Personalized Learning Systems:
essential components and their impact on Learning Outcomes

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Abstract

Personalized learning has emerged as a promising approach to meet the diverse needs of learners. Personalized learning flexibly provides various learning options to suit learners' needs and learning speed. Instructional designers and researchers need directions regarding the components of a personalized learning system that can support achieving learning objectives. Many researchers propose personalized learning components only to identify the characteristics of personalized learning. This paper explores and elucidates the key components of personalized learning as an instructional system to ensure the achievement of learning objectives. The research method used is a systematic literature review. This study reviews related literature to analyze the personalized learning system's input, process, and output components. We included literature that proposes personalized learning models in various application and experimental contexts to see the personalized learning components used and their impact. After the identification and screening process, we reviewed eligible works of literature. We proposed a conclusion that there are five components of personalized learning: 1) learner profile, 2) learning objectives, 3) learning path, 4) learning environment, and 5) learning result. This research recommends future research on personalized learning to measure and ensure the achievement of learning objectives with personalized learning.

KEYWORDS: Personalized Learning, System Approach, Instructional Systems, Personalized Learning Components, Systematic Literature Review.

1. Introduction

Education is undergoing a paradigm shift fueled by advancements in technology, evolving pedagogical theories, and a growing recognition of the uniqueness of each learner. One-size-fits-all instructional approaches gradually shift to personalized learning, a learner- centered approach that tailors the learning experience to individual needs, preferences, and abilities (Caporarello et al., 2020; Halverson, 2019). At its core, personalized learning incorporates various components that work synergistically to create a truly personalized educational experience (Peng, Ma, & Spector, 2019; Zhang, Basham, & Yang, 2020). Personalized learning recognizes that learners have various self-regulated skills, paces, and interests, and it seeks to optimize the educational journey for each learner, promoting deeper engagement, motivation, and academic success (Ghallabi et al., 2022; Zainuddin & Judi, 2022). The characteristics of personalized learning make researchers, academics, and practitioners believe that exploring and developing personalized learning is an appropriate investment for the future.

Many researchers have studied personalized learning from multiple perspectives. Some studies elaborate on how instructional technology could encourage various learning and assessment strategies to be offered by personalized learning, like learning analytics, artificial

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intelligence, learning management systems, and gamification. (Isaías, 2018; Källkvist et al., 2009). Some studies focus on learning behavior in personalized learning environments, exploring how personalized learning could affect self-regulation learning, students' interaction with learning, learning style, and intrinsic motivation in personalized learning contexts. (Ali, Eassa, & Hamed, 2019; Grant & Basye, 2014; Hooshyar et al., 2020; Perez-Ortiz et al., 2021; Thanyaphongphat, 2019). The variety of perspectives that enrich personalized learning research shows how personalized learning research has become such an important and urgent topic to be explored.

As a potential innovation in enhancing education quality, research in personalized learning faces its challenge, as insufficient empirical studies are dissecting how each component independently contributes to learning objectives (Davis et al., 2018; Shemshack, Kinshuk, & Spector, 2021; Zhang et al., 2020). Many studies proposed personalized learning components in the context of technology integration and innovation without providing a complete picture of other components to support successful learning (Jando et al., 2017; Peng et al., 2019; Tawafak et al., 2019). This condition aligns with how personalized learning focuses on technology development and innovation, so there is less research exploring how personalized learning can ensure the achievement of the expected learning objectives and present meaningful learning (Källkvist et al., 2009; Zhang et al., 2020). From the point of view of instructional design, components are essential to ensure the achievement of learning objectives (Bielik et al., 2023; Richey, Klein, & Tracey, 2011). For this reason, when viewing learning as a system, the design of a learning system must pay attention to how the learning system follows the conditions and circumstances of the environment. A proposal is needed to answer the existing research gaps and identify personalized learning components that can ensure the achievement of learning objectives in personalized learning systems.

The primary aim of this paper is to explore the key components of personalized learning within instructional systems and examine how these components interact to create cohesive and effective learning environments. This paper is structured to first explore the key components of personalized learning within instructional systems and then analyze how these components interact to form a cohesive and effective learning environment. Additionally, the paper investigates trends over the years, particularly in the use of technologies for personalizing learning environments, providing insights into how these technologies have evolved and their impact on instructional design.

2. Terms and Definitions

2.1 The Systems Approach to Instruction

This study adopts a systems approach to examine personalized learning, focusing on formulating the components within a learning system. Systematic approach theory generally explains how a system within an ecosystem influences its environment. Bertalanffy in Huang, Spector, and Yang defines systems as sets of interconnected elements in an environment (Huang, Spector, & Yang, 2019). Hall & Fagen in Buckley elaborates that a system comprises interconnected objects and their attributes, designed to function as a unified whole (Buckley, 2017). A system is the amalgamation of more than two elements into an integrated and interconnected organic entity that operates as a unified system (Bielik et al., 2023; Buckley, 2017; Richey, Klein, & Tracey, 2011).

In the educational context, the systems approach perceives education as a part of the broader societal framework, where education is considered a subsystem. The concept of the educational system is a collection of subsystems, including schools, curricula systems, assessment systems, grading systems, and learning objects. Mangan & Mangal in Huang, Spector, and Yang explain that a system comprises five fundamental elements (as illustrated in Figure 1):

1. various components that constitute the system,
2. interactions between each component within the system,
3. the environment in which the system operates, and
4. the output of the system to its environment (Huang et al., 2019).

The systems approach gives a clear guideline on how, as a system, personalized learning components should be an integral part of ensuring the achievement of learning objectives. Implementing the systems approach in understanding personalized learning emphasizes the function of each personalized learning component as input, process, and output elements.
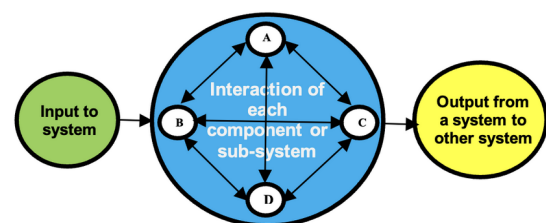

Figure 1 - Four Basic Elements of System.

2.2 Instructional

Instructional represents a system promoting learning (Brown & Green, 2016). The instructional system comprises several key components: learners, teachers,

instructional materials, and the learning environment (Dick, Carey, and Carey, 2015). When considering personalized learning within the framework of an instructional system, it becomes crucial to ensure the seamless integration of all components. Integrating all components will ensure that personalized learning, operating as an instructional system at the micro level, can effectively interact with the more extensive educational system at the mesolevel. By comprehending how the systems approach influences education and instruction, this study lays the groundwork for applying the systems approach to identify the components of personalized learning systems.

2.3 Personalized Learning

Personalized learning is a strategy for reforming education by enabling learning experiences tailored to each learner's diverse interests and capabilities (Halverson et al., 2015; Halverson, 2019). In this context, educators and related roles should create an environment where learners and instructors can collaboratively design study plans to achieve specific learning objectives. Personalized learning allows learners to progress at their own pace and adopt approaches that best suit their needs (Halverson, 2019; Peng et al., 2019; Zhang et al., 2020). Within this framework, learning objectives, approaches, instructional materials, and sequencing can be adjusted based on the learner's self-initiated needs.

Personalized learning encompasses a learning paradigm that prioritizes supporting the individual development of learners. It emphasizes that teaching methods, techniques, content, starting points, processes, and evaluation methods should be adapted to suit individual characteristics and potential development so that all aspects can be fully, freely, and harmoniously developed (Reigeluth, Myers, & Lee, 2017). Personalized learning empowers learners to reach their maximum potential through tailored learning experiences considering individual needs and prior experiences (Watson & Watson 2017). From these explanations, one can infer that personalized learning pertains to educational methods or frameworks that revolve around learning. Personalized learning incorporates elements to meet individual learners' unique requirements and capacities (Tkachuk, 2021). Importantly, personalized learning aims not only at facilitating knowledge acquisition but also at the achievement of specific learning objectives. Personalized learning extends beyond mere knowledge acquisition and includes the cultivation of self-regulation in students' learning (Peng, Ma, & Spector 2019). In the context of this research, personalized learning signifies an educational system that offers a diverse range of customizable learning components, adaptable to suit learners' objectives, pace, preferences, and individual traits, with a central focus on successfully attaining predefined learning goals.

3. Method

This study adheres to a systematic literature review framework guided by PRISMA standards for reporting results (Page et al., 2021). A Systematic Literature Review (SLR) is a comprehensive and structured approach utilized in academic and research settings to identify, assess, and synthesize existing, pertinent research studies on a specific topic or research question (Page et al., 2021; Kitchenham, 2004). The research questions guiding this literature review are as follows:

- What constitutes the elements of personalized learning within an instructional system?
- How do the various personalized learning components interact within the instructional system?

This research encompasses three critical stages in the Systematic Literature Review (SLR) process: 1) identification, 2) screening, and 3) inclusion, as illustrated in Figure 2. To establish a solid foundation for the literature review, we meticulously defined research objectives, eligibility criteria, search methods, data items, and comparisons for synthesis. The included literature review in this study varies from textbooks, scientific papers, and websites relevant to personalized learning components from 2013 to 2023. The primary search string used was: ("personalized learning" OR "personalized instruction") AND ("components" OR "elements" OR "systems") AND ("higher education" OR "professional training"). Searches were conducted in Scopus, Google Scholar, EBSCO, and ERIC, focusing on publications from 2013 to 2023. This timeframe captured contemporary developments in personalized learning technologies and methodologies.

This literature review focuses on personalized learning within the context of instructional systems, specifically targeting higher education and professional training environments. This focus was chosen to explore the integration and effectiveness of personalized learning components in structured educational settings. Studies related to K-12 education, while relevant, were excluded to maintain a focused scope on adult learning and its distinct characteristics in personalized learning systems.

To ensure transparency, we applied the following inclusion and exclusion criteria:

- *Inclusion*: Articles that address personalized learning components within instructional systems in higher education or professional training settings were included. To maintain the quality and rigor of the review, only peer- reviewed journal articles, books, and credible academic sources were included.

- *Exclusion*: Articles with restricted access or unavailable resources were excluded due to the inherent limitations in accessing and verifying the content. We deliberately excluded literature primarily centered on hardware and software technology specifications without explaining its use in learning. Additionally, unpublished articles, conference abstracts, editorials, opinion pieces, and marketing content were excluded to avoid bias and subjectivity. Articles that did not suggest personalized components from a system approach point of view were also excluded, as our focus is on literature aligning with the objective of examining personalized learning components within a unified instructional system.

The exclusion of certain types of literature was based on the need to ensure a coherent and focused review on personalized learning within instructional systems. By concentrating on higher education and professional training, the review aims to provide insights that are directly applicable to structured learning environments where personalized learning strategies are increasingly implemented.

4. Result

After undergoing a series of processes involving identifying and screening literature related to personalized l earning, we have included 43 works of literature in this study. The consideration that this literature offers sufficient explanations and elaborations enables us to conduct a more in-depth synthesis of the components comprising personalized learning as an instructional system.

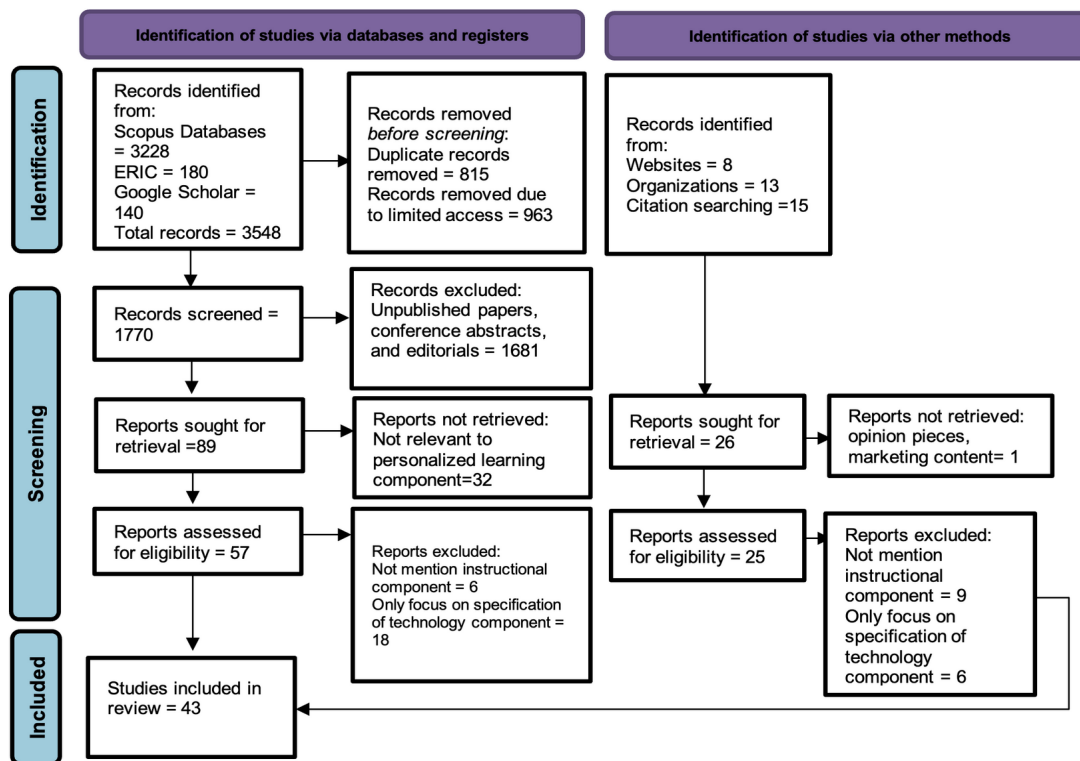Figure 2 will explain the outcomes of the identification and screening procedures.

Figure 2 – PRISMA Flow of Literature Review.

5. Discussion

5.1 Personalized Learning Components

We have organized the study's findings concerning the personalized learning component within the framework of personalized learning as an instructional system. An instructional system typically comprises three main parts: 1) input, 2) process, and 3) output. In the context of personalized learning as an instructional system, the 'input' encompasses the various components of a personalized learning system. These input components originate from external systems and subsequently influence the elements within the 'process' section of the learning system (Huang et al., 2019). Meanwhile, the 'output' section comprises the outcomes of the executed processes (Huang et al., 2019).

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We have identified and categorized the components of personalized learning as described in each literature source. We then classify them into the 'input', 'process', and 'output' categories within the context of personalized learning as an instructional system. In this section, we present the findings of our study on the various components that constitute personalized learning, shedding light on their effectiveness and impact on learner performance in learning objectives' achievement. Through qualitative literature, we examine personalized learning components offered by other researchers and classify the components according to the direction of the system approach.

The components in the 'input' section pertain to external input into the personalized learning system, which guides and influences the process components within the context of personalized learning as an instructional system. Based on our mapping, the included literature describes two major components: 1) learner profile and 2) learning objectives.

Learner profile

As the literature shows, understanding the learner profile comprises attributes brought by an individual learner from outside the system, and these attributes will influence the processes within the personalized learning system. The identify learner profile is an effort to identify and classify learners' traits, such as self-regulated learning skills, readiness, personality, characteristics, etc., as the basis of consideration. The learner profile component captures the learner's characteristics and readiness to achieve the desired learning goals (Halverson, 2019). Meanwhile, the International Association for K-12 Online Learning (iNACOL) describes the student profile as an effort to record individual students' skills, gaps, strengths, weaknesses, interests, and aspirations (Ferlazzo, 2017; Pipkin, 2015). Some literatures uses a different term to describe the learner profile, a learner model. A learner model refers to information and learner characteristics, including, among other things, the level of knowledge, learning style, personality type, emotional and motivational conditions, performance history, and cognitive abilities (Ghallabi et al., 2022; Grant & Basye, 2014). As an input component, initial information regarding the learner will influence the parameters and context of personalization that guide the personalized learning process (Ghallabi et al., 2022; Shemshack et al., 2021). The learner profile serves as a component that provides initial guidance for the processes within the personalized learning system. In this context, learners, with their diverse attributes, are entirely independent, necessitating facilitation to ensure a successful learning process. To facilitate this condition, instructional designers should consider conducting learner profiling before learning. This learner profiling can be a self-assessment report to assess the learners' self-regulated skills, readiness, and

prior knowledge. Information related to the learner thus becomes a crucial input component in personalized learning systems.

Learning objectives

The second input component in the personalized learning system is the 'learning objectives' component, which refers to the intended skill, knowledge, or attitude the student achieves at the end of the instruction. We contend that learning objectives should capture the learning needs arising from societal needs or demands at the related meso or macrolevels. Considering these considerations, we categorize learning objectives as inputs in a personalized learning system. Halverson mentions competency-based development components encompassing goals and achievement standards that students must attain (Halverson, 2019). On the other hand, Tkachuk elaborates on the 'implementation goal' component, highlighting the need for enhancing the learning process through personalized learning (Du, Wu, & D, 2020; Tkachuk, 2021; Zualkernan, 2016). Watson and Watson (2017) expound on the personalization of goals, emphasizing that students must identify and periodically monitor their short-term and long-term learning goals with guidance through social interactions with teachers and parents. As input in the personalized learning system, the learning objectives component constructs individual learning trajectories and enhances students' engagement in social participation (Halverson, 2019; Muslim et al., 2017; Tkachuk, 2021). This context illustrates that the learning objectives component serves as the input that shapes the trajectory of components within the personalized learning process as an instructional system.

The process of system involves the interaction and integration of components within the personalized learning system to ensure that the personalized instructional process necessary to achieve the expected learning objectives takes place. Based on a review of the included literature, we have identified two main components that facilitate the process within a personalized learning system: 1) learning path and 2) learning environment.

Learning path

We categorize the 'learning path' component, considering that some of the included literature describes components that pertain to a learning design offering various alternatives and flexibility based on existing input to ensure the achievement of learning objectives. The 'learning path' component encompasses learning strategies, assessment activities, content, and pedagogical conditions that enable personalization. Some researchers define a personal learning path as activities that can be adjusted to

support motivation and achieve learning goals (Halverson, 2019; Pipkin, 2015). Classify the learning path component as a static or dynamic learning path. The learner agent component refers to giving control to the learner to participate in designing their learning process and providing them with the option to demonstrate their learning objectives through performance-based assessments (Buitrago, Salinas, & Boude, 2023; Hans & Sachdeva, 2021; Pipkin, 2015). In line with this study, CIL Temple University explains a component related to personal competency, which refers to the competency needs chosen by the learner as the basis for all learning processes that prioritize a personalization context (Clarke, 2013; Colace, Santo, & Greco, 2014; Ghallabi et al., 2022; Murphy, 2016).

Aligned with those reviews, several included works of literature explicitly suggest other components that we consider classifying as 'learning path' components within the process of a personalized learning system. Watson and Watson (2017) explain the 'personalized scaffolding of instruction' component, emphasizing how the learning platform must be personalized according to the learner's self-regulation abilities in the personalized learning system. In addition to the 'personalized scaffolding of instruction' component, they also mention the 'personalized assessment of learning and performance' component. This component dictates that task performance and achievement assessments must be personalized by choosing among instructors, external experts, peers, or computer systems (Watson & Watson, 2017).

To enhance understanding of the learning path settings in personalized learning systems, we categorize the 'adaptation mechanisms' components as part of the 'learning path' components within the processes of personalized learning systems. The 'adaptation mechanisms' are various techniques and methods to support the learner's adaptation process in personalized learning settings (Ghallabi et al., 2022). Additionally, we include the 'learning schedule and pace' component proposed by Halverson (2015), which pertains to learning design that empowers students to control their own learning time and pace (Halverson et al., 2015).

We group the two components mentioned in Tkachuk's literature under the 'learning path' component. The first component is the 'main phase of implementation', which refers to managing learning activities and content used with software and technical support (Tkachuk, 2021). In addition, Tkachuk also explains the 'implementation principles' component, which refers to the basic rules and regulations for implementing personalized learning that form the structure and logic of the learning process, such as the principle of awareness, the principle of accessibility, the principle of flexibility, the principle of consistency, the principle of social participation, and the principle of control (Tkachuk, 2021). In the context of these studies, we ensure that the learning path component

allows students to determine their own learning goals, choose diverse learning experiences tailored to their individual needs, and prioritize personalization.

Learning environment

Based on the research we conducted, we found that the 'learning environment' is a component that pertains to the arrangements required to facilitate essential interactions between students and learning resources, students and their peers, and students and facilitators. According to our study, 'learning environments? not confined to structured classrooms with fixed settings. The 'learning environmentì' refers to an environment that is managed flexibly based on the learners' needs and extends beyond the physical environment by encompassing both physical and social components of the learning space (Halverson et al., 2015; Halverson, 2019; Ismail et al., 2023; Pipkin, 2015). Unlike classifications in other literature, Watson and Watson specifically mention the 'personalized task environment' component. The term 'environment' is coupled with 'task', signifying environmental settings that permit task personalization based on the learner's interests, goals, and initial abilities (Boubouh et al., 2020; Montebello, 2021; Watson & Watson, 2017). Within the context of this component, personalization of the task environment also governs how we should personalize collaboration between students and learners to complete tasks.

In managing the learning environment, a 'pedagogical condition' component is needed, which encompasses 1) conditioning the learning environment, 2) conditioning the readiness of the learner and facilitator, 3) conditioning the readiness of logistical and pedagogical support, including hardware and software, information technology, and the learning environment (Soltan et al., 2020; Tkachuk, 2021; Zainuddin & Judi, 2022). In more detail, the components of 'pedagogical knowledge' refer to the general elements used to create learning. These elements include domain models, learning materials, pedagogical models, learning resources, learning objects, content, learning activities, tests, and course structure (Ghallabi et al., 2022; Hwang & Fu, 2020; Tsatsou, Vretos, & Daras, 2017). Furthermore, Halverson guides the 'content' component, suggesting that content in personalized learning must give students control over the topic and direction of their learning (Halverson et al., 2015).

One of the core elements in the learning environment component is technology. The review observed significant changes in the technologies used to personalize learning environments over the last decade. Early implementations often relied on static content delivery systems, whereas recent advancements include adaptive learning platforms, AI-driven analytics, and real-time feedback mechanisms (Peng et al., 2019; Peyrony et al., 2018; Zhong et al., 2020). These technological evolutions have enhanced the ability to

tailor instructional content to individual learner needs, providing more dynamic and responsive learning experiences.

The 'learning environment' component within the personalized learning system process establishes the necessary boundaries and openness to facilitate the personalization process. The relevant boundary is where the learning environment maintains settings geared towards enabling students to attain their expected learning goals and fostering the personalization of the learning process. Conversely, the 'learning environment' must possess flexible openness to provide physical and social spaces for students to interact and plan their learning processes according to their preferences. The studies covered in the literature that elucidate the components of the 'learning environment' emphasize the need for a learning environment that supports the achievement of learning objectives while still offering the flexibility and openness characteristic of personalized learning.

The 'output' comprises a learning result component that gives the measurement guidance of students' achievement of learning objectives to ensure the effectiveness and efficiency of personalized learning systems. Some of the included literature describes this component using various terms. For example, Tkachuk uses the term 'result', which refers to measuring learning effectiveness in attaining learning goals and solving existing organizational problems (Tkachuk, 2021). Watson and Watson identified the 'personalized reflection' component, which pertains to reflection on the learning process and reflection on learning objectives, flexibly organized to reflect the achievement of expected outcomes (Beghetto, 2019; Peng, Wu, & Technology, 2019; Watson & Watson, 2017). The International Association for K-12 Online Learning (iNACOL) explains the 'individual achievement' component, referring to an arrangement where students measure learning completion based on their respective learning targets according to clearly defined standards and goals (Beghetto, 2019; Pipkin, 2015; Yang, Flanagan, & Ogata, 2022).

5.2 Interaction between Personalized Learning Components

In this section, we try to explain the interactions between components in personalized learning systems.

Figure 3 illustrates the relationship between components in personalized learning systems. Personalized learning systems consist of three main components: 1) input, 2) process, and 3) output.

In the input section, the 'learner profile' component encompasses the learner's characteristics, interests, expectations, and self-regulated learning skills as inherent attributes outside the personalized learning system. The elements of the learner profile will influence the personalized learning path choices made by the learner in the process section of the personalized learning system. Another component in the input section is 'learning objectives', which refer to the response of the organization and society that needs to be achieved by the end of the learning process. These learning objectives are personalized based on the learner's interests and aspirations.

The process section has two main components: 1) the 'learning path' and 2) the 'learning space'. These components interact with each other to offer personalized learning choices for students. The 'learning path' component provides a range of strategies, assessments, timeframes, and learning speed options that students can flexibly choose based on their student profile and the learning goals they aim to achieve. The 'learning environment' component encompasses various learning resources, learning objects, and physical and social learning spaces, all designed to support a variety of learning activities in line with the choices made by the learner profile.

The output section includes measuring the results stemming from the processes carried out. In the context of personalized learning systems, the output refers to the attainment of learning goals set by students. The output from personalized learning systems subsequently becomes input for the next phase of the system.
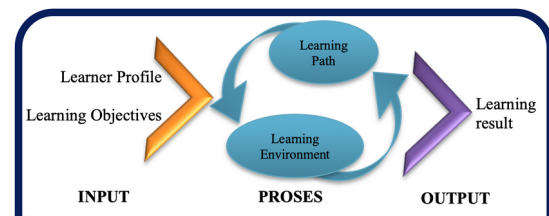

Figure 3 - Interaction between Personalized Learning Components.

6. Conclusion

This study posits that, with all its existing advantages and limitations, personalized learning indicates the future of education. From the perspective of systems approach theory, personalized learning design is a unified learning system with integrated components. Current research and studies in personalized learning predominantly emphasize learning technology components and infrastructure supporting personalized learning. Therefore, this study aims to explore literature that examines personalized learning as an instructional system and synthesizes its components to ensure the effectiveness and efficiency of personalized learning in supporting learning objectives.

This research addresses the problem formulation by searching and selecting literature that meets predefined

criteria and limitations. We included 43 pieces of literature for a comprehensive analysis to link and map the components of the personalized learning system. The selected articles encompass textbooks, scientific journals, research reports, and websites from reputable sources found during the search. The literature included spans the last ten years.

Based on a literature review, we identified components in the input, process, and output sections. The input component includes components 1) learner profile and 2) learning objectives, which provide direction and input to the process in the personalized learning system. The learner profile refers to the efforts to identify and classify learner attributes as considerations in designing and directing the learning process in a personalized learning system. The second input component in the personalized learning system is the 'learning objectives' component. This component pertains to the intended skills, knowledge, or attitudes students should achieve by the end of the instruction. The process section consists of components that ensure personalization supports achieving learning goals based on individual learner needs. The process includes 1) the learning path and 2) the learning environment. The learning path refers to a learning design offering various alternatives and flexibility, consisting of learning strategies, assessment activities, content, and pedagogical conditions that enable personalization. The learning environment is a component that maintains the arrangements required to facilitate essential interactions between students and learning resources, students and their peers, and students and facilitators. Finally, in the output, we consider the component of learning results, which refers to the measurement guidance of students' achievement of learning objectives to ensure the effectiveness and efficiency of personalized learning systems.

We aim to convey the personalized learning component from the learning design perspective within the scope of personalized learning as a learning system. Our study aims to provide new insights into research related to personalized learning. The insights provided by our study can assist researchers, practitioners, decision-makers, and instructors in designing personalized learning as a system that supports the achievement of expected learning goals. In the systems approach, personalized learning is detailed based on integrated components that mutually support each other to achieve the expected goals. Implementing personalized learning is challenging in the field, requiring significant efforts such as technology investment and readiness among instructors and learners. Therefore, the direction of this research is crucial to ensure that the implementation of personalized learning, with all its complexity and flexibility, still delivers meaningful learning objectives and ensures the achievement of expected learning objectives.

Through this study, we propose five complete components in the input, process, and output of a personalized learning system: 1) the learner profile, 2) the learning objectives, 3) the learning path, 4) the learning environment, and 5) learning results. The component classification scheme that we offer is different from previous research, such as the study that identified the main components of personalized learning, including learner profiles and attitudes, prior knowledge and beliefs, personalized adaptive learning paths, and flexible self-paced learning (Shemshack et al., 2021). The study has outlined the input and processes contained in personalized learning but has not explained how the achievement of learning objectives is then measured.

Meanwhile, many studies in personalized learning propose personalized learning components from the perspective of technology preparation. A study examines standard components, tools, and the foundational theory as a guideline for developing a personalized e-learning model (Jando et al., 2017). This study thoroughly reviews personalized learning as an entity supported by various technologies. This study is not incorrect, given that integrating communication and information technology is vital in supporting education. However, technology alone cannot guarantee that all technological investments can ensure memorable and practical learning. We address this gap through the findings of the study we conducted.

Limitations in this research include the limited literature that discusses personalized learning components from a systems approach perspective. With a limited literature review, we aim to present a proposal for personalized learning components that describe a personalized learning system. One potential area for further exploration is developing a personalized learning system model based on our proposed components, specifically for learning contexts in specific scientific areas. Researchers can investigate the effectiveness of personalized learning systems in promoting self-regulated learning and achieving learning goals. Additionally, researching the specifications and minimum criteria for each component of a personalized learning system in a specific scientific field could be a potential focus for future research.

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