2015 International Conference on Virtual and Augmented Reality in Education

The Gradual Immersion Method (GIM): Pedagogical Transformation into Mixed Reality

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Abstract

Through increased user interaction in mixed reality environments, the concept of user perception and living space evolves, adapts or is reconstructed. What criteria, however, define the contemporary hybrid learner’s perception? Should current educational methods be adapted to this transformation, or is it necessary to reinvent them altogether? This study proposes the Gradual Immersion Method (GIM), a transformation-sensitive form of creativity and learning exploration involving a collaborative approach to 3D digital creation. Supported by Augmented Reality (AR) technique, which promotes intuitive learning, the GIM focuses on concepts such as familiarization, reflection, technological appropriation, perception, and creative cognition. The result is a sequence of learning objects, from 2D to 3D, and finally in a mixed reality environment, which reveals the perceptions of hybrid learners during their performance as digital creators; while the overall method characterizes their perceptions in the context of contemporary learning.

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Keywords: Gradual Immersion Method; digital art creation; augmented reality; creative cognition; interactive surfaces

1. Introduction

In the ever dynamic non-formal and informal educational arenas, collaborative and creative competences are highly prized, due to their value in entrepreneurship, employment, and even entertainment. Keeping pace with learners’ capabilities, and developing such competences, are key challenges facing designers, developers, and
educators, particularly in the current process of transformation, where living space awareness is enhanced, causing the user identity to be strengthened, deformed or multiplied (in avatars, for example) in an adaptive response to the countless interactions to which the connected individual is exposed.

In order to delineate and enhance learners’ praxis in mixed reality environments, this study proposes the Gradual Immersion Method (GIM), an intuitive approach involving learners in creativity-enhancing activities that familiarize them with the use of technologies for digital creation.

2. Related work

Augmented reality, the technique of merging physical and digital environments, has been increasingly adopted as an aid in introducing educational topics that are abstract, difficult to grasp, dangerous, or impossible to access. Examples of its use include visualizing historical maps and their relationships to cultural heritage, enhancing math learning, promoting autonomous learning in engineering laboratories, and supporting computer science learning on mobile devices. The range of application is broad, and the developed creative competences are still being analyzed; but the broader the range of application, the more pressing becomes the need to develop methods for identifying and enhancing these competences.

Creative ideas are often thought of as the province of a limited number of gifted individuals, but in fact there exist a number of processes that can enhance such capabilities in anyone. Research on creativity from the cognitive perspective, for example, has shown that by deliberately combining different cognitive structures, the probability of obtaining creative or novel outcomes may be increased; that is, the level of creativity may be enhanced by identifying specific mental processes that can be applied in order to solve a problem, design a product, or create an artwork. The last two decades, meanwhile, have seen growing consensus in the study of conceptual combinations—the fusion or collision of two sets of information—as flexible cognitive structures that typically give birth to an idea or solution to a problem.

Notable among the robust contemporary theories on creativity, the ‘Geneplore’ model of creative thought was developed based on the creative cognition approach, rooted in the experimental methods of cognitive science. It maintains that creativity necessarily involves both the production of ideas, or ‘preinventive structures’ (generative phase), and the interpretation of such ideas (exploratory phase). For instance, a person addressing a challenge may enter the generative phase by picturing two or more discrete mental images and then combining them in some potentially useful manner; then, in the exploratory phase, interpreting the emerging result in a way meaningful to the challenge. Such combination of apparently unrelated entities (e.g., figures, objects, words), which results in emergent features not contained in the original entities, is known as mental synthesis, one of the cognitive processes considered in this theory. The Geneplore model can be described as a cyclical creative process with variable entity (imagery) constraints depending on the context (see Fig. 1).

![Fig. 1. The basic structure of the Geneplore model](#)
In light of such processes, as described in the Geneplor theory, a technology-enhanced method for enhancing creativity was here developed, aimed at facilitating collaborative work in non-formal and informal educational settings.

3. The Gradual Immersion Method

Developed from a pedagogical and cognitive perspective, the Gradual Immersion Method (GIM) exploits broadly used interactive technologies, such as large digital whiteboards and mobile devices, as well as augmented reality technique. It has been designed for interactive activities involving teams of four to five learners. As its name suggests, the method gradually immerses learners, through collaborative experience, in two respects: deepening the appropriation of knowledge through interactive tasks related to a particular topic; and enabling spatial transition from 2D to 3D, and then to AR, while progressing through the coordinated activities. Though theoretically broad in application, the GIM is here introduced in the context of artwork creation.

The GIM consists of three modules (see Fig. 2), each composed of integrated stages: (1) familiarization, consisting of six stages: observation, combination, association, grouping, discernment, and evaluation; (2) 3D digital creation, involving 3D capture in the field, 3D capture in the lab, 3D-model mounting in the lab, and field mounting of the final work; and (3) exhibition, involving audience assessment of the learner’s AR work, audience affective-response measurement, audience creation of 3D/AR works, and assessment by the researcher. Each stage of the GIM is introduced through on-screen instructions regarding the learning object to be accomplished.

3.1. Module I: Familiarization (2D to 3D transition)

The six phases of Module I, designed for interactive whiteboards, are shown in Figure 3. As a starting point, a generative phase is elicited in the observation and combination stages. Learners are first collaboratively exposed to 2D stimuli, to develop insights into a chosen topic, and these insights are then shared and manually registered by the team members. Then, learners are provided with 2D resources to express such insights by mentally developing entities (cognitive preinventive structures), combining them, and exteriorizing them through a creative visualization activity.

The GIM enables interpretation and measurement of learners’ creative performance relative to the schemas they have acquired before going through the process of immersion in the chosen topic. In the assessment of their peers’ digital work, after any phase from ‘combination’ to ‘discernment’, the evaluators’ degree of intuition concerning the topic, acquired through the activities, may be characterized by the learning-object designer (e.g., educator,
researcher) according to four basic categories (1st degree or ‘very low’; 2nd degree or ‘low’; 3rd degree or ‘medium’; 4th degree or ‘high’), enabling more canalized and relevant feedback from peers.

The six phases may themselves be seen as elements of two broader phases: a generative phase where preinventive structures are developed through creative visualization (mental synthesis and transformation of entities) in learning activities laddering a 2D to 3D transition; and an explorative phase that enriches these structures. The overall creative cycle is repeated, beginning again with a new generative phase (etc.), in the transition to the mixed reality environment.

![Image](image_url)

**Module I — Familiarization (2D to 3D transition)**

<table>
<thead>
<tr>
<th>Cognitive processes</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation and externalization of preinventive structures</td>
<td>Observation</td>
</tr>
<tr>
<td>Interpretation and further development of preinventive structures</td>
<td>Combination</td>
</tr>
<tr>
<td>Progressive conceptual and spatial immersion</td>
<td>Association</td>
</tr>
<tr>
<td>1st deg</td>
<td>Grouping</td>
</tr>
<tr>
<td>2nd deg</td>
<td>3rd deg</td>
</tr>
<tr>
<td>4th deg</td>
<td>Discernment</td>
</tr>
</tbody>
</table>

Intuition-sensitive peer evaluation

**Fig. 3. Module I: Five phases of the GIM on interactive surfaces**

### 3.2 Module II: Digital Creation (3D to AR transition)

As shown in Figure 4, Module II is a cyclical creative process that replicates the previous visualization in Phases 1 and 2 (‘observation’ and ‘combination’), and enhances the learners’ cognitive preinventive structures developed throughout Module I.

![Image](image_url)

**Module II — Digital Creation (3D to AR transition)**

<table>
<thead>
<tr>
<th>Cognitive processes</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation/regeneration/modification of preinventive structures; creative visualization</td>
<td>Idea building</td>
</tr>
<tr>
<td>Externalization of preinventive structures</td>
<td>AR creation</td>
</tr>
<tr>
<td>3D capture in the field</td>
<td>Field mounting of the final work</td>
</tr>
<tr>
<td>3D capture in the lab</td>
<td></td>
</tr>
<tr>
<td>3D-model mounting in the lab</td>
<td></td>
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</tbody>
</table>

**Fig. 4 Module II: AR generative phase on mobile devices**

The learners’ AR experience is preset by generating 3D-models (or familiarizing them with provided 3D-models) using mobile devices, and letting them explore the possibilities of the design tools (the same as were used in the
‘combination’ phase of Module I). Then, the learner teams engage in the same process of combining entities, but this time one of the entities is in the physical environment and will be combined with a digital entity using the interface. Providing 3D-models or eliciting them are examples of ‘product constraints’, a component of the creative process structure of the Geneplore model intended to influence the final outcome created by the learners.

3.3 Module III: Exhibition (Mixed Reality Experience)

The overall process of the GiM culminates in Module III, where the resulting products developed by learners are exhibited, replicating Phase 5 (‘evaluation’) but adding exposure to the public.

This explorative phase allows peers and the general public to observe the developed AR products on their mobile devices, and provide feedback through the same digital interface used for viewing the mixed reality productions. Following the Geneplore theory, feedback may be gathered in terms of exploratory processes, such as conceptual interpretation, functional inference, contextual shifting, etc., regarding the externalized final works. Finally, the public audience participates in a new generative phase where they design their own proposals reflecting their assimilation of the AR experience performed by the original learners.

Among the notable features of the GiM modules:

- they involve an integrated learning process that combines creating and assessing, with learners having active roles from several perspectives, as creators, reflectors, and evaluators of others’ work
- their application is ideal for creativity-demanding subjects such as science, math, arts, or engineering
- they encourage freedom in creation, since the activities are not focused on one single answer, but are open to any proposal
- their architecture has been designed for collaborative creativity, where learners are required to discuss, interact, and decide on the design of the products to be created on the interactive surfaces.

4. Discussion and conclusion

The GiM was developed with an eye to the non-formal and informal educational fields, which are less regulated than—and even opposed to the principles of—the formal academic system, and are closer to self-organized community development activities. Its various learning activities are well suited to informal education characteristics, such as the learning-by-doing approach, and were designed for collaborative learning using interactive devices.
The architecture of the GIM was designed for large interactive surfaces (vertical boards, tabletops, wall projections, etc.), enabling collaborative work with equal opportunities for peer participation (Piper, 2009). In addition, the GIM is easily scalable, for example to include an AR module with ‘multi-player’ capabilities, enabling access to other team creations, along with individual assessment. Viable applications of the GIM vary from creative art installations, such as those promoted by museums of art, to mobile campaigns that can be brought to community centers provided with such interactive surfaces.

In summary, the Gradual Immersion Method is proposed as a means to guide learners through collaborative activities (learning objects) aimed at developing their creativity while familiarizing them with different dimensions, from 2D to 3D and then AR, and with specific topics, through interactivity. Based on the creative cognition approach, and integrating both generative and explorative phases in collaborative creation, the GIM is designed for non-formal and informal scenarios; and has great flexibility built into its activities, enabling learning processes that combine creation and assessment in a stimulating and free environment, with broad applications in science, math, arts, or engineering.

Acknowledgements

This research was supported by the National Council of Science and Technology CONACYT.

References