The Effect of Different Recommendations Based on the Filtering Method (Content - Collaborative) in an E-learning Environment on Developing Scientific Thinking Skills and Improving the Quality of Feedback

Major: Educational Technology

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Research Summary

Introduction

Over the last decade, the world has witnessed rapid and successive developments in the structure of the Web 3.0 environment, significantly contributing to the emergence of diverse educational resources. However, this abundance of resources has made it increasingly difficult to manage and control them using traditional methods and tools. As a result, students often find themselves confused about which educational materials to choose to help them complete their tasks effectively. This situation highlighted the need for a system that would allow students to participate in the process of categorizing and describing available educational resources in a way that would streamline their organization.

In the course of the researcher's teaching through electronic platforms, she assisted students in locating educational resources. However, the resources provided were general and applicable to the course as a whole—such as (2) books, (3) blogs, and (5) video clips related to the topic—without considering each student's individual level or performance in educational activities. This approach is based on a linear learning environment, pre-designed for all students, which results in stereotypical thinking and may increase the cognitive load for learners.

Despite research emphasizing the need for university students to develop their scientific thinking skills, there remains a lack of scientific strategies to train students in this type of thinking (Zainab Muhammad Al-Arabi Ismail, 2019). As a result, customizing feedback has become an essential necessity rather than a luxury for many educational institutions. This shift requires the application of artificial intelligence to analyze the collaborative efforts of groups of students as they engage in online activities. By doing so, a system can identify groups with shared interests and experiences based on the behavioral characteristics of the target student. The system then filters content that might be relevant to the student according to the preferences of the group, a process known as *collaborative filtering*. Additionally, another method involves recommending items based on the student's individual preferences and previous interactions, without considering the preferences of the group.

Scientific thinking encompasses a set of competencies primarily based on mental processes related to scientific content, such as programming, solving technological problems, or engaging in scientific activities like educational design. However, it also includes various cognitive processes that extend to general areas of students' lives, such as scientific research, deduction, measurement, and other problem-solving strategies. These processes involve thinking critically about the causes of problems and finding logical solutions. Given the vast differences in students' abilities, it is essential to provide personalized feedback for each student (Yasser Ahmed Abdel-Moati Badr, 2021).

Muhammad Attia Khamis (2018) highlighted that feedback has become a fundamental component of all e-learning resources. Providing appropriate feedback enables students to assess their learning outcomes, actions, and responses to various learning activities. Similarly, Pardo et al. (2019) emphasize that feedback, when informed by learning analytics, can be tailored to effectively maximize its impact on the development of students' knowledge and skills by embedding it into academic content.

Measurement and evaluation experts have established several criteria to enhance the delivery of feedback in e-learning environments. These include ensuring that feedback is continuous, aligns with learners' characteristics, and relies on data analysis methods to understand and interpret results. Feedback should focus on performance rather than merely achievement, assist students in self-regulating their learning, encourage problem-solving strategies, and be delivered at the appropriate time with accuracy (Julia & Marco, 2021). Research has shown that feedback is crucial in developing higher-order thinking skills, particularly scientific thinking, as it involves mental processes students use to arrive at scientific knowledge. This process requires guidance to test hypotheses and facts within an objective framework. Since every fact we reach is connected to prior experiences in measurement or analysis, it remains a relative fact. Scientific thinking does not begin with absolute facts, but with information, observations, logical premises, or hypotheses that are testable and falsifiable. According to the logic of scientific thinking, these elements are valid to some degree and false to another degree.

Consequently, providing standardized feedback to all students often results in an average outcome, such as 70% grades, without improving the quality or type of feedback (content or collaboration). Numerous studies have emphasized the importance of feedback in e-learning programs, not only for academic guidance but for developing scientific thinking skills. Feedback offers several benefits, such as helping students better understand the subject matter, providing clear guidance on how to improve their learning, and boosting students' confidence, self-awareness, and enthusiasm for learning. Additionally, teachers can track their students' progress electronically through reports, ensuring the validity and effectiveness of their teaching methods and electronic interactions. In this way, feedback provides both teachers and learners with valuable information about the progress of the educational process, supporting continuous improvement and development toward achieving educational goals (Yorke, 2020).

Problem of the Research:

The problem addressed in this research is to identify which of the two filtering systems—content-based filtering or collaborative filtering—is more effective in e-learning environments for providing educational recommendations that foster the development of scientific thinking skills and enhance the quality of feedback among educational technology students.

Research Questions:

What is the effect of the difference between the two filtering systems (content-based filtering and collaborative filtering) in e-learning environments on the development of scientific thinking skills?

How do the two filtering systems (content-based filtering and collaborative filtering) in e-learning environments impact the quality of feedback provided to students?

What are the criteria for designing educational recommendation systems in e-learning environments based on the two filtering methods (content-based filtering and collaborative filtering)?

Research Objectives:

1. To identify the criteria for designing and implementing educational recommendation systems using the two filtering methods (content-based filtering and collaborative filtering).
2. To determine the scientific thinking skills that educational technology students should possess according to the twenty-first-century skills model.
3. To examine the impact of the differences in the design of educational recommendation systems (content-based filtering vs. collaborative filtering) in e-learning environments on the development of scientific thinking skills and the improvement of feedback quality among educational technology students.
4. To investigate the correlation between the type of filtering (content-based filtering or collaborative filtering) in educational recommendation systems and the quality of feedback in e-learning environments.

Significance of the Research:

The significance of this research lies in exploring the correlation between the type of filtering (content-based filtering and collaborative filtering) in educational recommendation systems and the quality of feedback in e-learning environments. This research is valuable in several key aspects:

1. **Improving the Learning Experience**
   By understanding how different filtering methods influence the quality of feedback, e-learning systems can be enhanced to provide a more personalized and effective learning experience for students.
2. **Guiding System Design**
   This research will assist researchers and designers in developing

more efficient educational recommendation systems based on filtering methods that cater to learners' needs, thereby promoting greater engagement and interaction.

3. **Enhancing Educational Quality**
   The quality of feedback is essential for improving student performance. By exploring the relationship between filtering systems and feedback quality, educators and content developers can optimize their feedback strategies.
4. **Supporting Self-Learning**
   Understanding how filtering methods impact feedback enables students to receive personalized feedback, which is crucial for fostering self-learning and the effective development of their skills.
5. **Developing Effective Assessment Strategies**
   This research can contribute to the development of innovative assessment strategies based on data from recommendation systems, enhancing the overall effectiveness of the teaching and learning process.

Research Limitations:

- **Sample Type:** The research is limited to third-year students in the field of educational technology at the Faculty of Specific Education, Fayoum University.
- **Educational Environment:** The study is conducted within the context of an electronic assessment course, utilizing an AI-based system designed and produced by the researcher (detailed design and production information in Chapter Three).
- **Types of Filtering:** The research focuses exclusively on two types of filtering systems: content-based filtering and collaborative filtering.

Research Methodology:

This research adopts a design-based approach within the field of educational technology, particularly focused on the development of educational recommendation systems using content-based filtering and collaborative filtering in e-learning environments based on artificial intelligence. The key components of this methodology include the design, production, presentation, management, and evaluation of these systems to address learning challenges. The research follows a combination of the following approaches:

1. **Descriptive Approach:**
   The descriptive approach will be used to examine the theoretical framework, which includes the study's significance, objectives, scientific methods, terminology, hypotheses, and relevant previous studies that contribute to understanding all aspects of the research problem.
2. **Quasi-Experimental Approach:**
   The quasi-experimental approach will be employed to assess the effects of the independent variables (educational recommendation systems using content-based filtering and collaborative filtering) on the dependent variables (scientific thinking skills and the quality of feedback) among educational technology students.
3. **Educational Design:**
   The researcher will use the Action Mapping model, focusing on achieving measurable educational outcomes that benefit learners in implementing the "electronic assessment" course activities and meeting learning objectives.

Research Tools:

1. **Scientific Thinking Test:**
   A test designed to measure students' ability to think scientifically and apply scientific methodologies in problem-solving. This tool will assess the level of scientific thinking in students before and after the intervention.
2. **Feedback Quality Scale (Learning Analytics):**
   A scale used to evaluate the quality of feedback provided to students through learning analytics systems. It will assess students' satisfaction with the feedback they receive and its impact on their learning, before and after the intervention.
3. **Personal Interviews (10 students per group):**
   Interviews with 10 students from each experimental group will be conducted to gather qualitative data regarding their experience with the experimental system, including their satisfaction and its impact on their learning and interaction in the e-learning environment.

Research Hypotheses:

1. There are statistically significant differences at the 0.05 level between the pre- and post-test results of the scientific thinking test for the first experimental group (content-based filtering), favoring the post-test results.
2. There are statistically significant differences at the 0.05 level between the pre- and post-test results of the feedback quality scale for the first experimental group (content-based filtering), favoring the post-test results.

3. There are statistically significant differences at the 0.05 level between the pre- and post-test results of the scientific thinking test for the second experimental group (collaborative filtering), favoring the post-test results.
4. There are statistically significant differences at the 0.05 level between the pre- and post-test results of the feedback quality scale for the second experimental group (collaborative filtering), favoring the post-test results.
5. There are no statistically significant differences at the 0.05 level between the post-test scores of the scientific thinking test for the first experimental group (content-based filtering) and the second experimental group (collaborative filtering).
6. There are no statistically significant differences at the 0.05 level between the post-test scores of the feedback quality scale for the first experimental group (content-based filtering) and the second experimental group (collaborative filtering).

Research Results

The results revealed statistically significant differences between the pre- and post-assessments of the scientific thinking tests and the feedback quality scale, demonstrating the effectiveness of the methods used in enhancing students' academic skills. The qualitative interviews further indicated that an excessive number of recommendations could lead to student distraction, emphasizing the importance of designing feedback that is clear and focused.

The study also provides recommendations on how to leverage artificial intelligence in education, such as developing customized educational strategies and improving classroom management. These findings underscore the critical role of integrating artificial intelligence into education to achieve better outcomes and more effectively meet students' needs.

When comparing the two groups, the study showed significant differences, favoring the second group, which used the content-based filtering system. The researcher attributes these results to the fact that content-based filtering addressed the real challenges of learning the topics, independent of students' preferences or tendencies toward specific types of educational materials. These results align with the study by Saptianty et al. (2024), which confirmed that recommendations based on the actual competencies of learning content are highly effective in enhancing the quality and efficiency of feedback. Providing immediate feedback after completing tasks, focusing on specific aspects, and offering clear guidance on how to improve are likely to positively impact students' learning and motivation.

Chen & Gao (2024) also emphasize the importance of designing feedback that offers students information on how to improve their work, rather than simply pointing out errors. While many factors contribute to effective feedback, there is strong support for the idea that educational recommendations should be content-based when the goal is to foster cognitive development. Constructive feedback serves as a powerful motivator, encouraging students to strive for improvement and reach their full potential. By providing guidance and recognizing students' strengths, teachers can instill self-confidence and belief in their abilities, which positively influences overall performance.

Research Recommendations

Based on the findings, the researcher recommends the development of a hybrid recommendation system for e-learning environments, combining both collaborative and content-based recommendations. This hybrid system can balance social interaction with direct guidance, significantly improving the quality of feedback. By integrating both types of recommendations, students can benefit from the collective knowledge of their peers, while also receiving precise and relevant guidance tailored to their learning content.

Such a system has the potential to greatly enhance the learning experience, leading to improved academic performance and deeper understanding among students. Therefore, educational institutions should consider developing and implementing these hybrid recommendation systems to achieve better learning outcomes.