Investigating the Impact of the Mindset of the Learners on Their Behaviour in a Computer-Based Learning Environment

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Abstract. Computer-based learning environments (CBLEs) are often used to provide customized learning experiences for students. To enhance their effectiveness, we propose analyzing learners' actions within CBLEs. In this study, we focus on the influence of learner mindset (fixed vs growth) on interaction patterns in a CBLE designed for teaching Python programming. Learner mindset refers to their beliefs about the malleability of their abilities. Individuals with a fixed mindset believe that their abilities are fixed, while those with a growth mindset believe abilities can be developed through learning. Using log data and pattern-mining techniques, we will identify learners' interaction patterns and behaviour while also assessing their mindset through a questionnaire. We will compare the interaction patterns of fixed and growth mindset learners using task models to support our findings.

Keywords: Learner Mindset · Learner Behaviour · Process Modelling for learners

1 Introduction

A Computer-based learning environment (CBLE) is an instructional method where learners use computer technology to acquire new knowledge. The learning process in the CBLE typically involves performing various tasks to understand concepts, apply the information to solve problems and receive feedback through assessments within the system. The log data generated from these actions can be analyzed to enhance the CBLE, making it more effective for remote education and promoting equity in learning opportunities for all.

Many factors, like learners' performance in various assessment activities, learner engagement, and learner-centric emotions, are reported to be used both in the classrooms and CBLEs to decide the pedagogical actions [1–3]. However, the learner mindset is not yet examined to analyse learner behaviour within CBLEs.

In cognitive psychology, mindset refers to activating different cognitive processes in response to a task, which influences how information is interpreted later on [4]. Mindsets are people's beliefs about human attributes [5] and shape the thoughts and perspectives people hold [6]. Mindset can also impact motivation and shape subjective and objective aspects of a task or a situation, especially in challenging conditions. During the learning process, learners may face difficulties such as unfamiliarity with the subject or difficulty answering assessment questions. Their mindset can play a crucial role in determining their actions while learning. All the learner's actions can be recorded in the CBLE as log data. Analysis of these actions will give insights into cognition and help improve the designs of CBLEs.

A "fixed mindset" sees abilities and qualities as unchanging, while a "growth mindset" believes they can be improved through effort, strategy, and sometimes assistance from others. These mindsets are based on beliefs about the nature of abilities, with a fixed mindset viewing them as unchangeable and requiring constant proof, while a growth mindset sees them as malleable and able to be developed through learning [7].

Mindset gets affected by various factors such as the subject, peer influence, and teachers. Numerous studies have shown that learners with a growth mindset tend to be more engaged and achieve better grades in traditional classroom settings [9–15]. However, the impact of mindset in computer-based learning environments (CBLEs) has not been studied yet. This makes a compelling case to consider mindset in the context of CBLEs.

2   Research Proposal

This section will discuss the research goal, research questions, proposed research plan, and expected outcomes.

2.1   Research Questions

The main goal of the research, based on the literature review and research gap, is *"to assess the effect of learners' mindset on their behaviour in a computer-based learning environment."* The research plan will address the following research questions related to this research goal.

1. What are the different interaction strategies or learning paths in a CBLE for cohorts of learners with different mindsets?
2. How do learners with different mindsets handle achievement and failure while learning in a CBLE?
3. What is the impact of mindset on the learners' emotions while interacting with the CBLE?
4. Can mindset be used to influence the design of CBLEs to provide more suited scaffolding?

2.2 Research Plan

We plan to use process models and other pattern-mining techniques to analyse the learner's behaviour from their log data. Process models depict the sequence of actions taken by learners pictorially and have been used in some studies to understand learning strategies [2,17,18]. The process models will show differences in learner behaviour based on their mindset. In the process models, each node represents an action taken by the learner, and each edge represents the transition from one action to another. Each node has a significance value (between 0 and 1), and each edge has a thickness indicating its significance, with darkness indicating correlation [16].
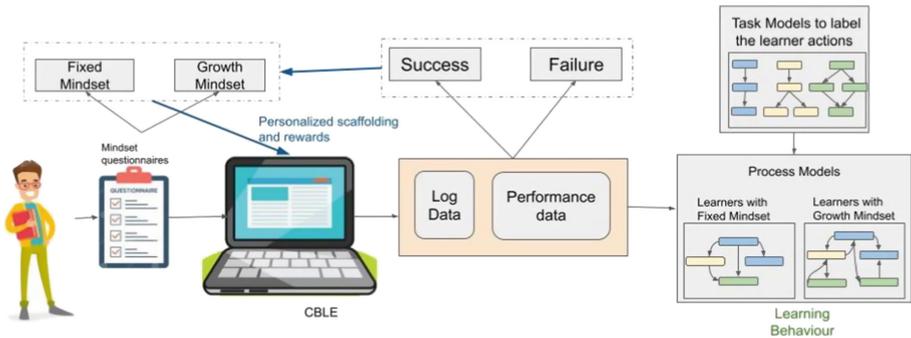

Fig. 1. Our proposed research approach and expected outcomes.

In a learning environment, learners acquire new knowledge to solve problems by performing tasks requiring cognitive skills. These tasks are organized into sub-tasks and mapped to actions in the CBLEs, known as the "Hierarchical Task Model" [19]. We plan on using such task models to identify the categories of actions performed by learners and compare the process models of learners with a fixed mindset versus those with a growth mindset. The prior research suggests that individuals with different mindsets react differently to failures and setbacks during learning [5,7,14]. The study aims to observe how learners' mindset affects their behaviour and emotions in a computer-based learning environment, especially with regard to achievement and failure within the system. Our proposed research approach and expected outcomes are shown in Fig. 1.

3 Methodology

The research goal is to understand whether the learner mindset impacts learners' behaviour while interacting with the CBLE. We are using the CBLE for capturing the learner's actions, the Mindset survey developed by Dr Dweck.

3.1   About PyGuru

We have developed a computer-based learning environment called PyGuru for
teaching and learning Python programming skills [3]. It has components like a
book reader where learners can read the content, a video player to watch the
video content, Integrated Development Environment (IDE), and a discussion
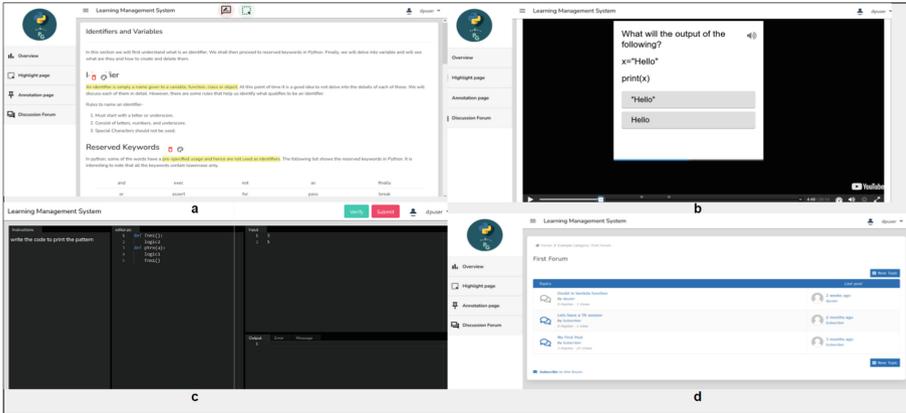forum, as shown in Fig. 2.

Fig. 2. PyGuru Environment (a) Book Reader (b) Video Player (c) IDE (d) Discussion
Forum

The book reader component allows users to navigate text-based content and
highlight text with colour. It also has an annotate feature for making notes,
adding comments, and tagging selected text. The interactive video player has
basic functions like play/pause/seek. It also has embedded questions, and it
pauses until the learner answers. There are two IDEs for executing Python pro-
grams: an in-page IDE within the book reader and another that assesses code
against test cases. All activities are logged.

3.2   Study Design

The study will be conducted with undergraduate students who preferably do
not know Python programming. A pre-test is to be conducted before students
start the interaction with the learning environment, along with a few demo-
graphic questions and the 3 item growth mindset scale questions developed by
Dweck [6,8]. The same survey would also include consent for data collection for
this research study. The post-test will be conducted after their interaction with
PyGuru. Students will interact with the CBLE for 2–4 hours. We plan to con-
duct a semi-structured interview with the students to better understand their
mindset, which will complement their self-reported mindset.

The log data will be collected in JSON format for the mouse clicks done and actions taken by the students while interacting with the CBLE. Data will be cleaned and analyzed using Python for the patterns, frequency, etc., of learner actions. The log data will be used with the ProM Tool, an open-source process mining tool (https://www.promtools.org/), to create the process models.

4   Current Status of Work

We conducted a study with 38 first-year undergraduate students enrolled for the B.Sc. (Information Technology) course between 18–19 years. The sample included 18 female and 20 male students. All the students interacted with the CBLE for 2 h daily during the two days in the workshop-like mode. Out of the 38 students, 15 have a Fixed Mindset (39.5%), and 23 have a Growth Mindset (60.5%). The scores in the pre-test and post-test were not statistically significantly different for both cohorts - learners with a growth mindset and learners with a fixed mindset. The study found variations in the process models for individuals with a growth mindset and those with a fixed mindset, as seen in the common sequences of actions. These differences align with the typical traits of individuals with a growth or fixed mindset.

We created a task model for our CBLE - PyGuru and used it to label the actions taken by students based on their log data. We then compared the sequences of actions from both groups and the task model to do a comparative analysis.

5   Proposed Plan

Our objective is to explore how learners' mindsets affect their behaviour and cognitive processes in CBLEs and to identify nuances in their actions. To achieve this, we plan to follow the action plan outlined below. -

1. Conducting another study to collect more data to establish the differences in the behaviour of students with Fixed and Growth mindsets.
2. Collecting multimodal data to understand the influence of mindset on learners' affect state.

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