

Enhancing Individualized Learning in Distance Education with Multi-Agent Systems

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Abstract- *This paper explores the use of Multi-Agent Systems (MAS) to enhance individualized learning in distance education. It specifically focuses on the role of MAS in facilitating feedback communication and improving the timeliness of feedback delivery. The study highlights the importance of feedback in the learning process and presents data on learners' preferences for clarification of information and feedback delivery modes. The findings suggest that learners require timely and clear feedback, which can be addressed through the coordination of various MAS agents. By leveraging MAS, educational institutions can optimize feedback processes, promote effective communication, and support individualized learning experiences in distance education environments*

Indexed Terms- *Multi-Agent Systems (MAS), individualized learning, Distance education*

I. INTRODUCTION

In distance education, providing effective feedback to learners is crucial for their academic progress and engagement. However, delivering timely and personalized feedback can be challenging due to the inherent limitations of remote learning environments. This paper proposes the utilization of Multi-Agent Systems (MAS) as a solution to enhance individualized learning through improved feedback communication. MAS is an innovative approach that employs multiple intelligent agents to coordinate and streamline various aspects of the learning process. By leveraging MAS, educational institutions can overcome the communication barriers in distance education and provide learners with timely and valuable feedback tailored to their specific needs.

II. THE EFFECT OF FEEDBACK ON LEARNERS

The following table presents data on the effect of feedback on learners. It provides information about the respondents' perspectives on the motivation they derive from feedback. The table is divided into three categories: motivating, neutral, and not motivating, representing the respondents' attitudes towards feedback. The population size is 20 respondents, and the table also includes the percentages for each category.

Table 1: Learner motivation from feedback

Category	Motivating	Neutral	Not motivating	Total
Population	8	6	6	20
%	40	30	30	100

Among the respondents, 40% indicated that feedback was motivating to them. This suggests that feedback has a positive impact on their motivation levels and likely contributes to their learning progress. In contrast, 30% of the respondents were neutral, which means they did not have an opinion on the motivational effects of feedback. This could be because they had not received any feedback or they did not consider feedback as a significant factor in their motivation. It is important to note that this group might benefit from receiving feedback and understanding its potential impact on their motivation and learning outcomes. Another 30% of the respondents expressed that feedback was not motivating to them. This indicates that for this group, the feedback they received did not have a positive impact on their motivation levels or may have even had a negative

effect. Exploring the reasons behind this perception is crucial to identify potential issues in the feedback process and address any barriers that may hinder its motivational impact.

- **Helpfulness of feedback**

In assessing the impact of feedback on learners, it is crucial to examine its perceived helpfulness. Feedback serves as a valuable tool for learners to gauge their progress, identify areas for improvement, and gain insights into their performance. The following table presents data on the helpfulness of feedback as reported by respondents. It categorizes their responses into helpful, neutral, and not helpful, providing an understanding of the learners' perspectives on the feedback they have received.

Table 2: Helpfulness of feedback

Category	Helpful	Neutral	Not Helpful	Total
Population	12	6	2	20
%	60	30	10	100

According to the data, 60% of the respondents agreed that feedback was helpful to them. This indicates that the majority of learners found value in the feedback they received, suggesting that it positively influenced their learning journey. The recognition of feedback as helpful implies that it provided meaningful guidance, clarifications, and suggestions that contributed to their understanding and growth. On the other hand, 30% of the respondents were neutral because they had not received any feedback, preventing them from rating its helpfulness. This highlights the importance of ensuring that all learners have access to timely and constructive feedback. For those who have not yet received feedback, it is essential to develop mechanisms and processes that provide them with opportunities to receive this valuable input and benefit from its potential impact.

A smaller proportion, 10% of the respondents, indicated that feedback was not helpful to them. Further investigation is necessary to understand the reasons behind this perception. Possible factors could include the quality or relevance of the feedback provided, the manner in which it was delivered, or the

learners' individual preferences and learning styles. Addressing these factors can help improve the effectiveness of feedback and ensure that it is perceived as helpful by all learners

The findings from this table underscore the significance of providing high-quality and relevant feedback to learners. Feedback that is constructive, specific, and actionable can empower learners and guide them towards achieving their learning goals. It is crucial for educators and instructors to continuously assess and refine their feedback practices to maximize its helpfulness and ensure that it supports learners' progress and development effectively.

- **Feedback informative**

The informativeness of feedback plays a crucial role in the learning process. Informative feedback provides learners with valuable insights, guidance, and specific information about their performance, enabling them to understand their strengths, weaknesses, and areas for improvement. The following table presents data on the perceived informativeness of feedback as reported by respondents. It categorizes their responses into informative, neutral, and not informative, shedding light on the learners' perspectives regarding the feedback they have received.

Table 3: Feedback Informative

Category	Informati ve	Neutr al	Not Informati ve	Tot al
Populati on	15	5	0	20
%	75	25	0	100

According to the data, a significant majority of respondents, 75%, agreed that feedback was quite informative to them. This indicates that the feedback they received provided meaningful and specific information that helped them understand their performance better. Informative feedback likely offered valuable explanations, suggestions, and examples that enabled learners to gain insights into their work and make the necessary adjustments to enhance their learning outcomes. In contrast, 25% of the respondents were neutral as they had not received

any feedback, making it challenging for them to rate its informativeness. This highlights the importance of ensuring that all learners have access to feedback to benefit from its informative nature. It is crucial for educators and instructors to establish effective feedback mechanisms that reach all learners, providing them with the necessary information and guidance to support their learning and growth. Notably, no respondents indicated that the feedback they received was not informative. This suggests that the feedback provided to the respondents in this study was generally perceived as informative, indicating a positive impact on their learning experience. However, it is important to note that different learners may have varying preferences and learning styles, and what is considered informative to one learner may not resonate with another. Thus, it is crucial for educators to tailor feedback to individual learners' needs and preferences to ensure its maximum informativeness. The findings from this table highlight the significance of providing informative feedback to learners. Informative feedback empowers learners by providing them with the necessary information and guidance to enhance their understanding and performance. It enables learners to make informed decisions, set goals, and take appropriate actions to improve their learning outcomes. Educators and instructors should continuously assess and refine their feedback practices, ensuring that the feedback they provide is informative, relevant, and supports learners' progress effectively.

• Discouraging effect

Feedback plays a crucial role in shaping the learning experience of individuals. While feedback is generally intended to provide guidance and support, it is important to assess whether it can have a discouraging effect on learners. The following table presents data on the perceived discouraging effect of feedback as reported by respondents. It categorizes their responses into discouraging, neutral, and not discouraging, shedding light on the learners' perspectives regarding the impact of feedback on their motivation and engagement

Table 3: Discouraging effect of feedback

Category	Discouraging	Neutral	Not Discouraging	Total
Population	2	2	16	20

According to the data, only 2 respondents, accounting for 10% of the population, found feedback to be discouraging. This indicates that the majority of learners did not perceive feedback as having a discouraging effect on them. It suggests that the feedback they received was likely constructive, supportive, and focused on helping them improve their learning outcomes. In contrast, an equal number of respondents, also 10%, were neutral, indicating that they did not have a clear opinion on whether feedback was discouraging or not. This could be due to various factors such as limited feedback received, individual interpretive differences, or a lack of awareness of the impact of feedback on their motivation. The remaining 80% of the respondents reported that feedback was not discouraging to them. This implies that the feedback they received was either motivating, neutral, or at the very least, did not have a negative impact on their motivation or engagement. It suggests that the feedback provided to these learners was likely effective in supporting their learning progress and maintaining their motivation levels.

It is important to note that the low percentage of respondents who perceived feedback as discouraging indicates that the feedback provided in this study was generally well-received by the learners. However, it is essential for educators and instructors to remain

mindful of the potential impact of feedback and ensure that it is delivered in a constructive and supportive manner. Continuous reflection and improvement on feedback practices can help mitigate any potential discouraging effects and maximize its positive impact on learners.

The findings from this table emphasize the importance of providing feedback that is constructive, supportive, and motivating. Feedback should be focused on highlighting strengths, identifying areas for improvement, and offering actionable suggestions. By tailoring feedback to individual learners' needs and maintaining a positive and encouraging tone, educators can foster a supportive learning environment that promotes growth and engagement.

III. FEEDBACK COMMUNICATION

Effective communication of feedback is crucial in the learning process. It is important to assess whether learners are receiving feedback and how frequently they are receiving it. The following table presents data on the communication of feedback to learners as reported by respondents. It categorizes their responses into receiving feedback and not receiving feedback, providing insights into the learners' experiences regarding the provision of feedback.

Table 5: Feedback communication to learner

Category	Receiving Feedback	Not Receiving feedback	Total
Population	17	3	20

According to the data, a majority of respondents, 85%, reported receiving feedback from the university. This indicates that the university has established a system or process to provide feedback to learners, which is a positive practice. The high percentage suggests that the majority of learners are receiving valuable guidance, insights, and suggestions on their academic performance, which can contribute to their learning and development. On the other hand, 15% of the respondents stated that they had hardly received any feedback, implying a lack of feedback communication. This subset of learners may be

missing out on the benefits and opportunities for improvement that feedback can provide. It is crucial for universities and educational institutions to identify and address the reasons behind the limited feedback provision for these learners. Evaluating and improving the feedback communication process can help ensure that all learners receive the necessary feedback to support their progress and growth.

The findings from this table highlight the importance of establishing effective feedback communication channels within educational institutions. Regular and timely feedback can play a vital role in learners' academic success, motivation, and engagement. It is essential for universities and institutions to prioritize feedback provision and ensure that it reaches all learners, addressing their individual needs and supporting their learning journey effectively.

Educators and administrators should continuously evaluate and refine the feedback communication process, considering factors such as the frequency, format, and clarity of feedback. By fostering a culture of open and transparent communication, educational institutions can enhance the overall learning experience and empower learners to reach their full potential.

IV. TIMELINESS OF THE FEEDBACK

Timeliness is a crucial aspect of feedback delivery that can significantly impact learners' motivation, progress, and overall learning experience. It is essential to assess whether feedback is provided in a timely manner to meet learners' needs and expectations. The following table presents data on the timeliness of feedback as reported by respondents. It categorizes their responses into timely feedback and feedback not timely, shedding light on the learners' experiences regarding the delivery of feedback.

Table 6: Timeliness of feedback

Category	Timely feedback	Feedback not Timely	Total
Population	1	19	20

According to the data, only 1 respondent, accounting for 5% of the population, reported receiving timely feedback. This indicates that the vast majority of learners, 95%, felt that the feedback they received was not delivered on time. The discrepancy between the perception of feedback being motivating, helpful, and informative, and its lack of timeliness, suggests a significant area for improvement in the feedback delivery process. The delay in providing feedback, especially on examination results and fees updates, had several negative consequences for the learners. It resulted in inconveniences, time wastage, and even discouragement. Timely feedback is crucial for learners to understand their progress, identify areas for improvement, and make any necessary adjustments in a timely manner. Delays in receiving feedback can hinder learners' ability to take immediate action, potentially leading to missed opportunities for growth and development. The findings from this table highlight the importance of addressing the issue of timeliness in feedback delivery. Educational institutions need to prioritize efficient systems and processes that ensure feedback reaches learners promptly. This includes timely release of examination results, providing updates on fees and administrative matters, and implementing mechanisms to address any delays or inconveniences that learners might face.

Improving the timeliness of feedback can significantly enhance the learning experience for learners, promoting their motivation, engagement, and overall satisfaction. It allows learners to make timely adjustments, set goals, and stay on track with their learning journey. Educators and administrators should collaborate to identify and address any bottlenecks or challenges in the feedback delivery process, ensuring that learners receive feedback in a timely and efficient manner. By prioritizing timeliness and streamlining feedback communication channels, educational institutions can enhance their support to learners, minimize inconveniences, and foster a positive learning environment that encourages continuous improvement and success.

V. CLARIFICATION OF INFORMATION

Clarity of information is vital for learners to have a comprehensive understanding of the content and instructions provided by educational institutions. It is

essential to assess the need for clarification of information and identify effective communication channels to address learners' queries. The following table presents data on the clarification of information as reported by respondents. It categorizes their responses into different communication channels, providing insights into learners' preferences for seeking clarification.

Table 7: Clarification of information

Clarification/Cat ory	Emai l	SM S	Phon e call	Tota l
Population	13	6	1	20

According to the data, 65% of the respondents expressed a desire for clarification of information posted on the website. This indicates that a significant portion of learners felt the need for additional explanations or details regarding the information available on the website. Clarity is essential to ensure that learners have a clear understanding of policies, procedures, course materials, and any other relevant information that may impact their learning experience. When it comes to seeking clarification, the table shows that the respondents preferred different communication channels. Thirteen respondents (65%) indicated a preference for clarification through email, while six respondents (30%) preferred short messages (SMS) sent via phone. Only one respondent (5%) reported a preference for seeking clarification through a phone call. These findings suggest that learners appreciate written forms of communication that provide them with a reference they can revisit when needed.

To address the need for clarification, educational institutions should consider incorporating multiple communication channels to cater to learners' preferences. By providing clear contact information and ensuring prompt responses, institutions can support learners in seeking the necessary clarifications. This may include responding to email inquiries, implementing messaging systems for SMS communication, or offering dedicated phone lines for clarification purposes. Moreover, institutions should prioritize the regular review and update of information on their websites to ensure its clarity and accuracy.

Clear instructions, explanations, and frequently asked questions (FAQs) can help minimize the need for clarification in the first place.

Efforts to improve the clarification of information should focus on creating a seamless and user-friendly experience for learners. Providing comprehensive and easily accessible resources, such as FAQ sections on the website or automated email responses addressing common queries, can also contribute to reducing the need for individual clarification requests. By addressing learners' preferences for clarification and improving the clarity of information provided, educational institutions can foster a supportive learning environment that empowers learners to navigate their academic journey with confidence and understanding

VI. FEEDBACK DELIVERY MODE

Feedback delivery mode is an important consideration in ensuring that learners receive feedback in a manner that suits their preferences and needs. It is crucial to assess the preferred modes of feedback delivery to optimize the effectiveness and efficiency of the feedback process. The following table presents data on the feedback delivery mode as reported by respondents. It categorizes their responses into different communication channels, providing insights into learners' preferences for receiving feedback.

Table 8: Feedback delivery mode

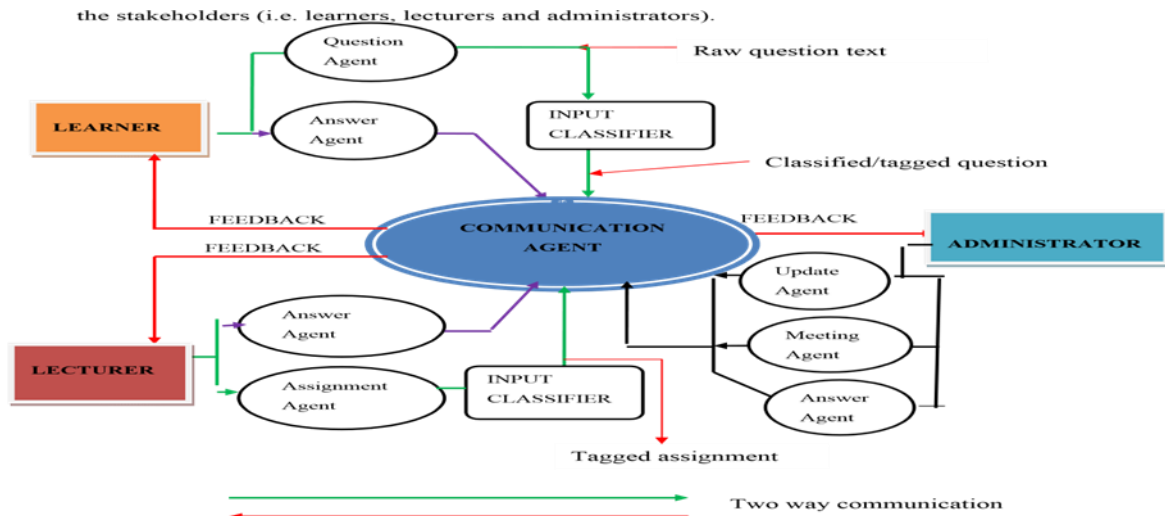
Feedback delivery/Category	Email	SM S	Phon e call	Tota l
Population	15	3	2	20

According to the data, the majority of respondents, 75%, expressed a preference for receiving feedback through emails. This suggests that learners appreciate the convenience, ease of access, and written format that email provides for receiving feedback. Emails can be easily stored, referenced, and reviewed, allowing learners to reflect on feedback at their own pace. Meanwhile, 15% of the respondents preferred receiving feedback through short messages (SMS), indicating a preference for concise and direct

communication. SMS can be an effective mode for delivering quick updates, reminders, or brief feedback that learners can easily access on their mobile devices. Only 10% of the respondents indicated a preference for receiving feedback through phone calls. Phone calls can provide a more personal and interactive mode of communication, allowing for immediate clarification and discussion. However, it is important to consider the potential limitations of phone calls in terms of time constraints and the need for synchronous communication.

From the analysis of the 20 samples, it is evident that all distant learners require feedback. However, the specific needs of learners vary, highlighting the importance of designing a system that can analyze, categorize, and meet individual learner needs to provide timely feedback that supports the learning process. Additionally, it was noted that most distant learners expressed a need for timely feedback. The dissatisfaction with the feedback they were receiving stemmed from its lack of timeliness and, in some cases, the associated costs and time-consuming efforts required to access the feedback. This highlights the significance of addressing these challenges and ensuring that feedback is delivered in a timely manner to remote learners. It is essential to establish efficient feedback communication channels and systems that minimize delays and inconvenience for learners, maximizing the benefits of feedback in their learning journey.

Educational institutions should consider the preferences and needs of learners when designing feedback delivery systems. Providing options for feedback delivery through email, SMS, and phone calls can cater to diverse learner preferences and circumstances. Efforts should be made to streamline the feedback delivery process, minimize costs and time wastage, and ensure that feedback reaches learners in a timely and accessible manner. By incorporating learner-centric feedback delivery modes and addressing the timeliness factor, educational institutions can enhance the overall feedback experience for distant learners, promoting their engagement, motivation, and success in their academic endeavors.



To effectively deliver feedback in a distance learning environment, a Multi-agent system was employed. The system consisted of several agents, each with specific characteristics and roles to address the communication and feedback needs of learners. Here are the characteristics of the agents and their respective roles:

- a. The Communication Agent: This agent serves as the master agent in the system, coordinating all other agents. Its role is to facilitate communication and information dissemination among different stakeholders, including students, lecturers, and administrators. It sends out alerts or feedback in the form of emails, SMS, and phone call requests. By default, email is used for alerts, while SMS and phone call requests are sent upon learner's request. Phone call requests are specifically used for information clarification and are limited to administrators.
- b. The Updates Agent: This agent receives updates from the user agent, encapsulates them into an updates object, and sends them to the Communication Agent. Its role is to ensure that relevant updates are communicated to the intended recipients.
- c. The Meeting Agent: This agent is responsible for creating meetings. It encapsulates meeting details into a meeting object, including the intended recipients, and sends it to the Communication Agent. The Communication Agent then routes the meeting information to the appropriate individuals.
- d. The Assignment Agent: This agent facilitates the creation and delivery of assignments. When a lecturer creates an assignment, the Assignment Agent

encapsulates it into an assignment object with relevant tags and forwards it to the Communication Agent for delivery to the intended recipients.

e. The Question Agent: Students use this agent to create and post questions to lecturers or fellow students. The agent classifies the questions using a classifier, such as a Naïve Bayes classifier model based on natural language processing (NLP). Once the question is classified, it is passed on to the Communication Agent for further processing.

f. The Answer Agent: This agent handles the creation and delivery of answers to questions. When an answer is created, the Answer Agent encapsulates it into an answer object and sends it to the person who asked the question.

These agents work together within the Multi-agent system to facilitate effective communication, coordination, and feedback delivery in the distance learning environment. By assigning specific roles to each agent, the system ensures that learners' needs for feedback and information clarification are met efficiently.

CONCLUSION

Multi-Agent Systems (MAS) offer a promising approach to enhance individualized learning in distance education by improving feedback communication and timeliness. Through the coordination of various intelligent agents, MAS streamlines feedback processes, allowing learners to receive personalized and constructive feedback

tailored to their specific needs. The utilization of MAS addresses the challenges of communication barriers and facilitates efficient clarification of information. By leveraging different communication channels based on learners' preferences, MAS ensures timely and accessible feedback delivery. Educational institutions should consider implementing MAS to optimize feedback processes, promote effective communication, and support individualized learning experiences in distance education environments.

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