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Designing a Universal Student Passport for Responsible AI-Driven Personalised Learning in Engineering Higher Education

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Abstract. Artificial Intelligence (AI), and particularly Generative AI, is increasingly being adopted in higher education to support content adaptation, feedback generation, concept explanation, and more personalised learning experiences. While these developments offer substantial promise, current approaches to AI-supported personalisation often remain fragmented, tool-driven, and insufficiently grounded in structured representations of learner needs and preferences. This creates a gap between the technical capabilities of AI and the pedagogical, organisational, and governance requirements necessary for its responsible integration in higher education.

This paper proposes a conceptual architecture for a Universal Student Passport to support responsible AI-driven personalised learning in engineering higher education. The work is developed within the context of the Erasmus+ funded MultAI-PASS project, and is grounded in early project design activities, including a review of learning preferences and learner variability, as well as an analytical synthesis of learner-related dimensions relevant to personalised support. The paper focuses on the design rationale of the passport, its core architectural layers, its intended information flow, and the governance principles required to ensure transparency, student agency, and educator oversight. In doing so, it offers a structured conceptual bridge between learner-related preferences and AI-supported educational adaptation in engineering higher education.

Keywords: Artificial intelligence in higher education · Personalised learning · Student passport · Responsible AI · Learning profiling · Engineering education

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1 Introduction

Artificial Intelligence (AI) is becoming an increasingly influential feature of higher education, with growing use across teaching, learning support, assessment, and academic administration [1–3]. More recently, the rapid emergence of Generative AI and multimodal AI tools has intensified this development by enabling conversational tutoring, automated feedback, on-demand explanation, exercise generation, and adaptive support at a scale previously difficult to achieve [4–6]. These developments have renewed interest in personalised learning, particularly in contexts where students benefit from alternative explanations, differentiated pacing, tailored support, and multiple modes of engagement with complex content.

The relevance of these developments is especially pronounced in engineering higher education. Engineering programmes are typically characterised by cumulative prerequisite knowledge, layered problem-solving processes, high cognitive demand, and strong alignment between conceptual understanding and applied competence. Students are often required to move iteratively between theory, modelling, visualisation, simulation, and calculation, and may therefore benefit from more flexible and responsive forms of instructional support. Recent work suggests that AI-enabled adaptation may be particularly valuable in engineering education because it can provide just-in-time explanation, scaffold complex concepts, and support different forms of learner engagement within technically demanding environments [7, 8]. At the same time, engineering learning increasingly takes place across digitally mediated systems, including learning management systems, simulation tools, coding environments, and design platforms, creating opportunities for richer forms of learner support while also raising new questions regarding coherence and governance.

Despite this promise, the adoption of AI in higher education remains uneven and conceptually under-structured. In many cases, AI is introduced at the level of individual tools or isolated teaching practices rather than through a coherent learner-centred framework. Personalisation is often approached through generic prompting, platform-level settings, or local adaptive features, without being anchored in a structured representation of learner characteristics that could support continuity across courses, activities, or institutions [9, 10]. As a result, AI-supported personalisation frequently remains shallow or episodic, offering immediate assistance within a particular system but lacking the persistence, portability, and interpretability required for broader educational value. This fragmentation creates a tension between the expanding technical capability of AI systems and the educational need for meaningful, consistent, and responsibly governed adaptation.

A related challenge is that learner-related information is rarely captured in a form that is both educationally useful and portable across contexts. Existing digital environments may store operational data such as enrolment records, assessment traces, interaction logs, or progression information, yet they do not typically provide a coherent learner-facing structure through which preferences, support needs, and adaptation-relevant characteristics can be represented and reused over time. Consequently, personalised support is often recreated from scratch within each module, retained within the boundaries of a single platform, or left to the student's unstructured interaction with external AI tools. Earlier work on personal user models and portable learner representation has pointed

to the value of persistent, inspectable, and learner-aware models that support continuity and agency beyond isolated educational settings [11]. However, such work has not yet been fully integrated with the contemporary realities of GenAI-supported teaching and learning in higher education.

These limitations become even more significant when viewed through the lens of responsible AI integration. A growing body of literature has emphasised that AI adoption in education must be guided not only by technical feasibility but also by transparency, fairness, privacy, accountability, inclusion, educator oversight, and student agency [4, 12, 13]. In higher education, responsible use also extends to issues such as academic integrity, explainability of AI-generated outputs, and the need to preserve pedagogical judgement rather than displace it [5, 6]. Yet much of the current governance discussion remains principle-based and institution-facing, with limited attention to the learner-facing structures through which AI-relevant personalisation data should actually be organised and used. While responsible AI is widely discussed, the design mechanisms needed to enact it in personalised learning settings remain comparatively underdeveloped.

This gap is particularly relevant for engineering higher education, where pedagogical quality depends strongly on the suitability of explanation, scaffolding, sequencing, and applied support. Personalisation in such contexts cannot be treated as a purely algorithmic matter; rather, it must be shaped by educational purpose, learner visibility, and human oversight. A structured, portable, and governance-aware learner representation may therefore offer a useful conceptual foundation for connecting AI capability with responsible pedagogical practice.

In response to these challenges, this paper proposes a **Universal Student Passport** as a conceptual architecture for responsible AI-driven personalised learning in engineering higher education. The passport is conceived as a structured and portable learner representation that captures selected learner-related characteristics in a form that can inform the use of AI-supported educational tools while remaining transparent to students and interpretable to educators. Rather than being integrated into a specific AI platform, it is intended to function as a reference layer that supports more coherent, learner-aware, and responsibly governed personalisation. The development of this concept is grounded in a criteria-driven process in which literature-informed requirements are used to guide the selection of suitable learner modelling frameworks and the subsequent design of the passport architecture. Drawing on the project's review of learning preferences and learner variability, together with the analytical mapping of learner-related dimensions, the paper addresses the following research question: **How can a Universal Student Passport be conceptually designed to support responsible AI-driven personalised learning in engineering higher education?**

2 Background and Problem Framing

2.1 AI-Supported Personalisation in Higher Education

AI, and more recently Generative AI, is increasingly used in higher education to support personalisation that was previously difficult to deliver at scale. Across recent studies, AI-enabled systems have been applied to conversational tutoring, question answering, automated feedback, adaptive practice generation, and the re-explanation of concepts in

alternative forms. In practical terms, this means students can receive more immediate, individually responsive support, while educators can draw on AI tools to extend explanations, provide differentiated materials, and create more flexible learning pathways. The recent literature suggests that this shift is particularly visible in systems that use large language models to generate examples, feedback, quizzes, and guided support in response to student interaction. At the same time, more classical adaptive approaches, including learning analytics, knowledge tracing, and rule-based sequencing, continue to underpin many personalised learning environments. Together, these developments indicate that AI-supported personalisation is no longer a peripheral topic in higher education, but an increasingly central feature of contemporary digital learning design [4, 6, 9].

For engineering higher education, the value of personalisation is especially pronounced. Engineering programmes typically involve cumulative prerequisite structures, multi-step reasoning, high cognitive load, and close coupling between conceptual understanding and applied competence. Learners are often required to move between text, mathematical representations, diagrams, simulations, and domain-specific software, which means that support needs may differ substantially across students and tasks. The literature reviewed for this study indicates that AI-driven personalisation may be especially useful in engineering contexts because it can support early detection of misconceptions, scaffold complex reasoning, adapt to difficulty and modality, and exploit rich digital traces generated by coding environments, simulation tools, and CAD/CAE platforms. In this sense, engineering education is not only a beneficiary of AI-supported personalisation, but also a demanding and revealing testbed for examining how such personalisation should be structured and governed [7, 8].

2.2 Fragmentation, Portability and Structural Limitations

Despite the growing use of AI and Generative AI in higher education, much of the current literature indicates that personalisation remains largely platform-bound. Existing implementations are typically embedded within individual learning management systems, adaptive learning platforms, or vendor-specific ecosystems, where learner representations are local to the system and rarely designed for reuse beyond that environment [6, 9, 10]. As a result, learner-related information is often limited to short-term interaction histories, recent performance, or course-specific usage patterns, rather than being structured as a persistent and portable learner representation.

A related strand of work has attempted to address this limitation through more durable forms of learner modelling and portable educational records. PUMLs, blockchain-enabled learning record stores, and universal micro-credential frameworks demonstrate that portability, traceability, and structured learner representation are feasible design objectives [11, 14–16]. However, most of these models either predate the recent rise of GenAI in higher education or do not yet connect explicitly to contemporary AI-supported tutoring, feedback, or adaptive content generation.

At the same time, the literature on AI in higher education increasingly emphasises the importance of responsible integration. Key concerns include transparency, explainability, privacy, fairness, accountability, educator oversight, academic integrity, and student agency [4, 5, 12]. Yet these issues are often discussed at the level of policy or institutional guidance rather than being embedded directly into the learner-facing structures through

which personalisation data are represented and used. Earlier work on open learner models and learner-controlled records suggests that transparency, provenance, and agency should be treated as architectural concerns rather than afterthoughts [11, 14].

2.3 Toward a Universal Student Passport

Taken together, the literature indicates that the constituent elements of a Universal Student Passport already exist, but in fragmented form. One strand provides AI- and GenAI-enabled personalised support; another provides portable learner-record and credential structures; and a third foregrounds responsible-AI requirements. What remains underdeveloped is a framework that brings these strands together in a single architecture for higher education. This gap is especially important in engineering higher education, where personalisation may be particularly valuable because of cumulative prerequisite structures, high cognitive load, and the need to scaffold multi-step reasoning and applied problem solving [7, 8]. The Universal Student Passport, therefore, emerges not as a minor extension of existing AI tools but as an integrative conceptual response to a fragmented field.

From this synthesis, a set of design requirements for the proposed passport can be identified. To be educationally useful, the passport must represent learner-related characteristics in a form that is meaningful and interpretable to both students and educators. To address fragmentation, it must be portable across courses, tools, and institutions rather than confined to a single platform. To support AI-enhanced learning responsibly, it must be capable of informing AI-supported educational tools without transferring ownership of the learner model to those tools. It must also remain student-controlled and governance-aware, supporting transparency, consent, and appropriate use. Finally, it must be sufficiently scalable and adaptable to function across diverse higher education contexts, including engineering domains characterised by multimodal learning and high cognitive demand.

3 Methodological Basis for Passport Design

3.1 Comparative Review of Learning Preference Frameworks

The conceptual basis of the Universal Student Passport was established through a structured comparative review of learning preference frameworks relevant to personalised learning in higher education. This review was guided by the design requirements identified in Sect. 2, which were operationalised into a set of evaluation criteria. The purpose of this review was not to identify a single dominant learning theory, but to determine which learner-related constructs could be represented in a way that is educationally meaningful, interpretable to students and educators, and suitable for later use in a portable learner profile.

The comparative review process was conducted collaboratively across the project partners participating in the MultAI-PASS initiative. A structured comparative review template was developed to support consistency in how the frameworks were examined across the consortium. Each framework family was reviewed against the agreed evaluation dimensions through literature-informed analysis and partner discussion, after

which the findings were synthesised comparatively in order to identify which frameworks provided the most suitable conceptual basis for a portable, interpretable, and student-controlled learner representation in engineering higher education.

Six framework families were reviewed in order to capture complementary perspectives on learner differences. **VARK** was included because it offers a concise and widely recognised representation of modality-related preference through the visual, aural, read/write, and kinaesthetic dimensions, while also explicitly framing its questionnaire as a reflective tool rather than a high-stakes diagnostic instrument [17]. The comparative review process further highlighted that VARK is most defensible when treated as a narrow perceptual-preference layer within a broader learner profile, rather than as a complete explanation of how students learn.

Felder–Silverman was reviewed because of its long-standing relevance to engineering education and its potential value for adaptive and technology-enhanced learning [18–20]. Its dimensions, including active/reflective, sensing/intuitive, visual/verbal, and sequential/global, provide a richer account of how learners process, organise, and structure information than modality-only approaches. In the partner review, Felder–Silverman was considered particularly promising for AI-informed educational adaptation because its dimensions can be translated into more nuanced support logic than simple content-format matching.

Kolb's Experiential Learning Theory was reviewed because it shifts the focus from input preference alone to the broader process through which learning takes place. Kolb's cycle of concrete experience, reflective observation, abstract conceptualisation, and active experimentation provides a pedagogically rich structure for thinking about how learning activities may be sequenced and supported, particularly in higher education and applied disciplines such as engineering [21–23]. The review also highlighted that Kolb is useful not as a rigid typing mechanism, but as a process-oriented lens that can help inform multimodal and adaptive learning pathways.

Three further framework families: Honey and Mumford, Gardner's Multiple Intelligences, and psychology-based approaches centred on deep/surface learning and metacognition, were also reviewed to test the broader design space, but were judged to be more suitable as secondary interpretive or reflective lenses than as core profiling foundations for a portable passport.

3.2 Analytical Synthesis and Framework Selection

Following the review, the frameworks were compared against a common set of evaluation criteria: validity, ease of use, digital/AI adaptability, cultural flexibility, educational impact, and scalability. These criteria directly reflect the passport design requirements identified in Sect. 2, including interpretability, portability, and responsible AI integration. This comparison was used not to rank theories in absolute educational terms, but to determine their suitability for informing a portable student passport within the specific context of MultAI-PASS. The resulting pattern showed a clear upper tier consisting of **VARK**, **Felder–Silverman**, and **Kolb**, while the remaining frameworks were retained as useful interpretive references rather than selected foundations.

Table 1. Overall suitability ranking of reviewed learning preference frameworks

Framework	Total Score	Role in Passport Decision
Vark	1.44	Core student-facing preference layer
Felder-Silverman	1.24	Fine-grained adaptation logic
Kolb	1.21	Pedagogical process layer
Others	Lower	Not selected as core foundations

The framework scores shown in Table 1 represent averaged and normalised comparative values derived from the six evaluation dimensions: validity, ease of use, digital/AI adaptability, cultural flexibility, educational impact, and scalability. Each framework family was comparatively assessed against these dimensions using the structured review template applied across project partners during the comparative review process. The resulting values, therefore, indicate relative suitability for informing passport design within the context of MultAI-PASS rather than absolute educational ranking. The synthesis supported the selection of VARK, Felder–Silverman, and Kolb as complementary foundations for passport design. VARK offered the clearest basis for a student-facing preference layer, Felder–Silverman provided the strongest basis for a more fine-grained adaptation layer, and Kolb contributed a pedagogical process layer. The remaining frameworks were retained as useful interpretive references rather than selected foundations.

3.3 Implications for Questionnaire and Passport Design

The selection of **VARK, Felder–Silverman, and Kolb** provided the conceptual foundation for the next design step: the development of a questionnaire intended to operationalise and refine candidate passport indicators. At this stage, the questionnaire is not presented as a complete profiling mechanism that directly generates the student passport. Rather, it functions as an intermediary design and validation instrument through which selected constructs are translated into item form, tested for clarity and relevance, and assessed for their suitability in shaping the future passport structure. In this sense, the three selected frameworks served as the conceptual backbone for questionnaire design. At the current stage of the research, the questionnaire should therefore be understood as an exploratory design and refinement instrument rather than as a fully validated learner profiling mechanism.

This selection also shaped the emerging logic of the passport itself. The review indicated that the passport should not be reduced to a single learning-style score or a rigid learner label. Instead, it should contain a **small set of interpretable indicators** that reflect complementary dimensions of learning. Under this logic, VARK can inform a reflective modality-preference layer; Felder–Silverman can inform more nuanced adaptation logic, especially in engineering contexts; and Kolb can inform a process-oriented pedagogical layer linked to the organisation of learning activities. The passport is therefore grounded in three selected framework families, chosen not because any one of them is sufficient alone, but because together they provide a more balanced and defensible basis

for responsible AI-informed personalisation in engineering higher education. The questionnaire development process therefore represents an intermediate operationalisation step through which these framework-derived constructs can later inform the evolution of the passport architecture.

Taken together, these selected framework contributions provide the conceptual basis for the next step of the paper: articulating the Universal Student Passport as a layered architecture through which learner-related characteristics are structured, interpreted, and made available to support responsible and student-controlled use of AI-supported educational tools, in line with the requirements and criteria-driven selection process established in this section.

4 Proposed Universal Student Passport Architecture

4.1 Design Objectives

The proposed Universal Student Passport is conceived as a **structured, portable, and learner-informed representation** intended to support responsible AI-driven personalised learning in engineering higher education. It is not an AI system in itself, nor is it designed to be embedded within a single digital platform. Rather, it acts as a reference layer through which selected learner-related characteristics can be captured, organised, and communicated across educational contexts. The concept emerged from the need to create a standardised mechanism through which students could communicate relevant learning-related characteristics across higher education settings, while also supporting more coherent personalisation in later stages of the research. The architecture is grounded in the framework selection process presented in Sect. 3, where literature-informed requirements and evaluation criteria were used to identify the most suitable learner-related constructs for inclusion.

The architecture is guided by five objectives. First, it should provide a **clear and interpretable learner profile** that can be understood by both students and educators. Second, it should be **portable across courses and institutions**, rather than remaining confined to one platform or vendor ecosystem. Third, it should be **structured enough to inform AI-supported educational tools** without allowing those tools to define or own the learner model. Fourth, it should support **responsible AI by design**, including transparency, student agency, oversight, and appropriate control of access and use. Finally, it should remain flexible enough to evolve as learner characteristics are refined over time and as educational contexts change. These objectives respond directly to a key limitation identified in the literature: the absence of portable, fine-grained, and governance-aware learner representations in current AI-enabled higher education systems.

4.2 Core Architecture Layers

Figure 1 summarises the layered conceptual architecture of the proposed Universal Student Passport. The figure is intended to illustrate the conceptual relationships between learner representation, pedagogical interpretation, AI-informing functions, governance, and portability, rather than a technical system implementation. The passport is best

understood as a layered architecture rather than as a single flat profile, since this separates learner-facing indicators, pedagogical interpretation, AI-informing functions, governance, and portability.

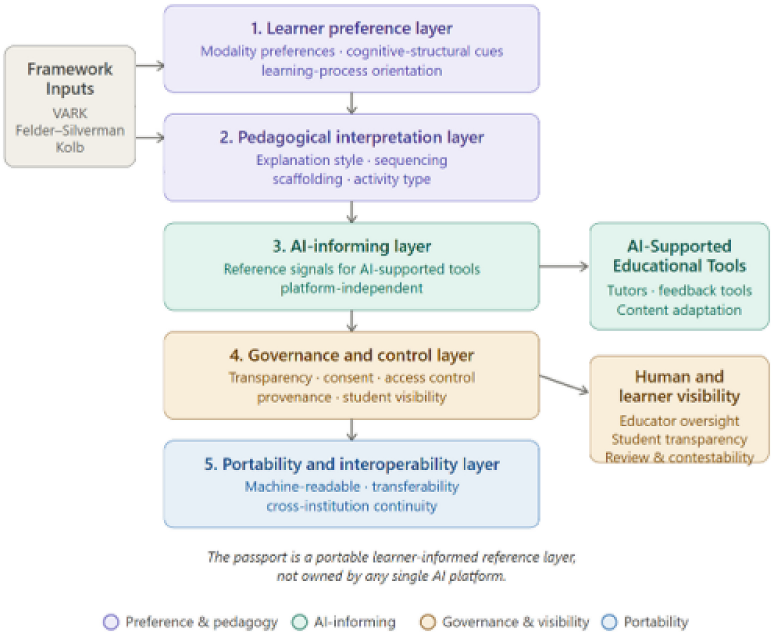


Fig. 1. Universal Student Passport – Conceptual Architecture

The **learner preference layer** contains the core student-facing indicators derived from the three selected framework families identified through the criteria-driven selection process described in Sect. 3, while the pedagogical interpretation layer translates these framework-informed indicators into educationally meaningful support logic. The **pedagogical interpretation layer** translates those indicators into descriptors relevant to explanation style, sequencing, scaffolding, activity type, and multimodal presentation. The **AI-informing layer** enables selected fields to be translated into a passport-derived prompt or profile summary that students may choose to use in external AI platforms. The **governance and control layer** ensures that the passport remains student-controlled through visibility rules, consent logic, provenance, and auditability. The **portability and interoperability layer** supports continuity across courses, institutions, and digital environments through structured and machine-readable fields.

The functional logic of the passport is therefore a sequence of interpretation and student-controlled use rather than automation. Learner-related information is organised into the passport profile and interpreted pedagogically, while its application in external contexts remains **student-mediated rather than system-driven**. In this way, the passport does not integrate into Generative AI platforms, make decisions autonomously, or dictate outputs. Instead, it provides structured information that may be used to obtain more coherent and learner-aware support. Responsible AI is thus

built into the architecture through transparency, student agency, educator oversight, and governance-by-design.

4.3 Operational Use of the Passport

The operational value of the Universal Student Passport lies not in automation, but in its role as a **student-controlled mechanism for informing external educational tools and interactions**. Once learner-related characteristics have been captured and interpreted within the passport structure, they can be expressed as a concise profile summary that the student may choose to use in different educational contexts for example as a passport-derived prompt when interacting with AI-supported tools. In practice, this means that the passport can serve as a structured prompt for communicating how the learner tends to engage with explanations, sequencing, scaffolding, and multimodal support.

This use is intentionally **student-mediated**. The passport does not connect directly to Generative AI platforms, nor does it autonomously trigger adaptation. Instead, the student remains the active agent in deciding whether the passport-derived profile should be used, when it should be shared, and for what purpose. In this sense, the passport supports informed personalisation without transferring control of the learner model to an external system.

Operationally, the passport can support three related functions. First, it can help students **understand and articulate their own learner profile** in a clearer and more structured way. Second, it can support **communication with educators**, for example by making visible the kinds of explanation or support that may be most useful in a given learning context. Third, it can be used to **inform interactions with AI-supported educational tools**, for instance by helping the student formulate a profile-informed prompt that requests explanations in a more suitable format or level of structure.

This operational logic preserves an important distinction between **learner representation** and **tool behaviour**. The passport does not determine how an external tool must respond; rather, it provides structured information that may help the learner obtain more coherent and personally meaningful support. Its function is therefore enabling rather than directive. This makes the passport compatible with the paper's broader argument that personalisation in higher education should remain transparent, student-controlled, and pedagogically governed.

4.4 Responsible Design Principles

A central argument of this paper is that the passport should embody **responsible AI by design**. Four principles are especially important. The first is **transparency**: students and educators should be able to understand what information is stored and how it may inform support. The second is **student agency**: learners should not be reduced to fixed categories, and the profile should remain open to reflection, revision, and contestation. The third is **educator oversight**: AI-supported outputs informed by the passport should remain pedagogically supervised rather than automatically enacted. The fourth is **governance and provenance**: the architecture should support auditability, access control, and clear separation between formative support uses and high-stakes uses.

4.5 Illustrative Use Case in Engineering Higher Education

A simple engineering use case helps clarify the role of the passport. Consider a first-year engineering student studying mechanics through conceptual explanation, worked examples, diagrams, and problem-solving exercises. The student's passport may indicate a preference for visual explanation, structured sequencing, and reflective engagement with worked examples. In this case, the passport could generate a profile summary that the student may choose to use in an AI-supported educational tool so that responses prioritise diagram-supported explanations, stepwise problem breakdowns, and reflective prompts before moving to more open-ended tasks. The passport does not dictate the output, nor is it embedded within the tool. Rather, it informs how support may be shaped within the educational context.

A second illustrative scenario could involve collaborative project-based learning in engineering education. In such a context, the passport may support students in communicating preferred approaches to explanation, sequencing, reflection, or multimodal interaction when engaging with AI-supported teamwork or design environments. This may help create more transparent alignment between learner preferences, educator guidance, and AI-assisted support during collaborative activities.

5 Discussion

5.1 Conceptual Implication of the Proposed Passport

The central conceptual contribution of this paper is the repositioning of learner representation within AI-supported higher education. Much of the current discussion on Generative AI in education focuses on the capabilities of tools: what they can generate, how they can support explanation, or how they can personalise feedback. By contrast, this paper shifts attention to the structure through which learner-related information is represented and mobilised. In doing so, it argues that meaningful personalisation requires more than adaptive tools; it also requires a learner representation that is portable, interpretable, and governed appropriately, and crucially, one that remains student-controlled and capable of informing AI-supported tools without being embedded within them.

This changes the discussion in three ways. First, it moves personalisation away from being treated as a feature internal to a platform and instead frames it as something that should be informed by a student-controlled profile that exists independently of any single system. Second, it reframes learner profiling not as a hidden or deterministic classification process, but as a transparent and pedagogically meaningful reference layer that students and educators can understand and use. Third, it embeds responsible AI directly into the architecture of personalisation by making transparency, agency, oversight, and governance part of the passport design itself rather than external policy considerations, thereby shifting responsible AI from a policy concern to an architectural design principle.

A further conceptual contribution lies in the paper's selective use of **VARK, Felder–Silverman, and Kolb**. Rather than relying on one framework alone, the proposed passport combines complementary perspectives on modality preference, cognitive-structural tendencies, and learning-process orientation. This strengthens the conceptual basis of the passport by avoiding simplistic learner typing and instead supporting a more balanced and interpretable learner representation.

5.2 Why Engineering Higher Education Is a Strong Testbed

Engineering higher education provides a particularly strong testbed for the proposed passport because it combines educational complexity with clear practical demands for personalisation, making it an analytically demanding environment in which the value of structured and portable learner representation can be meaningfully assessed. Engineering students often work within cumulative knowledge structures, where later learning depends heavily on earlier conceptual understanding. They must also move across multiple forms of representation, including text, diagrams, equations, simulations, and worked problem-solving sequences. In such contexts, the way support is structured can have a direct effect on how effectively students engage with difficult concepts and tasks.

This makes engineering an especially useful setting in which to explore whether a portable and learner-informed profile can add value. If the passport can support more coherent communication of learner-related characteristics in a domain marked by high cognitive demand, multimodal representation, and applied reasoning, then it has strong potential relevance for other higher education contexts as well. Engineering therefore functions not only as the paper's disciplinary focus, but also as a demanding environment in which the value and limitations of the concept become more visible.

At the same time, engineering education often involves the use of multiple digital tools and environments, both institutional and external. This makes the question of portability especially important. A learner representation confined to one platform is of limited value in such a setting, whereas a student-controlled passport that can travel across learning situations offers a more coherent basis for support. For this reason, engineering higher education is not simply an example application; it is an appropriate and analytically useful domain for examining the feasibility of the concept proposed in this paper.

5.3 Limitations

The paper remains conceptual in scope, and this creates clear limitations. The proposed architecture has not yet been empirically validated in authentic teaching and learning settings, and the selected framework contributions will require further refinement when translated into a practical passport structure. In addition, the portability and interoperability dimensions remain conceptual rather than technically implemented. The present contribution should therefore be understood as establishing a coherent design logic for the passport, rather than as demonstrating its effectiveness in practice, with empirical validation forming a necessary next stage of the research.

6 Conclusions

This paper is proposing a **Universal Student Passport** as a conceptual architecture for supporting responsible AI-driven personalised learning in engineering higher education, addressing the need for a portable, interpretable, and student-controlled learner representation in AI-supported learning environments. It has been argued that, although AI and Generative AI are increasingly used to support explanation, feedback, adaptation,

and learner support, current approaches remain fragmented, platform-bound, and insufficiently grounded in portable and interpretable learner representations. In response, the paper has advanced a student-controlled passport that functions not as an AI system in itself, but as a structured learner-informed reference layer capable of informing the use of AI-supported educational tools.

The paper contributes in two main ways. First, it establishes a methodological basis for passport design through the comparative review and selective use of **VARK, Felder–Silverman, and Kolb**. Second, it presents a layered architecture in which learner preferences, pedagogical interpretation, AI-informing functions, governance, and portability are treated as interrelated design elements. In this respect, the Universal Student Passport is positioned as a means of connecting learner representation, responsible AI, and personalised support within a single conceptual framework, while explicitly separating learner modelling from AI system ownership.

The next stage of the research will focus on refining the questionnaire and passport structure, examining how the passport may be represented in practice, and evaluating its usefulness within authentic higher education settings. Future work will also explore how passport-informed learner representations may support the design and evaluation of AI-supported learning activities and educational units within engineering higher education. In this sense, the present paper establishes a conceptual foundation for subsequent empirical validation and design-oriented implementation of responsible AI-supported personalisation.

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