Immersive Multimodal Environments for Psychomotor Skills Training

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1. Introduction

- The coordination of psychomotor skills requires deliberate practice and techniques, all of which are typically taught in the physical setting, where instructions and timely feedback are given by the teachers.
- However, doing so remotely is commonly ineffective and therefore, affecting the learner's progress to achieve their goal in a shorter time.
- Educational researchers in the technology-enhanced learning and artificial intelligence (AI) are progressively embedding sensor technologies for the collection of multimodal data, and machine learning approaches for tracking learner's behavior and progress in authentic learning contexts.
- Further, immersive technologies such as virtual reality (VR), augmented reality (AR) and game elements enable the creation of virtual training environments or simulations that typically consist realistic physical similarity to an actual learning context.

In this research, we aim to design and implement an immersive training environment for psychomotor skills using immersive technologies that deliver instructions and feedback to learners in a meaningful manner. Furthermore, we intend to investigate the effectiveness of the system and whether it can be applied to train skills in different psychomotor domains.

2. Research Questions

1. What level of technological support is available and appropriate for delivering effective instructions and feedback to the learners in psychomotor training?
2. How can we create an immersive and information-rich (remote/self-learning) training environment for psychomotor skills that deliver effective instructions and meaningful feedback to the learner?
3. To what extent can we generalize our training framework to multiple psychomotor domains?

Open Question

1. How would you like to receive instructions and feedback (frame of interaction, modalities, types of interaction) when training psychomotor skills such as running or any other similar psychomotor tasks (repetitive)?

References

1. T. Amiel, T. C. Reeves, Design-based research and educational technology: Rethinking technology and the research agenda, Journal of educational technology & society 11 (2008) 29–40.
2. M. De Villiers, P. Harpur, Design-based research-the educational technology variant of design re-search: illustrated by the design of an m-learning environment, in: proceedings of the South African institute for computer scientists and information technologists conference, 2013, pp. 252–261.

3. Methods

Phase 0 - An authentic problem is identified, and literature is reviewed to determine the importance of the problem and identify the current theory on the immersive multimodal environments in the psychomotor domain. Furthermore, the selection of application cases will be made. With these approaches, we are analysing the problem and constructing research goals.

Phase 1 - A theoretical framework is proposed based on the results from the systematic review, identifying the most promising pedagogical model in psychomotor training and the technologies that can be contributed to such a model.

Phase 2 - The development of the prototype is based on the theoretical framework proposed in phase 1. The outcome is an innovative and functional system that aims to address the problem and help us achieve our research goals.

Phase 3 - A user test involving the teachers should be conducted to reveal essential aspects of how the system can be improved. Additionally, questionnaires are helpful to provide insights on how users perceive the interaction between the system. The refinement of the system should then be followed to ensure that it is ready to be tested with the learners in the real-world setting. Then, data is collected and analysed to answer the research questions and to construct design principles.

Phase 4:

1) *Practical* - As reflection occurs, new designs can be further developed, which leads to an ongoing sub-cycle of the design-reflection process.
2) *Theoretical* - It is imperative to keep detailed records during the design research process concerning the outcomes. Through this documentation, it can be helpful for other researchers who are interested in those findings and examine them in relation to their context and needs.

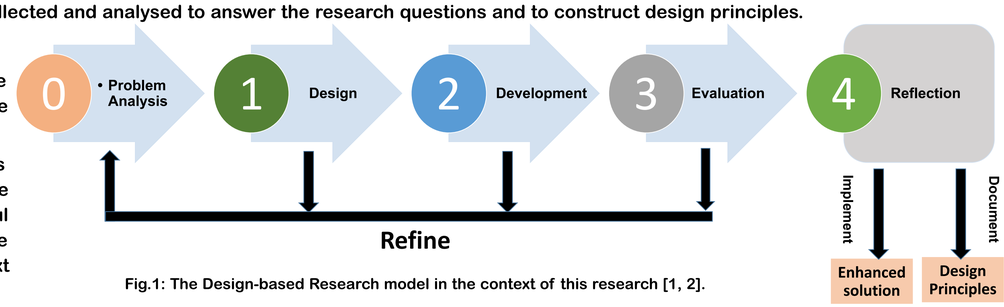

Fig.1: The Design-based Research model in the context of this research [1, 2].

4. Solution Approach

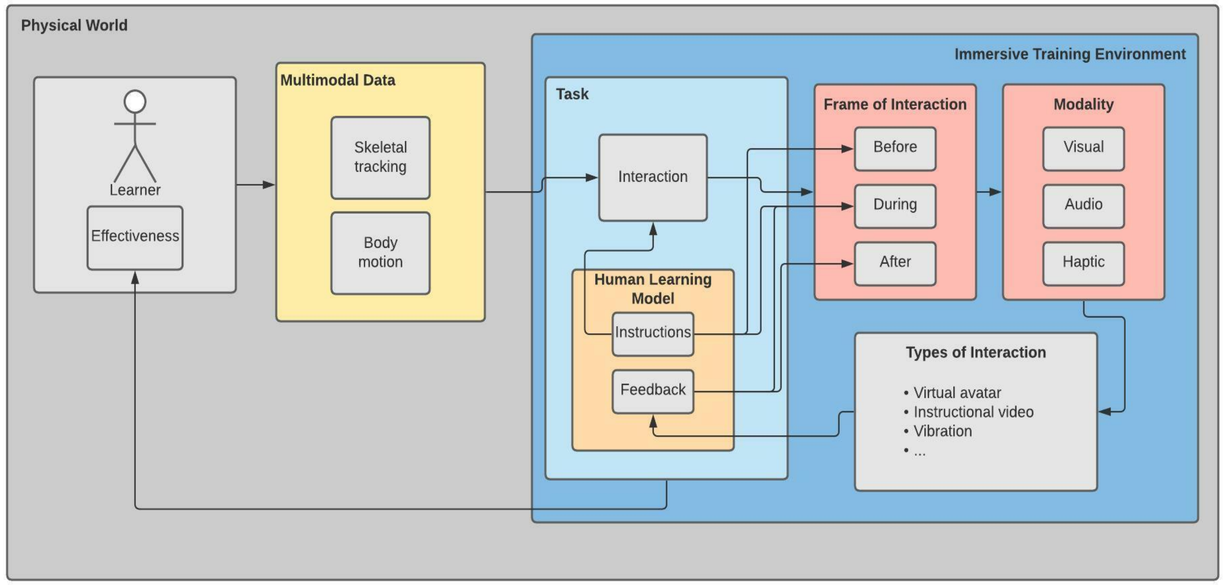

Fig. 2: The conceptual model of this research.

- Multimodal data can be collected by tracking skeletal points (e.g. depth cameras) and capturing body movements (e.g. wearable sensors) of the learner's body.
- The two aspects of the human learning model - instructions and feedback - can be given in multiple modalities depending on the frame of interaction.
  - Instructions are ideally given before the learner performs the specific tasks but may also given during training in the form of detailed feedback.
  - Feedback is typically given in real-time when mistakes are detected during training and as visual summative after training.