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Representing groups of students as personas: A systematic review of persona creation, application, and trends in the educational domain

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ABSTRACT

This study presents a comprehensive systematic review of the use of student personas in education, drawing insights from 83 publications identified through the ACM Digital Library, Web of Science, and Scopus. The analysis reveals that qualitative methodologies dominate persona development, with limited adoption of data-driven algorithmic approaches. Most studies constructed small persona sets—typically four or fewer—focusing on dimensions such as behaviors, beliefs, goals, needs, experiences, perceptions, and demographics, contrasting with larger sets found in industry. Predominantly featured in educational conferences, student personas were employed to (1) understand user needs, goals, and behaviors, (2) support the design and development of learning systems, (3) enhance teaching and learning practices, (4) facilitate persona-based roleplaying, and (5) promote diversity, inclusivity, and accessibility. However, the assessment of personas' impact in these areas remains minimal. The findings suggest significant opportunities for the educational sector to leverage algorithmic methods to advance persona creation and broaden their application scope.

1. Introduction

Personas are realistic representations of segments of people based on factual evidence, ideally developed through extensive research and analysis to promote immersion into people's needs [1,2]. Although they have their distractors [3], personas are more effective than analytics [4] for certain tasks [5], and personas positively contribute to design and communication about users across teams [6–8]. Due to their utility, personas have been developed in various domains, including human-computer interaction (HCI), software development, design, marketing, healthcare, and education [9–16].

In *education research*, personas have been used to understand students' needs and behaviors, which are relevant to their active learning [17–19]. For example, faculty members have used personas to create undergraduate student profiles of active learners [20] and improve students' learning of analytical tools [21]. Student-based personas have also been developed to understand distance learning experiences and needs [22], and the persona concept has been used to design humanized agents for education [23,24].

Specifically, a student persona is *a humanized, detailed, and realistic representation of a segment of a student population* (for example, see Fig. 1). A student persona is created based on research and data, and it includes specific characteristics of the student segment, such as demographics, learning styles, goals, and challenges. A student persona is used in education to design and tailor learning experiences that meet the diverse needs of learners, e.g., in the design of suitable learning tools [25] that consider their unique needs [26]. Considering their utility and effectiveness, personas could be valuable for understanding students' needs and communicating them to technology developers to design technology-mediated learning environments, such as AI and large language models (LLMs) [27], which leans itself to the development of AI-based chatbots [28]. Different methodologies, such as qualitative [21,29,30] and quantitative [22,31] have been used to develop personas in education. Researchers have built these personas from various data sources such as student admissions data and academic records [32] and surveys or interviews [21,22]. Specifically, personas could be *ad hoc*,

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manually created [20,21], algorithmically generated [31], or hybrids [22].

However, prior research concerning using personas within educational research and design is limited [32]. Given the impact of personas across multiple domains, this is a critical shortcoming for the educational community.

2. Background

In the following subsections, we describe personas and their usage in education.

2.1. Persona as a tool

As a humanized representation of people data, personas are an empathetic approach to representing segments of the target populations by presenting the data in a form that most people can relate to–that of another person [11,33]. The persona approach emerged in the late 1990s as HCI scholars were seeking ways to highlight the role of users in the design of technology [1,11]. Personas are widely employed in many domains and organizations using various methods, including qualitative and algorithmic approaches [34]. Personas have been evaluated in various ways, including statistical evaluation for segmentation identification tasks [5], with various benefits reported in the literature [35]. A persona is typically presented in a one- to two-page persona profile [36]. However, personas can be presented algorithmically in data-driven machine learning or artificial intelligence (AI) systems [37]. Personas are used for various tasks within organizations, including stakeholder communication, planning, and objective setting [38]. All of these apply to educational institutions.

2.2. Benefits of student personas in education

The creation of student personas can provide a multitude of benefits. Constructing an archetype of students provides a richer account of student needs, thereby equipping designers and developers in their technology design process to design learning tools that align with their endeavors [39,40]. These student personas make personal information about students more visible [41], and help better present students' profiles with specific goals, needs, learning objectives, behaviors, and challenges [26,42]. Additionally, student personas act as a lens through which similarities and differences between students come to light [22,43], ideally creating a shared understanding of the student group around which decisions are made [44]. Finally, creating student personas nurtures empathy, a critical element that helps create an in-depth understanding of student expectations, goals, needs, experiences, and behavior [45]. In sum, student personas can be of benefit to various educational endeavors.

3. Research questions

Our research seeks to provide an informed and consolidated perspective on student persona creation's applications, methodologies, and outcomes. Through a rigorous examination of current literature, this study aims to lay a robust foundation for developing future student personas by providing existing applications and design methodologies. Conducting a systematic literature review (SLR) on student personas in education provides a valuable summarization of current knowledge in

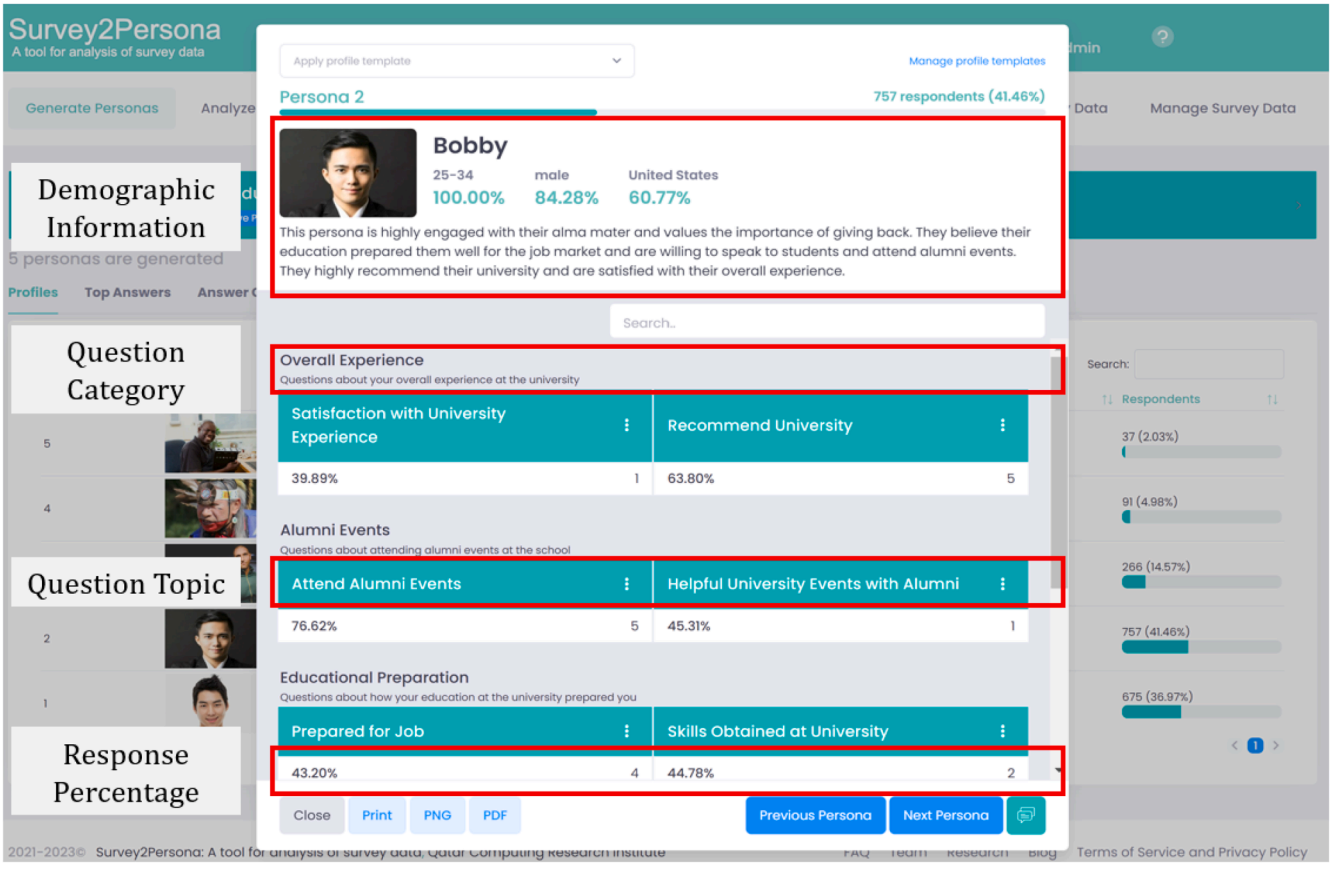

Fig. 1. Exemplar Student Persona Profile – Bobby, using the freely available personal tool, Survey2Persona (https://s2p.qcri.org). This is an example of a student persona, specifically, a student alumni persona from a higher education institution. The persona encapsulates key attributes, behaviors, and goals that typify a distinct user group within the student population. The profile combines demographic information, academic pursuits, technological preferences, and personal motivations, comprehensively representing the user segment's background and characteristics.

the field of research [46], identifies the existing knowledge gaps, and uncovers the future avenues [47] to further the employment of student personas, especially as students cope with the changing educational environment. To this end, the current work is guided by the following research questions (RQs):

- **RQ1**: *What is the research profile of relevant publications focused on student personas in higher education?*
- **RQ2**: *What is the research purpose of developing student personas?*
- **RQ3**: *Which methodologies are used to create student personas?*
- **RQ4**: *What are the gaps in existing student persona research?*

RQ1 maps the research landscape in this domain, providing a foundational understanding of publication trends, types, and venues. Identifying trends helps analyze how the concept of student personas has evolved over time. The type of publication distinguishes between original research and other types, such as reviews, editorials, and notes, to evaluate the strength of evidence. Documenting venues can indicate the research's credibility as impact factor journals and top area conferences have stricter review processes, and conferences offer emerging perspectives. For RQ2, the study uncover the motivations behind creating student personas and their applications. Understanding the purpose of these student personas highlights their roles in educational design and development. RQ3 analyzes the diversity in methodological approaches to student persona creation. By doing so, the study seeks to identify prevalent practices and potential gaps that could guide future methodological advancements in persona development in this area. RQ4 emphasizes the significance of continued inquiry and contributes to advancing the field of educational personas.

To our knowledge, there has been no previous SLR on personas in education as of the date of this research. So, the synthesis of knowledge provided in this work provides implications for educators, policymakers, and researchers in creating educational resources that align with the diverse profiles of students in educational entities.

4. Methodology

SLRs provide a fine-grained and nuanced view of prior research on a specific topic and are a widely used method for understanding the state-of-the-art across many disciplines. Examples include research in business [48], education [49], human-computer interaction [2], information systems [46], cybersecurity [50], as well as on the topic of personas [2,47]. SLRs synthesize the existing literature systematically, transparently, and reproducibly [51]. As such, a SLR of student personas can greatly benefit education researchers and practitioners by highlighting the benefits, shortcomings, and future avenues of research. This section explains the SLR methodology followed in this study, including how publications were identified, screened, and assessed (see Fig. 2).

4.1. Publication identification

We utilized the prominent research databases of ACM digital library (ACMDL), Scopus, and Web of Science (WofS) to explore current research on student personas in education and expand our knowledge in this field. While other sources like IEEE Xplore, Google Scholar, and Science Direct are commonly used for literature reviews, we favored ACMDL, Scopus, and WofS due to their superior quality, coverage, and relevance to privacy-related topics [2,50,52,53]. We avoided focusing

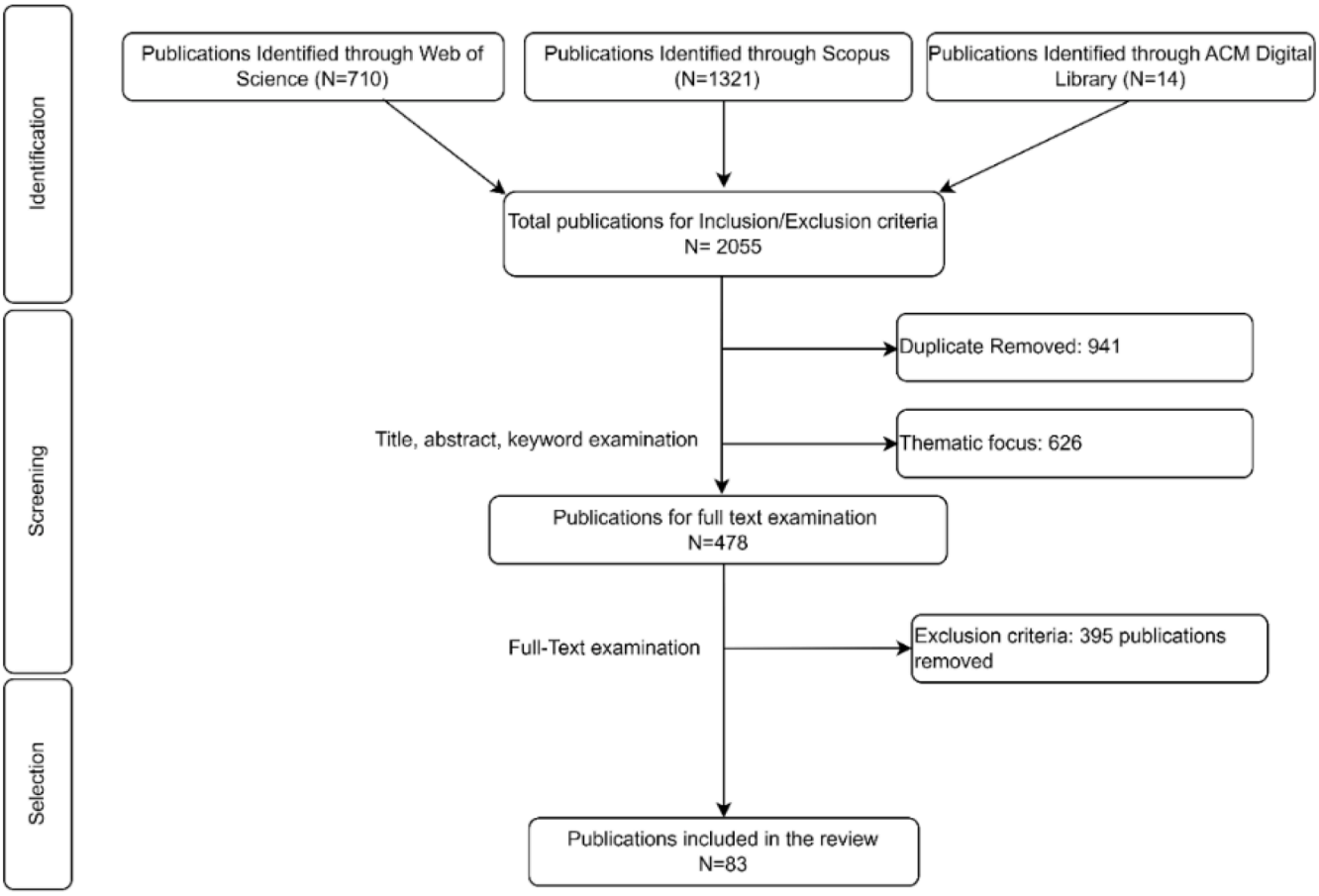

Fig. 2. Flow diagram showing the identification, screening, and selection of literature from identifying 2045 publications to screening eligible publications and arriving at our final set of 83 publications. Further excluded records in each step are also mentioned.

on specific publication forums to prevent bias in publication selection.

In line with the RQs, we created a search string "Personas AND (students OR graduates OR applicants OR alumni OR education OR schools OR university OR College)". This search string was created through an iterative process where several earlier SLRs on students and education were consulted. We restricted our search to peer-reviewed publications such as journal articles, conference proceedings (including proceedings published as book chapters), and book chapters. The lower time limit for the search was set to 2010, and the search was conducted in March 2023. The search was conducted on the title, abstract, and keywords in Scopus and topics in WofS, whereas only a search in the title was performed in ACMDL. Three screening criteria (time frame, language, and academic rigor) were also applied through automated functions in the databases above. By doing so, we identified 710, 1321, and 14 (total = 2045) potentially relevant WofS, Scopus, and ACMDL publications, respectively.

4.2. Screening

The following screening criteria (C) were used for identifying relevant publications:

1. **C1: Time frame.** The article was published between 2010-2022.
2. **C2: Language.** The article was written in English.
3. **C3: Academic rigor.** The article was peer-reviewed and communicated the research clearly, including journal or conference proceedings (including book chapters) and excluding grey literature, editorial, and similar writing pieces.
4. **C4: Thematic focus.** The article focused on student personas within school, college, and university education, describing the persona generation process.
5. **C5: Methodological focus.** Articles that were not empirical studies, such as conceptual papers, review papers, invited talks, or abstracts, were excluded.
6. **C6: Availability.** Articles were also excluded if the full text was unavailable.

The meta-data of the publications were downloaded to spreadsheet software, and duplicate entries (941 entries) were removed. The title and abstract of the remaining 1102 publications were examined for thematic focus by the first author, who had expertise in personas and student engagement. In this step, 626 publications were excluded due to irrelevancy, such as studies on online personas and social media personas of celebrities, artists, and musical personas. The full texts of the remaining 478 publications were examined by three authors of this paper, each with an allocation of 138 unique publications. The above-stated screening criteria were again applied, and to ensure the quality of this step, we included 64 common publications in each author's dataset. Later, we checked the coding of these common publications and found no significant difference in the coding of the three authors, showing the validity of the final step in the screening process. Cohen's kappa of the common screening was 0.80, indicating a substantial level of agreement. Consequently, 83 research articles were selected for analysis.

The RQs significantly influenced the screening and selection process of publications. Specifically, the inclusion and exclusion criteria were designed to align with the focus of each research question to ensure that only relevant and insightful studies were analyzed. For example, to address RQ1, emphasis was placed on selecting peer-reviewed journal articles, conference papers, and book chapters that provided comprehensive publication details, such as type and venue. This focus allowed for a detailed mapping of the research landscape. For RQ2, the screening emphasized publications that clearly articulated the objectives behind persona creation. Articles lacking detailed descriptions of their purpose or with vague mentions of personas were removed. For RQ3, the selection process highlighted studies that provided explicit details on their persona development methodologies. This step ensured the analysis could extract meaningful data points regarding various qualitative, quantitative, or mixed methods. Lastly, for RQ4, the selection criteria included a focus on studies that discussed challenges, limitations, or areas for future exploration in student persona research. This criterion helped to compile evidence that would inform the identification of research gaps and future opportunities.

To ensure the rigorousness of the systematic review and mitigate risks of bias of the used methodology and selectivity of findings, the study followed three procedures [54] First, a systematic database search approach was followed. Multiple, high-quality research archives (ACM Digital Library, Scopus, and Web of Science) ensured comprehensive coverage of relevant literature, reducing the risk of missing significant publications. The search string was also developed through an iterative process, consulting existing systematic literature reviews to create an inclusive and precise search query. Second, more than one reviewer was involved, each examining 64 common publications where the inclusion and exclusion criteria were consistently applied across all screening stages. One reviewer with expertise in personas and student engagement conducted the initial title and abstract screening. A full-text review by three reviewers followed this, each examining unique sets of publications. An inter-rater reliability was confirmed with a Cohen's kappa score of 0.80, indicating a substantial level of agreement. Third, transparent documentation of reasons for exclusion was maintained at each step of the process, where each reviewer reviewed and assigned relevant scores independently, ensuring that future researchers could replicate the methodology and clarify why certain publications were not included, enhancing the review's validity and replicability. These steps reduce the potential biases of systematic literature review, including source selection bias and rater's bias, and improve the transparency and reliability of the literature filtering process, ultimately strengthening the validity and reliability of the conclusions drawn from this systematic review.

4.3. Data extraction and analysis

Table 1 shows the RQs, the data points extracted, and the usual location of the data points in the papers.

To address RQ1, we examined the publication meta-data to identify publication type, year of publication, and publication venues; we created year-wise frequency distribution tables. To address RQ2, we conducted a thematic analysis of the publications by examining the meta-data of title, abstract, keywords, and the purpose for which personas were generated. The full text was also examined where required. The review process involved rigorous steps to identify and analyze key themes across the selected articles. Following the acquisition of an initial

Table 1
Research Questions and data points extracted from the publications.

Research Question	Data points	Data location
RQ1: *What is the research profile of relevant publications focused on student personas in education?*	Publication type Publication year Publication venues	Meta-data Meta-data Meta-data
RQ2: *What is the purpose of developing student personas?*	The purpose for creating and using personas	Abstract, introduction, methodology
RQ3: *How are student personas created?*	Methodology type Data type Persona characteristics Persona development techniques	Methodology
RQ4: *What are the future research directions in student persona research?*	By examining the above data points	Methodology, discussion, limitations and future work, conclusion,

pool of articles, an open coding technique was employed to derive emergent themes [55]. The themes were generated iteratively by one author and validated by another author. Both authors had expertise in qualitative analysis. In the open coding process, each article was meticulously examined, and each purpose was annotated with codes that encapsulated the essence of the text. The coding process was iterative and inductive, allowing for the emergence of themes directly from the data without preconceived notions. A total of 78 first-order descriptive codes describing the purpose of student personas were generated. In the second analysis stage, each code was assigned to broader categories while making notes to document the choices and further develop our insights. The co-authors cross-checked these to ensure soundness and validity.

During the categorization phase, the team performed several rounds of in-depth reviews of the first-order codes and refined them as our understanding evolved. In the third stage, we aggregated the categories into dimensions (aggregated dimensions), showing the purpose of using personas in the given study. To address RQ3, the methodology sections of 83 shortlisted publications were examined, and information such as the method for developing personas, the number of personas developed in each study, and the characteristics used for persona generation (persona dimensions) were identified and noted. Instead of describing each characteristic, we categorize them into demographics, behavior and beliefs, goals and needs, experience and perceptions [56], and affordances.

5. Findings

In this section, we provide the study's findings by describing the research profile of the shortlisted publications, identifying the purpose of persona use, and discussing the methodology of persona development and gaps in the existing work.

5.1. RQ1: What is the research profile of relevant publications focused on student personas in education?

Through the analysis steps described in Section 3.3, we created publication trends and identified publication types and venues described in this section. The findings from our systemic literature review offer valuable insights into the landscape of student personas in the educational domain, shedding light on their increasing prominence and significance.

5.1.1. Publication trends

There has been an upward trajectory in the number of publications on student personas in education from 2010-2022, with some notable peaks (Fig. 3). The first peak occurred in 2015 with 12 publications across various sources, and the second peak, also the highest across the years under review, occurred in 2019, with a total of 18 publications. The trend indicates an increasing interest in using student personas in education, evidenced by the rise in publications from various sources. The analysis of publication trends (2010-2022) highlights a consistent upward trajectory in the number of publications related to student personas, with distinct peaks in 2015 and 2019. These peaks underscore the growing interest in utilizing student personas within education and suggest pivotal moments when the concept gained notable attention within the academic community.

5.1.2. Publication types and venues

Conference papers constituted most of the publications (67%), followed by journal articles (30%) and book chapters, conference proceedings, and special issues (1% each). The prevalence of conference publications indicates that most research on student persona originates from more technical fields such as computer sciences and education technology. The distribution of publication types and venues provides a comprehensive view of the academic platforms where research on student personas predominantly resides. Notably, conference papers dominate the landscape, accounting for 67% of the publications, reflecting a clear affinity for more technical domains like computer science and educational technology. Fig. 3 presents the trend analysis of student persona publications in education.

Some publication venues appear more frequently than others, as depicted in Table 2. The American Society for Engineering Education (ASEE) Annual Conference and Exposition had the highest number of articles in our sample (5), followed by Frontiers in Education (3), ACM International Conference Proceeding Series (3), and Lecture Notes in Computer Science (3). Aside from journal articles from Communication in Computer and Information Science, the other publication venues with the greatest number of publications (frequency $\geq$2) were conferences. The increased number of articles by ASEE signifies the increased use of student personas in engineering education in various contexts, such as developing a help-seeking usage model for distance-delivered calculus

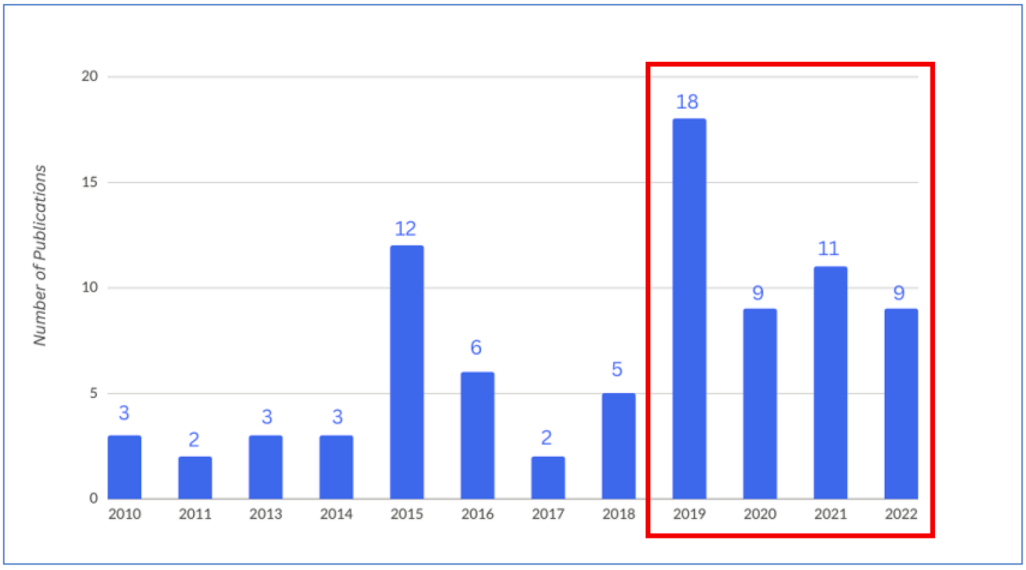

Fig. 3. An analysis of publications focusing on student personas in education during 2010-2022. As noted by the boxed years, there has been a notable increase in educational persona papers since 2019.

Table 2
Top publication venues with types

Publication Venue	Paper Counts	Venue Type
ASEE Annual Conference and Exposition	5	Conference
Frontiers in Education Conference (FIE)	3	Conference
ACM International Conference Proceeding Series	3	Conference
Lecture Notes in Computer Science	3	Conference
International Conference on Computer-Supported Education	2	Conference
Interaction Design and Children (IDC)	2	Conference
Human-Computer Interaction	2	Conference
Communications in Computer and Information Science	2	Journal
All others	61	Conferences & Journals
Total	83	

students who use online forums [57], considerations for persona and journey map use in engineering course design [58], and using an experience design approach for curriculum creation [59], among others.

Overall, the shortlisted publications were drawn from 69 unique publication venues, including conference proceedings, academic journals, and workshops representing specific research areas such as the Symposium on Visual Languages and Human-Centric Computing and the International Conference on Healthcare Informatics (ICHI), Computer Science education, as well as other interdisciplinary education elements such as the International Conference on Healthcare Informatics and the International Conference on Human-Machine Systems, which suggests a focus on the intersection of computer science and healthcare or human factors, respectively. The diverse outlets illustrate the breadth of the persona method to achieve an emphatic understanding of students within the educational domain.

The prominence of specific venues, such as the American Society for Engineering Education (ASEE) Annual Conference and Exposition, Frontiers in Education, ACM International Conference Proceeding Series, and Lecture Notes in Computer Science, underscores the multidisciplinary nature of student persona research. Particularly, the increased presence of articles in the ASEE indicates the expanding utility of student personas in diverse engineering education contexts, from developing models for online forums to guiding curriculum creation through experience design approaches. Collectively, these findings illuminate the significance of student personas as a dynamic and evolving research area, motivating further exploration and refinement to better cater to the diverse needs of learners in contemporary educational landscapes.

5.2. RQ2: What was the purpose of developing student personas?

To answer RQ2, we conducted a thematic analysis. From 83 publications, 78 concepts were identified, further divided into 16 categories. Ultimately, five themes to use student personas were identified. Fig. 4 shows the example concepts (first-order codes), categories (2nd order codes), and themes and concepts. Example codes are provided in Table A1 in the Appendix. The identified five key themes are: (1) understanding user needs, goals, and behaviors, (2) design and development of learning tools and systems, (3) supporting teaching and learning, (4) persona-based roleplaying, and (5) enhancing diversity, inclusivity, and accessibility.

These themes demonstrate the diverse uses of student personas in different fields (e.g., computer science, education) and educational institutions (e.g., primary schools, high schools, and universities).

5.2.1. Understanding user needs, goals, and behaviors

This theme explores students' preferences, needs, behaviors, and requirements in different contexts. It mainly focuses on understanding user needs and goals, as well as user behaviors and interactions, which were key dimensions in constructing personas in the reviewed studies.

Studies utilize student personas in education to identify the students' fears and challenges in learning scientific subjects like math and engineering [30,60]. Other studies look for the needs and goals of students who learn online and leverage their travel time to study [61]. Personas were also used to understand how employers in the field of social work perceive the theoretical knowledge of newly graduated students [62].

Moreover, studies aimed to understand the behaviors and interactions of users, specifically in media usage and interaction [63,64] and experiences with robotic shopping [65]. For instance, [63] developed six personas to illustrate extreme digital media usage. They realized that "there are many people who want to go digital, but that certain barriers fundamentally prevent them from changing their behaviors" (p. 8). In their paper, the development of personas helped find design opportunity spaces for the next generation of digital devices. Another project [69] aimed to create personas to identify different scholars' information-seeking activity patterns. Accordingly, five different personas were created to include Bachelor student, Master student, PhD student, and teaching and research academics. These personas helped uncover scholars' different needs and behaviors when retrieving information relative to their research or study.

5.2.2. Design and development of learning tools and systems

Personas play a significant role in creating, improving, and evaluating various learning tools and systems. This theme discusses how personas support the design and development of learning tools, technological applications, teaching aids, interface design, and user experience.

Numerous studies employed personas to develop learning systems, such as the automated data analytics (ADA) system [66] and the autism spectrum disorder (ASD) system [67]. Personas were also used to evaluate a tool system for Chinese course content [68] and develop games to learn Portuguese [69] and Chinese [70]. Authors also leveraged the power of personas to develop mobile applications to support students [70–72]. This approach is perceived as pivotal by researchers, especially in higher education institutions where "the goal of improved learning is to make gains in academic achievement" [39]. Some engineering programs used personas to design teaching/learning facilities to support students [73]. Additionally, teaching aids were designed using personas to communicate warnings about smoking hazards for elementary school students [74]. In the context of teaching support, personas were used to develop holistic rubrics [75], dictionaries [25], and online tutorials [76].

Finally, studies used personas to enhance current and planned tools' interface design and user experience. These persona-based tools have shown noticeable results, contributing to "improved student achievements over previous years" [39]. Personas helped identify the needs and requirements of graduate students to develop AI assistants for student telehealth [77]. For e-learning systems like university library websites and multimedia systems, personas provided exposure to the users' needs that shaped the design of the end products [78,79]. Different studies, such as [80], aimed to gather PhD student requirements to understand information-seeking practices and their information needs. Accordingly, personas were built to inform the functionalities of a proposed system to help students with relevant resource discovery and decision-making [80].

5.2.3. Supporting teaching and learning

Personas were valuable resources or tools to support and enhance the teaching and learning experience. They help in program assessment, facility design, student outcomes and engagement, and teacher support. In terms of program assessments, personas help decision-makers analyze the completeness and efficacy of learning programs [81]. By analyzing the needs of students, personas helped to support the design processes [82,83] and to help redesign classrooms to become more agile [84,85]. A study on classroom redesign using agile methodologies found that the

Fig. 4. The three stages of the analysis process employed to identify codes, categories, and themes to understand the purpose of using student personas in education.

use of student personas significantly improved learning outcomes such that attendance increased to 100%, strongly indicating that there was a "noteworthy positive impact resulting from the revised approach to course delivery" ([85], p. 5). Personas also helped support teachers in transitioning from schoolteacher to university cohorts. In terms of student outcomes, researchers used personas to improve student engagement [86,87], improve their digital behavior [88], and enhance learning experiences in distance learning [89]. Researchers believe that "through continued use (of) UCD (user-centered design) tools and techniques, STEM (science, technology, engineering, and mathematics) education researchers can increase the fidelity of research transfer and affect improvements in STEM instructors' capabilities to adapt to and/or apply contextualized findings within their course settings" [89]. In addition, personas were created to understand better students' learning experiences to support an engaging and flexible learning environment [22]. These personas were created to capture students' perceptions of online distance learning by discussing them with program administrators, educational technologists, and tutors.

5.2.4. *Persona-based roleplaying*

Another purpose of using student personas in education was conceptualized as persona-based roleplaying, where users assume end

users' roles to construct different user groups (e.g., student researchers, designers, users of systems, etc.) with unique needs in different domains.

Personas were used in several studies to facilitate user-centric designs. For example, personas helped understand the target users' requirements for wearable devices and e-textile applications [90]. Users embodying the target group of projects served as agents to advise on altering primary kits [91], promote analytics systems [92], and develop mobile applications for student-faculty communication [93]. Interestingly, personas were not limited to one cultural aspect, and one study employed cross-cultural personas to understand the personality traits and abilities required to become a talented designer [82]. This enabled a broader view of user needs as students developed a "cross-cultural persona with specific knowledge and cognitive process" (p. 10). In turn, this approach "creates a sense of working with a real person during design, and hence, the students persevere with the design and peer review activities" [82].

Personas were also used to gain user insights into the abilities of talented designers [94], learner personas [32], and student researchers [95]. Users who engaged in roleplaying and hypothetical scenarios also helped clarify the perceptions and obstacles of individuals using digital libraries and conducting research [96]. Finally, studies utilized roleplaying in generating personas that help introduce ideal graduate programs [59] and different career paths [97]. In a study investigating the success of electrical engineering students, traditional learners better represented the faculty compared to those pursuing interdisciplinary studies, such as engineering and arts [97]. To enhance representation, the study recommended employing role-playing techniques by assigning a faculty champion to each persona, including the nontraditional learners. This would prevent a standardization of the student learning experience and ensure the department does not produce students as a commodity with identical learning processes" ([97], p. 6).

5.2.5. Enhancing diversity, inclusivity, and accessibility

Personas were shown to promote and facilitate inclusive environments that foster value differences and empathy for users from diverse backgrounds and with special needs. This theme focuses on understanding diverse student profiles, addressing diversity and gender imbalance [98], and accessibility and inclusivity.

Studies used personas to promote cross-cultural understandings for children in the United Kingdom and India [43], enabling empathy with other children [99]. Personas were also helpful in addressing diversity and gender imbalance, specifically for women in video game development [100]. Finally, to support accessibility and inclusivity, personas were used to design inclusive tools for computer science education to improve the students' designs [82]. These design-related systems used personas to invoke empathy in university [101] and school settings [99]. Evidently, personas-driven designs not only require the recognition of diverse needs but also the creation of spaces and suitable technologies. For instance, in a study promoting literacy in school, children participating in the study demonstrated an ability to empathize with diverse personas. They applied this understanding by recognizing the diverse needs of others and including them in the design of library spaces that would promote reading and creative skills [99]. "More challenging was the design of appropriate technologies for the personas who cannot read, like Stella and Vicky. The children were very imaginative, coming up with talking flowers, trees, robots, and magic mirrors with different degrees of reading to correct the children's reading." ([99], p. 7).

5.3. RQ3: How were student personas created?

To answer RQ3, we conducted a content analysis of the methodology to identify the method, the number of personas generated, and the dimensions that were used to develop personas.

5.3.1. Method for student persona development

Persona creation by researchers in the sampled publications demonstrated a dominant use of qualitative methodology, accounting for 53%, while quantitative methodology accounted for only 27.71%, and mixed methodology trailed at 19.28% (see Fig. 5).

5.3.2. Number of personas developed

Among the shortlisted publications (N=83), 69 (83.13%) clearly mentioned the number of personas developed in the studies. The range of personas was 1-56, with a mean of 27 and a median of 4. Of the 69 publications, 13 (18.8%) developed four personas [62,79,94,96,99,100,102–108], 12 (17.4%) developed three personas, and 11 (15.9%) developed one or two personas, nine (13.0%) developed five, seven (10.1%) developed six, and two (2.9%) developed seven. Fig. 6 shows the number of personas created, with the frequency of publications. For references, check Table A2 in the Appendix.

5.3.3. Persona dimensions

The analysis revealed key dimensions that studies adopted to create personas. We mainly refer to demographics, behaviors and beliefs, goals and needs, experiences and perceptions, and affordances as the main criteria utilized in the selected studies. Fig. 7 provides details of persona dimensions, the percentage of total publications used in each dimension for developing a persona, and the corresponding sources.

We categorized the main criteria for studies creating customer personas into five dimensions: behaviors and beliefs, demographics, goals and needs, experience and perceptions, and affordances. *Behaviors and beliefs* refer to the students' interaction patterns, interests, and technology uses. *Demographics* refers to factors denoting basic information about the users' backgrounds like their name, age, gender, nationality, education, etc. *Goals and needs* focus on the users' motivations, frustrations, challenges, and objectives. *Experience and perceptions* refer to the students' attitudes, reactions, and sensitivities toward certain topics. Finally, *affordances* explain the characteristics of students that influence their help-seeking needs and wants.

Our findings reveal that 67.7% of the selected studies relied on behaviors and beliefs to construct their personas. Studies basing their student persona construction mostly used quantitative methods to examine personas in a variety of disciplines like education (e.g., [44,73,109]), computer science (e.g., [29,89,110]), and engineering [63]. Different aspects of students' behaviors and beliefs have been examined in these studies. These studies broadly explored user behaviors, habits, interests, hobbies, technology use, and interaction patterns. Among these elements, studies that utilized a behavior and belief approach in constructing their personas focused on the users' learning strategies. These studies utilized learning strategies as methods to gain, process, and maintain knowledge [39,44,61,79,89,104,111]. Salomão et al. [69] examined the students' process of learning languages (e.g., Portuguese). Other studies also focused on the users' experience with online courses [41], technology usage [70,90], and help-seeking preferences in distance learning [89].

Among the dimensions of personas construction, 57.8% of studies used the demographics criteria to build their personas. These studies explored factors such as occupation [44,60,63,80,112,113], age [95,107,113–115], and pictures [64,82,94,95,107]. Apart from the demographics, 22.8% of studies utilized the goals and needs as dimensions for personas. These studies looked at factors like the students' plans for university [32], task-related goals [26], and learning needs [44]. Within the dimension of experiences and perceptions, 12% of publications look at factors such as the students' experience with online courses [41], perceptions of the study environment [61], and performance grades [86]. In addition to these dimensions, 6% of studies utilized affordances as a factor in persona-building. Specifically, these studies looked at the students' motivation to research [29], help-giving interactions [114], and technology adherence, receptive-expressive language, and social interaction [67]. Finally, 7% of studies did not specify the exact dimensions for creating their personas. While such studies could have been excluded from the review, we kept them for their other valuable

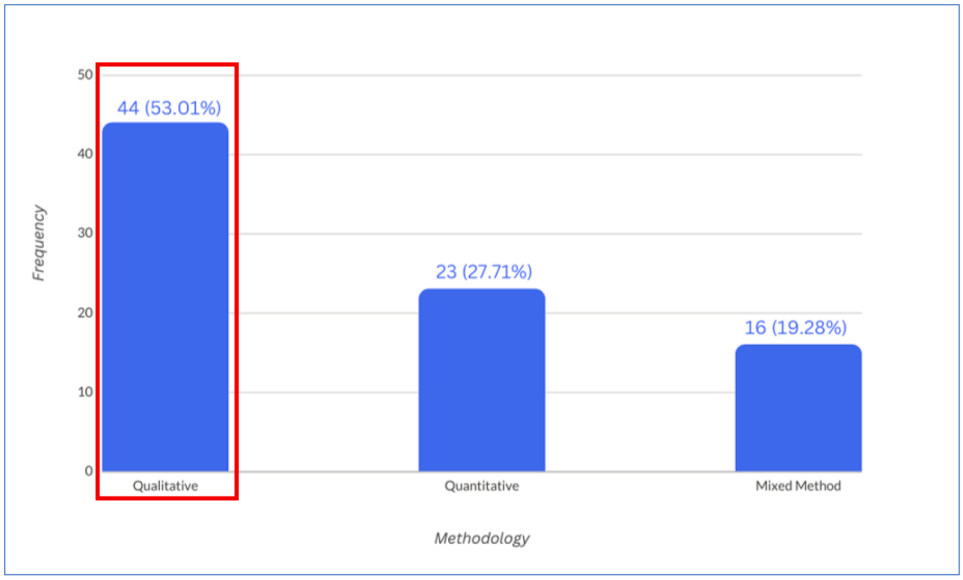

Fig. 5. Frequency of Different Methodologies. As denoted by the block method, the qualitative method is the most utilized approach for student persona creation. For details on sources, consult Table A3 in the Appendix.

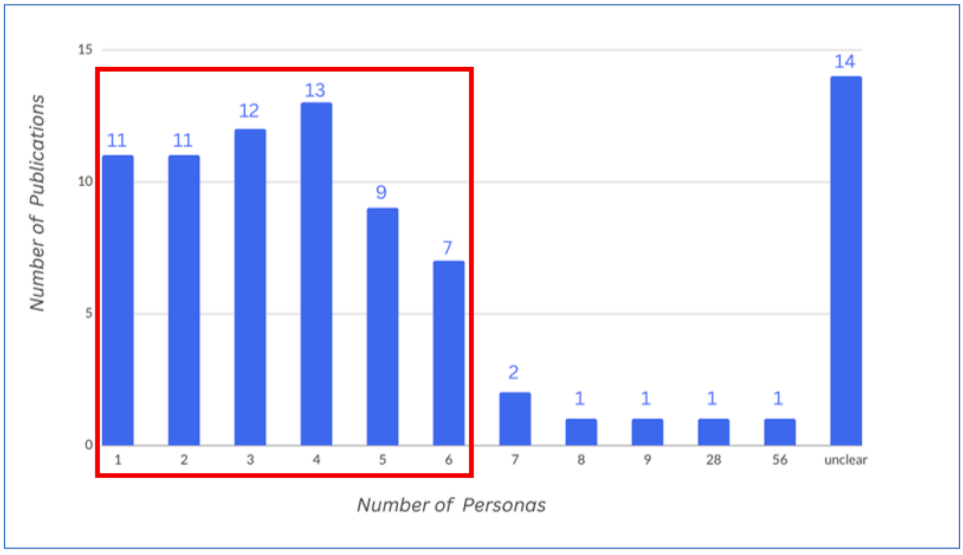

Fig. 6. Number of student personas developed and used in the shortlisted publications. As noted in the figure, the blocked number of personas, six or fewer personas, was the most common number of personas developed.

information related to this study.

5.4. RQ4: What are the gaps in existing student persona research?

While student persona research has shown promising developments and diverse applications, several notable gaps exist in the current literature. First, there is a need for more *standardized and systematic approaches to persona creation*. The prevalence of qualitative methodologies (see Fig. 4) and a lack of the use of more algorithmic methods of persona creation indicates the focus on individual case studies, but it may lead to variability and inconsistency in persona construction across different studies. Establishing a set of best practices and guidelines for persona development, including data collection methods, validation processes, and persona representation, would enhance the comparability and reliability of personas, ultimately advancing the field.

There is also a scarcity of research that addresses the *long-term efficacy and sustainability of student personas in educational contexts*. Many existing studies focus on the immediate impact of personas on instructional design or learning experiences, but little is known about their effectiveness over time. Investigating the longitudinal effects of persona-based interventions can provide insights into the stability and adaptability of personas in dynamic educational environments, offering valuable information for educators and policymakers seeking evidence-based strategies.

Furthermore, the current body of literature does not adequately cover the a*pplication of student personas in non-traditional or marginalized educational settings*. This may be due to the generally small number of personas created in these educational studies, with the industry generally reporting ten or more personas. While some research has explored personas in higher education or well-established learning environments, there is limited knowledge about their relevance and impact in underserved communities, special education, or non-formal learning settings. Understanding how personas can be adapted and implemented in diverse educational contexts can lead to more inclusive and equitable

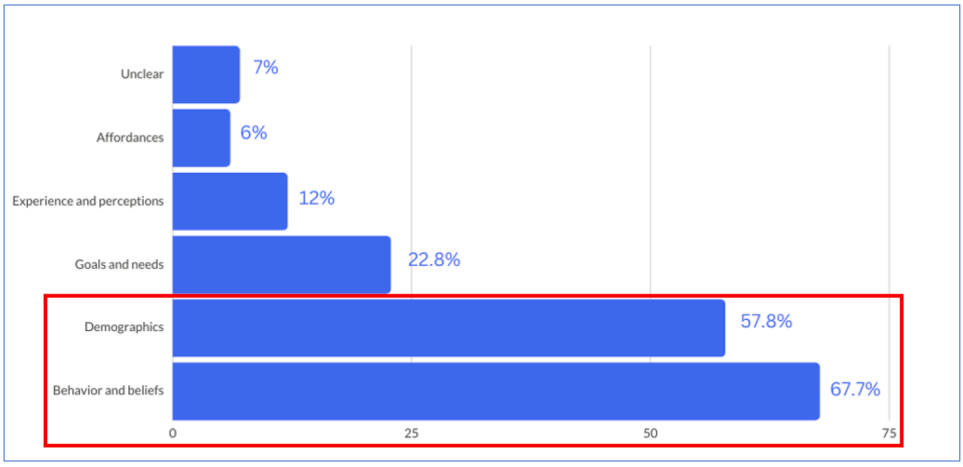

Fig. 7. Dimensions student personas and the percentage of total publications that used the given dimension for developing a persona. As noted in the figure, Demographics and 'Behavior and beliefs' were the most common persona dimensions. For sources, consult Table A4 in the Appendix.

practices, ensuring that all learners benefit from personalized and targeted support.

Finally, studies in this domain could more effectively draw insights from studies addressing student profiling and student modeling, pertinent in educational technology research. We discuss this possibility further in Section 5.4.

In summary, the gaps in student persona research point to the need for standardization in persona creation, the exploration of long-term effects, and a broader consideration of the applicability of personas in various educational settings, including educational technology research. Addressing these gaps can enhance the credibility and effectiveness of student personas as a valuable tool for supporting personalized and inclusive learning experiences across different domains of education.

6. Discussion and implications

This research provides a comprehensive and systematic literature review of student personas in education, covering various domains, applications, methodologies, and trends. The research employs a rigorous and transparent process to identify, screen, and analyze relevant publications, ensuring the validity and reliability of the findings. Finally, we offer valuable insights and implications for education researchers and practitioners, highlighting the benefits, challenges, and gaps of using student personas in different educational contexts.

6.1. Distribution of publication venues

Overall, the analysis revealed that research on personas is often disseminated through conference papers, which may be due to their timeliness and allowing for prompt insights from peer feedback. Notably, the American Society for Engineering Education (ASEE) Annual Conference and Exposition emerged as the most frequented venue, featuring five articles related to student personas. This observation suggests an interest in adopting student personas in engineering education, as evidenced by the development of help-seeking usage model for distance-delivered calculus students who use online forums, considerations for persona and journey map use in engineering course design, and the utilization of experience design approaches for curriculum creation, among others [58,75,89]. Frontiers in Education, the ACM International Conference Proceeding Series, and Lecture Notes in Computer Science also showcased a significant presence, each hosting three articles. Besides journal articles from Communication in Computer and Information Science, the other publication venues with higher publication frequencies ($n \geq 2$) were conferences. Most publications appeared in education conferences such as ASEE, FIE, and CSE, focusing more on application than development. This signals an area where the HCI community could provide critical assistance with more focused research on persona refinement for the educational domain.

6.2. Implications for current applications of student personas

The 78 identified concepts across 16 categories within 83 publications demonstrate the depth and breadth of student persona research through various academic disciplines and educational levels. The thematic analysis conducted in this study revealed five key themes that highlight the versatile and widespread use of student personas in various fields and educational institutions. Identifying the five key themes stemming from the systematic literature review offers key insights for HCI and educational researchers operating within the education domain. We outline these **key insights (KI)** below.

KI01: Student-centered design. Firstly, the theme of *Understanding user needs, goals, and behaviors* underscores the fundamental significance of empathetic design in educational contexts. By adopting student personas as a framework, researchers gain deep insights into learners' diverse motivations and behaviors, enabling the creation of more tailored and effective learning experiences. This theme emphasizes the value of human-centered design approaches in considering student needs to craft learning interventions that resonate authentically.

KI02: Integrating personas into the development of educational technologies. Secondly, the theme of *Design and development of learning tools and systems* underscores the pivotal role that student personas play in guiding the creation of educational technologies. As modern education becomes increasingly technology-mediated, employing personas to inform the design process can lead to the development of intuitive, student-friendly learning platforms.

KI03: Using personas to inform pedagogical strategies and identify learner profile gaps. Thirdly, the theme of *Supporting teaching and learning* accentuates the potential of student personas to bridge the gap between pedagogical strategies and learner profiles. Integrating persona-driven insights into learner profile based instructional design can contribute to enhancing teaching methodologies.

KI04: Persona-based roleplaying as an educational instrument. Fourthly, the theme of *Persona-based roleplaying* introduces an innovative perspective that researchers can explore. This theme suggests that personas could be leveraged for design and immersive learning experiences, enabling students to adopt persona roles and gain fresh perspectives on content and context.

KI05: Ethical and social dimensions of education. Finally, the theme of *Enhancing diversity, inclusivity, and accessibility* is a reminder of the ethical and social dimensions of educational personas. Researchers delving into this theme can contribute to creating educational systems that cater equitably to a diverse range of learners, ensuring that personas represent the range of students.

6.3. Current methods for designing student personas

The prevalent use of the qualitative methodology for persona creation, as evidenced by 53% of the sampled publications, signifies the emphasis on rich, in-depth insights into students' characteristics and behaviors. Qualitative approaches have allowed researchers to capture in-depth aspects of learners' needs, preferences, and experiences. On the other hand, the relatively lower adoption of quantitative methodology at 27.71% suggests that future researchers might prioritize exploring individual cases and narratives over generalizable statistical findings. Quantitative methods could afford data-driven personas reflecting broader patterns and trends among student populations.

On the other hand, the use of mixed methodology at 19.28% reflects a recognition of the potential synergies between qualitative and quantitative approaches in persona creation. Mixed methodologies allow for multiple data sources, which can help researchers triangulate the information in the student personas. Moreover, using mixed methods can enhance the richness of the student personas generated, as researchers can consider individual experiences and broader trends.

6.4. Future research directions for student personas

The SLR study highlights a need for standardized approaches to persona creation, as the prevalence of qualitative methodologies can lead to variability in persona construction. Establishing best practices and guidelines would enhance the comparability and reliability of student personas. Additionally, research on the long-term efficacy of student personas is scarce, and their adaptation in non-traditional or marginalized educational settings is underexplored. Longitudinal studies would help track student personas' impact in educational settings over time. These studies could capture the performance of persona-driven or persona-assisted educational interventions and thus provide empirical evidence on whether student personas support either learning or decision-making around students. Addressing these gaps is crucial to enhance the credibility and effectiveness of student personas as a decision-making tool. Moreover, researchers could integrate inclusivity attributes like socioeconomic status, cultural backgrounds, and gender to address the greater diversity of student personas.

Furthermore, there is potential for emerging technologies such as AI (LLMs) and VR to improve persona-based educational practices [116]. Ideally, integrating AI-driven personas can support dynamic and personalized learning experiences, while VR-based roleplaying scenarios can foster empathy and understanding among educators. Exploring these technologies in persona research opens exciting possibilities for optimizing instructional strategies and promoting learner-centric approaches for students and educators alike.

Future research directions in student persona research encompass refining and integrating quantitative methods, exploring emerging technologies like AI and VR, prioritizing inclusivity by incorporating diverse perspectives and embracing pedagogical transformations. Researchers can gain a more comprehensive understanding of student behavior by combining qualitative and quantitative insights. Additionally, AI-driven personas can enable personalized learning experiences, and VR-based roleplaying scenarios can foster empathy among educators. This becomes relevant as studies report the need to investigate how learning objects can be personalized for students and educators [117].

Ensuring the representation of diverse student populations and addressing ethical implications are vital for equitable educational practices. Thus, researchers should develop guidelines for creating personas for prioritizing student consent, data privacy, and fairness. The synergy between technological tools and a commitment to diversity helps eliminate biases within persona development in education, eradicating bias and guaranteeing an accurate portrayal of all stakeholders. Embracing these avenues will advance the field and enhance accuracy, empowering educators to create more effective and inclusive learning environments.

As personas are grounded in the HCI and marketing literature, and student models have their foundations in artificial intelligence and intelligent tutoring systems research, an additional consideration in understanding the implications of this study is the relationship between the phrase 'student personas' and related concepts such as *student profiling* and *student models*. While personas are often used in HCI and business contexts to represent archetypal user groups based on qualitative and quantitative data, 'student profiling' in AI and 'student models' in Artificial Intelligence in Education (AIED) focus more on data-driven, algorithmic representations (see [118,119]). These models leverage computational methods to create dynamic and adaptable student profiles that reflect student behavior, performance, and learning pathways. The distinction lies not only in the purpose and flexibility of these representations but in their theoretical roots and methodological approaches. Personas are primarily used for empathetic design and communication, helping stakeholders understand user needs and facilitate decision-making. In contrast, student models in AI and AIED applications are used for real-time personalization, adapting educational content and interactions based on a student's evolving data profile. Student profiling often emphasizes predictive capabilities that can support automated decision-making and system responses.

Drawing on these similarities and differences, future research could explore how both approaches can complement each other in educational technology designs. While personas are effective for fostering empathy and guiding initial design phases, incorporating aspects of student profiling and modeling could enhance the adaptability and precision of educational interventions. For instance, scholars could examine how analytics data from student modeling can be used to generate personas that align with the changing student needs. Researchers could also investigate how qualitative data from personas can develop or validate adaptive learning technologies. This combined approach could lead to more responsive and data-driven educational tools that maintain a learner-centered focus while leveraging the strengths of AI-driven insights.

6.5. Limitations of this study

Concerning limitations, this survey relies on three databases to search for publications, which may limit the scope and coverage of the literature review and exclude some relevant sources from other databases or platforms. Future research should explore the inclusion of other databases, though ACMDL, Scopus, and WofS have been shown to provide comprehensive coverage [120–122]. Also, we have not investigated the ethical or social implications of using student personas in education, including the potential risks of stereotyping, privacy, or bias. This would be a fruitful avenue for future research. Additionally, this study focuses on the use of 'personas' primarily within educational and HCI contexts. However, related concepts exist under different terminologies in other fields. As mentioned, the phrases *student profiling* and *student modeling* are more commonly used in AI and AIED contexts, as seen in works published in journals like User Modeling and User-Adapted Interaction (UMUAI, see [118]) and International Journal of Artificial Intelligence in Education (IJAIED, see [119]. These algorithmic alternative approaches, such as open student models influenced by the semantic web, have been evolving for years and could complement the predominantly qualitative persona development method reported in this review.

7. Conclusion

While student persona research has shown promise in guiding instructional design and fostering learner-centric pedagogies, there is a clear need for greater standardization and systematic approaches to student persona creation. Establishing best practices and guidelines can enhance the comparability and reliability of personas, ensuring their effectiveness in diverse educational settings. Moreover, the study revealed a scarcity of research investigating personas' long-term efficacy and adaptability. Addressing this knowledge gap is essential to provide educators and policymakers with evidence-based strategies for sustainable persona-driven learning interventions.

CRediT authorship contribution statement

Ali Farooq: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Amani Alabed:** Writing – original draft, Formal analysis. **Pilira Stella Msefula:** Formal analysis. **Reham AL Tamime:** Writing – original draft, Formal analysis. **Joni Salminen:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Soon-gyo Jung:** Conceptualization. **Bernard J. Jansen:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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A Appendices

Table A1, Table A2, Table A3, Table A4

Table A1
Example text excerpts (codes) and first-level conceptual codes

Text Excerpts from the papers	Concepts/first-level coding
To understand the stylistic variation in the text; Identify the needs of users to design positive user experiences in robotic assistance shopping; To use personas to gain insight into the information seeking activities of humanities scholars; To better understand these students' research processes and, more specifically, to make sense of their database selection choices by demonstrating the commonalities and differences among various types of users, personas were developed based on our participants' behavior; We therefore use personas to synthesize and communicate quantitative observations about study participant behavior; Personas were created to further define and explore particular types of users and how they interact with media; The persona represents patterns of users' behaviour, goals and motives, compiled in a fictional description of a single individual; To provide an overview of the participants' characteristics, describing the basic features of the participants' O2O and cross-device shopping behaviors; To determine information seeking practices and information needs of this community, to inform the potential functionalities of a proposed system, intended to help students with relevant resource discovery and decision making; To perform a pilot study for assessing music's influence on students enrolled in Computing Studies; To understand attitudes regarding academic life and the uses of new technologies.	"Stylistic variation in text" "Understanding user experience in robotic shopping" "Information seeking activities in humanities" "Understanding database selection in research." "Communicate quantitative observations about participant behavior" "Exploring user interactions with media" "Understanding user behavior patterns" "Analyzing shopping behaviors Identifying information-seeking practices for a system" "Assessing music influence on students in computing science" "Understanding attitudes toward tech/academics."
To capture value-added information about prospective PETE students and use those data to develop a strategic plan for recruiting into the PE teacher pipeline; The paper proposes a persona-based approach to identify students' goals or needs, pains or challenges besides their satisfaction when using educational application prototypes; To understand how the concept of persona, in the context of the concepts of viewpoint, goal, scenario, task, and requirement, may be integrated in a unified environment to enable stakeholders and developers gain a better understanding of target users' needs and behaviors and identify missing requirements early in the requirements engineering process; To explore the views of social work employers on theoretical knowledge for newly graduated young bachelors of social work; To understand the needs and requirements of students who learn on-line and who take advantage of their travel time to study or to carry out study-related tasks; Personas were created in order to understand students' characteristics, needs, and fears/anxiety when learning mathematics through technologies; To provide insights on how student pair programming can have benefits to online CS students in gender-equitable ways; Personas are used to offer a more precise understandings of the concepts of user, goal, and task are developed by distinguishing between organizational and user goals; To develop empathy that help to create this understanding of user expectation, goals, needs, experiences and behavior; Persona presented learners' profile, m-learning goals, experience, and attitude toward m-learning	"Identifying viewpoints, goals, and needs of engineering processes" "Understanding needs/challenges of online students" "Understanding students' fears, needs, and challenges in math technologies" "Understanding benefits of student pair programming in CS education" "Creating an understanding of user expectations and profiles" "Presenting m-learning profiles/goals"

Table A2
Number of student personas in shortlisted publications with references.

Number of Personas	Number of publications (%)	References
1	11(13.25%)	[44,59–61,67,68,70,77,109,123]
2	11(13.25%)	[25,26,64,68,72,78,80,83,91,93,124]
3	12(14.45%)	
4	13(15.66%)	
5	9(10.84%)	[22,30,71,75,88,95,97,125,126]
6	7(8.43%)	[63,82,87,110,113,114,127]
7	2(2.41%)	[81,128]
8	1(1.20%)	[31]
9	1(1.20%)	[129]
28	1(1.20%)	[115]

(*continued on next page*)

Table A2 (*continued*)

Number of Personas	Number of publications (%)	References
56	1(1.20%)	[43]
unclear	14(16.86%)	[32,41,65,66,73,76,85,86,92,101,112,130–132]
Total	83	

Table A3
List of publications using different methodologies for developing personas.

Methodology	Frequency (%)	Sources
Qualitative	44 (53.01%)	[26,29,30,43,44,58–62,64,65,67,69–72,76–78,80,81,83,85,88,96,97,99–102,104,106,107,110,114,115,123–125,127,132–134]
Quantitative	23 (27.71%)	[25,31,32,39,45,66,68,73,82,86,92,93,103,105,109,111,112,126,128,129,131,135]
Mixed method	16 (19.28%)	[22,41,63,74,75,79,87,89–91,94,95,108,113,130,136]

Table A4
Persona dimensions, the percentage of total publications used given dimension for developing a persona, and the corresponding sources.

Persona dimensions	% coverage	Sources
Behavior and beliefs	67.7%	[25,26,29,31,39,41,43,44,59–63,67–70,73,74,76,77,79,80,82,83,87–96,99,100,102–105,107–109,111,112,114,115,123,125,126,129,134,135]
Demographics	57.8%	[22,25,29,30,32,39,43,44,59,60,63,64,66,68,70,73,77,79,80,82,83,86–89,92,94–97,99–103,107,109,111–115,123,127,128,131,134,135]
Goals and needs	22.8%	[25,26,29,32,44,58,64,68,73,78,79,83,85,89,109,110,112,123,124]
Experience and perceptions	12%	[22,31,41,61,71,73,102,110,127,133]
Affordances	6%	[29,65,114,136,67]
Unclear	7%	[45,72,75,81,130,132]

Note: The total percentage exceeds 100%, as some papers have more than one persona dimension.

References

[1] Cooper A. The inmates are running the asylum. In: Arend U, Eberleh E, Pitschke K, editors. Software-Ergonomie '99: Design von Informationswelten. Vieweg+Teubner Verlag; 1999. https://doi.org/10.1007/978-3-322-99786-9_1. 17–17.

[2] Salminen J, Wenyun Guan K, Jung S-G, Jansen B. Use cases for design personas: a systematic review and new frontiers. In: CHI Conference on Human Factors in Computing Systems; 2022. p. 1–21. https://doi.org/10.1145/3491102.3517589.

[3] Chapman C, Milham RP. The personas' new clothes: methodological and practical arguments against a popular method. Proc Human Factor Ergon Soc Ann Meet 2006;50:634–6. https://doi.org/10.1177/154193120605000503.

[4] Ogunyemi AA, Quaicoe JS, Bauters M. Indicators for enhancing learners' engagement in massive open online courses: A systematic review. Comput Educ Open 2022;3:100088. https://doi.org/10.1016/j.caeo.2022.100088.

[5] Salminen J, Jung S, Chowdhury S, Sengün S, Jansen BJ. Personas and analytics: A comparative user study of efficiency and effectiveness for a user identification task. In: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems; 2020. p. 1–13.

[6] Anvari F. Effectiveness of persona with personality on conceptual design and requirements. Macquarie University; 2022. PhD Thesis, https://figshare.mq.edu.au/articles/thesis/Effectiveness_of_persona_with_personality_on_conceptual_design_and_requirements/19443833/1.

[7] Bowen J, Petrie H, Hinze A, Samaddar S. Personas revisited: extending the use of personas to enhance participatory design. In: Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society; 2020. p. 1–12. https://doi.org/10.1145/3419249.3420135.

[8] Korsgaard D, Bjørner T, Sørensen PK, Burelli P. Creating user stereotypes for persona development from qualitative data through semi-automatic subspace clustering. User Model User-adapt Interact 2020;30(1):81–125. https://doi.org/10.1007/s11257-019-09252-5.

[9] Dennen VP. Presence and positioning as components of online instructor persona. J Res Technol Educ 2007;40(1):95–108. https://doi.org/10.1080/15391523.2007.10782499.

[10] Holzinger A, Kargl M, Kipperer B, Regitnig P, Plass M, Müller H. Personas for artificial intelligence (AI) an open source toolbox. IEEE Access 2022;10:23732–47. https://doi.org/10.1109/ACCESS.2022.3154776.

[11] Nielsen L, Larusdottir M, Larsen LB. Understanding users through three types of personas. In: Human-Computer Interaction–INTERACT 2021: 18th IFIP TC 13 International Conference, Bari, Italy, August 30–September 3, 2021, Proceedings, Part II 18; 2021. p. 330–48.

[12] Park D, Kang J. Constructing data-driven personas through an analysis of mobile application store data. Appl Sci 2022;12(6):2869. https://doi.org/10.3390/app12062869.

[13] Sundt AD. User personas as a shared lens for library UX. J Library User Exp 2017;(6):1. https://doi.org/10.3998/weave.12535642.0001.601.

[14] Tauro E, Gorini A, Caglio C, Gabanelli P, Caiani EG. COVID-19 and mental disorders in healthcare Personnel: A novel framework to develop Personas from an online survey. J Biomed Inform 2022;126:103993. https://doi.org/10.1016/j.jbi.2022.103993.

[15] Terho H, Mero J, Siutla L, Jaakkola E. Digital content marketing in business markets: Activities, consequences, and contingencies along the customer journey. Ind Market Manag 2022;105:294–310. https://doi.org/10.1016/j.indmarman.2022.06.006.

[16] Toniolo F. Evolution of the Youtube personas related to survival horror games. Persona Studies 2020;6(2):54–68. https://doi.org/10.21153/psj2020vol6no2art964.

[17] Mathrani A, Susnjak T, Ramaswami G, Barczak A. Perspectives on the challenges of generalizability, transparency and ethics in predictive learning analytics. Comput Educ Open 2021;2:100060. https://doi.org/10.1016/j.caeo.2021.100060.

[18] Minichiello A, Hood JR, Harkness DS. Bringing user experience design to bear on stem education: a narrative literature review. J STEM Educ Res 2018;1(1):7–33. https://doi.org/10.1007/s41979-018-0005-3.

[19] Newton R, Doherty M. Know thy student, for she is not thee': User personas as a way to give agency to student voice. Transforming Higher Education With Human-Centred Design. Routledge; 2025. p. 243–57. https://www.taylorfrancis.com/chapters/edit/10.4324/9781003383161-28/know-thy-student-thee-radka-newton-michael-doherty.

[20] Guy BR. Movers, shakers, & everyone in between: faculty personas surrounding active learning in the undergraduate STEM Classroom. I.e.: Inquiry Educ 2017:9.

[21] Vorvoreanu M, Madhavan K, Kitkhachonkunlaphat K, Zhao L. Designing for STEM Faculty: the use of personas for evaluating and improving design. In: Duffy VG, editor. Digital Human Modeling: Applications in Health, Safety, Ergonomics and Risk Management. Springer International Publishing; 2016. p. 369–80. https://doi.org/10.1007/978-3-319-40247-5_37.

[22] Lilley M, Pyper A, Attwood S. Understanding the student experience through the use of personas. Innov Teach Learn Inf Comput Sci 2012;11(1):4–13. https://doi.org/10.11120/ital.2012.11010004.

[23] Davis RO, Park T, Vincent J. A systematic narrative review of agent persona on learning outcomes and design variables to enhance personification. J Res Technol Educ 2021;53(1):89–106. https://doi.org/10.1080/15391523.2020.1830894.

[24] Schroeder NL, Adesope OO. A systematic review of pedagogical agents' persona, motivation, and cognitive load implications for learners. J Res Technol Educ 2014;46(3):229–51. https://doi.org/10.1080/15391523.2014.888265.

[25] Li Y-J, Lee L-H, Cheng Y-T, Ou Y-Y. Design and evaluation of a healthcare management terminology mobile learning application. In: 2019 IEEE

International Conference on Healthcare Informatics (ICHI); 2019. p. 1–9. https://doi.org/10.1109/ICHI.2019.8904572.
[26] Dittmar, A., & Forbrig, P. (2019). Integrating personas and use case models. In D. Lamas, F. Loizides, L. Nacke, H. Petrie, M. Winckler, & P. Zaphiris (Eds.), *Human-Computer Interaction – INTERACT 2019* (Vol. 11746, pp. 666–686). Springer International Publishing. https://doi.org/10.1007/978-3-030-29381-9_40.
[27] Salminen J, Jung S-G, Medina J, Aldous K, Azem J, Akhtar W, Häyhänen E, Jansen BJ. Communication design for an educational ai chatbot: analyzing cipherbot's communication style and challenges. In: Proceedings of the 27th International Academic Mindtrek Conference; 2024. p. 176–87. https://doi.org/10.1145/3681716.3681727.
[28] Alabed A, Javornik A, Gregory-Smith D, Casey R. More than just a chat: A taxonomy of consumers' relationships with conversational AI agents and their well-being implications. Eur J Mark 2024;58(2):373–409. https://doi.org/10.1108/EJM-01-2023-0037.
[29] Huynh T, Madsen A, McKagan S, Sayre E. Building personas from phenomenography: A method for user-centered design in education. Inf Learn Sci 2021;122(11/12):689–708. https://doi.org/10.1108/ILS-12-2020-0256.
[30] Weinhandl R, Mayerhofer M, Houghton T, Lavicza Z, Eichmair M, Hohenwarter M. Personas characterising secondary school mathematics students: development and applications to educational technology. Educ Sci (Basel) 2022;12(7):447. https://doi.org/10.3390/educsci12070447.
[31] Almahri FAAJ, Bell D, Arzoky M. Personas design for conversational systems in education. Informatics 2019;6(4):46. https://doi.org/10.3390/informatics6040046.
[32] Brooks C, Greer J. Explaining predictive models to learning specialists using personas. In: Proceedings of the Fourth International Conference on Learning Analytics And Knowledge; 2014. p. 26–30. https://doi.org/10.1145/2567574.2567612.
[33] Jansen BJ, Salminen JO, Jung S. Data-driven personas for enhanced user understanding: Combining empathy with rationality for better insights to analytics. Data Inf Manag 2020;4(1):1–17. https://doi.org/10.2478/dim-2020-0005.
[34] Volden F, Wattne OE. Wayfinding and navigation in the outdoors: quantitative and data driven development of personas and requirements for wayfinding in nature. In: International Conference on Human-Computer Interaction; 2023. p. 199–210.
[35] Hemzo MA. Defining the persona: segmentation and targeting. Marketing Luxury Services: Concepts, Strategy, and Practice. Springer; 2023. p. 75–94.
[36] Pruitt J, Grudin J. Personas: Practice and theory. In: Proceedings of the 2003 Conference on Designing for User Experiences; 2003. p. 1–15. https://doi.org/10.1145/997078.997089.
[37] Jiang B, Zhou W, Yang J, Yang C, Wang S, Pang L, Scott D, Bel N, Zong C. Pednet: A persona enhanced dual alternating learning network for conversational response generation. In: Proceedings of the 28th International Conference on Computational Linguistics; 2020. p. 4089–99. https://doi.org/10.18653/v1/2020.coling-main.361.
[38] Pruitt J, Adlin T. The persona lifecycle: Keeping people in mind throughout product design. Elsevier; 2010.
[39] Greer JE, Frost S, Banow R, Thompson C, Kuleza S, Wilson K, Koehn G. The student advice recommender agent: SARA. In: International Workshop on Personalization Approaches in Learning Environments; 2015.
[40] Weinhandl R, Mayerhofer M, Houghton T, Lavicza Z, Kleinferchner LM, Anđić B, Eichmair M, Hohenwarter M. Enhancing user-centred educational design: Developing personas of mathematics school students. Heliyon 2024;10(2):e24173. https://doi.org/10.1016/j.heliyon.2024.e24173.
[41] Sun N, Rosson MB. Connection enablers in online learning community: from informative online personae to meaningful social space. In: Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing; 2017. p. 315–8. https://doi.org/10.1145/3022198.3026348.
[42] Silva PA, Motti VG. Evaluating a multi-component classroom intervention to teach accessibility in higher education: a case study with persona cards. IEEE Access 2024;12:20299–312. https://doi.org/10.1109/ACCESS.2024.3360135.
[43] Sim, G., Shrivastava, A., Horton, M., Agarwal, S., Haasini, P. S., Kondeti, C. S., & McKnight, L. (2019). Child-generated personas to aid design across cultures. In D. Lamas, F. Loizides, L. Nacke, H. Petrie, M. Winckler, & P. Zaphiris (Eds.), *Human-Computer Interaction – INTERACT 2019* (Vol. 11748, pp. 112–131). Springer International Publishing. https://doi.org/10.1007/978-3-030-29387-1_7.
[44] Peters M, Simo LP, Amatller AM, Linan LC, Kreitz PB. Toward a user-centred design approach for ar technologies in online higher education. In: 2021 7th International Conference of the Immersive Learning Research Network (iLRN); 2021. p. 1–8. https://doi.org/10.23919/iLRN52045.2021.9459409.
[45] Ekşioğlu M, Güler H, Terzi F, Yıldırım HS, Yücel B. UXD for a prototype campus information kiosk. In: Proceedings of the 2nd International Conference on Computer-Human Interaction Research and Applications; 2018. p. 176–82. https://doi.org/10.5220/0007229801760182.
[46] Farooq A, Dahabiyeh L, Maier C. Social media discontinuation: A systematic literature review on drivers and inhibitors. Telemat Inform 2023;77:101924. https://doi.org/10.1016/j.tele.2022.101924.
[47] Salminen J, Guan K, Jung S-G, Chowdhury SA, Jansen BJ. A literature review of quantitative persona creation. In: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems; 2020. p. 1–14. https://doi.org/10.1145/3313831.3376502.
[48] Neely A, Hii J. Innovation and business performance: A literature review. The Judge Institute of Management Studies, University of Cambridge; 1998. p. 0–65.
[49] Witte KD, López-Torres L. Efficiency in education: A review of literature and a way forward. J Oper Res Soc 2017;68(4):339–63. https://doi.org/10.1057/jors.2015.92.
[50] Naqvi B, Perova K, Farooq A, Makhdoom I, Oyedeji S, Porras J. Mitigation strategies against the phishing attacks: A systematic literature review. Comput Secur 2023;132:103387. https://doi.org/10.1016/j.cose.2023.103387.
[51] Tranfield D, Denyer D, Smart P. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. Br J Manag 2003;14(3):207–22. https://doi.org/10.1111/1467-8551.00375.
[52] "Oz," Spors V, Laato S, Buruk O, Hamari J. Longing to be the mountain: a scoping review about nature-centric, health-minded technologies. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems; 2023. p. 1–16. https://doi.org/10.1145/3544548.3581479.
[53] Stefanidi E, Bentvelzen M, Woźniak PW, Kosch T, Woźniak MP, Mildner T, Schneegass S, Müller H, Niess J. Literature reviews in HCI: a review of reviews. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems; 2023. p. 1–24. https://doi.org/10.1145/3544548.3581332.
[54] Thomé AMT, Scavarda LF, Scavarda AJ. Conducting systematic literature review in operations management. Prod Plann Control 2016;27(5):408–20. https://doi.org/10.1080/09537287.2015.1129464.
[55] Strauss AL, Corbin JM. Basics of qualitative research: Techniques and procedures for developing grounded theory. 2nd ed. Sage Publications; 1998.
[56] Yan W, Hu B, Liu Y, Li C, Song C. Does usage scenario matter? Investigating user perceptions, attitude and support for policies towards ChatGPT. Inf Process Manag 2024;61(6):103867. https://doi.org/10.1016/j.ipm.2024.103867.
[57] Minichiello A, Jouffray M. Board 107: communicating findings about online forum use among undergraduates in distance-delivered calculus: developing a help seeking usage model. In: ASEE Annual Conference & Exposition Proceedings; 2018. p. 29869. https://doi.org/10.18260/1-2–29869.
[58] Fila N, Rover D, Duwe H. Considerations for the use of personas and journey maps in engineering course design. In: American Society for Engineering Education (ASEE) 2022 Annual Conference; 2022. American Society for Engineering Education (ASEE) 2022 Annual Conference, Minneapolis Minnesota.
[59] Vorvoreanu M, Connolly P. Using an experience design approach to curriculum creation. In: 2015 ASEE Annual Conference and Exposition Proceedings. 26; 2015. https://doi.org/10.18260/p.24992. 1656.1-26.1656.12.
[60] Sim WW, Brouse P. Developing ontologies and persona to support and enhance requirements engineering activities – a case study. Procedia Comput Sci 2015;44:275–84. https://doi.org/10.1016/j.procs.2015.03.060.
[61] Rebaque-Rivas P, Gil-Rodríguez EP, Manresa-Mallol I. Mobile learning scenarios from a UCD perspective. In: Proceedings of the 12th International Conference on Human Computer Interaction with Mobile Devices and Services; 2010. p. 389–90. https://doi.org/10.1145/1851600.1851679.
[62] Van Bommel M, Kwakman K, Boshuizen HPA. Employers' views on desirable theoretical knowledge qualities of newly qualified social workers: a qualitative exploration. Br J Soc Work 2015;45(4):1330–48. https://doi.org/10.1093/bjsw/bcu006.
[63] Kim E, Kocsik VS, Basnage C, Eren, Agogino A, Merner. Human-centric study of digital paper transitions: framing design opportunity spaces. In: *International Conference on Engineering Design, ICED13, VOL 7: Human Behaviour in Design*; 2013.
[64] Stojmenova E, Superina A, Guna J, Kos A, Bester J, Pogacnik M. User-centered design approach to promoting multimedia university degree program. In: 2014 IEEE International Conference on Multimedia and Expo Workshops (ICMEW); 2014. p. 1–5. https://doi.org/10.1109/ICMEW.2014.6890679.
[65] Fink, V., Zeiner, Katharina. M., Ritter, M., Burmester, M., & Eibl, M. (2022). *Design for Positive UX: From Experience Categories to Psychological Needs | SpringerLink*. 148–155. https://doi.org/10.1007/978-3-031-19679-9_19.
[66] Celik, D., Mikroyannidis, A., Hlosta, M., Third, A., & Domingue, J. (2019). ADA: a system for automating the learning data analytics processing life cycle. In M. Scheffel, J. Broisin, V. Pammer-Schindler, A. Ioannou, & J. Schneider (Eds.), *Transforming Learning with Meaningful Technologies* (Vol. 11722, pp. 714–718). Springer International Publishing. https://doi.org/10.1007/978-3-030-29736-7_73.
[67] Silva S, Teixeira A. Design and development for individuals with asd: fostering multidisciplinary approaches through personas. J Autism Dev Disord 2019;49(5):2156–72. https://doi.org/10.1007/s10803-019-03898-1.
[68] Li, M., & Zhang, Q. (2022). A prototype design and usability evaluation of a Chinese educational system. In M. M. Soares, E. Rosenzweig, & A. Marcus (Eds.), *Design, User Experience, and Usability: Design for Emotion, Well-being and Health, Learning, and Culture* (pp. 279–294). Springer International Publishing. https://doi.org/10.1007/978-3-031-05900-1_19.
[69] Salomão RCS, Rebelo F, Rodríguez FG. Defining personas of university students for the development of a digital educational game to learn portuguese as a foreign language. Procedia Manuf 2015;3:6214–22. https://doi.org/10.1016/j.promfg.2015.07.941.
[70] Chen Z, Dauly D, Amaral S, Martinho R, Ruppel S, Toro J, Li Y, Zhao J. Developing persona for the Chinese learning application for foreigners in china on mobile devices. In: Rau P-LP, editor. Cross-Cultural Design. Applications in Health, Learning, Communication, and Creativity. Springer International Publishing; 2020. p. 237–49. https://doi.org/10.1007/978-3-030-49913-6_20.
[71] Albrechtsen C, Pedersen M, Pedersen NF, Jensen TW. Proposing Co-design of personas as a method to heighten validity and engage users: a case from higher education. International Journal of Sociotechnology and Knowledge Development 2016;8(4):55–67. https://doi.org/10.4018/IJSKD.2016100104.

[72] Loureiro C, Dominique-Ferreira S. Integrating the User Experience and User Interface into an Educational Mobile App: A Case Study in Product Design. In: 3rd International Conference on Design & Digital Communication; 2017. p. 159.

[73] Salmenbayeva, A., Aimbetova, A., Seksenbayeva, G., Turkyilmaz, A., & Pastuszak, Z. (2019). *Design of Learning and Teaching Space Professional Graduate Degree Program using User Experience Design*. 8030–8038. https://doi.org/10.21125/edulearn.2019.1966.

[74] Firdaus A, Mubarak A, Suzianti A. Design of Teaching Aids for Understanding Smoking Hazards with Design Thinking. In: Proceedings of the 2019 5th International Conference on Industrial and Business Engineering; 2019. p. 306–10. https://doi.org/10.1145/3364335.3364359.

[75] J., Ph. D. Rynearson DrA, Marie Gartner, Miller DrM. Use of personas in exploring scholarship applicants. In: ASEE Annual Conference and Exposition, Conference Proceeding; 2021. ASEE Annual Conference and Exposition, Conference Proceeding

[76] Walters K, Bolich C, Duffy D, Quinn C, Walsh K, Connolly S. Developing online tutorials to improve information literacy skills for second-year nursing students of university college Dublin. New Rev Acad Libr 2015;21(1):7–29. https://doi.org/10.1080/13614533.2014.891241.

[77] Ghunaim H, Weekes TR, Eskridge TC. Designing an AI assistant for student telehealth: a case study using human-centered design. In: 2022 IEEE 3rd International Conference on Human-Machine Systems (ICHMS); 2022. p. 1–6. https://doi.org/10.1109/ICHMS56717.2022.9980800.

[78] Guo J, Yan P. User-centered information architecture of University Library Website. In: 2011 3rd International Conference on Computer Research and Development; 2011. p. 370–2. https://doi.org/10.1109/ICCRD.2011.5764153.

[79] Ostrowski S, Rolczyński R, Pniewska J, Garnik I. User-friendly E-learning platform: a case study of a design thinking approach use. In: Proceedings of the Mulitimedia, Interaction, Design and Innnovation; 2015. p. 1–8. https://doi.org/10.1145/2814464.2814483.

[80] Gardasevic S. User-driven efforts in creating knowledge graph information system. Digit Libr Perspect 2020;36(2):97–111. https://doi.org/10.1108/DLP-12-2019-0043.

[81] Sankupellay M, Mealy E, Niesel C, Medland R. Building personas of students accessing a peer-facilitated support for learning program. In: Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction; 2015. p. 412–6. https://doi.org/10.1145/2838739.2838831.

[82] Anvari F, Richards D, Hitchens M, Tran HMT. Teaching user centered conceptual design using cross-cultural personas and peer reviews for a large cohort of students. In: 2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET); 2019. p. 62–73. https://doi.org/10.1109/ICSE-SEET.2019.00015.

[83] D'Ettole, G., Bjørner, T., & De Götzen, A. (2020). How to design potential solutions for a cross-country platform that leverages students' diversity: a user-centered design approach – and its challenges. In A. Marcus & E. Rosenzweig (Eds.), *Design, User Experience, and Usability. Case Studies in Public and Personal Interactive Systems* (Vol. 12202, pp. 415–426). Springer International Publishing. https://doi.org/10.1007/978-3-030-49757-6_30.

[84] Gao Y. MOOCs video recommendation using low-rank and sparse matrix factorization with inter-entity relations and intra-entity affinity information. Inf Process Manag 2024;61(6):103861. https://doi.org/10.1016/j.ipm.2024.103861.

[85] Vilchez-Sandoval J, Vasquez-Paragulla J, Llulluy-Nunez D. On the of use agile methodologies to re-design a Networks and Data Communications course. 2020 IEEE World Conference on Engineering Education (EDUNINE) 2020:1–5. https://doi.org/10.1109/EDUNINE48860.2020.9149550.

[86] Almahri FAAJ, Bell D, Arzoky M. Applications of machine learning in education: personas design for chatbots. Machine Learning Approaches for Improvising Modern Learning Systems. IGI Global; 2021. p. 72–113. https://doi.org/10.4018/978-1-7998-5009-0.ch004.

[87] Holmgren RA. Learning commons: a learning-centered library design. Coll Undergr Libr 2010;17(2–3):177–91. https://doi.org/10.1080/10691316.2010.481598.

[88] Dick S, Heavin C, Vasiliou VS, Davoren MP, Dockray S, Linehan C, Byrne M. The design of a digital behaviour change intervention for third-level student illicit substance use: a persona building approach. In: Hawaii International Conference on System Sciences; 2020. https://doi.org/10.24251/HICSS.2020.415.

[89] Minichiello A, Jouffray M. Communicating findings about online forum use among undergraduates in distance-delivered calculus: developing a help seeking usage model. In: 2018 ASEE Annual Conference & Exposition Proceedings; 2018. p. 29869. https://doi.org/10.18260/1-2–29869.

[90] Spieler B, Krnjic V, Slany W, Horneck K, Neudorfer U. Design, code, stitch, wear, and show it! mobile visual pattern design in school contexts. In: 2020 IEEE Frontiers in Education Conference (FIE); 2020. p. 1–9. https://doi.org/10.1109/FIE44824.2020.9274120.

[91] Kusmin M, Kusmin K-L, Laanpere M, Tomberg V. Engaging students in co-designing wearable enhanced learning kit for schools. In: Buchem I, Klamma R, Wild F, editors. Perspectives on Wearable Enhanced Learning (WELL): Current Trends, Research, and Practice. Springer International Publishing; 2019. p. 97–120. https://doi.org/10.1007/978-3-319-64301-4_5.

[92] Treuillier C, Boyer A. A New Way to Characterize Learning Datasets. In: Proceedings of the 14th International Conference on Computer Supported Education; 2022. p. 35–44. https://doi.org/10.5220/0010982500003182.

[93] Alnanih R, Bahatheg N, Alamri M, Algizani R. Mobile-D approach-based persona for designing user interface. Int J Adv Trends Comput Sci Eng 2019:2597–607. https://doi.org/10.30534/ijatcse/2019/111852019.

[94] Anvari F, Richards D. Using personality traits and a spatial ability test to identify talented aspiring designers in user-centred design methodologies. In: Proceedings of the 10th International Conference on Evaluation of Novel Approaches to Software Engineering; 2015. p. 90–101. https://doi.org/10.5220/0005366600900101.

[95] Dease N, Villaespesa E, MacDonald CM. Working together: Using student-driven UX projects to improve library websites. Coll Undergr Libr 2020;27(2–4):397–419. https://doi.org/10.1080/10691316.2021.1888838.

[96] Lewis C, Contrino J. Making the invisible visible: personas and mental models of distance education library users. J Libr Inform Serv Dist Learn 2016;10(1–2):15–29. https://doi.org/10.1080/1533290X.2016.1218813.

[97] Ozkan DS, Reeping D, McNair LD, Martin TL, Harrison S, Lester L, Knapp B, Wisnioski M, Patrick A, Baum L. Using personas as curricular design tools: engaging the boundaries of engineering culture. In: 2019 IEEE Frontiers in Education Conference (FIE); 2019. p. 1–7. https://doi.org/10.1109/FIE43999.2019.9028358.

[98] Liu M, Xie Z, Yang AJ, Yu C, Xu J, Ding Y, Bu Y. The prominent and heterogeneous gender disparities in scientific novelty: Evidence from biomedical doctoral theses. Inf Process Manag 2024;61(4):103743.

[99] Itenge-Wheeler H, Winschiers-Theophilus H, Soro A, Brereton M. Child designers creating personas to diversify design perspectives and concepts for their own technology enhanced library. In: Proceedings of the 17th ACM Conference on Interaction Design and Children; 2018. p. 381–8. https://doi.org/10.1145/3202185.3202760.

[100] Berg C, Shaw M. Moving toward a humanistic social studies and history curricula: a review of recent reflective practices. Sage Open 2014;4(1):215824401452891. https://doi.org/10.1177/2158244014528919.

[101] Richardson J. Exploring student perceptions of learning analytics in higher education-developing approaches for consultation and feedback. In: ICERI2018 Proceedings; 2018. p. 3675–80. https://doi.org/10.21125/iceri.2018.1817. Https://Library.Iated.Org/View/RICHARDSON2018EXP.

[102] Al Shboul MK, Abrizah A. Modes of information seeking: Developing personas of humanities scholars. Inform Dev 2016;32(5):1786–805. https://doi.org/10.1177/0266666915627673.

[103] Almirall M, Rivera J, Valverde L. Learning contents in mobile scenarios. In: 2010 Second International Conference on Mobile, Hybrid, and On-Line Learning; 2010. p. 151–7. https://doi.org/10.1109/eLmL.2010.38.

[104] Anvari, F., & Richards, D. (2018). *Personas with knowledge and cognitive process: Tools for teaching conceptual design*.

[105] Bai GR, Clee B, Shrestha N, Chapman C, Wright C, Stolee KT. Exploring tools and strategies used during regular expression composition tasks. In: 2019 IEEE/ACM 27th International Conference on Program Comprehension (ICPC); 2019. p. 197–208. https://doi.org/10.1109/ICPC.2019.00039.

[106] Clear T, McDermott R, Parsjo E, Cajander A, Daniels M, Lagerqvist N. A framework for writing learning agreements. In: 2016 IEEE Frontiers in Education Conference (FIE); 2016. p. 1–8. https://doi.org/10.1109/FIE.2016.7757718.

[107] Huang J, Zhou J, Liao G, Mo F, Wang H. Investigation of Chinese students' O2O shopping through multiple devices. Comput Human Behav 2017;75:58–69. https://doi.org/10.1016/j.chb.2017.04.050.

[108] Li L, Xiao J. Persona profiling: A multi-dimensional model to study learner subgroups in Massive Open Online Courses. Educ Inf Technol (Dordr) 2022;27(4):5521–49. https://doi.org/10.1007/s10639-021-10829-0.

[109] Limtrairut P, Marshall S, Andreae P. Know the mobile learning application users—transactional distance perspective. In: Proceedings of the 8th International Conference on Computer Supported Education; 2016. p. 378–87. https://doi.org/10.5220/0005791303780387.

[110] Rank AD, Mushtare R. Using personas as a tool for teaching civic communication. J Gen Educ 2019;68(3–4):252–62. https://doi.org/10.5325/jgeneeduc.68.3-4.0252.

[111] Wolters MK, Niven E, Runardotter M, Gallo F, Maus H, Logie RH. Personal photo preservation for the smartphone generation. In: Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems; 2015. p. 1549–54. https://doi.org/10.1145/2702613.2732793.

[112] Buraga S, Dospinescu O. A knowledge-based pilot study on assessing the music influence. Comput Mater Contin 2021;66(3):2857–73. https://doi.org/10.32604/cmc.2021.014429.

[113] Ní Shé C, Farrell O, Brunton J, Costello E. Integrating design thinking into instructional design: The #OpenTeach case study. Austral J Educ Technol 2022;38(1):33–52. https://doi.org/10.14742/ajet.6667.

[114] Ahmed, I., Clark, A., Metzger, S., Wylie, R., Bergner, Y., & Walker, E. (2021). Interactive personas: towards the dynamic assessment of student motivation within ITS. In I. Roll, D. McNamara, S. Sosnovsky, R. Luckin, & V. Dimitrova (Eds.), *Artificial Intelligence in Education* (Vol. 12749, pp. 43–47). Springer International Publishing. https://doi.org/10.1007/978-3-030-78270-2_7.

[115] Onorati T, Díaz P. Integrating Gender inclusion in web design courses through design workshops. In: Proceedings of the XXI International Conference on Human Computer Interaction; 2021. p. 1–8. https://doi.org/10.1145/3471391.3471430.

[116] Salminen J, Jung S, Medina J, Aldous K, Azem J, Akhtar W, Jansen BJ. Using Cipherbot: An exploratory analysis of student interaction with an llm-based educational Chatbot. In: Proceedings of the Eleventh ACM Conference on Learning @ Scale; 2024. p. 279–83. https://doi.org/10.1145/3657604.3664690.

[117] Chiu TKF, Xia Q, Zhou X, Chai CS, Cheng M. Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. Comput Educ: Artif Intell 2023;4:100118. https://doi.org/10.1016/j.caeai.2022.100118.

[118] Gardner J, Brooks C. Student success prediction in MOOCs. User Model User-adapt Interact 2018;28:127–203. https://doi.org/10.1007/s11257-018-9203-z.
[119] Zawacki-Richter O, Marín VI, Bond M, Gouverneur F. Systematic review of research on artificial intelligence applications in higher education – where are the educators? Int J Educ Technol High Educ 2019;16(1):39. https://doi.org/10.1186/s41239-019-0171-0.
[120] Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of pubmed, scopus, web of science, and google scholar: strengths and weaknesses. The FASEB J 2008; 22(2):338–42. https://doi.org/10.1096/fj.07-9492LSF.
[121] Farooq A, Feizollah A, ur Rehman MH. Federated learning research: trends and bibliometric analysis. In: ur Rehman MH, Gaber MM, editors. Federated Learning Systems: Towards Next-Generation AI. Springer International Publishing; 2021. p. 1–19. https://doi.org/10.1007/978-3-030-70604-3_1.
[122] S. Adriaanse L, Rensleigh C. Web of science, scopus and google scholar: a content comprehensiveness comparison. Electron Libr 2013;31(6):727–44. https://doi.org/10.1108/EL-12-2011-0174.
[123] Kralick J, Karanian B. Implementing abbreviated personas into engineering education. In: 2020 ASEE Virtual Annual Conference Content Access Proceedings. 34778; 2020. https://doi.org/10.18260/1-2–34778.
[124] Zanudin NN, Sulaiman S, Samingan M, Razak, Mohamed H, Sh. A Raof ShK, Abd Samad AR. Case Study on Prototyping Educational Applications Using Persona-Based Approach. In: *2021 8th International Conference on Computer and Communication Engineering (ICCCE), 2021 8th International Conference on Computer and Communication Engineering (ICCCE)*; 2021. https://doi.org/10.1109/ICCCE50029.2021.9467242.
[125] Dong Phuong DT, Harada F, Shimakawa H. Estimating student persona through factorization of learning portfolio. In: 2013 IEEE Region 10 Humanitarian Technology Conference; 2013. p. 221–6. https://doi.org/10.1109/R10-HTC.2013.6669045.
[126] Ots, K., Loizides, F., & Sousa, S. (2015). Information seeking behaviour of scholars using resource discovery systems. In S. Kurbanoglu, J. Boustany, S. Špiranec, E. Grassian, D. Mizrachi, & L. Roy (Eds.), *Information Literacy: Moving Toward Sustainability* (Vol. 552, pp. 405–414). Springer International Publishing. https://doi.org/10.1007/978-3-319-28197-1_41.
[127] Ramsaroop S, Petersen N. Portraits of primary school pre-service teachers at a South African university: Implications for nuanced student support. J Educ 2020; 81. https://doi.org/10.17159/2520-9868/i81a05.
[128] Kang, D., Gangal, V., & Hovy, E. (2019). *(Male, Bachelor) and (Female, Ph.D) have different connotations: Parallelly Annotated Stylistic Language Dataset with Multiple Personas* (arXiv:1909.00098). arXiv. http://arxiv.org/abs/1909.00098.
[129] Stanca L, Tiron-Tudor A, Bresfelean VP, Pandelica I. Determining IT student profile using data mining and social network analysis. Int J Comput Commun Control 2020;15(5). https://doi.org/10.15837/ijccc.2020.5.3897.
[130] Jones E, Henninger M, Williams S. Using Journey Mapping and Personas for Targeted Student Recruitment in PETE. J Phys Educ Recreat Dance 2022;93(7): 17–25. https://doi.org/10.1080/07303084.2022.2100528.
[131] Motti VG, Dura E. Evaluating an accessibility intervention based on persona cards with diverse needs to teach accessibility to undergraduate students. Univers Access Inf Soc 2023;22(2):369–85. https://doi.org/10.1007/s10209-021-00853-9.
[132] Valguarnera S, Landoni M. Designing Collective Teacher-Children Personas in Preschool: A Methodological Approach. Interaction Design and Children 2021: 488–92. https://doi.org/10.1145/3459990.3465186.
[133] Kuttal SK, Gerstner K, Bejarano A. Remote Pair Programming in Online CS Education: Investigating through a Gender Lens. In: 2019 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC); 2019. p. 75–85. https://doi.org/10.1109/VLHCC.2019.8818790.
[134] Rempel, H. G., Buck, S., & Deitering, A.-M. (2013). Examining student research choices and processes in a disintermediated searching environment. *Portal: Libr Acad*, 13(4), 363–384. https://doi.org/10.1353/pla.2013.0036.
[135] da Costa AC, Rebelo F, Teles J. Child-Persona: What I Think to What They Are. In: Rebelo F, Soares M, editors. Advances in Ergonomics in Design. Springer International Publishing; 2016. p. 43–51. https://doi.org/10.1007/978-3-319-41983-1_5.
[136] Mesgari M, Okoli C, de Guinea AO. Affordance-based user personas: a mixed-method approach to persona development. In: Twenty-First Americas Conference on Information Systems; 2015. p. 1–17.