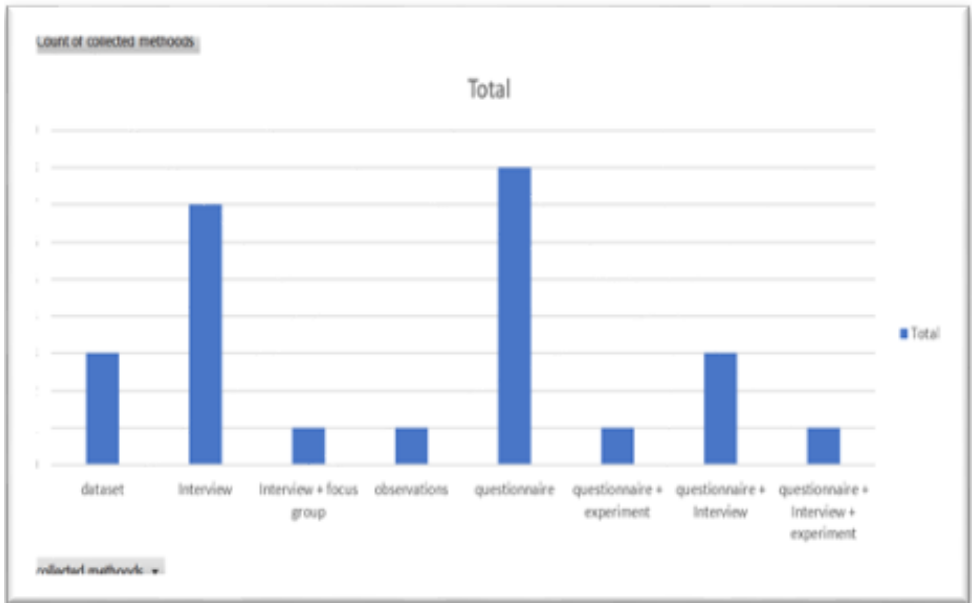

Fig. 8. Methods of Data Collection

4) Analyzing Methods: Statistical analysis emerged as the most frequently employed analytical method, utilized in 80% of the papers analyzed [31, 38-40], often in conjunction with questionnaires and interviews. It was observed that certain methods, such as cluster analysis, can be considered subsets of statistical analysis. Despite its utility, K-means clustering was less commonly used [20], which might be correlated with the utilization of APIs as a data collection tool [33].

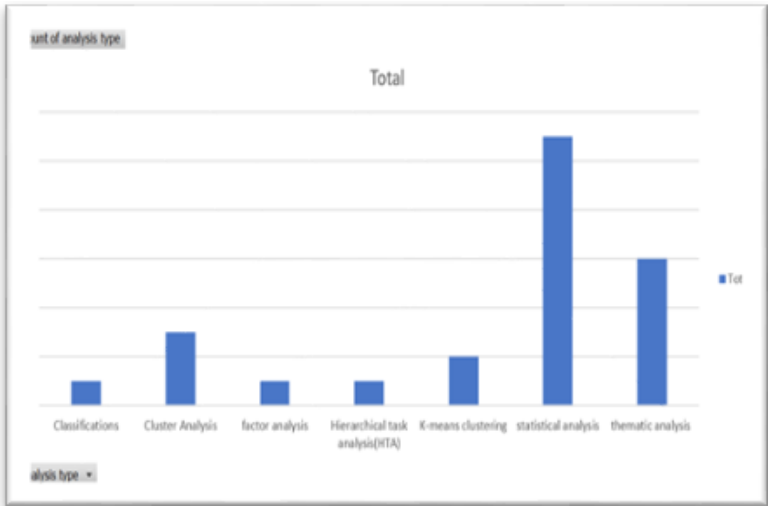

Fig. 9. Analysis Methods Employed in the Literature

The predominant analysis techniques used in the development of e-learning personas are summarized in Table III.

Table III. Description of Analysis Methods

Methods	Description	Example	Frequency
K-means clustering (KMC)	A machine learning approach that groups a dataset into a predetermined number of clusters (k) [41].	[20, 28, 33]	N=3
Hierarchical task analysis (HTA)	A method that determines the distances between components to create clusters based on similarity in a hierarchical manner [42].	[26]	N=1
Statistical analysis	| A process for identifying patterns and trends through the collection and examination of data, typically associated with quantitative research [43].	[9, 38]	N=11

Thematic analysis	A qualitative approach to analyzing text data, often applied to interview transcripts or other text collections [44].	[32, 38]	N=7

IV. Central Research Gaps

Upon completing this systematic review, several significant research gaps within the domain of e-learning persona studies became apparent. The following sections delineate perceived research deficiencies and suggest potential avenues for future investigation.

A. E-learning Personas as a Secondary Focus:Predominantly, the e-learning persona does not constitute the primary subject of the scrutinized research. Therefore, a gap exists for studies with a concentrated focus on the development of e-learning personas.

B. Underutilization of Emerging Technologies in Data Collection:The review indicates a preference for traditional data collection methods such as questionnaires and interviews over modern technologies like APIs [9, 32], which offer real-time data and efficiency [4, 6]. This highlights a research void in the application of advanced data collection techniques within e-learning persona studies.

C. Evaluation of E-learning Personas: A notable deficiency is the absence of a standardized evaluation process for e-learning personas in the literature examined. This shortfall extends to general user persona studies as well [6].

D. Ethical Considerations: Ethical issues related to the handling of learner data are paramount, yet the literature within our scope does not sufficiently address these concerns.

E. Addressing Learner Needs:The research largely overlooks the distinct needs of students, often treating them as generic software users, which undermines the potential efficacy of the e-learning personas created [45].

F. Leveraging Social Media Data: Despite the wealth of data available on social media, its use in e-learning persona studies has been minimal. There is a gap in research on automated eLearning persona development utilizing such readily available data [14].

V. Future Works

The identification of literature gaps sets the stage for future research directions, such as:

A. Studies focusing primarily on eLearning personas.
B. Investigations into the optimal use of APIs in e-learning persona development.
C. Research on data mining for constructing e-learning personas.
D. Exploration of automated e-learning persona development.
E. Utilization of social media data in e-learning persona creation.
F. Application of learning theories, like learning styles, in e-learning persona development.
G. Ethical considerations in e-learning persona creation.
H. Evaluation methods for e-learning personas.

VI. Conclusion

This study has synthesized the existing body of literature on e-learning personas using the PRISMA methodology. The descriptive analysis and literature classification addressed RQ1 by charting the evolution of research interests and methodologies. In response to RQ2, we have identified several research gaps, such as the lack of primary focus on e-learning personas, the limited use of advanced data collection technologies, and the absence of persona evaluation processes. Furthermore, in response to RQ3, this paper proposes future research opportunities that could enrich the field of e-learning personas, including automated persona development, the integration of learning theories, and ethical considerations in persona creation. These proposed directions aim to guide and inspire further research in this evolving study area.

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