Paper

How to Model an Engaging Online Quiz? The Emotion Modeling Approach

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Abstract—The article focuses on software technology used to provide a more engaging and exciting learning environment for students by introducing a variety of quizzes. Presently, quiz development can range from simple multiple-choice questions, true or false, drag-and-drop, dropdown menu selections, to 3D interactive techniques. This study introduces a systematic way of creating an engaging application using emotion modeling. Emotion models are being introduced in order to collect and model the systems' meaningful emotional needs. According to the findings, agent-oriented modeling is capable of modeling the emotional requirements of a system and of transforming these into a specific solution enabling to rapidly prototype an engaging system. A quantitative study has been performed on the novel approach to determine the feasibility of the proposed methodology in terms of analyzing, designing, and developing engaging applications.

Keywords—emotion modeling, agent-oriented modeling, learning technology.

1. Introduction

Learning methods such as online quizzes and massive open online courses (MOOCs) are being introduced to create a more engaging learning environments relied upon in teaching students [1]. Engagement a core principle of motivating learners, as it allows them to select a suitable topic [2], [3]. Without engagement, it will be difficult to absorb knowledge and complete courses relying on MOOCs or other similar applications [4]. The primary domains of learner engagement are cognitive, behavioral, and emotional [5]. Seeking additional information concerning the materials, preparing for completing quizzes, and a desire to learn are all indicators of cognitive engagement [6].

The level of contribution demonstrated by students performing classroom activities is referred to as behavioral engagement [5]. Emotional engagement refers to the students' emotional connections with institutions, teachers, peers, and MOOC material [7]. Positive and negative feelings are included in the emotional component.

To date, quizzes have evolved from simple multiple-choice questions [8], true or false, drag-and-drop [9], dropdown menu selections [9], to 3D interactive techniques [10]. Although lots of online quizzes have been introduced back in the days, those of the text-based or multimedia variety failed to engage the students.

How to develop an engaging online quiz? A technique for eliciting user emotional goals has yet to be found [11]. This may be due to the fact that emotion is a subjective and complex notion. Despite of that, in order for the application to be successful, the software developer must address the emotional needs of the users. Emotion modeling is necessary to capture what the users desire to feel, to ensure that all user concerns are addressed, to discover new requirements, to improve the system, and to reduce application failure and rejection rates [11], [12]. As a result, the suggested research was driven by a desire to incorporate emotion thinking into all phases of the development process, in order to reduce the complexity of designing an emotion-oriented application. Emotional modeling was chosen over other methodologies because it is utilized to address gaps in the original unified modeling language (UML), by extending agent-oriented modeling (AOM). The reason for this is that conventional software development approaches were primarily concerned with functional requirements in order to demonstrate system behavior. Unlike UML, which is excellent for modeling functional requirements, UML is incapable of dealing with the human factor.

AOM is an agent-oriented methodology that employs the concept of an agent at all stages of its execution via modeling steps [13]. In AOM, the interaction diagram depicts the interactions of agents (human or artificial) with the system [12]. AOM is useful for modeling a socio-technical system. AOM has been used in the Mauritius smart parking system [14], project-based ICT4D Education in the Field [15], and Digital Media Design [16].

This paper presents preliminary results of modeling an engaging online quiz through the agent-oriented approach. A systematic approach is introduced to create an engaging application through emotion modeling. A quantitative analysis of the novel approach is conducted to understand the feasibility of the proposed methodology. From the findings, AOM is able to model a non-functional requirement of a system and to transform it into a concrete model for rapid prototyping of an engaging system.

2. Emotion Modeling

Student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that learners show while learning [17]. Engagement is defined as "energy in action" and symbolizes the connection between a person and the specific activity [18]. In addition, engagement can be defined as the user's focus on the application [19]. There are four aspects that need to be taken into consideration in terms of maintaining the users' involvement in online courses. These include skills engagement (keeping up with readings), emotional engagement (making the course fascinating), interaction engagement (having fun while participating in small group discussions), and performance engagement (performing well during tests, receiving a decent grade) [20].

The learning engagement has the potential to increase the performance of a user completing an online course [21], [22]. For example, when a person receives feedback from their tutor on their work, it helps them improve their learning process [22]. Meanwhile, when guided by the instructor, students may develop cognitive abilities and enhance their understanding of the topic. As a result, such an approach improves the student's achievement [22]. In addition, engagement can help address the problem of user isolation and dropout in online learning. Learner engagement has been bolstered through discussion and interaction with peers and the instructor. Sharing an idea encourages students to remain involved and to enjoy their learning experience [23].

A comparison of the findings and functionalities of the proposed system reveals similarities with those found in the existing literature [11], [12], [24]–[26]. These similarities include taking into account emotion models which are introduced in order to capture and represent the systems' meaningful emotional demands. Those emotion models are the qualities of individuals that are tied to the roles and to the system as such [12]. Furthermore, emotional goals should be given the same weight as functional and quality goals [11]. In addition, an emotional goal derived based on the emotion model is associated with its functional counterpart and is expressed as the third goal, after functional and qualitative goals.

Recent studies fail to fully cover the process of including emotional goals in the software development cycle. In the context of software engineering, emotional goals are usually regarded as non-functional requirements.

There are two kinds of emotional goals. Positive emotions that the user wishes to feel while interacting with the application are classified as emotional goals [12]. Positive emotions include the feelings of joy, trust, interest, curiosity, calm, and surprise. Emotion goals are linked to a goal model representing how the functional goal could deliver what the user needs. An emotional threat refers to negative feelings that represent emotions the user does not desire or that must be avoided in the application [12], i.e. boredom, grief, distraction, fear, rage, and frustration.

In a case study involving an emergency alarm system for orderly persons [12], the emotional goal has been used. Such a system is developed to keep elderly people safe at home while they live alone. They may experience emergency situations that require the assistance of emergency services [11]. Thanks to such a system, an elderly person can raise an alarm. If the older person requires assistance, the service provider will contact them. Meanwhile, the persons rely on a well-being check to show that they are doing fine, by pressing a button on a regular basis. This, however, fails to address the emotional needs of consumers. As a result, their independence is threatened. They feel less independent, because they assume the emergency alarm system would stigmatize them as incapable of taking care of themselves. Furthermore, users lack control over the emergency system because they must hit the well-being button within a specific time frame. If they fail to press the button, the service provider will contact them with a reminder message. Consequently, people feel burdened because they must check-in on a daily basis.

Emotion modeling is used in smart homes, but according to studies, this technology is focused on the system's functionality rather than the on the user's feelings and emotions [25].

Personal and context-specific emotions have been added to the emotional goal [26]. A personal emotion is defined as an emotion that a person wants to feel regardless of whether the system is well designed or not. The context-specific emotional goal is defined as emotions that a person feels or desires to feel about the system. A process model is used for emotion-led requirement modeling. A process model is introduced to help with emotion modeling in AOM.

The process model begins with determining the activities that need to be completed. Following that, an activity that will be investigated is chosen. The next step is to collect information on the activity. Such data may be obtained through a combination of interviews, observations, technology probes, surveys, brainstorming sessions, domain research, and user feedback. Once data is collected, the fourth step is to extract roles and primary emotional goals. Next, key functional goals, i.e. quality, and context-specific emotional goals are extracted. In parallel, the modeler defines the motivational scenarios and the role models that have not yet been identified together with the personal emotional goals.

3. An Agent Oriented Approach

AOM modeling takes place at three distinct layers: motivation layer, system design layer, as well as platform specific design and implementation layer. The motivation layer is on the top and was used to discuss the issue and try to understand what people wanted. This involves the use of an emotion model, a goal model, determination of the role and organization, identification of a domain model, and the Tropos goal model [13].

The system design layer is located in the middle of the system. It shows how the system is designed. The motivation

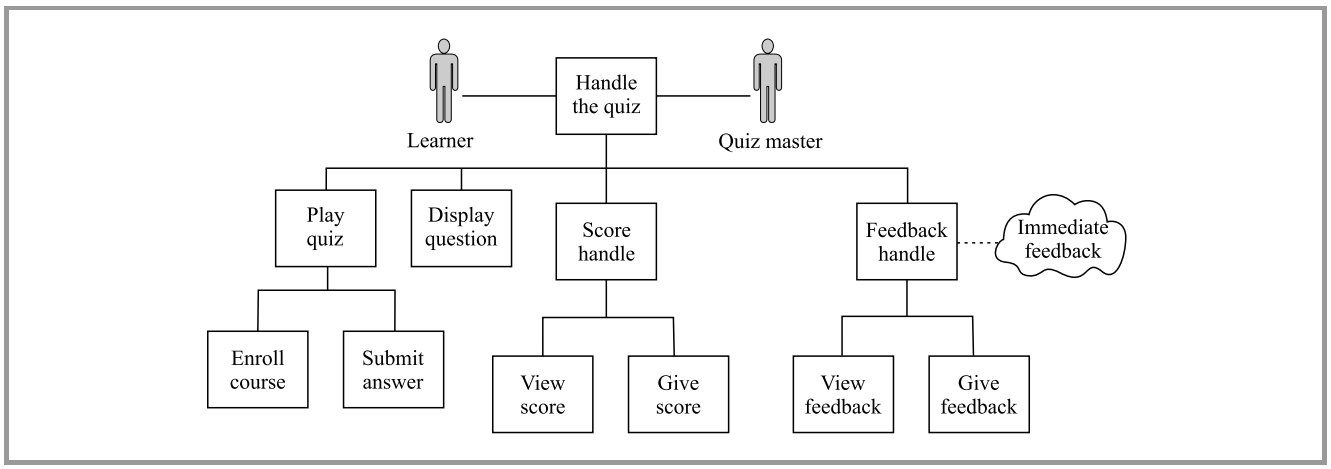

Fig. 1. Example of an overall goal model of the QuizMASter application.

layer is transformed into system design layer models. It introduces interaction, scenarios, and behavior models to illustrate the system's design.

The system's lower-level component has the form of the platform-specific design and implementation layer. It expresses how the system deploys the design models conceptually in order to construct a valuable solution by utilizing a programming platform, technology, and architecture.

3.1. Model Goal, Decide Roles and Organization

In this study, an online quiz called QuizMASter is designed. It is an educational game-based learning system that is integrated with an intelligent software agent to provide the learner with suitable feedback [10].

The entire goal model of the QuizMASter is depicted in Fig. 1. It illustrates the goals (functional, quality, and emotional) and the corresponding roles [25]. A goal model is a model that specifies which components of a problem the roles are capable of solving in a hierarchical manner.

It is made up of several components, including functional quality and emotional goals, as well as roles. All of them are organized and structured by the goal model [12] being the primary tool for discussing the issue with all stakeholders [12]. They assist in getting an overview of the overall system but do not provide a sufficient amount of development-related details.

Furthermore, the goal model enables the stakeholders to understand the problem, purpose, and requirements of the system at an early stage. It also uses a simple notation to improve understanding and communication between the development team and non-technical personnel [12].

The main goal of QuizMASter is to "handle the quiz". Several system purposes have been translated into functional goals in order to achieve the main functional aim (sub-goals), i.e. play quiz, display question, score handle, and feedback. The learner is responsible for achieving the play quiz's functional goal and then enrolling in the course and submitting the answer.

The quiz master is responsible of accomplishing the display question's functional goal. After the learner enrolls in the course, the quiz master will display the question. The score handle is made up of the view score and give score sub-goals. The learner is responsible for achieving view score. This includes the sub-goals of high score and low score. The learner will see the top score if he or she submits the correct answer. If the learner provides a wrong answer, they will see the low score.

Feedback handles are made up of two sub-goals: view feedback and give feedback. The learner is responsible of achieving view feedback. If the student provides the correct answer, the positive feedback will be displayed and negative feedback will be shown in response to a bad answer. The feedback handle functional goal is linked to the "immediate feedback" quality goal [9].

3.2. Emotion Modeling Through Extended Goal Model

The emotional model has two elements: emotional goal and emotional threat, as seen in Fig. 2.

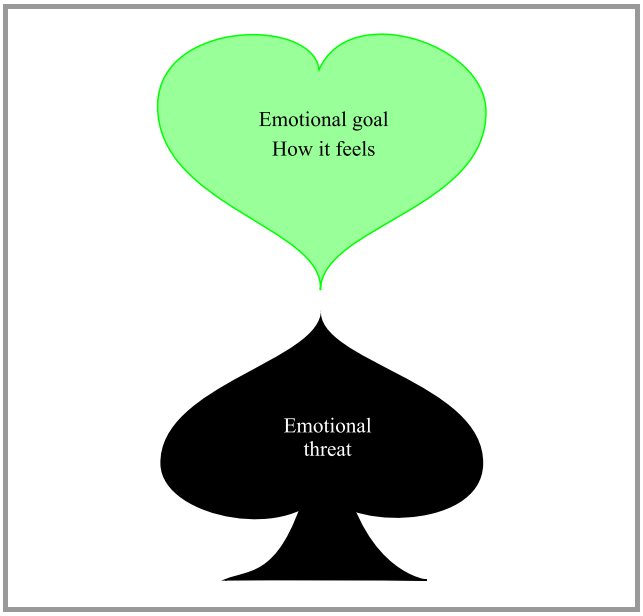

Fig. 2. Notation for emotional goals and threats.

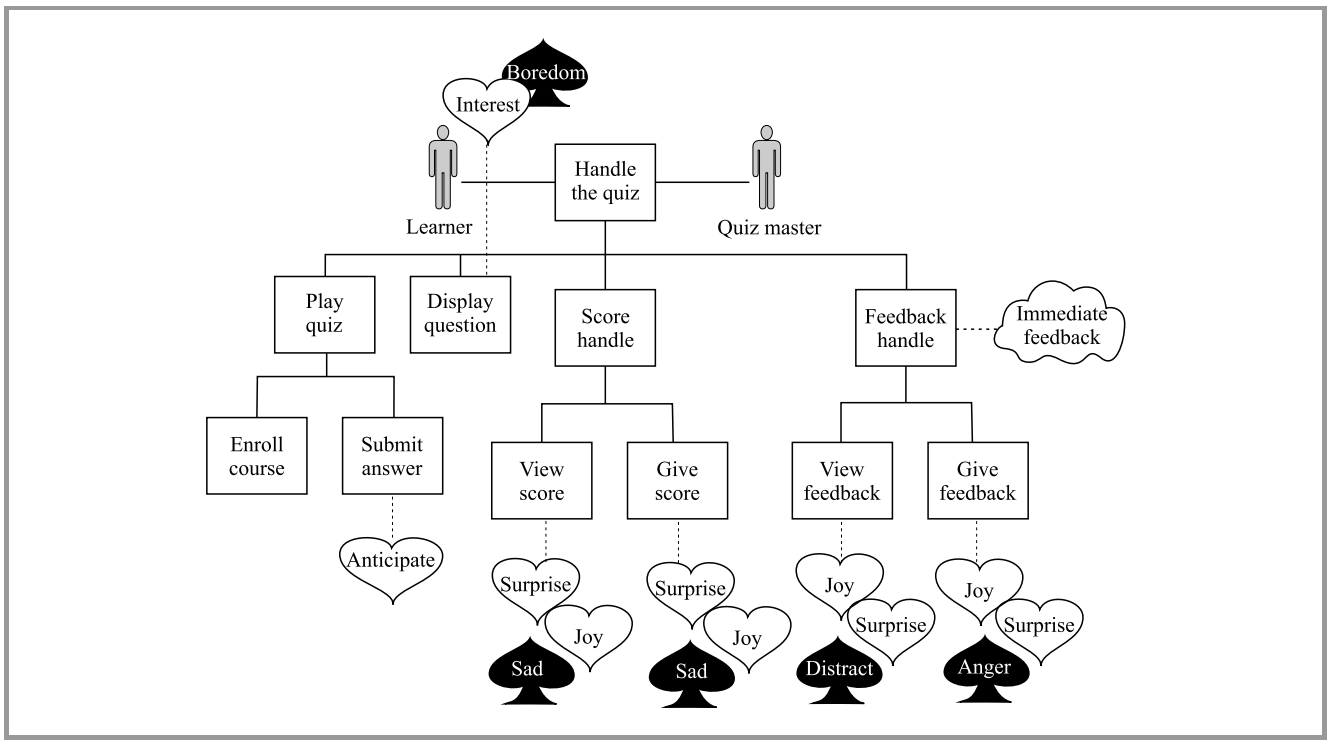

Fig. 3. Example of emotion-oriented goal model for QuizMaster application.

The emotional goal is a non-functional aim that captures, supports or improves the emotional need, or a goal describing what the user desires to feel and how people feel about a specific software application. The emotional goal does represent a positive emotion (heart shape) in order to capture or support the user's good feeling.

The emotional threat is a negative emotion (spades) capturing what the user does not desire or what needs to be avoided. All negative emotions should be addressed to ensure all user concerns are taken into consideration. By including the negative emotion in the model, the developer can maintain the traceability of negative emotions throughout the model. Emotional goals help remind the developer of the need to prioritize requirements by counteracting or eliminating negative emotions. However, it is up to the stakeholders to decide whether a given emotion is mapped as positive or negative.

Figure 3 shows an example of an emotion-oriented goal model for QuizMaster. The feeling is based on responses obtained during the requirement study. The learner wishes to feel anticipation when submitting an answer. They enjoy imagining and planning what is going to happen once they submit their answer. The quiz master wishes to capture the learner's interest while displaying the question and the answer affects the score and result in feedback. When displaying questions, boredom is regarded as a bad emotion that the quiz master does not want to experience, particularly while displaying the question [27]. Following the learner's response to the question, the quiz master will assign a score and provide feedback. If the learner provides the correct answer, they wish to experience joy during the process.

If the student provides a wrong answer, the learner only wants to be surprised by the low score and negative feedback. The student does not want to be sad when viewing a low score or distracted and then unable to realize their mistake. The quiz master, on the other hand, wants to be surprised when giving a low score and does not want to be angry while providing negative comments.

3.3. Define Emotion Dependency Analysis Through Tropos Model

From the emotion-oriented goal model shown in Fig. 3, we can develop the Tropos goal model to define how the interaction of a given role can influence the feeling of another individual role. A dependency may be described as a situation in which one actor (the depender) depends on another actor (the dependee) for gaining some dependum [13].
In general, the depender would be able to achieve a goal by depending on the dependee for the dependum. If the dependee fails to deliver the dependum, the depender would be unable to achieve its goals on its own, or would not be able to do that easily. Since emotion is an interactive mechanism, a model is needed capable of modeling the interaction between the emotion's elements. The main actors are the learner and the quiz master.
The quiz master is relying on the learner to display the question. When displaying the question, the quiz master wants the learner to be interested, and not bored. The quiz master is counting on the learner to provide an answer. When submitting the answer, the learner wishes to feel a sense of anticipation. The learner relies on the quiz master to provide the score. When the learner views a high score, he wants to feel joy. In case of a low score,

he wants to feel surprised and do not want to feel surprised, but not sad. The quiz master wants to feel joy when the learner receives a high score. The quiz master wants to feel surprised when the learner receives a low score. The quiz master does not want to feel sad when giving a low score to the learner.

3.4. Define the Emotion Handling Strategy Through Extended Goal Model and Domain Models

Once the emotion linked with goal achievement has been identified, we can continue to identify the strategy for dealing with the emotion as well as the knowledge entities that will be influenced by the emotion. This is accomplished using the goal and the domain models. Figures 4 and 5 show examples of an emotion-oriented goal model for the expression of joy and a domain model to be applied by the quiz master. Joy is expressed through the use of a simple and natural method of notation. The quiz master aims to demonstrate joy by smiling, giving the student a thumbs up, playing a clap sound, complimenting the learner, displaying motivational images, a bright color background, and unlocking a new level.

Though several approaches have been developed to measure and detect emotions, our research focuses on how to model emotion-oriented applications. Emotions are subjective and complex, hence there is no guarantee that users will feel happy using the software. However, it all depends on how the learner perceives the application [11].

A domain model consists of domain entities and their relationships. It represents the knowledge that the program is expected to handle. An object type can be used to represent such entities. In a system, a domain entity is a modular unit of knowledge. These include the environments, services, and types of resources produced and stored by roles and role connections. Domain entities in our model correspond to the course, question, answer, score/answer, and feedback. We will transform the goal model and the domain model into the design phase.

This includes modeling the emotion component using a scenario model, an interaction model, and a behavior model.

3.5. Designing Emotion-Oriented Application Through Scenario, Interaction and Behavior Model

Once the approach for dealing with emotion and knowledge entities has been determined, we may proceed to designing an emotion-oriented application using scenario, knowledge, interaction, and behavior models. A scenario model consists of collective activities that must achieve functional goals. The activities are based on the functionalities described in the motivation layer. It provides functionality-related information by specifying the number, aim, initiator, trigger, failure, condition, constituent stages, set of activi-

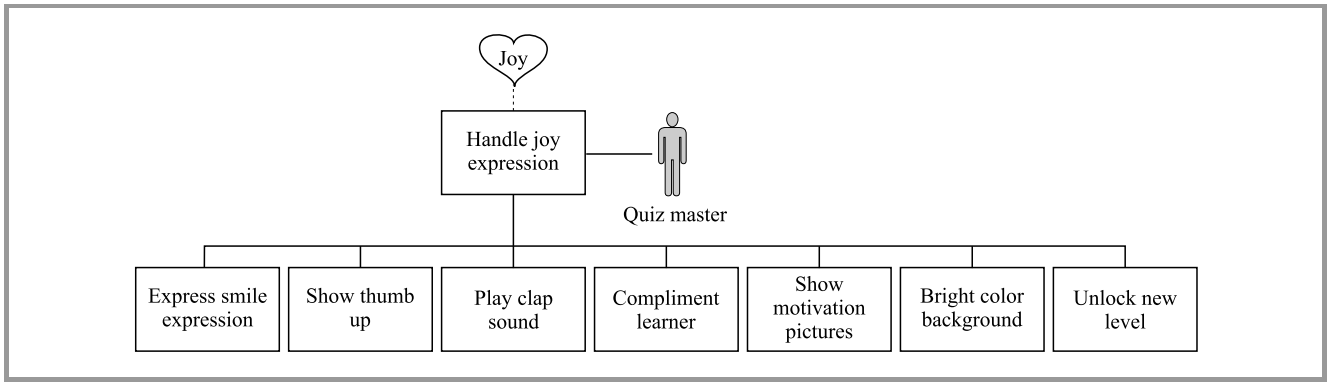

Fig. 4. Example of an emotion-oriented goal model to handle the expression of joy.

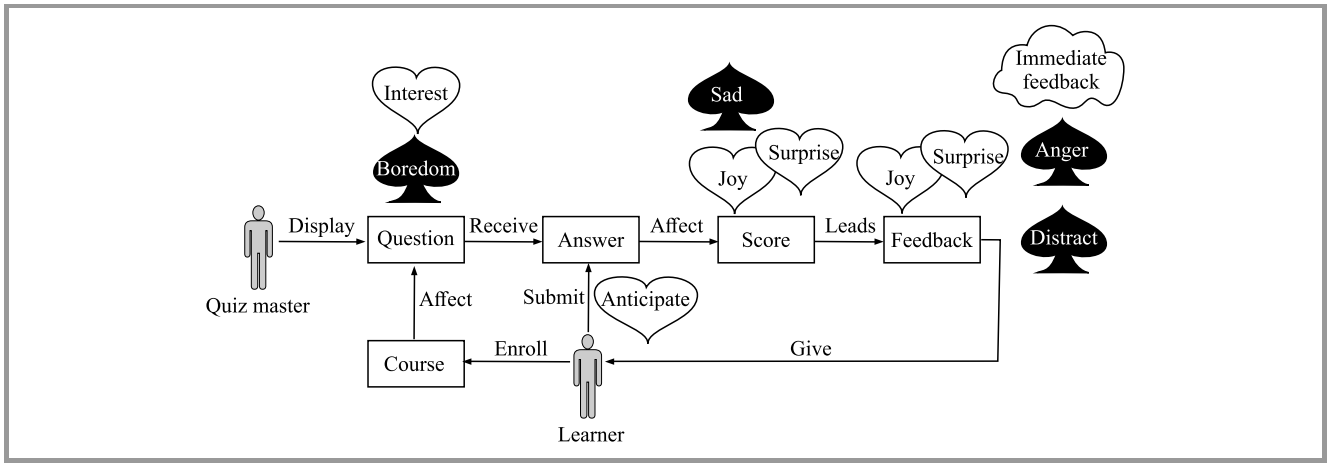

Fig. 5. Example of an emotion-oriented interaction model applied by the quiz master.

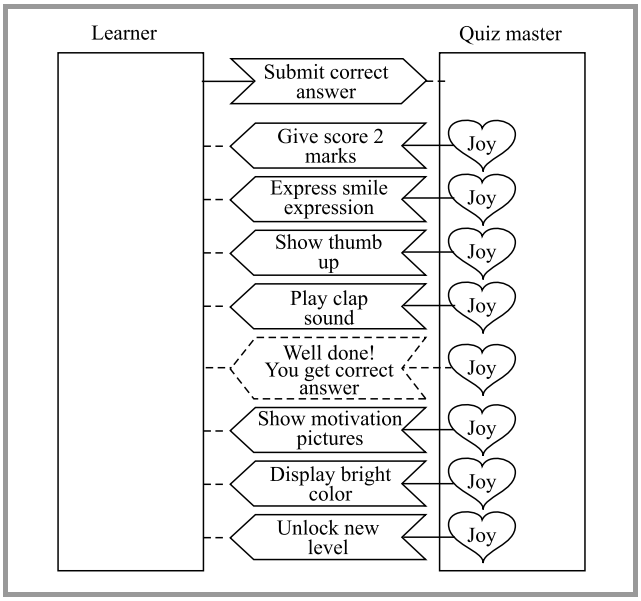

Fig. 6. Example of emotion-oriented interaction model for quiz master.

ties, agent types/roles, as well as quality [13] and emotional goals [26].

An interaction model can be designed from the scenario model. An example thereof is shown in Fig. 6.

An interaction model represents a set of interactions between the application agents. Interaction is defined as actions in which people exchange information through communication or physical action. The interaction model notation has been expanded by incorporating the applicable emotional threat in each emotional goal for the specific activities, triggers, and situations. The quiz master is the perceiving agent and the learner is the acting agent. This is due to the fact that the student starts the exercise by virtually submitting the correct response. When the student provides the correct answer, the quiz master awards two points to the student.

In the meantime, the quiz master wants to be happy when the student gets the right answer. As a result, the quiz master expresses joy by smiling, showing a thumbs up, and playing a clap sound.

After that, a new level will be unlocked. Furthermore, the quiz master wishes to share their satisfaction by displaying motivational images, such as graduation pictures, study groups at the library, or employment-related achievements.

The final step in the process of designing an emotion-oriented application is to model the behavior model. It describes the internal behavior of a specific individual agent within the system by triggering rules and messages in this final step of designing an emotion-oriented application.

3.6. Build Emotion-oriented Quiz MASter Application

Once the modeling is finalized, we will proceed to implementing the QuizMASter. Figure 7 depicts the evolution of the application. A 3D character is created to serve as the game host. Thanks to this feature, the learner will be greeted at the start of the quiz session, so that they feel motivated and not bored.

4. Evaluating Emotion Modeling

4.1. Evaluation Through an AOM Survey

A survey of 30 students at FCSIT, Unimas was performed. 28 respondents were studying software engineering, one computer science, and one network computing. 28 students with no prior knowledge of or experience with AOM participated in the session.

All participants are familiar with programming concepts, the software development cycle, and UML. The survey's goal is to better understand the learner's function in respect to each of the AOM model types and to learn how novices may understand the feasibility of the emotion modeling ap-

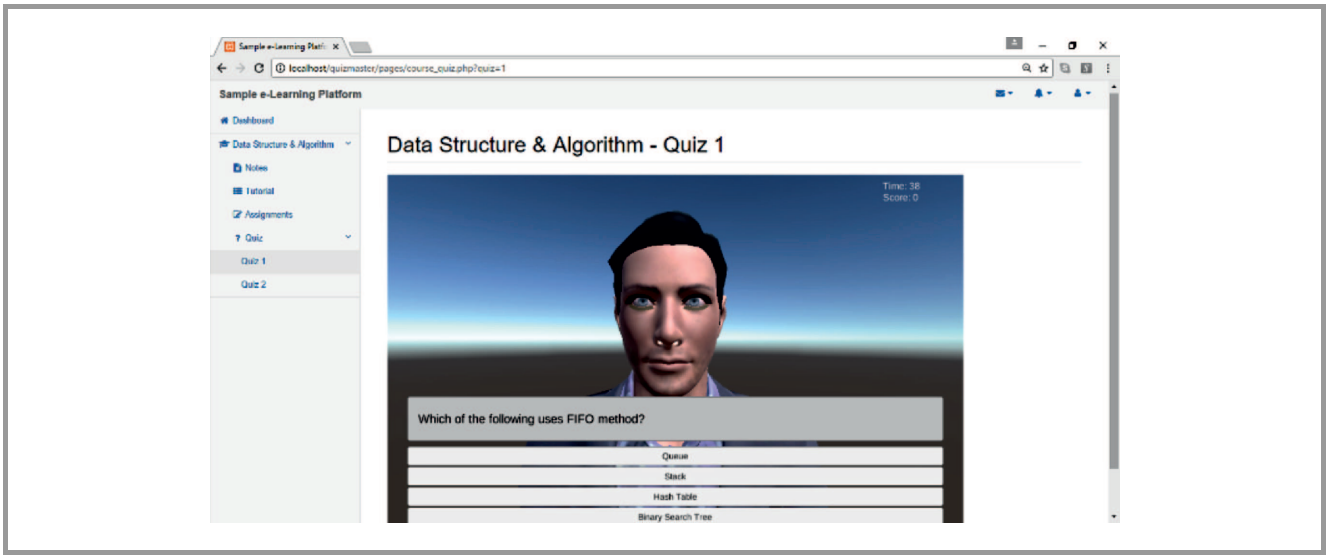

Fig. 7. Exported objects: base, happy, worried, and mouth opened.

proach being analyzed and how to develop an engaging application. The survey participants used three dimensions of the AOM model. The first question involves understanding the role of agent models in emotion-oriented applications. These include client validation, implementation, documentation, and clarification [28].

In other words, the questions verify whether AOM is capable of managing specific modeling requirements in collaboration with the client's representatives being on the project team, to specify the system's implementation-related needs. We asked if AOM may be used as a potential communication tool or an understandable artifact among programmers.

The second set of questions examines the user's functionalities in connection with each of the agent models in an emotion-oriented application. These involve creation, evaluation, and approval.

The final set of questions explores the rationale behind not employing any or all agent models in the emotion-oriented application.

4.2. Evaluation of AOM Survey Data

Figure 8 depicts the findings of a survey concerned with agent models in emotion-oriented modeling. Clearly, the majority of students (22 and 21, respectively) believe that the goal model may be employed for client validation and clarification. Meanwhile, implementation has been selected by 19 people asked. Only 16 students believe the goal model can be utilized for documentation. The domain model can be used for clarification and client validation, according to 19 and 18 students, respectively. Only 16 students agreed that the domain model could be utilized for documentation. According to the findings, 17 students agreed that the objective of the Tropos model is clarification.

This is followed by client validation, which is agreed upon by 14 persons.

Only 12 of the surveyed believe the Tropos model can be used for implementation and documentation. It is clear that clarification was the primary goal of employing the interaction model. This answer was chosen by 22 pupils.

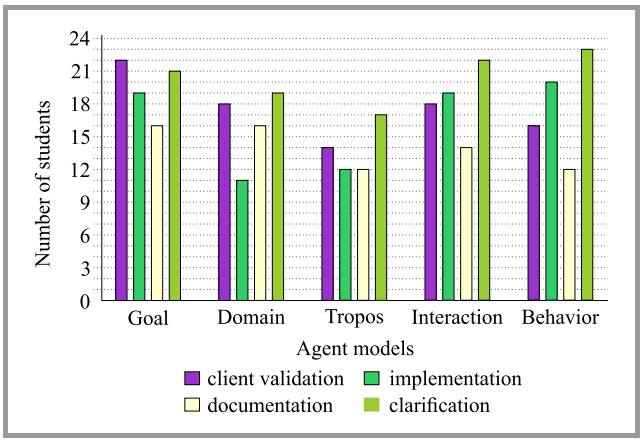

Fig. 8. Survey results in regards to the purpose of agent models.

This is followed by implementation, on which 19 participants agreed. The interaction model can be used for client validation, according to 18 votes. Only 14 students believe the interaction model can be applied for the purpose of documentation. According to the chart, clarification is the ultimate goal of the behavior model. Client validation and clarification received a relatively low number of votes (16 and 12, respectively).

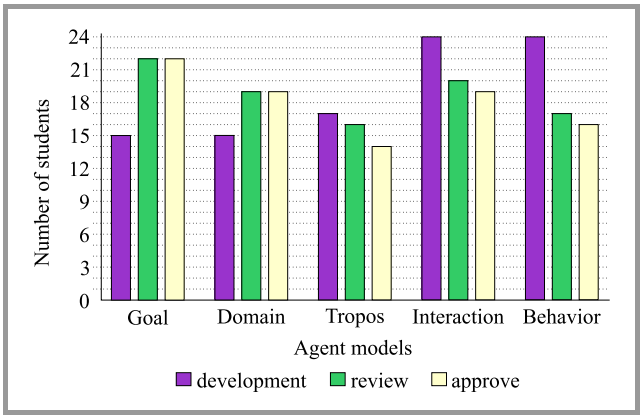

Fig. 9. Survey results regarding the user's role in relation to each of the agent models.

Figure 9 shows the findings regarding the user's involvement in respect to each of the agent models in emotion-oriented modeling.

It can be concluded that 22 students agreed the user was most likely to be involved in reviewing and approving the goal model.

While users were less likely to assist in the development of the goal model, only 15 students agreed with such a choice. The same is true for the domain model. The user, according to 19 students, is most likely to be active in reviewing and approving the domain model.

This is followed by the development option which was selected by 15 pupils only. According to the findings, the majority of participants (17 and 16, respectively) agreed that users were most likely to be involved in the development and review of the Tropos model. Approval was a relatively minor reason, with only 14 persons agreeing thereon. The user was most likely to be involved in the development of the interaction model, according to 24 of the surveyed. Review and approval were very minor reasons, with 20 and 19 students selecting them, respectively. According to the graph, it was development that was the most popular user role. This was followed by review and approval as the user's role, selected by 17 and 16 participants, respectively.

Figure 10 shows the survey responses in relation to the various reasons for not employing agent models in emotion-based modeling. Among other things, the most plausible reasons include the fact that analysis is not well understood, that there is insufficient value to justify the cost, and that it is not useful for most projects.

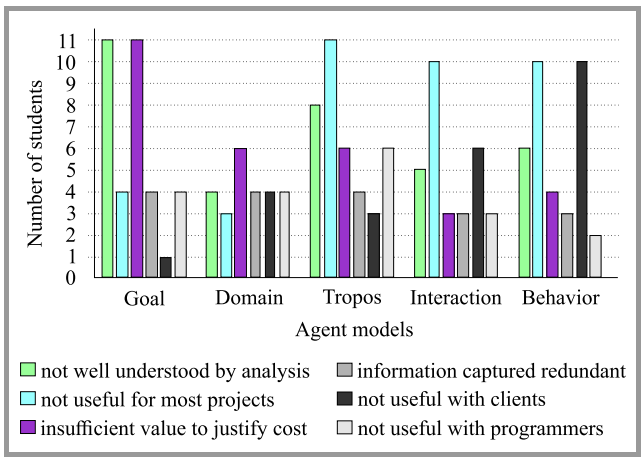

Fig. 10. Number of students selecting the reasons for not using some or all of the agent models.

It is reasonable to conclude that improper understanding based on an analysis, and inadequate value to justify the expense were both equally valid arguments for not implementing the goal model. These options were selected by 11 survey participants. The score is seven times greater than the one for the following options: not useful for most projects, information captured is redundant, and not beneficial for programmers. Not useful for clients was a reason that was selected relatively seldom, with only one person asked agreeing with it. Six persons agreed that the most important reason for not using the domain model is the lack of value justifying the expenditure borne. Analysis not well understood, information captured redundant, and not useful for clients and programmers were all equally popular as reasons for not adopting the domain model (selected by 4 respondents). Not useful for most projects, meanwhile, was a relatively unpopular reason, with only three students choosing this option.

According to the findings, 11 students agreed that being not useful for the majority of projects is the most important reason for not using the Tropos model. This choice was followed by a poorly understood analysis, on which just 8 peoples agreed. Inadequate value to justify expense and redundant nature of the information acquired were both plausible reasons for not implementing the Tropos paradigm. Redundant nature of the information obtained and lack of usefulness for customers were modest contributors, as these answers were selected by 4 and 3 users, respectively.

One may notice that the most obvious cause for not using the interaction model was that it was not useful for most projects. This reason was selected by 10 of the surveyed. This score is four times greater than that related to the model not being useful for clients. Only 5 students agreed that one of the possible reasons for not employing the interaction model was that it was not well understood based on the analysis conducted. Inadequate value to justify the expense, information acquired being redundant and unusable with programmers were all equally minor reasons for not implementing the interaction model and were ranked third.

According to Fig. 10, the most common reasons for not adopting the behavior model included statements that it was not beneficial for most projects and that the information obtained was redundant. This was followed by insufficient value to justify expense, information acquired being redundant and useless for programmers, which were all relatively minor contributors. A usability test, on the other hand, was conducted among 13 students enrolled in the ”data structure and algorithm” course. They were instructed to experiment with the quiz application and answer a few questions using the provided questionnaire, with an emphasis on rating the amount of usage challenges, understanding the questions after taking part in the quiz, interactivity, assessing its interactivity, engagement, and usefulness. The rating scale varied from 1 to 5, with 1 being the lowest and 5 being the highest score. The students were asked to rate these elements for text-based quizzes, which are currently employed in FC-SIT, as well as for the emotion-oriented QuizMASter application that was developed as part of this research.

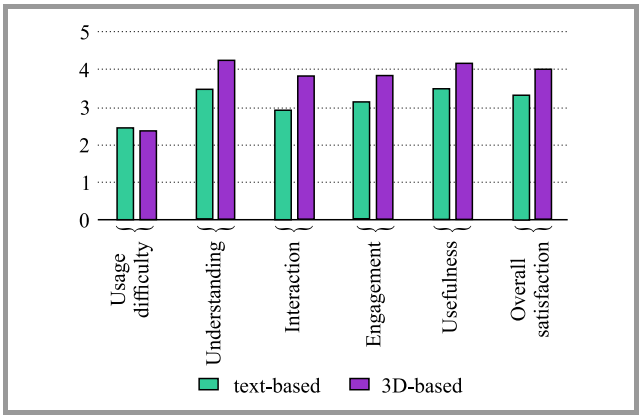

Fig. 11. Average rating of text-based and emotion-oriented quiz.

Figure 11 shows the average rating of a text-based quiz and of the emotion-oriented QuizMASter. The rating for the emotion-oriented QuizMASter is superior to that of the text-based quiz, in every way. Difficulties related to using the emotion-oriented QuizMASter are slightly less prominent that in the case of the text-based quiz, with the score equaling 2.38 for the emotion-oriented variety and 2.46 for the text-based quiz. Students believed that after taking the quiz, they had a better understanding of the questions in the emotion-oriented (4.23) than in the text-based (3.46) quiz. The amount of involvement for the emotion-oriented quiz is also greater than for text-based variety, with the score amounting to 3.85 and 2.92, respectively. While the level of engagement for the emotion-oriented quiz is evaluated at 3.85, it is greater than the level of engagement for the text-based quiz, with its score equaling 3.15. Additionally, usefulness of the emotion-oriented quiz is ranked higher than that of its text-based counterpart (with the scores amounting to 4.15 and 3.46, respectively). The overall level of satisfaction with the emotion-oriented quiz is rated at 4.00, while it equals 3.31 for the text-based quiz.

5. Conclusion

Creating an emotionally engaging learning application is not an easy task. The emotional anticipation of the user is a major predictor of the application's acceptance level. However, not much study has been conducted into incorporating user's emotional expectations into the software development cycle. We tried to help by suggesting a systematic strategy for creating an emotionally engaging application which would require more validation and verification in the course of future research.

Acknowledgements

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References

[1] S. Y. Wai, C. W. Shiang, S. F. Zulkifli, N. B. Jali, and M. A. Khairuddin, , "Requirement engineering meets emotion: A case study of Quiz MASter", *Int. J. of Adv. Sci. and Technol.*, vol. 28, no. 2, pp. 215–222, 2019.

[2] C. A. Courtad, "Making your classroom smart: Universal design for learning and technology", in *Smart Education and e-Learning 2019*, V. Uskov, R. Howlett, and L. Jain, Eds. *Smart Innovation, Systems and Technologies*, vol. 144, pp. 501–510. Springer, 2019 (DOI: 10.1007/978-981-13-8260-4_44).

[3] A. Khan, O. Egbue, B. Palkie, and J. Madden, "Active learning: Engaging students to maximize learning in an online course", *The Electron. J. of e-Learn.*, vol. 15, no. 2, pp. 107–115, 2017 [Online]. Available: https://files.eric.ed.gov/fulltext/EJ1141876.pdf

[4] R. Deng, P. Benckendorff, and D. Gannaway, "Learner engagement in MOOCs: Scale development and validation", *British J. of Educ. Technol.*, vol. 51, pp. 245–262, 2019 (DOI: 10.1111/bjet.12810).

[5] T. D. Nguyen, M. Cannata, and J. Miller, "Understanding student behavioral engagement: Importance of student interaction with peers and teachers", *J. of Educ. Res.*, vol. 111, no. 2, pp. 163–174, 2016 (DOI: 10.1080/00220671.2016.1220359).

[6] L. M. Daniels, C. Adams, and A. McCaffrey,, "Emotional and social engagement in a massive open online course: An examination of Dino 101", *Emotion, Technol. and Learn.*, in *Emotions, Technology, and Learning*, S. Tettegah and M. P. McCreery, Eds. Elsevier, 2016, pp. 25–41 (DOI:10.1016/B978-0-12-800649-8.00004-3).

[7] S. R. Jimerson, E. Campos, and J. L. Greif, "Toward an understanding of definitions and measures of school engagement and related terms", *The California School Psycholog.*, vol. 8, no. 1, pp. 7–27, 2003 (DOI:10.1007/BF03340893).

[8] F. Zhao, "Using quizizz to integrate fun multiplayer activity in the accounting classroom", *Int. J. of Higher Educ.*, vol. 8, no. 1, pp. 37–43, 2019 [Online]. Available: http://files.eric.ed.gov/fulltext/EJ1203198.pdf

[9] S. H. Gamage, J. R. Ayres, M. B. Behrend, and E. J. Smith, "Optimising moodle quizzes for online assessments", *Int. J. of STEM Educ.*, vol. 6, no. 1, 2019 (DOI:10.1186/s40594-019-0181-4).

[10] S. Leung, S. Virwaney, F. Lin, A. Armstrong, and A. Dubbelboer, "TSI-enhanced pedagogical agents to engage learners in virtual worlds", *Int. J. of Distance Educ. Technol.*, vol. 11, no. 1, pp. 1–13, 2013 (DOI: 10.4018/jdet.2013010101).

[11] M. Kissoon Curumsing, "Emotion-oriented requirements engineering", Ph.D. thesis, Swinburne University of Technology, Melbourne, Australia, 2017 [Online]. Available: https://nzjohng.github.io/publications/theses/anju2017.pdf

[12] A. A. Lopez-Lorca, T. Miller, S. Pedell, L. Sterling, and M. Kissoon Curumsing, "Modelling Emotional Requirements", 2014 [Online]. Available: https://people.eng.unimelb.edu.au/tmiller/pubs/modelling-emotional-requirements.pdf

[13] L. Sterling and K. Taveter, *The Art of Agent-Oriented Modeling.* London, England: The MIT Press, 2009 (ISBN: 9780262013116).

[14] H. Dargaye, B. Gobin-Rahimbux, and N. G. Sahib-Kaudeer, "Agent-based modeling for a smart parking system for Mauritius", in *Information Systems Design and Intelligent Applications. Proceedings of Fifth International Conference INDIA 2018, Volume 2*, S. C. Satapathy *et al*., Eds. *AISC*, vol. 863, pp. 367–377. Springer, 2019 (DOI: 10.1007/978-981-13-3338-5_34).

[15] A. Bon *et al*., "Community-centered, project-based ICT4D education in the field", in *Proc. of 15th Int. Conf. on Social Implic. of Comp. in Develop. Countr.*, Warsaw, Poland, 2019, pp. 386–397 (DOI: 10.1007/978-3-030-19115-3_32).

[16] J. Marshall, "Agent-based modeling of emotional goals in digital media design projects", in *Innovative Methods, User-Friendly Tools, Coding, and Design Approaches in People-Oriented Programming*, S. Goschnick, Ed. Publisher IGI Global, 2018, pp. 262–284 (ISBN: 9781522559696).

[17] "Student Engagement", The Glossary of Education Reform, 2016 [Online]. Available: https://www.edglossary.org/student-engagement/

[18] V. Sagayadevan and S. Jeyaraj, "The role of emotional engagement in lecturer-student interaction and the impact on academic outcomes of student achievement and learning", *J. of the Scholarship of Teach. and Learn.*, vol. 12, no. 3, pp. 1–30, 2012 [Online]. Available: https://files.eric.ed.gov/fulltext/EJ992115.pdf

[19] A. Dirin and T. H. Laine, "User experience in mobile augmented reality: Emotions, challenges, opportunities and best practices", *Computers*, vol. 7, no. 2, pp. 215–222, 2018 (DOI: 10.3390/computers7020033).

[20] M. D. Dixson, "Creating effective student engagement in online courses: What do students find engaging?", *J. of the Scholar. of Teach. and Learning*, vol. 10, no. 2, pp. 1–13, 2010 [Online]. Available: http://files.eric.ed.gov/fulltext/EJ890707.pdf

[21] C. Taylor *et al*., "Student engagement: A framework for on-demand performance assessment tasks", Stanford Center for Opportunity Policy in Education, 2016 [Online]. Available: https://edpolicy.stanford.edu/sites/default/files/publications/student-engagement-framework.pdf

[22] F. Martin and D. U. Bolliger, "Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment", *Online Learning J.*, vol. 22, no. 1, pp. 205–222, 2018 [Online]. Available: https://files.eric.ed.gov/fulltext/EJ1179659.pdf

[23] J. Banna, M. F. G. Lin, M. Stewart, and M. K. Fialkowski, "Interaction matters: Strategies to promote engaged learning in an online introductory nutrition course", *J. of Online Learn. and Teach.*, vol. 11, no. 2, pp. 249–261, 2015 [Online]. Available: https://pdfs.semanticscholar.org/65c7/0b42305630dc9da07d2cdd2d9b3939d6b971.pdf

[24] M. Sherkat, A. Mendoza, T. Miller, and R. Burrows, "Emotional Attachment Framework for People-Oriented Software", *Online Learn. J.*, vol. 22, no. 1, pp. 205–222, 2018 [Online]. Available: https://arxiv.org/pdf/1803.08171.pdf

[25] D. Curumsing, M. K. Fernando, M. Abdelrazek, R. Vasa, K. Mouzakis, and J. Grundy, "Emotion-oriented requirements engineering: A case study in developing a smart home system for the elderly", *J. of Syst. and Softw.*, vol. 147, pp. 215–229, 2019 (DOI: 10.1016/j.jss.2018.06.077).

[26] T. Miller *et al*., "Emotion-led modeling for people-oriented requirements engineering: The case study of emergency systems, *J. of Syst. and Softw.*, vol. 22, no. 1, 105, pp. 54–71, 2015 (DOI: 10.1016/j.jss.2015.03.044).

[27] R. S. J. D. Baker, S. K. D'Mello, M. M. T. Rodrigo, and A. C. Graesser, "Better to be frustrated than bored: The incidence, persistence, and impact of learners' cognitive-affective states during interactions with three different computer-based learning environments", Int. J. of Human-Comp. Stud., vol. 68, no. 4, pp. 223–241, 2010 (DOI: 10.1016/j.ijhcs.2009.12.003).

[28] B. Dobing and J. Parsons, "Dimensions of UML diagram use: A survey of practitioners", *J. of Database Manag.*, vol. 19, no. 1, pp. 1–18, 2008 (DOI: :10.4018/jdm.2008010101).

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